UOP RUSSELL, LLC
Tulsa, Oklahoma

JOB NO: J-447 DATE: 1/4/13
CLIENT: UOP Russell BY: DDO
SUBJECT: 60 MMscfd Cryo Plant

EXPANDER / COMPRESSOR

Tag. No.		EC-101	Design	EC-101	OD1
Service		Expander	Compressor	Expander	Compressor
Suction	(PSIA)	865	175	865	205
	(°F)	-28	73.5	0	73.5
Discharge	(PSIA)	190	229.1	220	273.7
	(°F)	-123.9	117.8	-87.8	118.7
Vol. Flow @ 14.7 & 60° F	(MMSCFD)	23.8	40.2	28.1	44.6
Mass Flow	(Lb/Hr)	49,313	74,211	61,306	88,763
Mol. Wt.		18.88	16.82	19.84	18.13
Wt.% Condensed	(%)	19.9	--	18.6	--
Efficiency	(%)	84.0	78.0	81.0	78.0
Power	(BHP)	682	642	795	757
Speed	(RPM)	40,000		39,000	
Req'd. Lube Oil	(GPM)				
Req'd. Supply	(PSI/°F)				
Req'd. Seal Gas	(SCFM)				
Req'd. Supply	(PSI/°F)				
Lube Oil Temp. Out	(°F)				
Inlet Connection Size	NPS (inch)	6" 600 lb ANSI RF Flg.	12" 300 lb ANSI RF Flg		
Outlet Connection Size	NPS (inch)	8" 600 lb ANSI RF Flg.	10" 300 lb ANSI RF Flg		
Gas Analysis	(Mol.Fract.)				
N_2		0.0281	0.0270	0.0242	0.0244
CO_2		0.0059	0.0057	0.0065	0.0077
C_1		0.8332	0.9465	0.7894	0.8576
C_2		0.1038	0.0205	0.1313	0.1079
C_3		0.0251	0.0003	0.0409	0.0023
iC_4		0.0012	0.0000	0.0022	0.0000
nC_4		0.0024	0.0000	0.0047	0.0000
iC_5		0.0002	0.0000	0.0004	0.0000
nC_5		0.0002	0.0000	0.0004	0.0000
C_6		0.0000	0.0000	0.0001	0.0000
C_7		0.0000	0.0000	0.0000	0.0000
Total	(Mols/Hr)	2,612.5	4,411.7	3,090.0	4,895.2
Model		LA Turbine L2000		Approx. Weight	

NOTES:

1) Items to be included with Expander/Compressor are: Fisher diaphragm actuator, automatic thrust equalizer, vibration pick-up assembly (pick-up probe, proximeter, pigtail, & holder), tachometer pick-up and temperature probes (Expander and Compressor) with explosion-proof holder with coax assembly, and lube oil skid.
See attached "Scope of Supply".

2) Unit must operate efficiently in all cases.
Cases: Design: Recov C1 GSP-1.hsc; OD1: Reject C1.hsc; OD2: Recov C2 GSP-1.hsc
OD3: SC6 120°F Recov-ref.hsc; OD4: SC6 120°F Rej Truckable.Rev1.hsc

REVISION	A	0		
ENGINEER/DATE	DDO 1/4/13	JRG 8/11/16		
ISSUED FOR	RFQ	Purchase		

UOP RUSSELL, LLC
Tulsa, Oklahoma

JOB NO:	J-447	DATE:	1/4/13
CLIENT:	UOP Russell	BY:	DDO
SUBJECT:	60 MMscfd Cryo Plant		

EXPANDER / COMPRESSOR

Tag. No.		EC-101	OD2	EC-101	OD3
Service		Expander	Compressor	Expander	Compressor
Suction	(PSIA)	1015	175	820	250
	(°F)	-28	79.5	-30	109.1
Discharge	(PSIA)	190	212.3	265	315.7
	(°F)	-132.7	112.1	-109.5	149.4
Vol. Flow @ 14.7 & 60° F	(MMSCFD)	18.4	40.1	37.1	50.8
Mass Flow	(Lb/Hr)	38,297	74,084	73,355	90,619
Mol. Wt.		18.97	16.81	18.01	16.24
Wt.% Condensed	(%)	24.8	--	13.7	--
Efficiency	(%)	80	76.0	80.0	78.0
Power	(BHP)	504	473	782	744
Speed	(RPM)	35,600		39,300	
Req'd. Lube Oil	(GPM)				
Req'd. Supply	(PSI/°F)				
Req'd. Seal Gas	(SCFM)				
Req'd. Supply	(PSI/°F)				
Lube Oil Temp. Out	(°F)				
Inlet Connection Size	NPS (inch)	6" 600 lb ANSI RF Flg.	12" 300 lb ANSI RF Flg		
Outlet Connection Size	NPS (inch)	8" 600 lb ANSI RF Flg.	10" 300 lb ANSI RF Flg		
Gas Analysis	(Mol.Fract.)				
N_2		0.0300	0.0270	0.0076	0.0080
CO_2		0.0057	0.0055	0.0003	0.0002
C_1		0.8305	0.9473	0.8928	0.9853
C_2		0.1013	0.0199	0.0712	0.0063
C_3		0.0273	0.0003	0.0230	0.0002
iC_4		0.0014	0.0000	0.0018	0.0000
nC_4		0.0031	0.0000	0.0026	0.0000
iC_5		0.0003	0.0000	0.0004	0.0000
nC_5		0.0003	0.0000	0.0002	0.0000
C_6		0.0000	0.0000	0.0001	0.0000
C_7		0.0000	0.0000	0.0000	0.0000
Total	(Mols/Hr)	2,018.1	4,407.7	4,072.0	5,580.0
Model		LA Turbine L2000		Approx. Weight	

NOTES:

1) Items to be included with Expander/Compressor are: Fisher diaphragm actuator, automatic thrust equalizer, vibration pick-up assembly (pick-up probe, proximeter, pigtail, & holder), tachometer pick-up and temperature probes (Expander and Compressor) with explosion-proof holder with coax assembly, and lube oil skid.
See attached "Scope of Supply".

2) Unit must operate efficiently in all cases.
Cases: Design: Recov C1 GSP-1.hsc; OD1: Reject C1.hsc; OD2: Recov C2 GSP-1.hsc
OD3: SC6 120°F Recov-ref.hsc; OD4: SC6 120°F Rej Truckable.Rev1.hsc

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ENGINEER/DATE	DDO 1/4/13	JRG 8/11/16		
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UOP RUSSELL, LLC
Tulsa, Oklahoma

JOB NO:	J-447	DATE:	1/4/13
CLIENT:	UOP Russell	BY:	DDO
SUBJECT:	60 MMscfd Cryo Plant		

EXPANDER / COMPRESSOR

Tag. No.		EC-101	OD4		
Service		Expander	Compressor		
Suction	(PSIA)	820	260		
	(°F)	-8	90		
Discharge	(PSIA)	275	327.7		
	(°F)	-85.9	127.5		
Vol. Flow @ 14.7 & 60° F	(MMSCFD)	35.4	54.7		
Mass Flow	(Lb/Hr)	71,906	103,509		
Mol. Wt.		18.50	17.24		
Wt.% Condensed	(%)	12.7	---		
Efficiency	(%)	79.0	78.0		
Power	(BHP)	791	758		
Speed	(RPM)	36,800			
Req'd. Lube Oil	(GPM)				
Req'd. Supply	(PSI/°F)				
Req'd. Seal Gas	(SCFM)				
Req'd. Supply	(PSI/°F)				
Lube Oil Temp. Out	(°F)				
Inlet Connection Size	NPS (inch)	6" 600 lb ANSI RF Flg.	12" 300 lb ANSI RF Flg		
Outlet Connection Size	NPS (inch)	8" 600 lb ANSI RF Flg.	10" 300 lb ANSI RF Flg		
Gas Analysis	(Mol.Fract.)				
N_2		0.0073	0.0075		
CO_2		0.0003	0.0003		
C_1		0.8741	0.9165		
C_2		0.0786	0.0736		
C_3		0.0310	0.0021		
iC_4		0.0029	0.0000		
nC_4		0.0045	0.0000		
iC_5		0.0007	0.0000		
nC_5		0.0005	0.0000		
C_6		0.0002	0.0000		
C_7		0.0000	0.0000		
Total	(Mols/Hr)	3,886.0	6,006.0		
Model		LA Turbine L2000		Approx. Weight	

NOTES:

1) Items to be included with Expander/Compressor are: Fisher diaphragm actuator, automatic thrust equalizer, vibration pick-up assembly (pick-up probe, proximeter, pigtail, & holder), tachometer pick-up and temperature probes (Expander and Compressor) with explosion-proof holder with coax assembly, and lube oil skid.
See attached "Scope of Supply".

2) Unit must operate efficiently in both cases.
Cases: Design: Recov C1 GSP-1.hsc; OD1: Reject C1.hsc; OD2: Recov C2 GSP-1.hsc
OD3: SC6 120°F Recov-ref.hsc; OD4: SC6 120°F Rej Truckable.Rev1.hsc

REVISION	A	0		
ENGINEER/DATE	DDO 1/4/13	JRG 8/11/16		
ISSUED FOR	RFQ	Purchase		

L.A. Turbine™

Rethinking Turboexpanders

INSTRUCTION MANUAL

TURBOEXPANDER WITH COMPRESSOR LOAD

DESIGNED AND MANUFACTURED FOR:

UOP RUSSELL, LLC

PROJECT NAME:

60 MMscfd Cryo Plant JOB#: J447XX

CUSTOMER P.O. NO.: 4500743460

LAT PROJECT: LAT574EC

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SECTION ONE

DESCRIPTION AND TECHNICAL DATA

1.1 INTRODUCTION

The system described in this instruction manual is designed for the expansion and compression of hydrocarbon gas streams and consists of one frame size L2000 Turboexpander-Compressor unit. The unit is single-stage Turboexpander loaded by an integral, single-stage centrifugal compressor.

The Turboexpander-Compressor unit is mounted on a structural steel baseplate and is supported by commonly mounted auxiliary lube oil and seal gas systems. The package includes the complete control system, instrumentation, valves, cables, junction boxes, etc., which are all fully connected within the skid. A Local Control Panel is also mounted on the skid for the control and shut down of the Turboexpander-compressor.

The unit has been designed for UOP Russell LLC.

UNIT IDENTIFICATION	Model No.	Serial No.
Main Unit:	2000-6E6C	1203
Spare MCS:	2000-6E6C	1204

1.2 DESIGN SPECIFICATIONS

See “Mechanical Datasheet” drawing (LAT574EC-20-A83) for the design operating conditions.

1.3 SEAL GAS REQUIREMENTS (at skid edge)

Molecular weight	: 16/19
Supply pressure	: 400/800 PSIG (min/max)
Supply temp	: 90/120 F (min/max)

1.4 INSTRUMENT AIR REQUIREMENTS

Operating pressure	: 80/110 PSIG
Design Pressure	: 150 PSIG

1.5 LUBRICATION SYSTEM DATA

1.5.1 LUBE OIL RESERVOIR CAPACITY

Maximum Operating Level:	2” measured from above centerline of reservoir
Volume at the Maximum Operating Level:	90 Gallons
Minimum Operating Level:	centerline of reservoir
Volume at the Minimum Operating Level:	75 Gallons
Rundown Volume:	120 Gallons

1.5.2 LUBE OIL SYSEM DATA

OPERATING PARAMETERS

ITEM NO.	DESCRIPTION	NORMAL OPERATION RANGE
1	Oil viscosity	150 SSU @ 100 F
2	Bearing Oil Flow	14-15 GPM
3	Oil Differential Pressure (supply pressure vs. reservoir pressure)	100 PSID
4	Oil Supply Temperature,	120 F
5	Minimum Reservoir Oil Start Up Temperature	90 F
6	Oil Drain Temperature	150/165 F (Nor./Max.)
7	Accumulator Pre-charge Pressure	160 PSIG (Note 1)
8	IGV Actuator Stroke	1.098 inches
8	Unit Running Speed	40,000 rpm
10	Speed to Avoid	N/A

1: Accumulator charge pressure is the same as the reservoir operating pressure. For Off-Design cases when the reservoir operating pressure is greater than 225 psig the accumulator should be recharged to the same pressure as the reservoir operating pressure.

WARNING:

START-UP AND CONTINUOUS RUNNING OF THE TURBOEXPANDER, WITH A BEARING OIL SUPPLY TEMPERATURE OF LESS THAN 90 F, MAY RESULT IN DAMAGE TO THE SOFT METAL OF THE BEARINGS.

1.5.3 LUBE OIL COOLER

Cooler Tag No.:	C-101
Cooler Type:	Single 100% Air Cooler
Cooler Heat Load:	140,000 Btu/hr
Oil Flow:	21 GPM
Max Ambient Design Temp:	110 F
Max Elevation:	2900 ft asl

1.5.4 OIL SPECIFICATIONS

General Requirements are for a NON-FOAMING, NON-DETERGENT TURBINE GRADE LUBE OIL with the following properties:

ISO Viscosity Grade	32
Pour Point	-17 to -40 ºF or Better
Flash Point	315 to 350 ºF or Better
Viscosity:	150 SSU @ 100 ºF
Gravity, API	31.2-33.1
Specific	~0.86

Mobil DTE™, Chevron GST®, Citgo Pacemaker® T or equivalent turbine grade oil is recommended

1.6 RECOMMENDED CONTROL SETTINGS

For recommended Control Settings refer to the P&ID (LAT574EC-20-D3) and Instrument Setpoint List (LAT574EC-20-C16).

1.7 DETAILED DESCRIPTION

Refer to the Service Assembly (LAT574-20-D1), Parts List (LAT574-20-A9) and P&ID (LAT574EC-20-D3).

1.7.1 INLET GUIDE VANES

The perimeter of the turbo expander wheel is surrounded by the variable inlet guide vane assembly. The inlet guide vanes (IGVs) control rate of the process gas flow through the machine. The inlet guide vane assembly upper nozzle actuator rod is connected to the IGV pneumatic diaphragm actuator. The electropneumatic positioner that is mounted on the IGV actuator will operate the IGV assembly throughout its full range of motion based on receiving a 4-20mA control signal.

1.7.2 SEALING SYSTEM

The seal gas system supplies buffer gas to the shaft labyrinth seals on the expander and compressor side of the Turboexpander shaft. The seal gas keeps the lube oil from entering the processes as well as keeping the cold expander process gas away from the bearing. Refer to the P&ID (LAT574EC-20-D3) for the schematic representation of the system. The seal gas system consists of a duplex filter, differential pressure reducing regulator and necessary monitoring instrumentation.

This seal gas/lube oil mixture is discharged from the bearing housing and flows through the machine drain piping to the pressurized reservoir. In the reservoir, the seal gas evolves from the lube oil, vents through a mist eliminator and is returned to the compressor suction.

CAUTION:

IF HEAVY HYDROCARBONS ARE PRESENT IN THE SEAL GAS, THERE IS A TENDENCY FOR ACCELERATED DILUTION OF THE VISCOSITY OF THE LUBE OIL IN THE RESERVOIR. ESPECIALLY AT START-UP AND WITH UNITS WITH HIGH RESERVOIR OPERATING PRESSURES. FREQUENT CHECKS OF THE LUBE OIL VISCOSITY ARE ADVISED.

1.7.3 LUBRICATION SYSTEM

The lubrication system regulates and controls the operating pressure and temperatures for oil supply to the bearings of the Turboexpander. Refer to the P&ID (LAT574EC-20-D3) for the schematic representation of the system. The operating details for the lubrication system can be found in Sub-Section 1.5 and the recommended control settings are located in LAT Instrument Setpoint List (LAT574EC-20-C16). Descriptions for the components Manufacturer's Data is provided in the System Bill of Materials (LAT574EC-20-A11). The Service Assembly (LAT574EC-20-D1) shows in cross-section of the machine including the lube oil supply and discharge passages within the unit.

In the case of an expander trip, the bladder type accumulator supplies oil to the bearings during the coast down of the Turboexpander. The accumulator will also sustain lube oil pressure above the low lube oil differential pressure trip setting before the auxiliary pump reaches operating pressure (after a low lube oil differential pressure alarm). A detailed description of servicing the accumulator bladder is given in Section 3.

1.7.4 ALARM & SHUTDOWN CONTROL SYSTEM

The Turboexpander control consists of an Allen Bradley Programmable Logic Controller, which is used for the annunciation and system control of the unit. The PLC, which is pre-programmed with all the control logic and alarm & shutdown conditions as well as start-up permissive, continuously monitors the unit's operating condition and signals an alarm when any of the preset process parameters are exceeded. It will also shut down the unit if any of its preset safety parameters are exceeded. A Panel View 1000 Plus standard terminal is used for operator graphic interface and annunciation.

There are two types of alarms: warning alarms and trip alarms. Warning alarms are initiated when an operating parameter is exceeded. This alarm signifies an abnormal condition which requires operator attention or intervention. Trip alarms are initiated when either an operating parameter is exceeded beyond the possibility of any corrective action, or a safety parameter is surpassed. When a trip alarm is triggered, the PLC will automatically shut down the Turbo expander. For a list of Warning Alarms/Shutdowns and their corresponding settings, refer to Sub-Section 1.6. Also refer to the Instrument Setpoint List (LAT574EC-20-C16) and the HMI instruction manual (LAT574EC-20-A42) for detailed information of the settings and HMI instruction. Some of the features provided in the PLC system are as follows:

- A "first-out" capability is programmed into the PLC for trip alarms, (i.e. upon receipt of concurrent trip alarms), the PLC will select the alarm which occurred first and annunciate it on the HMI with a fast flashing red display. First out alarm will lock in.

- The trip/shutdown alarms, which lock in, identify any complications subsequent to the "first out," and are displayed as slow flashing red display points on the HMI.

- A "first-out" alarm feature for warning alarms is also programmed into the PLC so that upon receipt of concurrent warning alarms, the PLC will select the alarm which occurred first and annunciate it on the HMI with a fast flashing amber (yellow) display. First out alarm will lock in.

- Warning alarms, which lock in, identifying any complications subsequent to the "first out", are displayed as slow flashing amber display points on the HMI.

- To acknowledge and reset alarms and shutdown signals there are "Acknowledge/Reset" buttons. This button is located on the Local Control Panel and serves to clear alarms and shutdown signals subsequent to the "first out" and bring the unit into ready condition. If the fault still remains after an "Acknowledge/Reset" button is activated, flashing display points will become steady and the unit will not go into a Ready condition.

  The Panel View 1000 Plus terminal displays the operating parameters of the Turboexpander. The terminal can record and display important data on triggered alarms, while alarm banners alert operators and maintenance personnel to slow or faulty conditions. In addition, it offers the ability to secure applications to qualified users upon request. Some of the features provided in the PLC/HMI system are as follows:

- The first screen of HMI is the "Main Menu" with 16 active keys called F-1 to F-16 each assigned to one of the different viewing/control functions. By touching various keys, the operator can navigate between the different screens to observe operating values of the machine monitoring parameters. They can also view the alarm set point screen or alarm/shutdown/ analog display summaries. The System has a "first-out" alarm feature. When a number of alarms are triggered, the Panel View unit displays the first alarm. To see other alarms on the screen, two push buttons are used which allow the operator to scroll up/down through the

alarms. The first-out alarm is locked-in, and can only be cleared if the cause of the alarm is removed and the operator pushes the “Alarm Acknowledge” button.

- During normal operation of the machine where there are no alarms, all windows on the “ALARM SUMMARY“ screen are lit in green and on the “SHUTDOWN SUMMARY” screen in red with a continuous light. However, if there is a window with an alarm, that window will turn flashing yellow.

- To clear subsequent alarms, the operator has to acknowledge each of them individually on their corresponding screens

- When it becomes necessary to change alarm or shutdown setpoints in the HMI, it can only be done by entering the passcode within 25 seconds on the “Set point Security Screen” and then going to the “Alarm Setpoints Screen” or the “Shutdown Setpoints Screen” and entering the desired values using the key pad. After saving the value, the operator can then return to the “Main Menu.”

DOCUMENT LAT574EC-20-A42 CONTAINS THE DETAILED HMI INSTRUCTION MANUAL.

1.7.5 AUTOMATIC THRUST BALANCE SYSTEM

To protect the thrust bearings from overload and damage, the unit is provided with an Automatic Thrust balancing System. The thrust balance system provides continuous thrust adjustments by sensing the hydrodynamic oil pressure on the front (expander) and back or load (compressor) thrust bearings and adjusts the position of the ATB valve which varies the pressure behind the compressor wheel so that the rotor system remains balanced and within the thrust load limits. Any increase in the thrust bearing pressure towards the expander will cause the automatic thrust balancing valve to close, which will build up the pressure behind the compressor wheel. An increase in the thrust bearing pressure towards the compressor will cause the automatic thrust-balancing valve to open and to relieve the pressure behind the compressor wheel.

An alarm is activated if the differential pressure between the front and back thrust bearings reaches the alarm level. The alarm and trip set points are listed in the Instrument Setpoint List (LAT574EC-20-C16). The thrust balancing system is installed at the factory and does not need to be readjusted.

1.7.6 ANTI-SURGE CONTROL SYSTEM

The unit is equipped with an Anti-Surge Control System designed to eliminate compressor surge. Surging is an unstable operational state that occurs when the flow through a compressor is reduced well below the design condition. When the incoming flow to the compressor is decreased below normal operating conditions, the pressure difference between the compressor inlet and discharge is increased. This increased pressure difference can cause a reversal of flow direction and an axial thrust on the shaft.

The Anti-Surge Control System protects the compressor from this condition by monitoring the compressor process conditions and, when needed, controlling the flow of recycled compressor process gas. To monitor the compressor process condition, the system uses signals from a flow transmitter and two pressure transmitters. Two pressure transmitters (PIT-101, PIT-101F) are used to monitor the compressor suction and discharge pressures and the Customer provided flow transmitter (FIT-101) measures the compressor suction flow using the differential pressure across the Customer supplied flow annubar.

The function of the anti-surge controller is to keep the ratio between these two signals within a preset limit. The anti-surge controller accomplishes this task by sending a control signal to the anti-surge valve (FV-101) supplied by customer. The anti-surge valve recycles compressor discharge gas to the compressor suction to provide the additional flow required to operate within a safe margin in from the surge line.

SECTION TWO

INSTALLATION

2.1 DELIVERY, CHECK OF CONSIGNMENT AND STORAGE

If any damage to packing or any missing parts are discovered, make a note of it on the shipping documents when he equipment is received and have this countersigned by recipient and carrier and inform the insurance company accordingly. If packing is removed for inspection of material on receipt, make sure that no parts of equipment or other material is discarded with the packing.

In case of Turboexpander-Compressor plant should be stored at Customer's premises for extended period of time (up to one year or longer), please contact our Service Department for detailed instructions.

2.2 EQUIPMENT FOUNDATIONS

The skid dimensions for mounting the equipment skid on its foundation is shown on the Expander-Compressor Machinery Arrangement (LAT574EC-20-D2). The Customer should provide a level foundations that will support the entire weight of the skid.

2.3 LIFTING AND HANDLING

A suitable hoist or crane should be provided for lifting the skid onto the foundation. There are lifting lugs on the side of skid for attaching the hoist or crane.

NOTE:

Spreader bars should be used to avoid damage to the unit by the slings. The spread bar should be used to prevent damage to the parts on the skid when lifting the skid.

2.4 PLANT PROCESS CONNECTIONS

Connection sizes, ratings, and locations for plant process inlet and discharge piping are shown on the Expander-Compressor Machinery Arrangement (LAT574EC-20-D2). Allowable pipe nozzle loads for the expander and compressor flanges are listed on the Maximum Pipe Nozzle Loads (LAT574EC-20-A10).

2.5 INLET SCREENS

The Customer shall provide the recommended 80-mesh expander inlet screen and an 30-mesh compressor suction screen in the process inlet piping to the unit. The screens should be installed in the locations shown on the P&ID (LAT574EC-20-D3).

It's recommended that the inlet screens be designed to withstand a maximum differential pressure of 75 psid

2.6 PROCESS PIPE CLEANLINESS

The process pipe to the expander and compressor should be thoroughly cleaned of all pipe scale, residual welding materials and any other debris prior to being connected to the machine.

2.7 SEAL GAS SYSTEM

Connect Customer's seal gas supply to the connection located at the edge of the skid. For seal gas requirements see Section 1 of the IOM and to the Expander-Compressor Machinery Arrangement (LAT574EC-20-D2) and P&ID (LAT574EC-20-D3) for the connection's size, rating, and location.

2.8 INSTRUMENT AIR

Connect the instrument air supply to the connection located at skid edge for the IGV actuator. Refer to Section 1 for instrument air requirements and to the P&ID (LAT574EC-20-D3) and Expander-Compressor Machinery Arrangement (LAT574EC-20-D2) drawings for the connection's size, rating, and location.

2.9 VARIABLE NOZZLE ACTUATOR

Install the variable nozzle actuator on the bonnet assembly, and connect the actuator rod. Be sure to align the rod and the adjusting nut. Connect electronic signal wiring to the electropneumatic positioner. Check the calibration of the nozzle actuator. The actual actuator travel range, which means the nozzle fully closed to 100% open. This is set at the factory, but it may require re-adjustment after shipment. There should be a full range of motion of the nozzles with the corresponding input signal being applied. Refer to the Nozzle Actuator Assembly (LAT574-20-D110) and P&ID (LAT574EC-20-D3). Also refer to Section 4 for detailed installation and calibration details.

2.10 EXPANDER INLET SHUTDOWN VALVE

The Customer provided expander inlet shutdown trip valve assembly with solenoid should be installed in the process piping at the expander inlet within 10 pipe diameters from the expander inlet flange. The valve shall be been designed to close within 1/2 second after the solenoid valve has been de-energized.

2.11 ELECTRICAL CONNECTIONS

Refer to the following drawings for wiring connection information:

Drawing Title	LAT Dwg. No.
Expander- Comp. Machinery Arrangement	LAT574EC-20-D2
P&ID	LAT574EC-20-D3
Control Wiring Diagram	LAT574EC-20-D4
Unit Control Panel Layout	LAT574EC-20-D5
Electrical Bill of Material	LAT574EC-20-A8
System Bill of Material	LAT574EC-20-A11
Heat Tracing Control Panel	LAT574EC-20-D38

Refer also to Section 6 for Component Manufacturer's Data. On all components, care must be taken to ensure the correct terminal connections. Make certain that sensor lines to the various transmitters are NOT shorted to ground and are properly connected to the terminals in the junction boxes.

CAUTION:

VERIFY THAT ALL POWER FEEDS ARE DE-ENERGIZED AND CIRCUIT BREAKERS ARE IN THE OFF POSITION WHEN CONNECTING THE POWER SUPPLY.

2.12 JUNCTION BOXES

Junction boxes should always be closed except during actual wiring and connecting. In no case should the junction boxes be allowed to stand open overnight or for extended periods. This precaution will protect the electric circuitry from dirt, rain, moisture and other potential sources of electrical failures.

2.13 COMPRESSOR DISCHARGE VALVE

A shutdown valve or other method of preventing reverse flow such as a check valve is recommended to be installed in the Customer's process piping at the compressor discharge to prevent the process gas from back flowing through the compressor after a unit shutdown.

2.14 LUBE OIL COOLER

The cooler fan motor with space heater shall be connected to the plant's electric power supply. The motor's power rating and voltage requirements can be found in the Utility Consumption List (LAT574EC-20-A62). The electrical connections sizes are found in the description for the air cooler in the Systems BOM (LAT574EC-20-A11).

2.15 HYDROCARBON RECOVERY SYSTEM

Connect piping from the out flange of the reservoir safety relief valve to the appropriate Customer's hydrocarbon recovery system. The connection size, rating and location are shown on the Expander-Compressor Machinery Arrangement (LAT574EC-20-D2) and P&ID (LAT574EC-20-D3) drawings.

2.16 EXPANDER/COMPRESSOR DRAIN CONNECTION

Expander and compressor drain connections are provided on the expander and compressor casings. It is recommended that valves be installed to facilitate draining any liquid from the expander and compressor casings that may have accumulated. Refer to the Expander-Compressor Machinery Arrangement (LAT574EC-20-D2) and P&ID (LAT574EC-20-D3) for the connections sizes, ratings and locations. Before every startup, the drain valves should be opened to drain any accumulated liquid from the casing and then closed before startup.

2.17 RESERVOIR DRAIN CONNECTION

A drain valve and skid edge connection is provided on the lube oil reservoir. Refer to the Expander-Compressor Machinery Arrangement (LAT574EC-20-D2) for the size and location.

2.18 RESERVOIR FILL PUMP CONNECTION

When the lube oil reservoir is pressurized the manual fill pump (HP-001) is utilized to transfer oil to the reservoir when the operating level drops below the minimum operating level as listed in Section 1.5.1. When the system is not in service, the reservoir may be filled using the inspection port on the reservoir.

SECTION THREE

OPERATING INSTRUCTIONS

3.1 PRECAUTIONS

Ensure that all process piping has been thoroughly cleaned of debris prior to connecting it to the Turboexpander/compressor process connections.

NOTE:

It is recommended to have an LAT Field Technical Advisor be present to instruct the Customer's personnel in the assembly and disassembly of the unit prior to initial start-up.

Compressor Surge:

To avoid compressor surge, the unit has been equipped with an anti-surge control system in the PLC. For the system description refer to Sub-section 1.7.6 “Anti-Surge Control System” and P&ID (LAT574EC-20-D3). The anti-surge valve and compressor suction flow element has been supplied by the Customer.

Inlet Screens:

Expander and compressor inlet screens should be checked at the earliest opportunity and repeatedly until no foreign matter is found. A BLOCKED SCREEN REDUCES PRESSURE, FLOW, AND EFFICIENCY.

3.2 EXPANDER OVERSPEED - CAUTION

THERE IS A DANGER OF OVERSPEED UNTIL THE COMPRESSOR SUCTION REACHES DESIGN PRESSURE. THE EXPANDER COULD REACH FULL SPEED WITH LESS THAN FULL EXPANDER POWER UNTIL THE COMPRESSOR SUCTION OPERATING PRESSURE HAS STABILIZED. THE MACHINE WILL AUTOMATICALLY SHUT DOWN WHEN THE SPEED REACHES THE TRIP RPM SETTING. (REFER TO INSTRUMENT SETPOINT LIST (LAT574ECEC-20-C16).

3.3 PRE-START INSTRUCTIONS

The following steps must be taken before placing the system into operation:

3.3.1 Oil Reservoir

PROCEDURE FOR FILLING RESERVOIR

Fill the lube oil reservoir with the proper turbine oil in accordance with specifications given in Section 1. When the system is not in service, the reservoir may be filled using the inspection port on the reservoir. When the reservoir is pressurized, oil may be added by using the manual fill pump (HP-001). After oil has circulated and all components, such as the coolers or filters, are free from entrapped air confirm that the lube oil reservoir is filled to a point between maximum and minimum levels, as specified in Section 1.5.1.

CAUTION:

THE OIL SYSTEM (RESERVOIR, ACCUMULATOR, COOLER, AND PIPING SYSTEM) WAS FLUSHED PRIOR TO TESTING THE MACHINE AT LA TURBINE. THE CUSTOMER MUST PREVENT DIRT OR OTHER FOREIGN MATTER FROM ENTERING THE LUBE OIL SYSTEM. DO NOT USE AN OIL CONTAINING DETERGENT. NON-FOAMING, NON-DETERGENT TURBINE GRADE LUBE OIL IS SUITABLE AND PREFERABLE FOR FLUSHING.

3.3.2 Electrical

Verify that all electrical circuits are properly connected; perform insulation resistance check of all motors and check that they rotate in the proper direction. Refer to Wiring Diagram (LAT574EC-20-D4).

3.3.3 Accumulator Bladder

Verify that the accumulator bladder is charged to the correct pressure level specified in Section 1.6. To charge the accumulator bladder before placing the unit into service, perform as follows:

- Close the accumulator block valves to isolate the accumulator from the oil system.
- Open the accumulator drain valve.
- Connect the provided charge kit to the gas valve located on top of the accumulator.
- Fill the accumulator with nitrogen gas to the pressure level listed in Section 1.6 (Accumulator Charge Pressure) or the Instrument Setpoint List (LAT574EC-20-C16)
- Remove the charge kit.
- Close accumulator drain valve.
- Slowly open accumulator block valve.

3.3.4 Valves

Verify that all valves are in the correct open or closed position. Refer to the P&ID (LAT574EC-20-D3).

3.3.5 Control Settings

Verify that all gauges, transmitters and safety devices are connected and operating properly. Refer to Section 1.5.2 for recommended control values. These control values were set at the factory but may have drifted during transit.

3.3.6 Seal Gas

Verify that a suitable seal gas supply is properly connected. The seal gas supply requirements are listed on Section 1 and the P&ID (LAT574EC-20-D3) and in Section 1.3 of this manual as well as the Utility Consumption List (LAT574EC-20-A62).

3.3.7 Instrument Air

Verify that a suitable instrument air supply is properly connected to the air supply connection for the IGV actuator. The instrument air supply requirements are listed in Section 1.4 and on the P&ID (LAT574EC-20-D3). The filter regulator set point values can be found in the Instrument Setpoint List (LAT574EC-20-C16).

3.3.8 Nozzle Actuator

Verify that the range of the nozzle actuator rod responds to the 4-20mA input control signal. Refer to Section 6, Component Manufacturer's Data and Nozzle Actuator Assembly Drawing (LAT574EC-20-D110).

3.3.9 Inlet Shutdown Valve

Verify that the expander inlet shutdown valve (supplied by Customer) is installed in the process piping within 10 pipe diameters from the expander inlet and is functional. The expander shutdown valve has been designed to close **within one-half (1/2) second** after de-energizing the solenoid valve.

3.3.10 Expander/Compressor Inlet Screens

Verify the installation of the expander and compressor inlet screens provided by Customer as shown on the P&ID (LAT574EC-20-D3).

3.4 INITIAL START UP PROCEDURE

3.4.1 General Instructions

The startup procedure generally consists of:

- Opening the expander outlet block valve (if installed)
- Admitting seal gas to pressurize expander and compressor casing gradually
- Opening the compressor discharge block valve (if installed)
- Starting the lube oil supply system.
- Opening compressor suction block valve.
- Opening expander inlet manual block valve as the IGV and expander inlet trip valve remain closed.
- Opening casing drain valves to drain and then close them
- Monitoring all control instruments and adjusting the oil pressure after the expander speed and flow rate are stabilized.

3.4.2 Detailed Instructions

For correct seal gas and instrument air supply requirements and for correct lube oil operating temperatures, pressures, and viscosity requirements refer to sections 1.3, 1.4 and 1.5.

NOTE:

ENSURE THAT THE PLANT PROCESS GAS IS COMPLETELY SHUT OFF FROM THE EXPANDER BEFORE PROCEEDING WITH THE FOLLOWING STEPS:

- Admit seal gas from customer seal gas supply system.
- Apply power to the lube oil pump motors, oil reservoir heater, and control instrumentation. Verify that the heater thermostat is properly set. For power

supply ratings, refer to the Utility Consumption List (LAT574EC-20-A62).

- Ensure that the lube oil is filled between the maximum and minimum levels.
- Check that the expander inlet shutdown valve is closed.
- Verify that the inlet guide vanes "IGV" (turbine nozzles) are in the closed position.
- Open the expander outlet block valve (if installed)
- Open compressor discharge block valve
- Confirm that the seal gas has reached the correct differential pressure
- Open the lube oil pump relief valve bypass valves and lube oil filter bleed valves.
- Set the lube oil filter transfer valve so that oil will flow through both filters.
- Confirm that the main lube oil pump motor switch is in the “HAND” position and the auxiliary pump switch is in the “AUTO” position.
- Slowly close the pump relief valve bypass valve.
- Verify that minimum lube oil differential pressure has been established.
- When the duplex oil filter has been purged of gasses as indicated by the stable pressure readings, slowly close the filter bleed valve.
- Check the differential oil pressure across the duplex oil filter. A higher than normal reading may suggest that the filter elements should be inspected and/or replaced if necessary.
- Clear annunciator system of all alarm and shutdowns.

NOTE:

- The above start-up steps for the lube oil system do not need to be performed during a re-start if the lube oil and seal gas systems have not been shutdown and are actively flowing to the unit.
- Inspect all seal gas and lube oil system temperature, pressure, and flow gauges and verify that they are showing normal operating values.
- Verify that the minimum bearing oil supply temperature (90F start-up, 120F continuous operation) downstream of the coolers has been reached.

CAUTION:

Starting the units with low oil supply temperature may result in damaging the bearings.

- Carefully open the expander and compressor case drain valves (installed by others) to drain any liquid that may have accumulated in the casings. Use extreme caution when opening the drain valves, since the casings have been pressurized. After all the liquid has been drained, close the drain valves.
- Verify that the compressor discharge process block valve (if installed) and expander inlet process block valve are initially closed and then pressurize the compressor case by opening the compressor inlet process block valve.
- Verify that the startup interlocks have been established. "Expander Ready" light on the unit control panel should be on.
- Using the HIC in the HMI to fully close the IGV with 0% opening.
- Open expander inlet shutdown valve by pushing the “Expander Start” button.
- Gradually open the expander inlet guide vanes (IGV's) by operating control unit from local control panel HMI. Opening IGV's will allow process gas to enter the expander and the machine will begin to rotate. Monitor all gauges and ensure that speed stabilizes, which may require several minutes or more. Verify that the lube oil is at the correct temperature and differential pressure.
- Gradually increase the expander speed in steps of about 12% of design speed per minute by further opening the inlet guide vanes IGV's. A 5-minute hold at 50% speed and 80% speed is recommended to verify bearings temperature and vibration levels are stable and within limits. Continue opening the inlet guide vanes from HMI until the desired operating speed is reached.
- Observe the seal gas system pressure instruments. Check that the seal gas differential pressure to the unit is as specified in Section 1 and per the P&ID (LAT574EC-20-D3). Monitor the lube oil system pressure and temperature instruments and verify that the readings are within the normal operating range. The unit should be running at normal operating condition and speed.
- Monitor thrust instruments and recording all operating pressures and temperatures.

3.5 NORMAL OPERATION & PERIODIC SERVICE

During normal operation routine monitoring of the control system instruments and operating values shall be performed. The following items should be checked frequently. Any variations from normal operation should be investigated immediately.

- Reservoir oil level
- Seal gas differential pressure
- Lube oil differential pressure
- Lube oil supply and drain temperatures
- Lube oil viscosity.
- Lube oil filter differential pressure.
- Thrust pressure and differential pressure instruments

NOTE

Frequent checks of oil viscosity should be made immediately after start-up to determine the extent and rate of possible oil dilution. Subsequent checks shall be made following start up and after the machine is in operation.

3.5.1 Servicing Oil Filter

If a filter is taken out of service and drained it must be refilled with oil before being placed back in service. Otherwise, any air/gas left inside the filter may be forced through the bearings and cause damage. To replace an oil filter element while in operation:

- Move the transfer valve to the filter opposite the one to be serviced.
- Close the filter equalizing valve.
- Open the appropriate filter bleed valve of the filter to be serviced. This will relieve some of the filter pressure to the filter.
- Close the filter bleed valve.
- Since the filter housing is still under pressure, carefully drain the filter housing by opening its drain valve.
- Remove the filter housing cover and remove the used element, cover gasket and O-ring.
- Install the new filter element et and O-ring.
- Once the new filter element has been installed, the filter housing cover and cover gasket. Close the filter drain valve and manually refill the filter housing with oil.
- Slowly open the filter equalizing valve.
- Slowly open the filter bleed valve to remove any remaining air from the housing.
- Be sure to open only the vent and drain valve at the non-operating housing.
- Select desired filter to be in operation using the transfer valve.

3.5.2 Auxiliary Lube Oil Pump Test

The auxiliary oil pump start due to a low lube oil pressure alarm may be checked periodically by carefully cracking open the pump bypass valve. This lowers the differential pressure at (PDI-102) which will automatically activate the auxiliary pump when the low lube oil differential pressure alarm level has been reached. Care must be taken as to not lower the lube oil differential pressure below the trip value as the expander will shut down. Refer to the Instrument Setpoint List (LAT574EC-20-C16) for the low lube oil differential pressure alarm and trip set points.

NOTE:

Auxiliary pump control station must be in the auto position when the machine is running.

3.5.3 Expander-Compressor

Inspection of the Turboexpander-Compressor is generally not required unless changes to the machine operating parameters have been logged or if damage is suspected.

3.5.4 Bearings

Expander-compressor bearings are designed to last indefinitely under normal operating conditions. However, operating under abnormal conditions will result in bearing damage.

3.6 NORMAL SHUTDOWN

To shut down the Turboexpander-Compressor, follow the procedure below.

- Close inlet guide vanes via the HIC in HMI

  NOTE:

  Use the same rate during shut down as on startup (See section 3.4.2 "Detailed Instructions"). Machine flow is generally very small at 70% of speed and the unit can be tripped via shut down signal.

- Press the "Expander Stop" button on the unit control panel to close the expander inlet shutdown valve, expander and compressor discharge valves.
- Verify that the expander inlet shutdown valve is closed and observe the expander speed (RPM) to determine that rotation has come to a complete stop.

NOTE:

If the shutdown is to be short term, it is recommended that the seal gas system and the lube oil system remain operating and pressurized. The seal gas pressure will prevent lube oil from leaking into the casings. If the shutdown is to be long term continue as follows:

- Close the expander and compressor inlet and discharge process block valves and allow the seal gas and lube oil systems to run for approximately five minutes.
- Shut down the lube oil system and allow the seal gas system to run for another five minutes.
- The seal gas supply may be shut off only if the lube oil system has been shut down.
- If an extended shutdown is anticipated, de-pressurize the expander and compressor casings using casing drain valves or other plant installed depressurization devices.

3.7 EMERGENCY SHUTDOWN

In the event of emergency conditions, the safety devices will automatically signal the expander inlet shutdown valve to close shutting off the process flow to the expander.

SECTION FOUR

MAINTENANCE

IN CASE OF INCONSISTENCIES IN ANY PART NUMBER THE PART NUMBER ON THE SPECIFIC DRAWING IS TO PREVAIL.

4.1 DISASSEMBLY OF THE EXPANDER-COMPRESSOR

Disconnect all lube oil and seal gas piping and the vibration and temperature pickup probes. Plug all lines to prevent the entry of any foreign matter.

The referenced drawings clearly indicate the attachment of all assembled parts; therefore, detailed hardware descriptions are omitted from the following procedures:

4.1.1 Field Removal

Some of the components are heavy and a hoist should be made available for support during field removal. When the mechanical center section (M.C.S.) is removed in the field, extreme caution should be exercised in the handling of internal parts. These parts have been precision machined and dynamically balanced and careless handling of parts may result in irreparable damage. Avoid marring any flange face or gasket face.

4.1.2 Disassembly Into Major Components

LA Turbine modular design enables disassembly into three major components: expander case, mechanical center section (M.C.S.) and compressor case. This eliminates the necessity of total disassembly when the main concern is isolated in one of the three primary areas. To separate the system into major components proceed as follows, referring to the Service Assembly (LAT574-20-D1) and the Parts List (LAT574-20-A9) drawings.

- Disconnect process piping, instrument air and seal gas piping, and all instrumentation lines to the unit.

- Support the compressor inlet spacer (330) with a hoist or forklift. Two threaded holes in the compressor inlet spacer are provided for the temporary use of eye bolts (502) which will aid in the removal. Remove screws (901) to disassemble the compressor inlet spacer (330) and O-ring (902).

- Steady the bearing housing (200) with a hoist. Remove hex nuts and stud (943 and 943a), which secure the compressor case (300) to the bearing housing (200). Then slide compressor case (300) away from the bearing housing, **TAKING CARE NOT TO STRIKE COMPRESSOR CASE AGAINST THE COMPRESSOR WHEEL** (280). Two threaded holes in the bearing housing are provided for the temporary use of eye bolts (503) which will aid in this step. Move the compressor case to the end of its support so that the weight is distributed between the two vertical supports and the compressor wheel (280) is clear of the casing. Remove O-ring (910). If necessary, the compressor case may now be removed from the skid, being sure that the compressor wheel (280) is completely clear of the compressor case.

- While continuing to support the bearing housing (200), remove stud and hex nuts (944 and 944a), which secure bearing housing (200) to Expander Case (100). Two threaded holes in the bearing housing are provided for eye bolts (503) to aid in moving the bearing housing away from the Expander Case. The complete mechanical center section may now be withdrawn. Care must be exercised not to strike the expander wheel (210) against any other internal components while withdrawing the assembly. Remove the Labyrinth housing spacer (120) and Raco seals (955, 955a). The entire mechanical center section should now be taken to a clean location for disassembly.

The machine is now separated into three major components. At this stage, the variable nozzle assembly is still attached to the expander case. The expander wheel and compressor wheel remain attached to the mechanical center section (M.C.S.). For further disassembly of the major components see the appropriate section in the following procedures.

4.1.3 Mechanical Center Section (MCS) Disassembly

Most parts in the mechanical center section (M.C.S.) fit tightly together, and are provided with threaded holes for the use of eye bolts (503) to facilitate removal.

- Position the unit horizontally on a workbench to facilitate component removal. **CARE MUST BE TAKEN NOT TO BUMP OR MAR EXPANDER WHEEL (210), COMPRESSOR WHEEL (280), HEAT BARRIER WALL (221), COMPRESSOR SEAL (270), COMPRESSOR WHEEL BACK SEAL (290) OR EXPANDER WHEEL BACK SEAL (220).**

- **Expander Wheel:** Carefully remove expander wheel (210) from shaft (230) by removing retaining screw (211) and retaining washer (212). Remove expander wheel (210) utilizing the threaded hole provided for screw. **DO NOT PRY OR USE ANY TOOL EXCEPT A JACK SCREW TO REMOVE THE EXPANDER WHEEL**. Remove keys (213) from the shaft.

- **Compressor Wheel:** Carefully remove compressor wheel (280) from shaft (230) by removing retaining screw (281), retaining washer (282). Remove compressor wheel (280) utilizing the threaded hole provided for jack screw. **DO NOT PRY OR USE ANY TOOL EXCEPT A JACKSCREW TO REMOVE THE COMPRESSOR WHEEL**. Remove keys (283) from the shaft.

- Disassemble the expander wheel back seal (220), by removing screws (942).

- To separate the heat barrier wall (221) from the bearing housing (200), remove screws (937) and washers (938). Remove the heat barrier wall (221) and Raco-seal (956) and O-rings (936, 932, 933 and 934).

- Remove screws (911) to disassemble the compressor wheel back seal (290).

- Disassemble compressor seal (270). Remove O-ring (922, 923 and 924).

- Break lock wires and remove screws (918) and washers (919). Using the two threaded holes provided for jackscrews; remove load (compressor side) bearing (251). Remove O-rings (920 & 921).

- Withdraw the shaft (230). **EXERCISE CARE TO KEEP SHAFT CENTERED IN ORDER TO AVOID DAMAGING DRIVE (EXPANDER SIDE) BEARING.**

- Break lock wires and remove screws (927) and washers (928) to remove drive bearing (250). Two threaded holes are provided for jack screws. Remove O-rings (925 & 926).

4.1.4 Nozzle Actuator Assembly Removal

Refer to the Nozzle Actuator Assembly (LAT574-20-D110) drawing, the Parts List (LAT574-20-A9) and to Section 6 “COMPONENT MANUFACTURERS’ DATA” under Fisher’s 667 Actuator IOM.

- To remove the nozzle actuator, follow Fisher’s instructions. Remove Sel-lok pin (946) in the actuator rod, make certain there is no burr in the pinhole and lift the nozzle actuator off the bonnet assembly.

- To remove the bonnet assembly (111), loose actuator locking nut and remove screws (949) at the base of assembly. To remove upper section of actuator rod, lift assembly and remove jam nut (945). Remove Raco seal (957).

Make sure that the lower actuator rod (112) does not get hung up on the nozzle adjusting ring and pin (132) during removal. The actuator rod (112) should be positioned to relieve the force on the pin in the nozzle adjusting ring (132) in order to ease removal of the nozzle assembly. Care must be exercised during the removal procedure to ensure that the actuator rod or pin does not get bent. Support the nozzle assembly with a hoist.

4.1.5 Variable Nozzle Assembly Removal

- NOTE: It will be found that this is easier to keep the nozzle assembly square to the expander case. Refer to the Service Assembly Drawing (LAT574-20-D1) and Parts List (LAT574-20-A9).
- Remove screws (950), which secure the variable nozzle assembly to the expander case (100). Take care that the assembly does not fall. The nozzle cover (130), nozzle segments (131) and nozzle adjusting ring & pin (132) are secured together with shoulder screws (951). The nozzle assembly will slide out as one unit. Take the assembly to a clean work area for further disassembly. Be aware that the piston ring (135) does not slide off with the unit. Remove the piston ring (135) from the nozzle fixed ring (133) that is still secured to the expander case (100).
- Place the assembly on a workbench with the nozzle adjusting ring (132) facing upwards. Remove shoulder screws (951) to separate the nozzle adjusting ring and pin (132) from the assembly. Take care not to bend the pin or drop the nozzle segment (131) from nozzle cover (130) while removing the nozzle adjusting ring and pin (132). If you encounter difficulty in separating these components use jackscrews.

4.1.6 Expander Case Disassembly

- Remove screws (952) to separate the nozzle fixed ring (133) from the expander case (100).
- If necessary, the expander case diffuser (104) may be removed from the expander from the expander case (100) by pulling it through the expander exhaust. Remove gasket shim (134).

4.1.7 Compressor Case Disassembly

- To separate the compressor follower (310) from the compressor case (300), Remove screws (904). Remove shims (311).

4.2 CLEANING & REASSEMBLY

4.2.1 Cleaning

After disassembly, the parts should be cleaned thoroughly. Parts other than those in the cold expander housing should be coated with a thin film of lubricating oil to protect against rusting.

4.2.2 Re-assembly

Re-assembly of the unit is the reverse order of disassembly. Ensure that the expander end of the unit is not tilted below a horizontal position, which could allow coating oil to leak into labyrinth seal housing.

The following list specifies applications of different sealants and lubricants that are recommended for use in re-assembly. Unless noted in Related Documents/Drawings, the following practices should be followed:

RECOMMENDED SEALANTS AND LUBRICANTS

	Product Name	Application
1.	Tungsten Disulfide (WS2) Spray	Nozzle/Inlet Guide Vane Assembly
2.	Anti Seize Paste Dow Corning Molykote P 37	Casing Bolts, Studs, Nut Faces Retaining Screws, Retaining Washers, All Fasteners, Threads & Nut Faces for Internal Parts of the Machines (Core Units)
3.	Leak Lock Joint Sealer by Highside Chemicals	Tach Pick-up Threads
4.	O-Ring Adhesive #404 by Loctite	All O-Rings Joint Adhesives
5.	Teflon Paste Loctite PST 567	Sealants for all Threaded Pipe & Fittings
6.	Molykote III Compound Dow Corning	Lubricants for O-Rings
7.	LOCTITE Superbond Adhesives Item #495	Bonding Between Rubber, Metal, and Plastic Parts With Gaps to .004" in Electrical Shop Practices
8.	LOCTITE Threadlocker # 242	Threads between Expander Wheel Back Seal & Heat Barrier Wall, Heat Barrier Wall Insert & Heat Barrier Wall, Compressor Seal & Compressor Wheel Back seal, Expander Case & Nozzle Fixed Ring

4.2.3 Re-assembly of Variable Nozzle Assembly

- To re-assemble this unit, place the nozzle segments (131) on the pins of the nozzle cover (130) in a closed position. Place the nozzle adjusting ring and pin (132) over the nozzle segments and engage the segment pins into the slots of the adjusting ring. Replace screw (951) to secure the assembly together.
- To reinstall the variable nozzle assembly into the expander case (100), make sure piston ring (135) is secured on nozzle fixed ring (133). The pin of the nozzle adjusting ring (132) must engage with the hole in the bottom of the actuator rod (112). This may require some manipulation of the adjusting rod. **DO NOT FORCE**. To avoid bending the lower actuator rod you can move it up and down slightly to make sure the pin has engaged properly. Observe that slight manipulation of the actuator rod is opening and closing nozzle segments. Insert screws (950) to secure the nozzle assembly in the expander case.

4.2.4 Tachometer Pickup/Vibration Probes

Refer to Service Assembly (LAT574-20-D1), P&ID (LAT574EC-20-D3) and Electrical Bill of Materials (LAT574EC-20-A8).

Tachometer probes can only be installed when the machine has stopped. Make sure that there is **NO ROTATION** of the shaft. Screw in the threaded probe. After the probe is set, apply lock-tite to the threads and secure the probe with the locknut.

CAUTION:

The vibration probes should be connected to the vibration monitoring system before installing them into the unit. Be sure not to scratch the polished surface of the shaft when installing the vibration probes. When the shaft is being handled, protect the polished surface of the shaft to avoid any damage or scratches.

4.2.5 Torque

See service assembly drawing for detailed information, others see the following table.

TABLE (1): TORQUE FOR CASING BOLTS

Bolt Size (in)	Thread Type	Torque (ft-lb)	Torque (Kg-m)	Bolt Size (in)	Thread Type	Torque (ft-lb)	Torque (Kg-m)
1/4	10 UNC	4.75	0.66	1	8 UNC	284	39.27
5/16	48 UNC	8.5	1.18	1 1/8	7 UNC	404	55.86
3/8	16 UNC	15	2.07	1 1/4	7 UNC	569	78.67
7/16	14 UNC	24	3.32	1 3/8	6 UNC	753	104.11
1/2	13 UNC	37.5	5.18	1 1/2	6 UNC	989	136.74
9/16	12 UNC	46	6.36	1 3/4	5 UNC	1609	222.46
5/8	11 UNC	63.5	8.78	2	4 1/2 UNC	2436	336.79
3/4	10 UNC	113	15.62	2 1/4	4 1/2 UNC	3549	490.67
7/8	9 UNC	189.5	26.10	2 1/2	4 1/2 UNC	4466	617.4

A. Lubricate the expander wheel and compressor wheel retaining screws (211 & 281) with the recommended lubricant listed in Sub-Section 4.2.2 and then torque the retaining screws to the value called out on the Service Assembly Drawing (LAT574-20-D1).

4.3 INSPECTION

4.3.1 Recommended Clearance

Check the journal and thrust bearings, and shaft for wear. Carefully examine the bearings and thrust washer faces for any signs of wear, such as scoring or babbitt depletion. If the wear is excessive, replace them with new parts. If there is difficulty determining whether the bearing is still satisfactory for use, consult the manufacturer before putting them back in operation. The recommended allowable clearances for the unit are given on the Assembly Clearances Drawing (7770006207)

4.3.2 Balance

The shaft (230), expander wheel (210), and compressor wheel (280) have been accurately machined and dynamically balanced. It is not necessary to check the balance of the assembly or to follow alignment marks between its components unless suspicion of imbalance exists. If inspection reveals that the clearance or imbalance figures exceed those specified, the part should be corrected or replaced.

4.3.3 Labyrinth Seal Clearance

See Assembly Clearances Drawing (7770006207).

4.3.4 Compressor Wheel Clearance

To set the clearance between the compressor wheel (280) and the compressor follower (310), first measure the shaft axial endplay. Next, push the shaft towards the expander end as far as the thrust bearings permit, and place soft solder wire at several points on the face of the blades. Engage MCS and compressor case in normal operating relationship, including tighten the retaining screws. This crushes the solder to the thickness of the maximum clearance. Withdraw the compressor follower through the compressor inlet and measure the crushed thickness of the solder wire. Subtract the axial endplay from the crushed thickness of the solder. This yields the maximum clearance between the compressor wheel (280) and the compressor follower (310). This clearance should be set per Assembly Clearances Drawing (7770006207). Adjustment is made by adding or removing shims (311).

4.4 RECOMMENDED SPARE PARTS LIST

"USE OF UNAUTHORIZED PARTS NOT ONLY INCREASES YOUR RISK EXPOSURE IN TERMS OF A REDUCTION OF LAT WARRANTY OBLIGATIONS AND AN INCREASED PRODUCT LIABILITY RISK, BUT ALSO SUCH USAGE NEGATIVELY AFFECTS THE PRODUCTIVITY AND PERFORMANCE OF THE TURBOEXPANDERS."

4.5 FIELD SERVICE

For 24-hour emergency service, please contact our Service Department in LA Turbine headquarters:

Valencia, California, USA,

Phone: (661) 294-8290,

Fax: (661) 294-8249

LAT Europe Office:

Christian Maskaluk

Managing Director

Europe, Middle East, Africa

Phone: +32 (0) 4 247 30 11

Mobile: +32 (0) 491 08 48 99

4.6 LATURBINE SERVICE /EMERGENCY CONTACT LIST

DIRECT SERVICE RESPONSE PARTNER

Office Phone: (661) 294-8290

Mr. Troy O'Steen – Sales Director
Office Phone: (661) 294-8290 Mobil Phone: (661) 755-0949
e-mail: tosteen@laturbine.com

Mr. Mike Beneteau – Service Manager
Office Phone: (661) 294-8290 Mobile Phone: (281) 615-0049
e-mail: mbeneteau@laturbine.com

Mr. David Bloss – Field Service Manager
Office Phone: (661) 294-8290 Mobil Phone: (661) 755-1942
e-mail: dbloss@laturbine.com

Mr. Tadeh Avetian – Engineering Director
Office Phone: (661) 294-8290 Mobil Phone: (661) 289-2139
e-mail: tavetian@laturbine.com

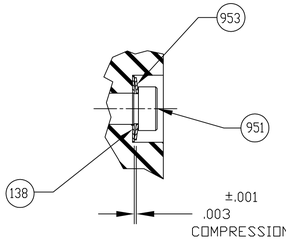
SECTION FIVE

DRAWINGS

Drawing Title	Rev	L.A. TURBINE Dwg. No.
LAT574-20-D1	1	Service Assy Exp-Comp
LAT574EC-20-D2	2	Expander- Comp. Machinery Arrangement
LAT574EC-20-D3	2	System P&ID
LAT574EC-20-D4	3	Control Wiring Diagram
LAT574EC-20-D5	3	Control Panel Layout
LAT574EC-20-A8	4	Electrical Bill of Material
LAT574-20-A9	0	Part List
LAT574EC-20-A10	1	Maximum Pipe Nozzle Load
LAT574EC-20-A11	5	System Bill of Material
LAT574EC-20-C16	2	Instrument Index
LAT574EC-20-D38	1	Heat Tracing Control Panel
LAT574EC-20-A41	2	EBOM for Controls
LAT574EC-20-A42	0	Turbo Expander Operator Manual
LAT574EC-20-A62	2	Utility Consumption List
LAT574EC-20-A81	1	Expected Performance Curves
LAT574EC-20-A82	0	Campbell Diagram
LAT574EC-20-A83	1	Mechanical Datasheet
LAT574EC-20-A86	0	Anti-Surge Algorithm
LAT574EC-20-A94	0	Performance Test Data
LAT574EC-20-A95	0	Mechanical Test Data
LAT574-20-D110	0	Nozzle Actuator Assembly
LAT574EC-20-A542	1	Combined Modbus Address List
7770006270	0	Assembly Clearances Exp-Comp (2000 Frame)

MATERIAL	TORQUE FT-LBS									
BOLT & THD SIZE	#10-24UNC	1/4-20UNC	5/16-18UNC	3/8-16UNC	1/2-13UNC	3/4"-10UNC	7/8-9UNC	1" -8UNC	1 1/8" -8UN	1 1/4" -8UN
ASTM 574 ALLOY ST ASTM A193 GR. B7 C. S.	1.75	4.2	8.6	15.3	37.4	132	213	319	378	658
ASTM F837 GR 1 S. STL	.67	1.6	3.3	5.8	14.2	50	81	121	178	250

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASE FOR FABRICATION	10-17-16	SB
1	ADDED MATING FLG, STUD & NUT @ EXP. OUTLET	02-15-17	SB



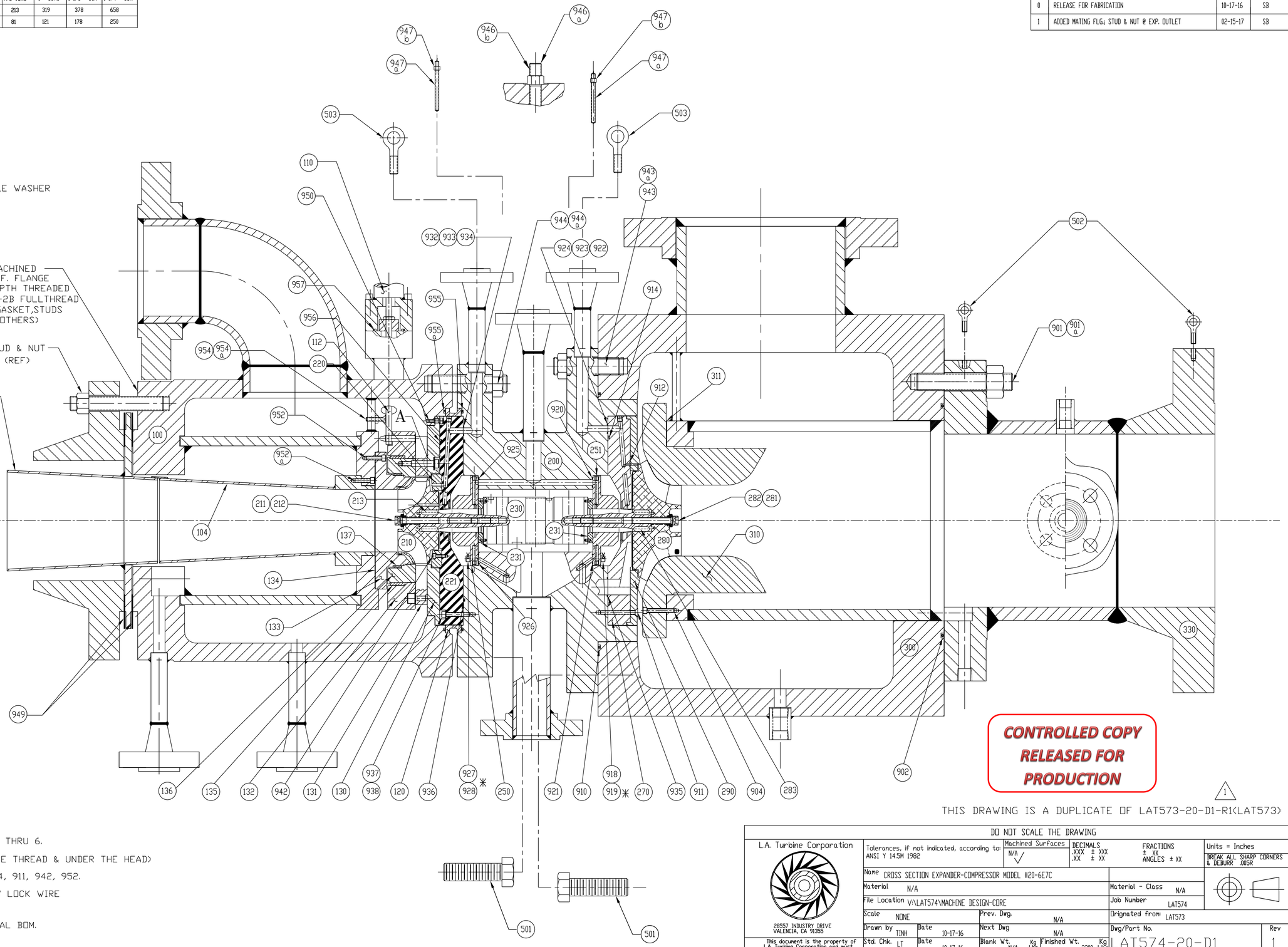
±.001
.003
COMPRESSION-BELLEVILLE WASHER

DETAIL-A

SCALE: NONE

EXP. OUTLET FACE IS MACHINED TO ACCEPT A 8"-600# R.F. FLANGE WITH QTY 12, 1 3/4" DEPTH THREADED HOLES FOR 1 1/8"-7UNC-2B FULLTHREAD STUDS (MATING FLANGE,GASKET,STUDS AND NUTS SUPPLIED BY OTHERS)

1 STUD & NUT (REF)



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1 THIS DRAWING IS A DUPLICATE OF LAT573-20-D1-R1(LAT573)

NOTES:

1. FOR PART LIST SEE LAT574-20-A9 SHEET 1 THRU 6.
2. TORQUE ITEM 211 & 281 TO 30 FT-LBS (LUBE THREAD & UNDER THE HEAD)
3. APPLY LOCTITE THREADLOCKER #242 TO 904, 911, 942, 952.
4. ✳ 2X Ø.078 DRILL THRU HEAD OF EACH SCREW LOCK WIRE IN PAIRS USING Ø.032 WIRE.
5. FOR IT# 946a,946b,947a,947b SEE ELECTRIAL BOM.

DO NOT SCALE THE DRAWING

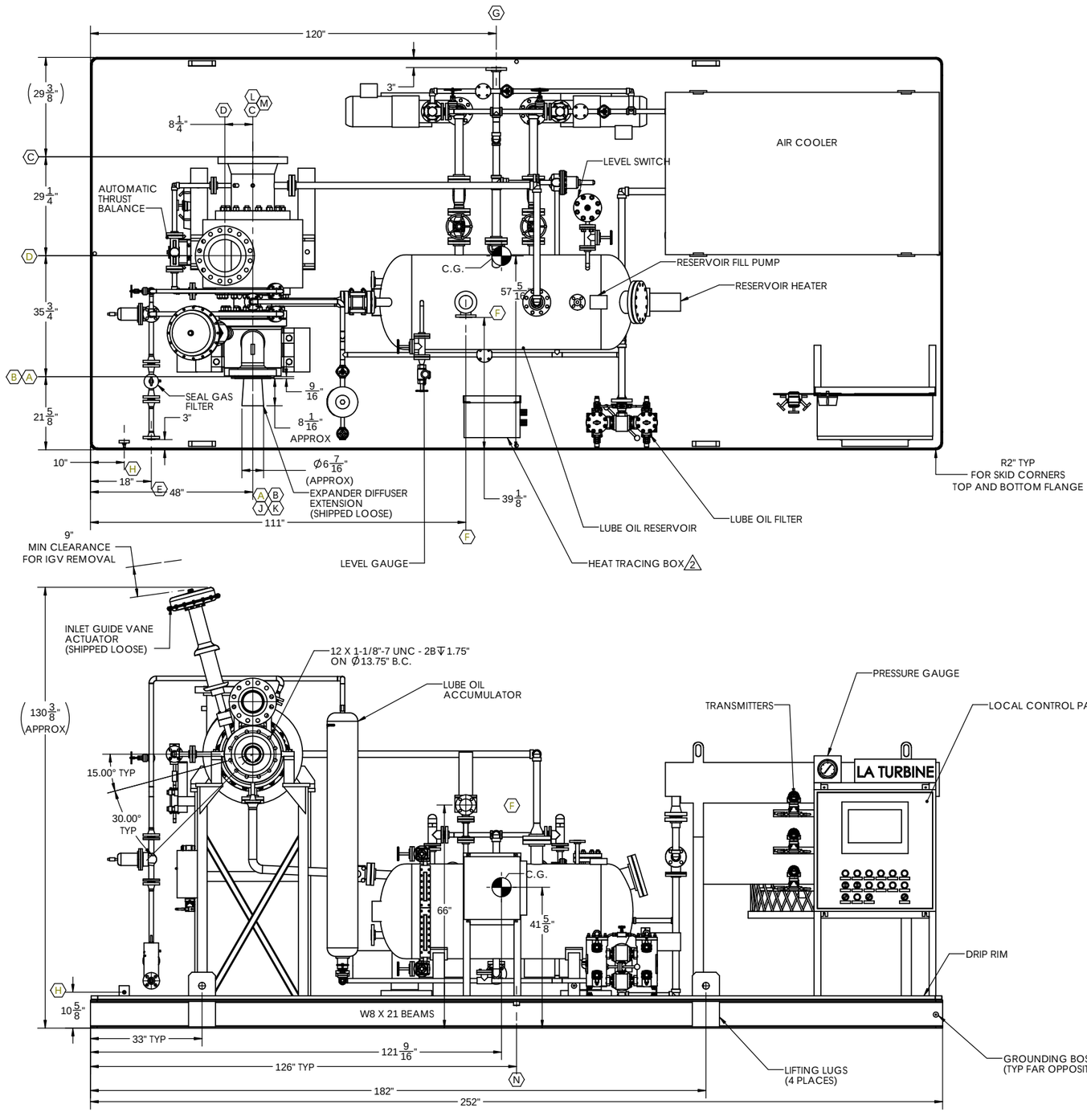
L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, if not indicated, according to: ANSI Y 14.5M 1982
Machined Surfaces N/A
DECIMALS .XXX ± XXX .XX ± XX
FRACTIONS ± XX
ANGLES ± XX
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name: CROSS SECTION EXPANDER-COMPRESSOR MODEL #20-6E7C
Material: N/A
Material - Class: N/A
File Location: V:\LAT574\MACHINE DESIGN-CORE
Job Number: LAT574
Scale: NONE
Prev. Dwg.: N/A
Orignated from: LAT573
Drawn by: TINH Date: 10-17-16
Next Dwg: N/A
Dwg/Part No.: LAT574-20-D1
Rev: 1
Std. Chk.: LT Date: 10-17-16
Blank Wt.: N/A Kg Lbs
Finished Wt.: 2200 Kg Lbs
Design Chk.: SB Date: 10-17-16
Approved: HSH Date: 10-17-16
SHEET 1 OF 1

REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	10/21/16	H.SH.
1	REVISED CONN N SIZE, WAS 3/4" UPDATED PO AND JOB NUMBER IN TITLE BLOCK	12/2/16	SB
2	AS BUILT	5/9/2017	SB

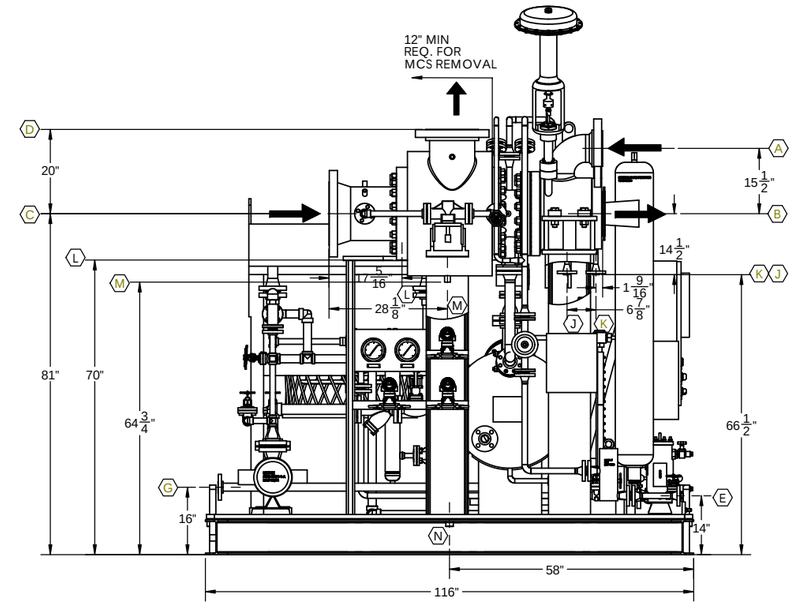


AS BUILT

CUSTOMER CONNECTIONS

CONNECTION	COMPONENT	MATING SIZE
A	EXPANDER INLET	6"-600# ANSI RF FLANGE
B	EXPANDER OUTLET	8"-600# STUDDING
C	COMPRESSOR SUCTION	12"-300# ANSI RF FLANGE
D	COMPRESSOR DISCHARGE	10"-300# ANSI RF FLANGE
E	SEAL GAS SUPPLY	1"-600# ANSI RF FLANGE
F	RESERVOIR SAFETY RELIEF	2"-150# ANSI RF FLANGE
G	RESERVOIR DRAIN	1-1/2"-300# ANSI RF FLANGE
H	INSTRUMENT AIR SUPPLY	1/2" NPTF
J	EXPANDER INLET DRAIN	3/4"-600# ANSI RF FLANGE - BLINDED
K	EXPANDER OUTLET DRAIN	3/4"-600# ANSI RF FLANGE - BLINDED
L	COMPRESSOR SUCTION DRAIN	3/4" NPT (PLUGGED)
M	COMPRESSOR DISCHARGE DRAIN	3/4" NPT (PLUGGED)
N	SKID DRAIN (QTY 4)	1" NPT (PLUGGED)

1



NOTES:
1) 3-5 PIPE DIAMETERS OF STRAIGHT PIPE ON COMPRESSOR SUCTION
2) 3-5 PIPE DIAMETERS OF STRAIGHT PIPE ON EXPANDER DISCHARGE
3) SHUTDOWN VALVE TO BE LOCATED AT MAX 10 PIPE DIAMETERS FROM EXPANDER INLET FLANGE
4) ALL DYNAMIC LOADS ARE NEGLIGIBLE.
5) CLEARANCE REQUIRED ABOVE EXPANDER/COMPRESSOR TO ALLOW FOR OVERHEAD CRANE FOR ROTATING ASSEMBLY SERVICE.
6) DRY WEIGHT OF SKID FOR LIFTING 18000 LBS. OPERATING WEIGHT: 19000 LBS.

CUSTOMER	UOP RUSSELL, LLC
FOR	TBD
PROJECT	60 MMSCFD CRYO PLANT (J447-XX)
LOCATION	TBD
P.O. NO.	4500743460
ITEM NO.	EC-101
SERVICE	TURBOEXPANDER / RECOMPRESSOR

1

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L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

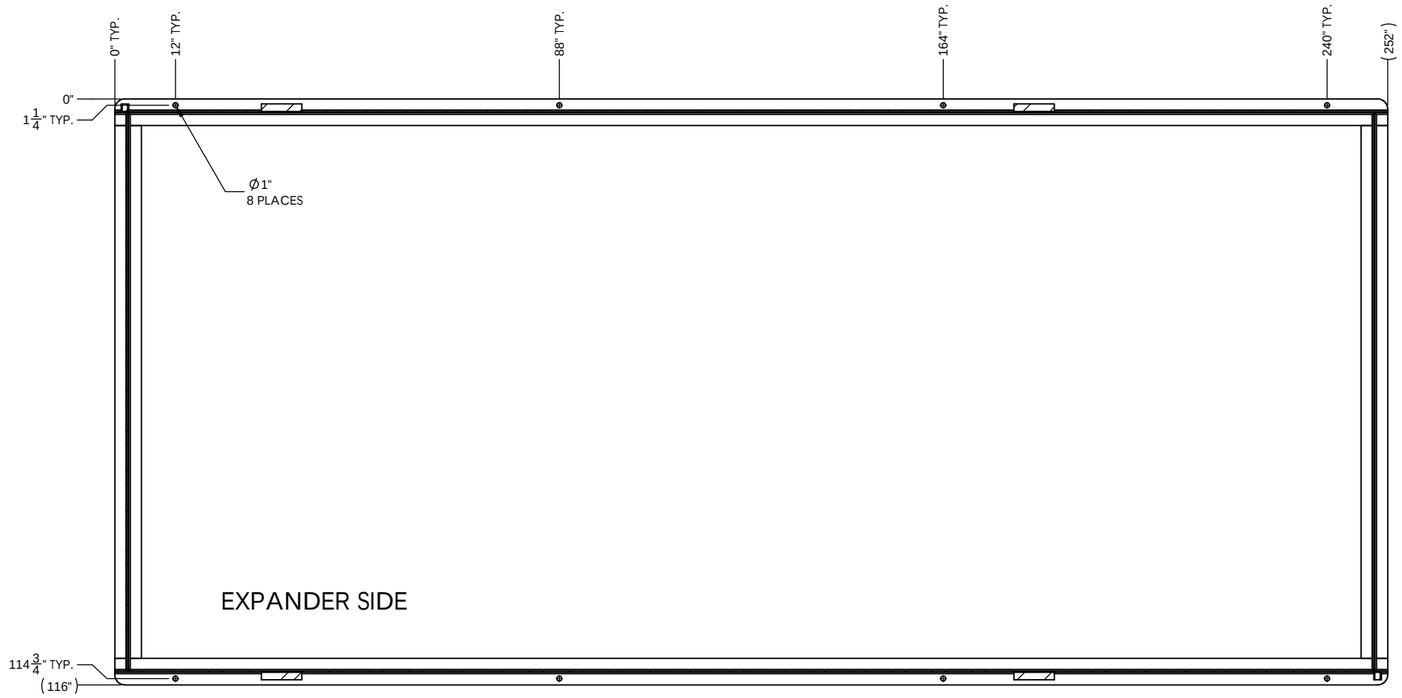
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Tolerances, if not indicated, according to: ANSI Y14.5M-2009
Machined Surfaces 125 √ UNLESS NOTED
FRACTIONS ± 1/8" ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

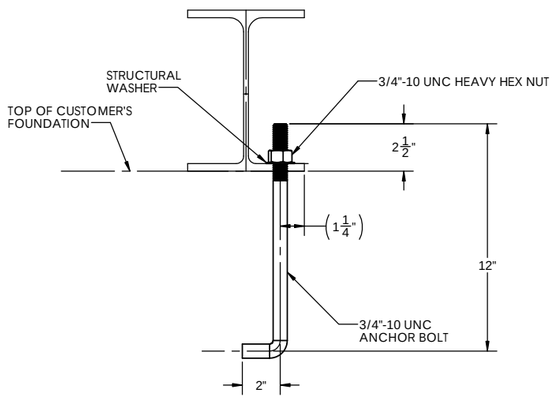
Name	LAT574 GENERAL ARRANGEMENT		
Material	N/A	Material - Class	N/A
File Location	V:\LAT574EC\GA-SKID	Job Number	LAT574
Scale	N/A	Prev. Dwg.	N/A
Drawn by	SB	Date 10/21/2016	Next Dwg N/A
Std. Chk.	RG	Date 10/21/2016	Blank Wt. N/A Kg Lbs / Finished Wt. N/A Kg Lbs
Design Chk.	H. SH.	Date 10/21/2016	Approved H.SH. Date 10/21/2016
Orignated from:	LAT573		
Dwg/Part No.	LAT574EC-20-D2	Rev	2

SHEET 1 OF 2

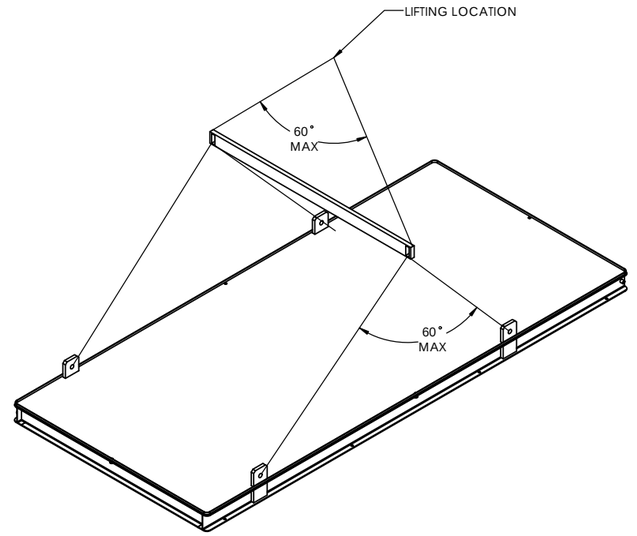
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	10/21/16	H.SH.
1	SEE SHEET 1	12/2/16	SB
2	AS BUILT	5/9/17	SB



FOUNDATION BOLTING PLAN
(TOP VIEW)
(TOP FLANGE HIDDEN FOR CLARITY)



ANCHOR DETAIL
(BY OTHERS)



LIFTING DIAGRAM
(FOR REFERENCE ONLY)
(LIFTING EQUIPMENT PROVIDED BY OTHERS)

AS BUILT

DO NOT SCALE THE DRAWING

L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, if not indicated, according to: ANSI Y14.5M-2009
Machined Surfaces 125 UNLESS NOTED
FRACTIONS ± 1/8" ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name	LAT574 GENERAL ARRANGEMENT				
Material	N/A			Material - Class	N/A
File Location	V:\LAT574EC\GA-SKID			Job Number	LAT574
Scale	N/A		Prev. Dwg. N/A	Orignated from:	LAT573
Drawn by	SB	Date 10/21/2016	Next Dwg N/A	Dwg/Part No.	LAT574EC-20-D2
Std. Chk.	RG	Date 10/21/2016	Blank Wt. N/A Kg Lbs	Finished Wt. N/A Kg Lbs	Rev 2
Design Chk.	H. SH.	Date 10/21/2016	Approved H.SH.	Date 10/21/2016	SHEET 2 OF 2

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR APPROVAL	11/03/16	HSH
1	REVISED AS NOTED	03/10/16	TA
2	AS BUILT	05/09/17	TA

SEAL GAS SIMPLEX FILTER
FILTRATION: 5 MICRON NOMINAL

F-201

CUSTOMER SUPPLIED SEAL GAS
FLOW RATE: 90/200 SCFM (MIN./MAX.)

SUPPLY PRESSURE: 400/800 PSIG (MIN./MAX.) @ 90/120°F
CONNECTION: 1"-600# ANSI RF FLG

CUSTOMER INSTRUMENT AIR SUPPLY
SUPPLY PRESSURE: MIN 80 PSIG
CONNECTION: 1/2"-NPTF

1" SCH.80 S.S.

1.5" SCH.80 C.S.

2" SCH.80 C.S.

CUSTOMER SUPPLIED

CHARGE KIT REMOVED AFTER BLADDER CHARGED (PART OF ACCUMULATOR)

PSV TO CUSTOMER CLOSED COLLECTION SYSTEM
1"-300# X 2"-150# ANSI RF FLG
SET @ 650 PSIG

INSPECTION HOLES
6"-300# ANSI RF FLG

LUBE OIL IMMERSION HEATER
3 kW, 3"-300# CONNECTION
460V/3Ø/60HZ
CL. 1, DIV. II, GR. C,D

LUBE OIL RESERVOIR
RETENTION TIME: 5 MIN.
DESIGN PRESSURE: 650 PSIG

LUBE OIL AIR COOLER
HEAT LOAD: 140,000 BTU/HR
OIL FLOW RATE: 21 GPM
LUBE OIL IN/OUT: 150/120°F
FAN MOTOR: 460V/3Ø/60HZ; 5 HP
CL. 1, DIV. II, GR. C,D

LUBE OIL DUPLEX FILTER
FILTRATION: 10 MICRON NOMINAL

LUBE OIL PUMPS
DP ACROSS PUMP: 125 PSID (NOR)
OIL FLOW TO BEARING: 15 GPM
PUMP CAPACITY: 21 GPM
PUMP MOTOR: 460V/3Ø/60HZ; 5 HP
CL. 1, DIV. II, GR. C,D

SIGNAL FROM PDAL-102

SIGNAL FROM PDAL-201
PERMISSIVE TO START

EXPANDER START — HS 101
EXPANDER STOP — HS 102 — XA 102
ALARM ACKN./RESET — HS 103
LAMP TEST — HS 104
POWER ON — HS 108 — XL 108
COMMON TROUBLE ALARM — XL 103 — XA 103
COMMON TROUBLE SHUTDOWN — XL 104 — XA 104
EXPANDER READY — XL 101
EXPANDER RUNNING — XL 102

FROM SE-501 SHAFT SPEED — ST 501 — SI 501
FROM VXE-501 EXP. BRG. VIBRATION — VXT 501 — VXI 501
FROM VXE-502 COMP. BRG. VIBRATION — VXT 502 — VXI 502
FROM TE-501A (TE-501B, SPARE) — TI 501
FROM TE-502A (TE-502B, SPARE) — TI 502

20. ✳✳ HEAT TRACING / INSULATION
19. ✳ LAT PROVIDED & SHIPPED LOOSE
18. BALL VALVE
17. NEEDLE VALVE
16. GLOBE VALVE
15. CHECK VALVE
14. GATE VALVE
13. TUBING
12. PIPING
11. ELECTRICAL
10. SOFTLINK
9. LAT INTERFACE CONNECTION
8. MCC — MOTOR CONTROL CENTER (BY CUSTOMER)
7. CUSTOMER MATING CONNECTION
6. DCS DISPLAY (BY CUSTOMER)
5. PLC ON CONTROL PANEL
4. HMI DISPLAY
3. LOCAL LAMP
2. LOCAL PANEL MOUNTED INSTRUMENT
1. LOCALLY MOUNTED INSTRUMENT

NOTES:

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

AS BUILT

L.A. Turbine Corporation
28557 INDUSTRY DR
VALENCIA, CA 91355

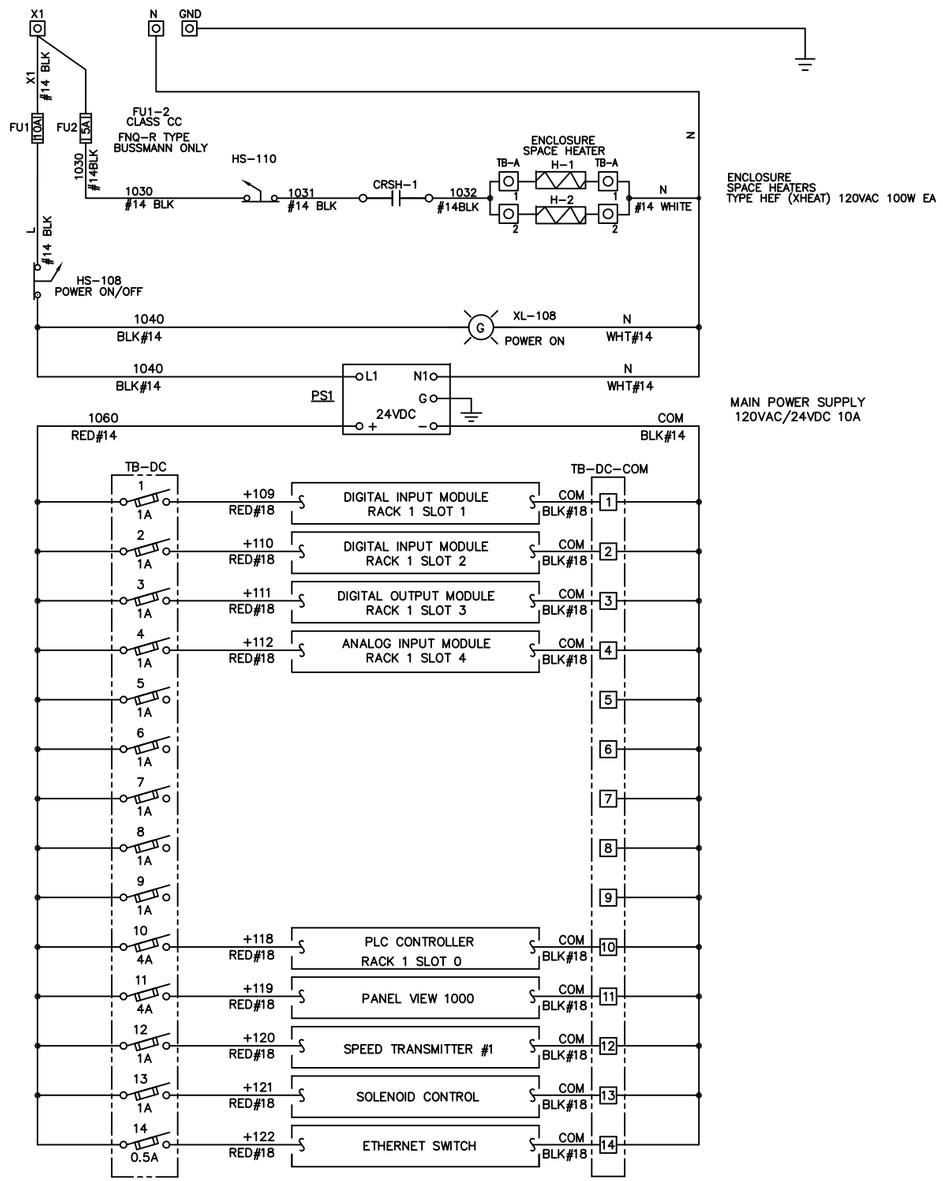
Name	SYSTEM P&ID		
Dwg/Part No.	LAT574EC-20-D3 SHEET 1 OF 1		Rev 2
Job Number	LAT574EC	File Location	V:\574EC\PID&BOM
Drawn by	B.G.	Date	11/03/16
Std. Chk.	SB	Date	11/03/16
Design Chk.	RG	Date	11/03/16
Approved	HSH	Date	11/03/16

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POWER DISTRIBUTION

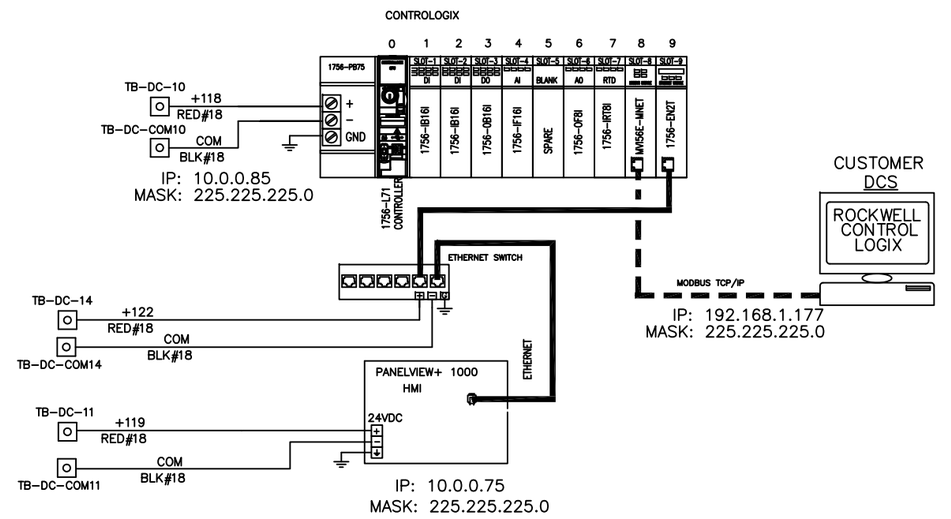
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/8/17	R.S.
2	REPLACED ANALOG OUTPUT & RTD MODULES SHT7 & 8	04/3/17	R.S.
3	AS BUILT FINAL	05/12/17	R.S.

DISCONNECTING MEANS AND
UPS POWER SUPPLY BY CUSTOMER
POWER CONSUMPTION
115V/1PH/60HZ, 8 FLA
USE 60/75° COPPER WIRE ONLY
TORQUE: 6.5 LB-IN
TERMINALS SUITABLE FOR AWG22...12, 600V 30A



ENCLOSURE
SPACE HEATERS
TYPE HEF (XHEAT) 120VAC 100W EA

MAIN POWER SUPPLY
120VAC/24VDC 10A



General Notes:

1. Individual wire, except as noted, is type MTW, THHN, or similar stranded copper, rated 600 volt, 90 deg. C
2. Minimum wire size in control enclosures, unless otherwise noted:
   18 AWG for individual conductors
   22 AWG for multiconductor jacketed cable
3. Minimum wire size outside control enclosures:
   18 AWG for individual conductors in raceways
   22 AWG for multiconductor jacketed
   DC power wiring shall be minimum
   16 AWG for individual conductors
4. Wire color shall be as follows:

   120VAC power – H/N/G = black/white/green
   24VDC power +/– = red/black
   24DC signal = purple
   120VAC signal = yellow
   Analog signal = (pairs) +/– black/white
   = (triads) +/Sig/– red/black/white

5. All single conductors wires shall be labeled. Labels shall be machine printed tubular heat shrink labels. All labels shall be legible, handwritten labels are not acceptable
6. Grounding: All metal enclosures and panels exposed to electrical wiring shall be grounded.
7. Grounding conductors shall be copper. Conduit and enclosures shall not be used as a grounding conductor.

1756-L71 Firmware version 24.12
Studio 500 Logix Designer Version 24.01
Factory Talk Studio Software Version 8.0

AS BUILT

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

DO NOT SCALE THE DRAWING

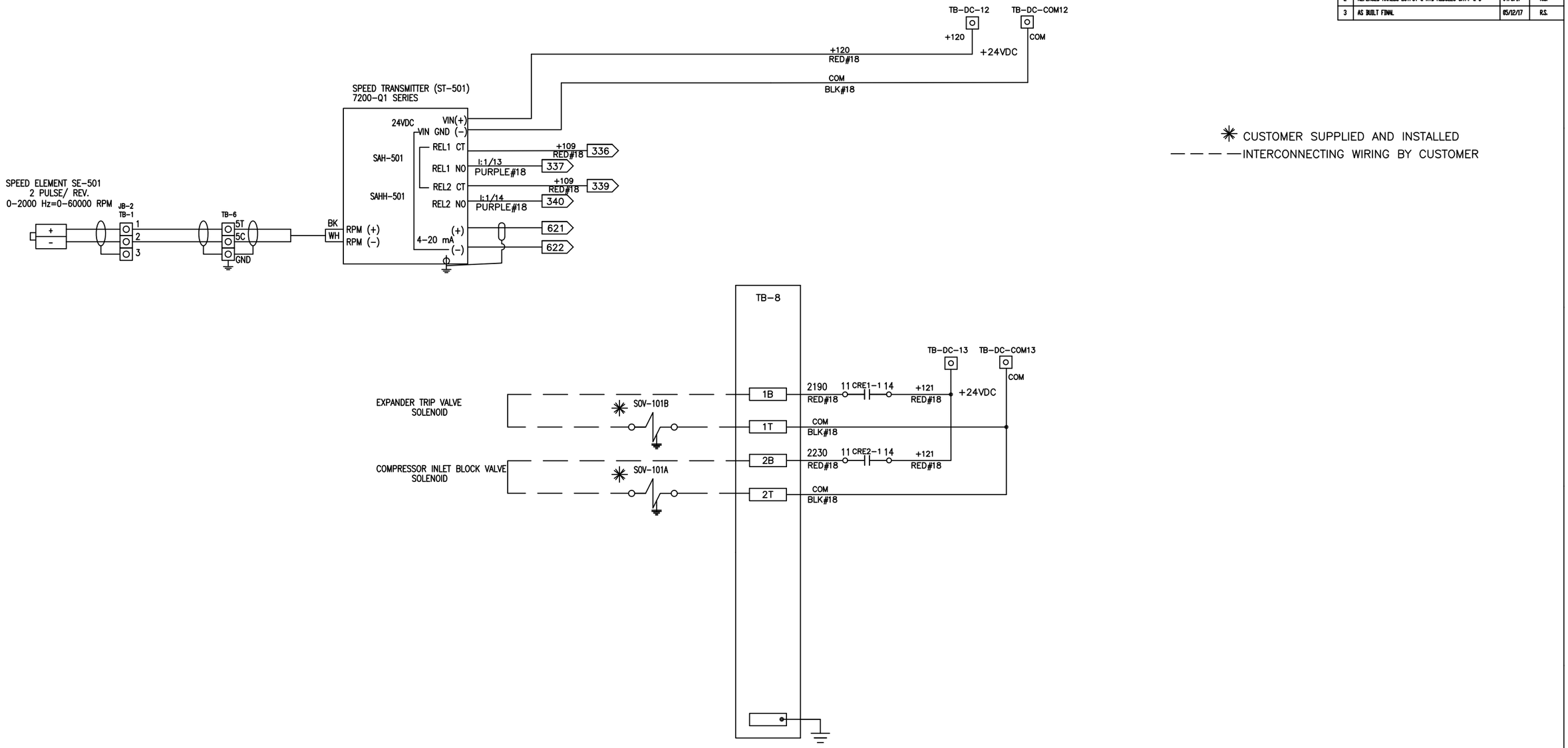
L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

Tolerances, if not indicated, according to ANSI Y 14.5M 1982
Machined Surfaces 125 √ UNLESS NOTED
DECIMALS XXX ± 0.005 XX ± 0.01
FRACTIONS ± 1/8 ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name: CONTROL WIRING DIAGRAM
Material: N/A
File Location: V:\VAULT\LAT574\ELECTRICAL
Scale: XX
Drawn by: LB Date: 8/29/16
Std. Chk.: JBR Date: 8/29/16
Design Chk.: R.S. Date: 8/29/16
Prev. Dwg.: N/A
Next Dwg: N/A
Blank Wt.: N/A Kg Lbs
Finished Wt.: XXX Kg Lbs
Approved: R.S. Date: 8/29/16
Material - Class: N/A
Job Number: STL 001-D4 R1
Originated from: N/A
Dwg/Part No.: LAT574EC-20-D4
Rev: 3
SHEET 1 OF 8

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REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/8/17	R.S.
2	REPLACED ANALOG OUTPUT & RTD MODULES SHT7 & 8	04/3/17	R.S.
3	AS BUILT FINAL	05/12/17	R.S.



AS BUILT

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

DO NOT SCALE THE DRAWING

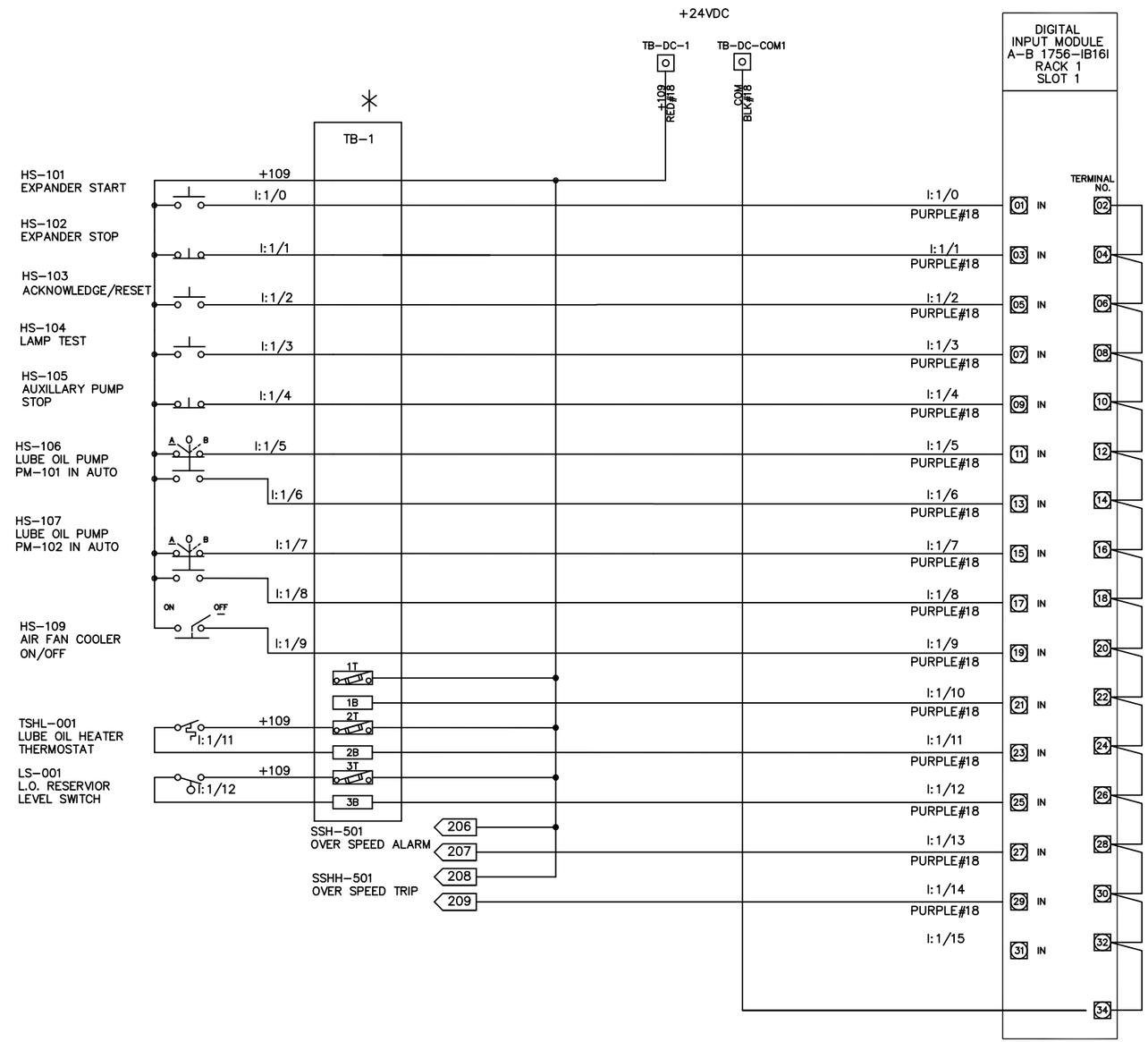
L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

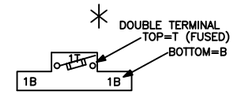
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Tolerances, if not indicated, according to: ANSI Y 14.5M 1982
Machined Surfaces 125 √ UNLESS NOTED
DECIMALS .XXX ± 0.005 .XX ± 0.01
FRACTIONS ± 1/16 ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name: CONTROL WIRING DIAGRAM
Material: N/A
File Location: V:\VAULT\LAT574\ELECTRICAL
Scale: XX
Drawn by: J.B. Date: 8/29/16
Std. Chk.: JBR Date: 8/29/16
Design Chk.: R.S. Date: 8/29/16
Prev. Dwg.: N/A
Next Dwg: N/A
Blank Wt.: N/A Kg Lbs
Approved: R.S. Date: 8/29/16
Finished Wt.: XXX Kg Lbs
Material - Class: N/A
Job Number: STL 001-04 R1
Originated from: N/A
Dwg/Part No.: LAT574EC-20-D4
Rev: 3

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/8/17	R.S.
2	REPLACED ANALOG OUTPUT & RTD MODULES SHT7 & 8	04/3/17	R.S.
3	AS BUILT FINAL	05/12/17	R.S.





AS BUILT

DIGITAL INPUT 1

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

DO NOT SCALE THE DRAWING

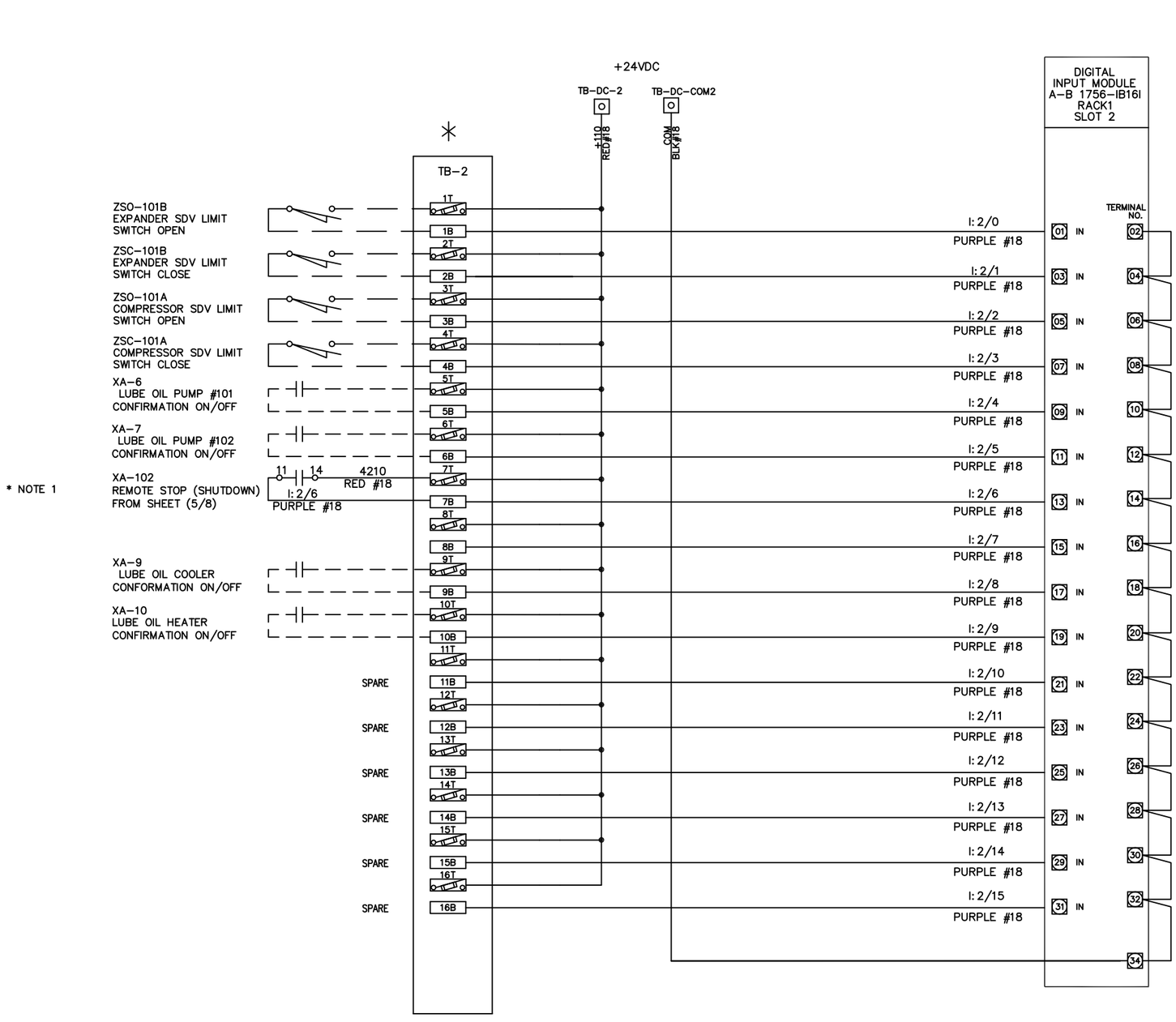
L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

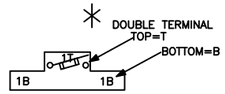
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Tolerances, if not indicated, according to ANSI Y 14.5M 1982
Machined Surfaces 125 √ UNLESS NOTED
DECIMALS XXX ± 0.005 XX ± 0.01
FRACTIONS ± 1/8" ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR 305R

Name	CONTROL WIRING DIAGRAM				
Material	N/A			Material - Class	N/A
File Location	V:\VAULT\LAT574\ELECTRICAL			Job Number	STL 001-D4 R1
Scale	XX		Prev. Dwg.	N/A	Originated from N/A
Drawn by	J.B.	Date 8/29/16	Next Dwg	N/A	Dwg/Part No. LAT574EC-20-D4 Rev 3
Std. Chk.	J.B.R.	Date 8/29/16	Blank Wt. N/A Kg Lbs	Finished Wt. XXX Kg Lbs	
Design Chk.	R.S.	Date 8/29/16	Approved R.S.	Date 8/29/16	SHEET 3 OF 8

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/8/17	R.S.
2	REPLACED ANALOG OUTPUT & RTD MODULES SHT7 & 8	04/3/17	R.S.
3	AS BUILT FINAL	05/12/17	R.S.





Notes:

1. Customer supplied process interlock shutdown contact will trip expander/compressor, closing the fast acting trip valve and closing the IGV.

— — — — INTERCONNECTING WIRING BY CUSTOMER

AS BUILT

DIGITAL INPUT 2

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

DO NOT SCALE THE DRAWING

L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, if not indicated, according to ANSI Y 14.5M 1982
Machined Surfaces 125 √ UNLESS NOTED
DECIMALS XXX ± 0.005 XX ± 0.01
FRACTIONS ± 1/16 ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR JABR

Name: CONTROL WIRING DIAGRAM
Material: N/A
Material - Class: N/A
File Location: V:\VAULT\LAT574\ELECTRICAL
Job Number: STL 001-D4 R1
Scale: XX
Prev. Dwg.: N/A
Originated from: N/A
Drawn by: J.B. Date: 8/29/16
Next Dwg: N/A
Dwg/Part No.: LAT574EC-20-D4
Rev: 3
Std. Chk.: JBR Date: 8/29/16
Blank Wt.: N/A Kg Lbs
Finished Wt.: XXX Kg Lbs
Design Chk.: R.S. Date: 8/29/16
Approved: R.S. Date: 8/29/16
SHEET 4 OF 8

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/8/17	R.S.
2	REPLACED ANALOG OUTPUT & RTD MODULES SHT7 & 8	04/3/17	R.S.
3	AS BUILT FINAL	05/12/17	R.S.

DIGITAL OUTPUT 1

+24VDC

TB-DC-3 — +111 RED#18 — +111 RED #18AWG

TB-DC-COM3 — COM BLK#18

DIGITAL OUTPUT MODULE
A-B 1756-OB16I
RACK 1
SLOT 3

TB-3

TERMINAL NO.				
02	OUT0	O:3/0 PURPLE#18	G	XL-101 EXPANDER READY
04	OUT1	O:3/1 PURPLE#18	R	XL-102 EXPANDER RUNNING
06	OUT2	O:3/2 PURPLE#18	A	XL-103 COMMON TROUBLE ALARM
08	OUT3	O:3/3 PURPLE#18	R	XL-104 COMMON TROUBLE SHUTDOWN
10	OUT4	O:3/4 PURPLE#18	A	XL-105 AUXILIARY PUMP RUNNING
12	OUT5	O:3/5 PURPLE#18	1T(160mA) 1B	CRA 1 — COMMON TROUBLE ALARM
14	OUT6	O:3/6 PURPLE#18	2T(160mA) 2B	CRS 1 — COMMON TROUBLE SHUTDOWN
16	OUT7	O:3/7 PURPLE#18	2T(160mA) 3B	CRSH 1 — SPACE HEATER CONTROL RELAY
18	OUT8	O:3/8 PURPLE#18	4T(160mA) 4B	CRE 1 — EXPANDER INLET TRIP VALVE SOLENOID SOV-101B CONTROL RELAY
20	OUT9	O:3/9 PURPLE#18	5T(160mA) 5B	CRP 1 — LUBE OIL PUMP PM-101 MOTOR CONTROL RELAY
22	OUT10	O:3/10 PURPLE#18	6T(160mA) 6B	CRP 2 — LUBE OIL PUMP PM-102 MOTOR CONTROL RELAY
24	OUT11	O:3/11 PURPLE#18	7T(160mA) 7B	CRF 1 — OIL FAN COOLER FM-101 MOTOR CONTROL RELAY
26	OUT12	O:3/12 PURPLE#18	8T(160mA) 8B	CRL 1 — LUBE OIL LEVEL LOW CONTROL RELAY HEATER CUT OFF
28	OUT13	O:3/13 PURPLE#18	9T(160mA) 9B	CRE 2 — COMPRESSOR SUCTION BLOCK VALVE SOLENOID SOV-101A CONTROL RELAY
30	OUT14	O:3/14 PURPLE#18	10T(160mA) 10B	
32	OUT15	O:3/15 PURPLE#18	11T(160mA) 11B	
34				

COM BLK#18AWG

** 7B I:2/6 11 — 7T 4210 14 — XA 11 (A1+ / A2-)

TB-CR1

5040 YEL#16 — 11 CRA1-1 14 — 5041 YEL#16	1T / 1B	COMMON TROUBLE ALARM XA-103
5070 YEL#16 — 11 CRS1-1 14 — 5071 YEL#16	2T / 2B	COMMON TROUBLE SHUTDOWN XA-104
5110 YEL#16 — 21 CRE1-2 24 — 5111 YEL#16	3T / 3B	XA-101B EXPANDER RUNNING STATUS (TRIP VALVE RELAY ENERGIZED)
5210 RED#18 — A1+	4T	24VDC REMOTE STOP (SHUTDOWN) FROM DCS XA-102 (SEE SHEET 4/8)
A2- — 5211 BLK#18	4B	
5220 YEL#16 — 21 CRE2-2 24 — 5221 YEL#16	5T / 5B	COMPRESSOR SUCTION BLOCK VALVE SOLENOID CONTROL RELAY STATUS

TO DCS

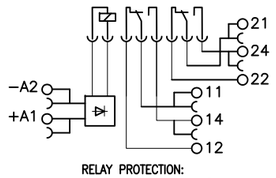
TB-CR2

5150 YEL#16 — 11 CRP1-1 14 — 5151 YEL#16	1T / 1B (+ / -)	LUBE OIL PUMP PM-101 MOTOR CONTROL RELAY
5190 YEL#16 — 11 CRP2-1 14 — 5191 YEL#16	2T / 2B	LUBE OIL PUMP PM-102 MOTOR CONTROL RELAY
5230 YEL#16 — 11 CRF1-1 14 — 5231 YEL#16	3T / 3B	OIL FAN COOLER FM-101 MOTOR CONTROL RELAY
5270 YEL#16 — 11 CRL1-1 14 — 3271 YEL#16	4T / 4B	LUBE OIL LEVEL LOW CONTROL RELAY HEATER H-001 CUT OFF

TO MCC

RELAY DETAILS

PLC-RSC- 24DC/21-21
COIL: 17.5mA
CONTACTS: Limiting continuous current 6 A



RELAY PROTECTION:
Internal Polarity Protection Diode

Notes:

1. For Utility Consumption List see drawings: LAT574EC-20-A62 & LAT574EC-20-A11

* DOUBLE TERMINAL TOP=T BOTTOM=B (1T / 1B)

** Relay contact rating:
Maximum inrush current 15 A (300 ms)
Min. switching current 10 mA
Limiting continuous current 6 A
Interrupting rating (ohmic load) max. 140 W (for 24 V DC)
1500 VA (for 250 V AC)

AS BUILT

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

DO NOT SCALE THE DRAWING

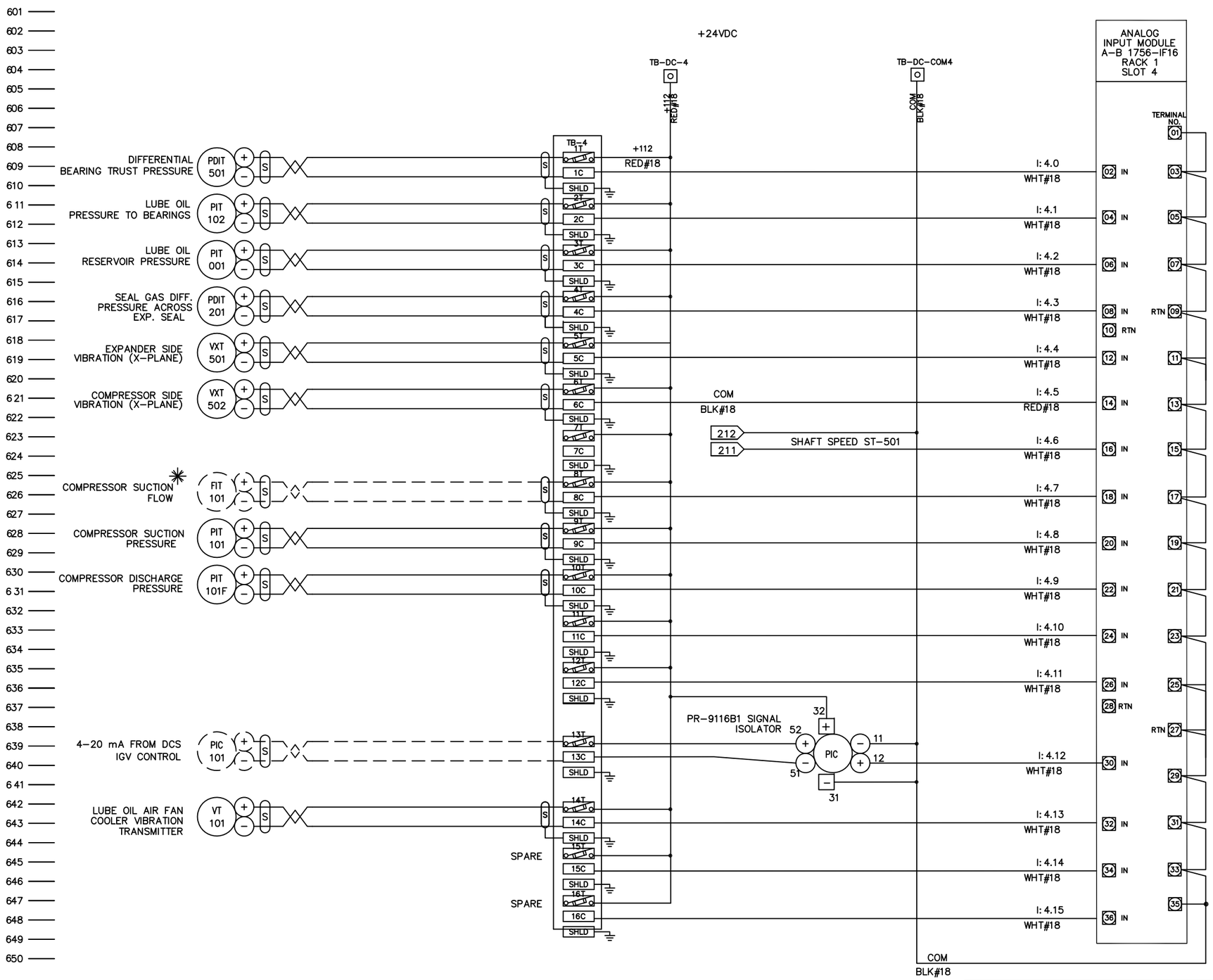
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28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, if not indicated, according to ANSI Y 14.5M 1982 — Machined Surfaces 125 √ UNLESS NOTED — DECIMALS XXX ± 0.005 XX ± 0.01 — FRACTIONS ± 1/8 ANGLES ± 1/4° — Units = Inches — BREAK ALL SHARP CORNERS & DEBURR .005R

Name	CONTROL WIRING DIAGRAM				
Material	N/A			Material - Class	N/A
File Location	V:\VAULT\LAT574\ELECTRICAL			Job Number	STL 001-D4 R1
Scale	XX		Prev. Dwg. N/A	Originated from	N/A
Drawn by	J.B.	Date 8/29/16	Next Dwg N/A	Dwg/Part No.	LAT574EC-20-D4 — Rev 3
Std. Chk.	JBR	Date 8/29/16	Blank Wt. N/A Kg Lbs	Finished Wt. XXX Kg Lbs	
Design Chk.	R.S.	Date 8/29/16	Approved R.S.	Date 8/29/16	SHEET 5 OF 8

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/8/17	R.S.
2	REPLACED ANALOG OUTPUT & RTD MODULES SHT7 & 8	04/3/17	R.S.
3	AS BUILT FINAL	05/12/17	R.S.



AS BUILT

ANALOG INPUT 1

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

DO NOT SCALE THE DRAWING

L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Machined Surfaces 125 √ UNLESS NOTED
DECIMALS XXX ± 0.005 XX ± 0.01
FRACTIONS ± 1/8 ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name: CONTROL WIRING DIAGRAM
Material: N/A
File Location: V:\VAULT\LAT574\ELECTRICAL
Scale: XX
Drawn by: JB Date: 8/29/16
Std. Chk.: JBR Date: 8/29/16
Design Chk.: R.S. Date: 8/29/16
Prev. Dwg.: N/A
Next Dwg: N/A
Blank Wt.: N/A Kg Lbs
Finished Wt.: XXX Kg Lbs
Approved: R.S. Date: 8/29/16
Material - Class: N/A
Job Number: STL 001-D4 R1
Originated from: N/A
Dwg/Part No.: LAT574EC-20-D4
Rev: 3
SHEET 6 OF 8

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ANALOG OUTPUT 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/8/17	R.S.
2	REPLACED ANALOG OUTPUT & RTD MODULES SHT7 & 8	04/3/17	R.S.
3	AS BUILT FINAL	05/12/17	R.S.

ANALOG OUTPUT
A–B 1756–OF8I
RACK 1
SLOT 6

OUT_0/V	2	
OUT_0/I	4	OUT–0:6/0
RTN_0	6	RTN–0:6/0
OUT_1/V	1	
OUT_1/I	3	OUT–0:6/1
RTN_1	5	RTN–0:6/1
NOT USED	7	
NOT USED	8	
OUT_2/V	10	
OUT_2/I	12	OUT–0:6/2
RTN_2	14	RTN–0:6/2
OUT_3/V	9	
OUT_3/I	11	OUT–0:6/3
RTN_3	13	RTN–0:6/3
NOT USED	15	
NOT USED	16	
OUT_4/V	18	
OUT_4/I	20	
RTN_4	22	
OUT_5/V	17	
OUT_5/I	19	
RTN_5	21	
NOT USED	23	
NOT USED	24	
OUT_6/V	26	
OUT_6/I	28	
RTN_6	30	
OUT_7/V	25	
OUT_7/I	27	
RTN_7	29	
NOT USED	31	
NOT USED	32	
NOT USED	33	
NOT USED	34	
NOT USED	35	
NOT USED	36	

* TB–6

CBL O:6.0
- S
- 1T
- 1C
- SHLD

S → I/P PY 101 (+ / –)

CONTROL SIGNAL TO INLET GUIDE VANE (IGV) PNEUMATIC CONVERTOR
(EACH TIME EXPANDER SHUTS DOWN, IGV CLOSES)

CBL O:6.1
- S
- 2T
- 2C
- SHLD

S → FY 101 (+ / –)

RECYCLE /ANTI–SURGE VALVE PNEUMATIC CONVERTOR

CBL O:6.2
- S
- 3T
- 3C
- SHLD

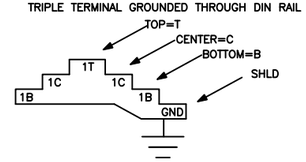
S → SI 501

SPEED INDICATION TO DCS
4–20mA = 60000RPM

CBL O:6.3
- S
- 4T
- 4C
- SHLD

SPARE

* TRIPLE TERMINAL GROUNDED THROUGH DIN RAIL



– – – – INTERCONNECTING WIRING BY CUSTOMER

AS BUILT

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC–101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

DO NOT SCALE THE DRAWING

L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

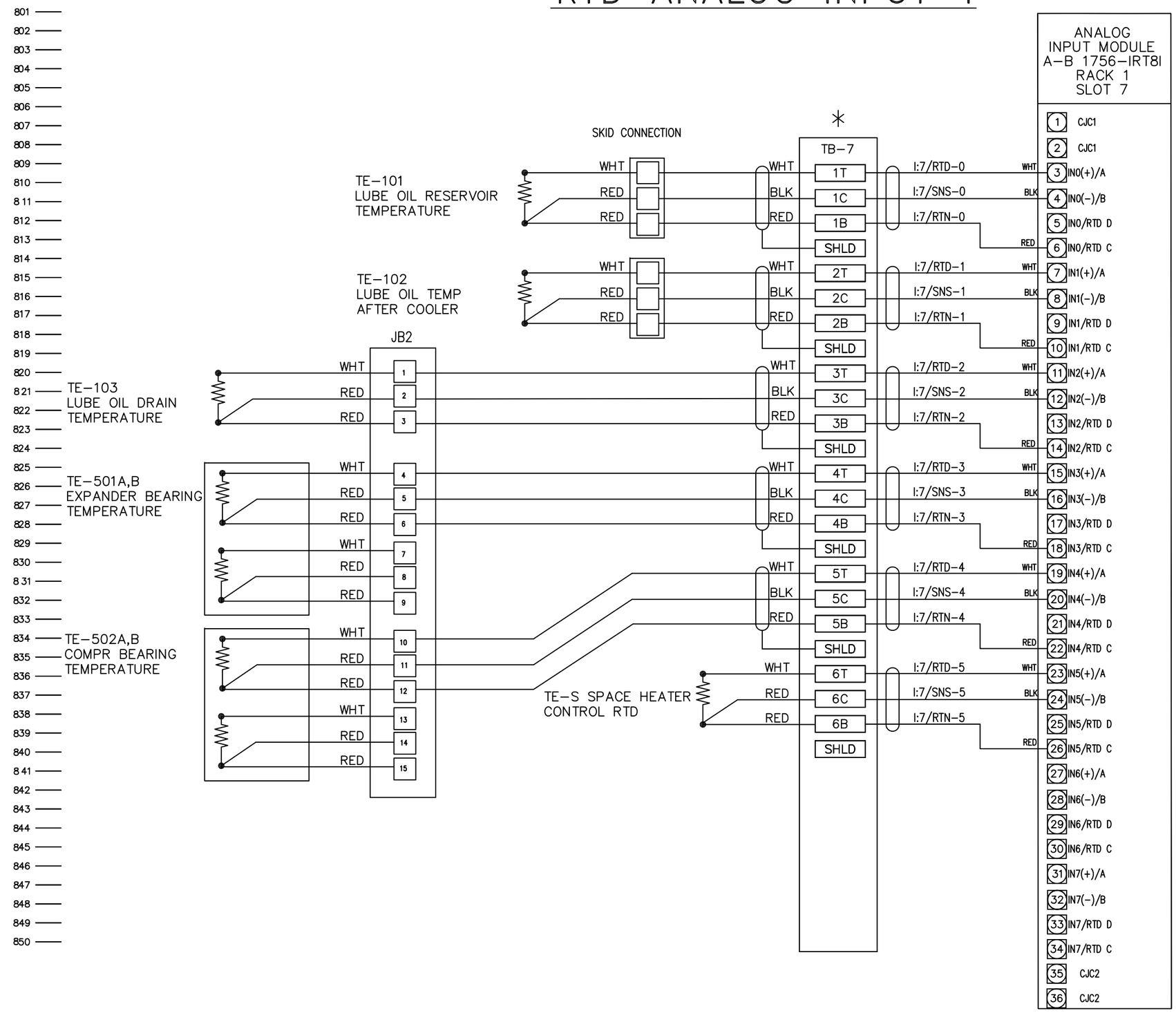
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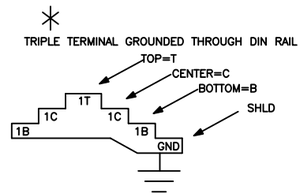
Tolerances, if not indicated, according to ANSI Y 14.5M 1982
Machined Surfaces 125 √ UNLESS NOTED
DECIMALS XXX ± 0.005 XX ± 0.01
FRACTIONS ± 1/8 ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name: CONTROL WIRING DIAGRAM
Material: N/A
File Location: V:\VAULT\LAT574\ELECTRICAL
Material – Class: N/A
Job Number: STL 001–D4 R1
Scale: XX
Prev. Dwg.: N/A
Originated from: N/A
Drawn by: JB Date: 8/29/16
Next Dwg: N/A
Std. Chk.: JBR Date: 8/29/16
Blank Wt.: N/A Kg Lbs
Finished Wt.: XXX Kg Lbs
Design Chk.: R.S. Date: 8/29/16
Approved: R.S. Date: 8/29/16
Dwg/Part No.: LAT574EC–20–D4
Rev: 3

RTD ANALOG INPUT 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/8/17	R.S.
2	REPLACED ANALOG OUTPUT & RTD MODULES SHT7 & 8	04/3/17	R.S.
3	AS BUILT FINAL	05/12/17	R.S.





AS BUILT

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

DO NOT SCALE THE DRAWING

L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

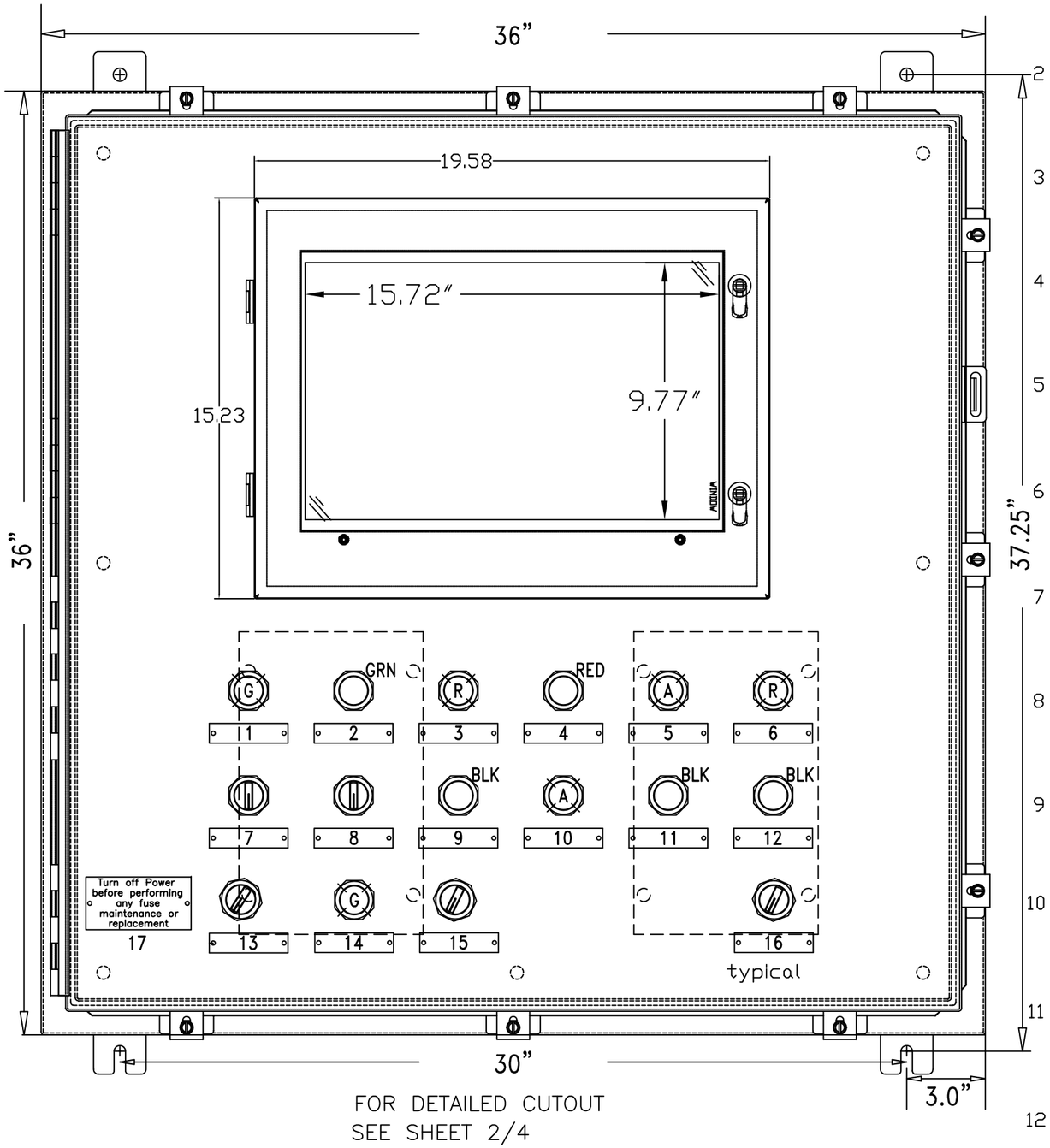
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Tolerances, if not indicated, according to ANSI Y 14.5M 1982
Machined Surfaces 125 √ UNLESS NOTED
DECIMALS XXX ± 0.005 XX ± 0.01
FRACTIONS ± 1/8" ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name	CONTROL WIRING DIAGRAM		
Material	N/A	Material - Class	N/A
File Location	V:\VAULT\LAT574\ELECTRICAL	Job Number	STL 001-04 R1
Scale	XX	Prev. Dwg.	N/A
Drawn by	J.B. Date 8/29/16	Next Dwg	N/A
Std. Chk.	JBR Date 8/29/16	Blank Wt. N/A Kg Lbs	Finished Wt. XXX Kg Lbs
Design Chk.	R.S. Date 8/29/16	Approved R.S. Date	8/29/16
Originated from	N/A		
Dwg/Part No.	LAT574EC-20-D4	Rev	3

SHEET 8 OF 8

RTD ANALOG INPUT 1

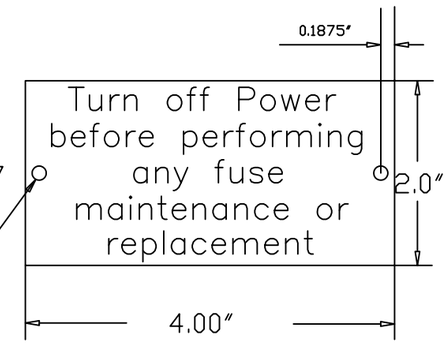


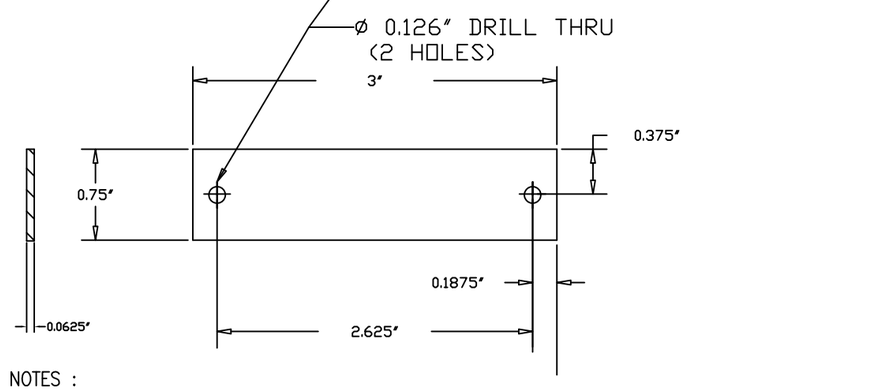
FOR DETAILED CUTOUT
SEE SHEET 2/4

1	EXPANDER READY
2	EXPANDER START
3	EXPANDER RUNNING
4	EXPANDER STOP
5	COMMON TROUBLE ALARM
6	COMMON TROUBLE SHUTDOWN
7	HAND OFF AUTO LUBE OIL PUMP PM-1
8	HAND OFF AUTO LUBE OIL PUMP PM-2
9	AUX. PUMP STOP
10	AUX. PUMP RUNNING
11	LAMP TEST
12	ALARM ACKNOWLEDGE /RESET
13	ON OFF CONTROL POWER
14	CONTROL POWER ON
15	ON OFF AIR FAN COOLER
16	ON OFF SPACE HEATER POWER
17	Turn off Power before performing any fuse maintenance or replacement

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/08/17	R.S.
2	UPDATED	4/03/17	R.S.
3	AS BUILT FINAL	5/12/17	R.S.

1. LETTERS TO BE 1/4" HIGH GOTHIC TYPE, ENGRAVED THRU RED PLASTIC WITH WHITE LETTERS.





NOTES :
1. LETTERS TO BE 1/8" HIGH GOTHIC TYPE, ENGRAVED THRU WHITE PLASTIC WITH BLACK LETTERS.
2. DIMENSIONS SHOWN ARE IN DUAL UNITS, i.e., IN. [MM].

AS BUILT

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

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28557 INDUSTRY DRIVE
VALENCIA, CA 91355

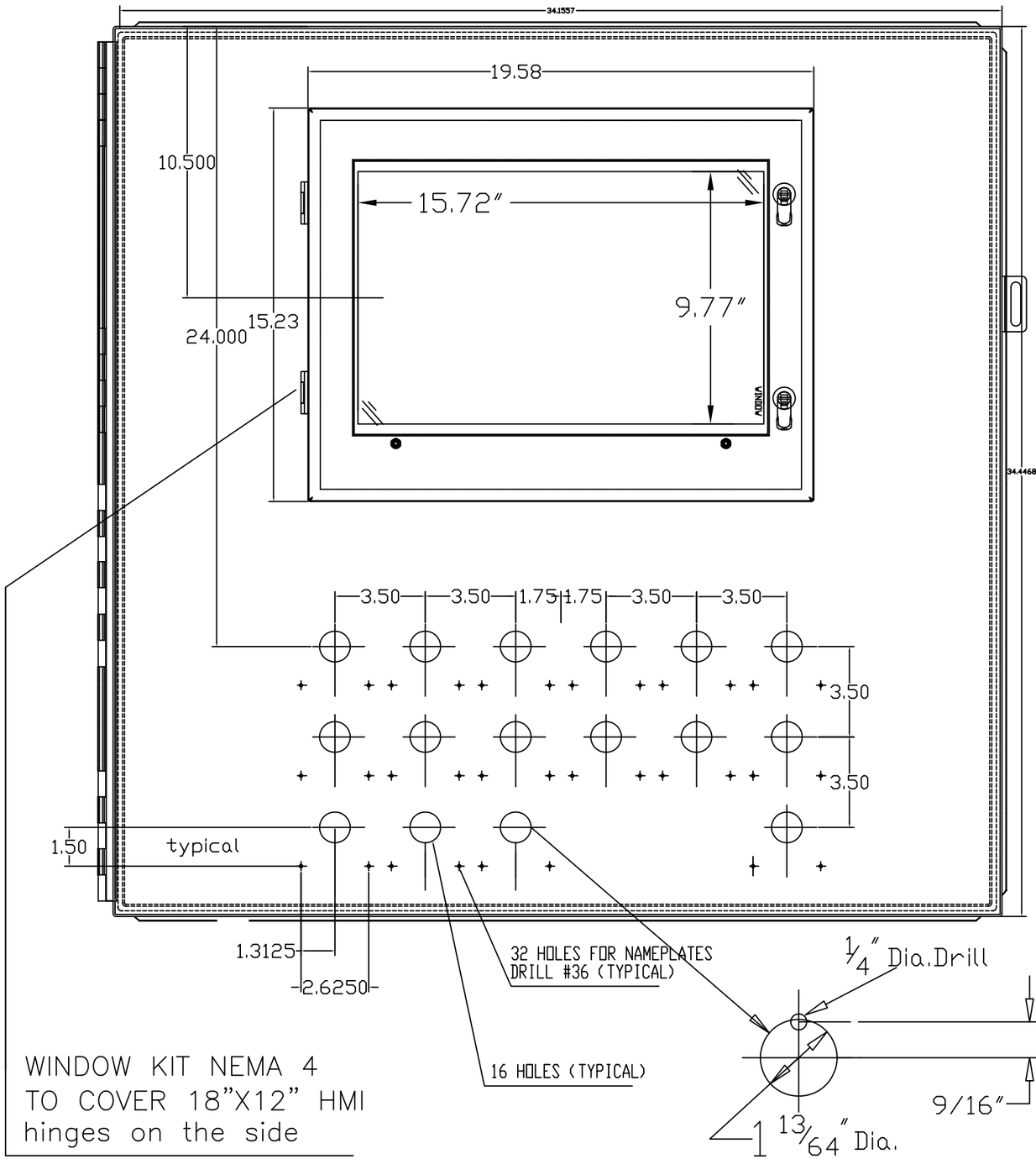
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Tolerances, if not indicated, according to: ANSI Y 14.5M 1982
Machined Surfaces 125 UNLESS NOTED
DECIMALS .XXX ± 0.005 .XX ± 0.01
FRACTIONS ± 1/8" ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name	CONTROL PANEL LAYOUT				
Material	N/A			Material - Class	N/A
File Location	V:\VAULT\LAT574\ELECTRICAL			Job Number	STL 001-D5 R1
Scale	X:X		Prev. Dwg.	N/A	Drignated from N/A
Drawn by	J.B.	Date 8/29/16	Next Dwg	N/A	Dwg/Part No. LAT574EC-20-D5 Rev 3
Std. Chk.	JBR	Date 8/29/16	Blank Wt.	N/A Kg Lbs	Finished Wt. XXX Kg Lbs
Design Chk.	R.S.	Date 8/29/16	Approved	R.S.	Date 8/29/16

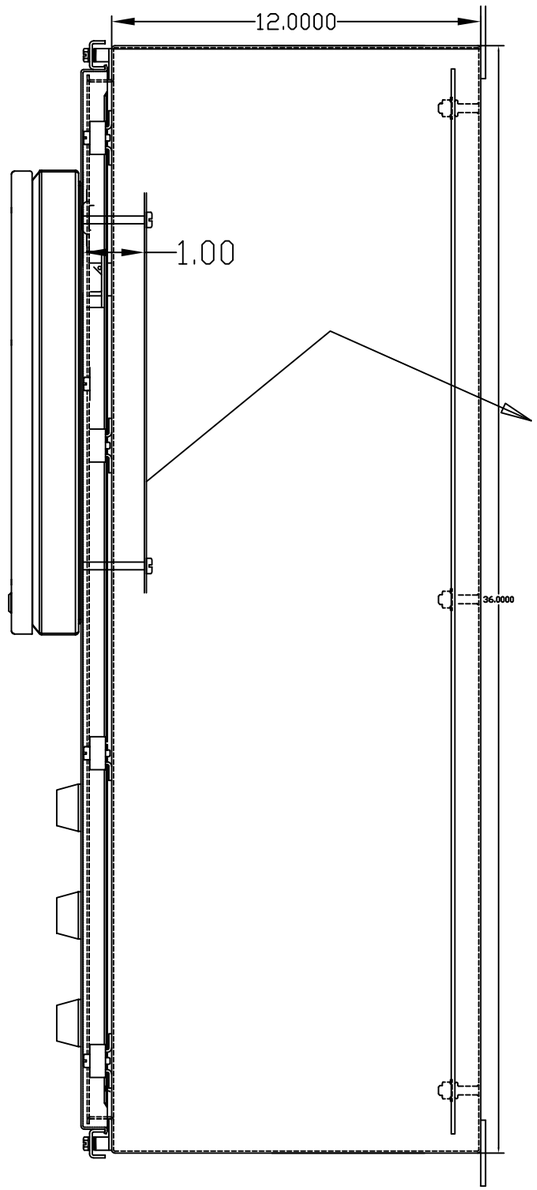
SHEET 1 OF 4

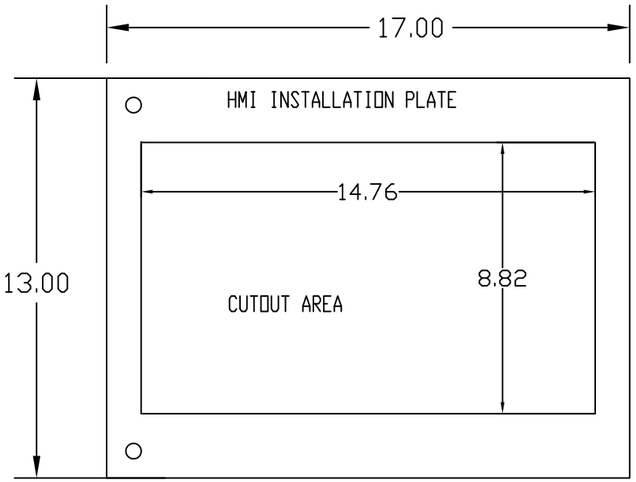
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/08/17	R.S.
2	UPDATED	4/03/17	R.S.
3	AS BUILT FINAL	5/12/17	R.S.



WINDOW KIT NEMA 4
TO COVER 18"X12" HMI
hinges on the side

HOLES FOR PILOT LIGHTS & SWITCHES DETAIL





1. ENCLOSURE 36X36X12 NEMA 4
2. WINDOW KIT TO COVER 18"X12" HMI NEMA 4
3. PANEL ONLY FOR AN HMI INSTALLATION 17 x 13,

AS BUILT

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

DO NOT SCALE THE DRAWING

L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

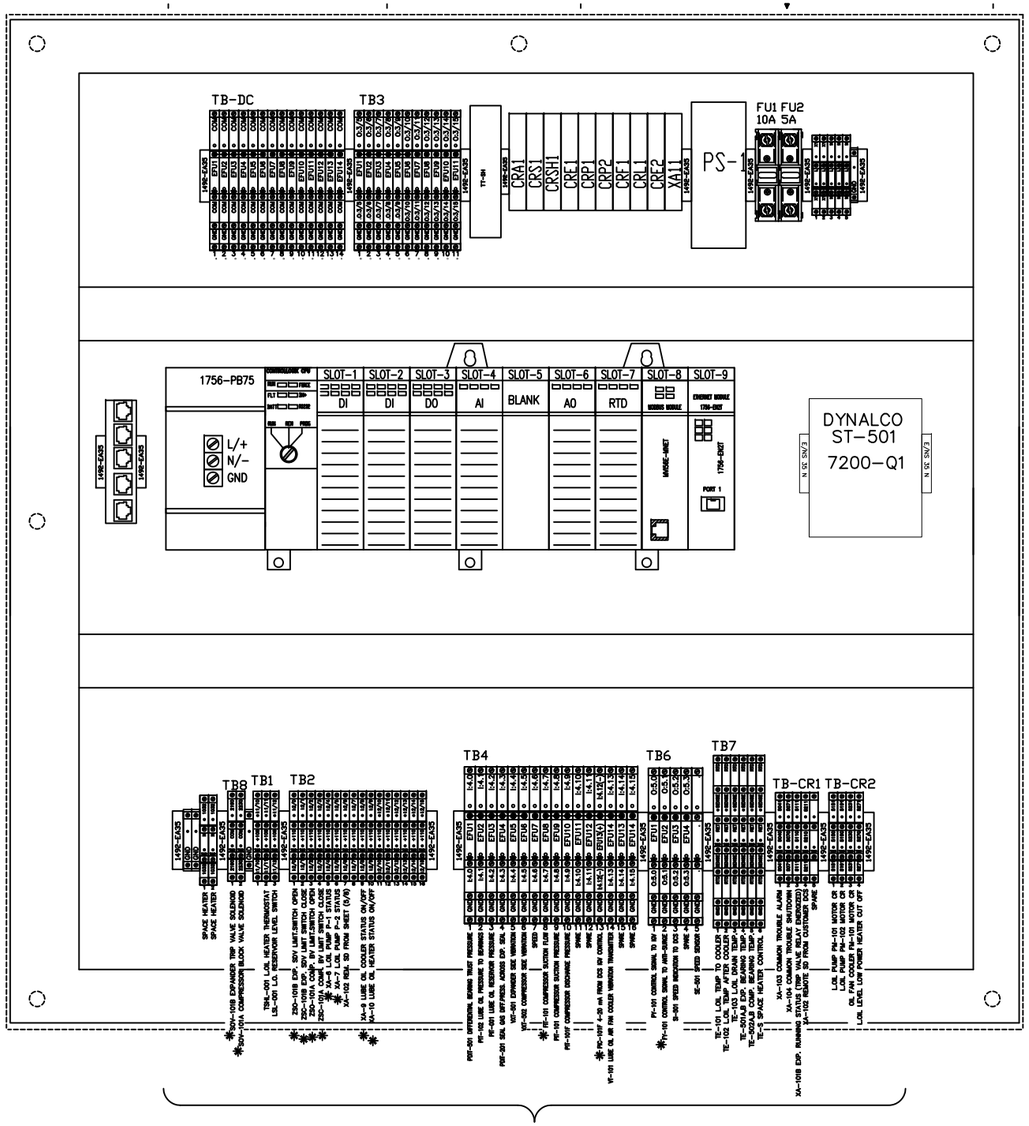
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Tolerances, if not indicated, according to: ANSI Y 14.5M 1982
Machined Surfaces 125 UNLESS NOTED
DECIMALS .XXX ± 0.005 .XX ± 0.01
FRACTIONS ± 1/8' ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name	CONTROL PANEL LAYOUT				
Material	N/A			Material - Class	N/A
File Location	V:\VAULT\LAT574\ELECTRICAL			Job Number	STL 001-D5 R1
Scale	X:X		Prev. Dwg. N/A	Orignated from	N/A
Drawn by	J.B.	Date 8/29/16	Next Dwg N/A	Dwg/Part No.	LAT574EC-20-D5
Std. Chk.	JBR	Date 8/29/16	Blank Wt. N/A Kg Lbs	Finished Wt. XXX Kg Lbs	Rev 3
Design Chk.	R.S.	Date 8/29/16	Approved R.S.	Date 8/29/16	SHEET 2 OF 4

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/08/17	R.S.
2	UPDATED	4/03/17	R.S.
3	AS BUILT FINAL	5/12/17	R.S.

✳ CUSTOMER SUPPLIED & INSTALLED



FOR DETAILS SEE SHEET 4 OF 4

AS BUILT

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

DO NOT SCALE THE DRAWING

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VALENCIA, CA 91355

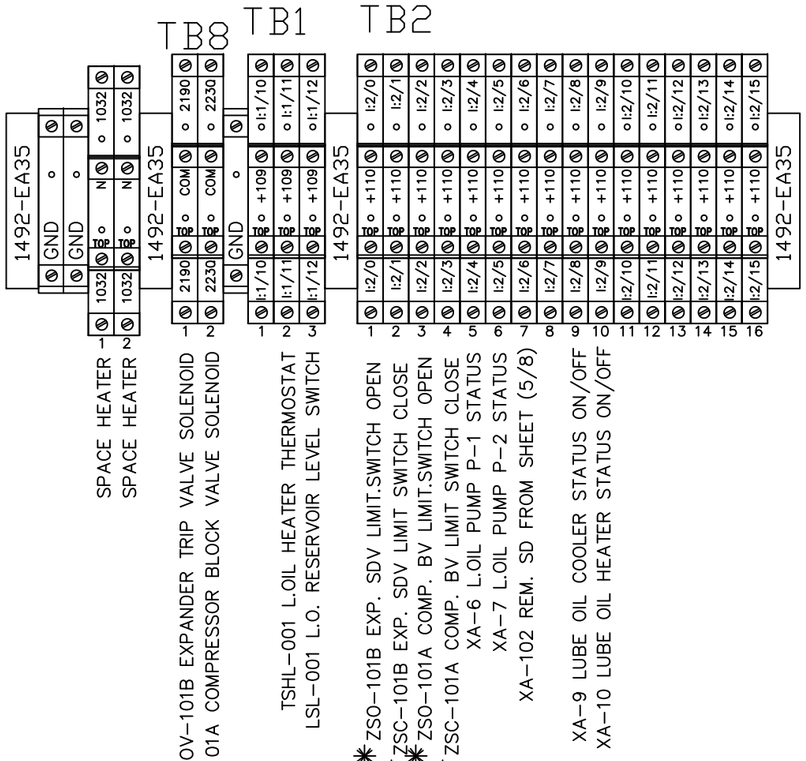
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Tolerances, if not indicated, according to: ANSI Y 14.5M 1982
Machined Surfaces 125 √ UNLESS NOTED
DECIMALS .XXX ± 0.005 .XX ± 0.01
FRACTIONS ± 1/8" ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name	CONTROL PANEL LAYOUT				
Material	N/A			Material - Class	N/A
File Location	V:\VAULT\LAT574\ELECTRICAL			Job Number	STL 001-D5 R1
Scale	X:X		Prev. Dwg. N/A	Orignated from	N/A
Drawn by	J.B.	Date 8/29/16	Next Dwg N/A	Dwg/Part No.	LAT574EC-20-D5 Rev 3
Std. Chk.	JBR	Date 8/29/16	Blank Wt. N/A Kg Lbs	Finished Wt. XXX Kg Lbs	
Design Chk.	R.S.	Date 8/29/16	Approved R.S.	Date 8/29/16	SHEET 3 OF 4

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	8/30/16	R.S.
1	AS BUILT	2/08/17	R.S.
2	UPDATED	4/03/17	R.S.
3	AS BUILT FINAL	5/12/17	R.S.

✳ CUSTOMER SUPPLIED & INSTALLED



AS BUILT

CUSTOMER	: UOP RUSSELL LLC
FOR	: TBD
PROJECT	: 60 MMSCFD CRYO PLANT (J447XX)
LOCATION	: TBD
P.O. NO.	: 4500743460
ITEM NO.	: EC-101
SERVICE	: TURBOEXPANDER / RECOMPRESSOR

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VALENCIA, CA 91355

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Tolerances, if not indicated, according to: ANSI Y 14.5M 1982
Machined Surfaces 125 √ UNLESS NOTED
DECIMALS .XXX ± 0.005 .XX ± 0.01
FRACTIONS ± 1/8" ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name	CONTROL PANEL LAYOUT		
Material	N/A	Material - Class	N/A
File Location	V:\VAULT\LAT574\ELECTRICAL	Job Number	STL 001-D5 R1
Scale	X:X	Prev. Dwg.	N/A
Drawn by	J.B. Date 8/29/16	Next Dwg	N/A
Std. Chk.	JBR Date 8/29/16	Blank Wt.	N/A Kg Lbs
Design Chk.	R.S. Date 8/29/16	Finished Wt.	XXX Kg Lbs
		Approved	R.S. Date 8/29/16
		Drignated from	N/A
		Dwg/Part No.	LAT574EC-20-D5
		Rev	3

SHEET 4 OF 4

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	08/30/16	R.S.
1	ADDED HEAT TRACE, REMOVED FT-101	10/21/16	R.S.
2	AS BUILT	02/13/17	R.S.
3	UPDATED	04/03/17	R.S.
4	AS BUILT FINAL	05/12/17	R.S.

AS BUILT

CUSTOMER	**:**	**UOP RUSSELL LLC**
FOR	**:**	**TBD**
PROJECT NO.	**:**	**60 MMSCFD CRYO PLANT (J447XX)**
LOCATION	**:**	**TBD**
P.O. NO,	**:**	**4500743460**
ITEM NO.	**:**	**EC-101**
SERVICE	**:**	**TURBOEXPANDER/RECOMPRESSOR**

DO NOT SCALE THE DRAWING

L.A. Turbine Corporation

28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, If not indicated, according to ANSI Y14.5M-1982 UNLESS NOTED

Machined Surfaces

DECIMALS .XXX ± 0.005 .XX ± 0.01 FRACTIONS ± 1/8" ± ¼"

Units = Inches

BREAK ALL SHARP CORNERS & DEBURR .005R

Name **ELECTRICAL BILL OF MATERIAL**

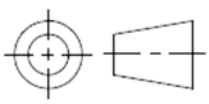
FG N/A

Material N/A

Material – Class N/A

File Location V; \VAULT\LAT574\ELECTRICAL

Job Number STL 001-D4 R1



Scale N/A

Prev. Dwg. N/A

Originated from

Drawn by J. B.

Date 8/29/16

Next Dwg. N/A

Dwg/Part No. LAT574EC-20-A8

Rev 4

STD Check

Date 8/29/16

Blank Wt. Kg N/A Lbs

Finished Wt. Kg N/A Lbs

Design Check

Date 8/29/16

Approved R.S.

Date 8/29/16

Ref:	Description	Qty.	Part №	Drawing №	Rev:
H-001	Immersion Heater Incoloy Elements 480V/3Ø/60 Hz; 3 KW with SPST Line duty thermostat (TSHL-001); Adjustable Range 50-250 degree ºF Lube oil service 15 watts/in² Density Explosion proof Terminal Box Class I, Div II, Groups C & D, Carbon Steel 3” -300# RF Flange Design Temperature and Pressure For Reservoir is 680 Psig @ -20/200 ºF Manufacturer: Caloritech Model: CXFT3033F331X-005 Certify drawing required Certification Required	1			
PIT- 001 102 101 101F	Pressure Transmitter, Gauge Pressure Range: -14.2 to +2000 Psig 4-20 mA with digital signal based on HART Protocol 4-20 mA = 0 to +1000 Psig; Class I, Div II, Groups C & D, FM Explosion Approval Manufacturer: Rosemount Model: 2051CG5A22A1AE5M5 Certification Required	4			
PDIT- 501	Pressure Differential Indication Transmitter, Pressure Range: -300 to +300 Psid 4-20 mA with digital signal based on HART Protocol Set to Center Zero and Bi-Directional 4-12-20 mA = -300 to 0 to +300 Psid; Class I, Div II, Groups C & D, FM Explosion Approval With LCD display and Manufacturer: Rosemount Model: 2051CD4A22A1AE5M5 Certification Required	1			
PDIT- 201	Pressure Differential Transmitter, Pressure Rang: 0-300 Psid 4-20 mA with digital signal based on HART Protocol Calibrated to: 4-20 mA = 0 - 50 Psid; Class I, Div II, Groups C & D, T2D FM Explosion Approval With LCD display and	1			

AS BUILT

Ref:	Description	Qty.	Part №	Drawing №	Rev:
	Manufacturer: Rosemount Model: 2051CD4A22A1AE5M5 Certification Required				
SE-501	Speed Element– Magnetic Pickup, 3/4" – 20 UNEF, 15.24 cm (6") Long Class I, Div II, Groups C & D, CSA Explosion Approval Manufacturer: AL-TEK Model: 70085-1010-414	1			
LS-001	Level Switch-Liquid Level 316 S. S. float, LS-1950 Series Float Activated SPST switch, 20VA Normally Open, UL & CSA listed Manufacturer: GEM Model: LS-01950	1			
TE-103 102	Temperature Sensor RTD Single Element 100 OHMS @ 0 ºC 316 SS Sheath; 3 Wires System, 6" Probe Length with 6' Armored Extension Cable Manufacturer: Thermo Electric Model: RTD-14-LT-06-72-2A Certification Required	2			
TE-101	Temperature Sensor RTD Single Element 100 OHMS @ 0 ºC 316 SS Sheath; 3 Wires System, 15" Probe Length with 6' Armored Extension Cable Manufacturer: Thermo Electric Model: RTD-14-LT-15-72-2A Certification Required	1			
TE-501a/b 502a/b	Temperature Sensor RTD Dual Element 100 OHMS @ 0 ºC 316 SS Sheath; 3 Wires System, 7" Probe Length with 6' Armored Extension Cable Manufacturer: Thermo Electric Model: D-RTD-14-LT-07-72-2A	2			

AS BUILT

Ref:	Description	Qty.	Part №	Drawing №	Rev:
TW-101	Refer to: LAT574EC-20-A11	1			
TW-102 103	SS Body with Bore Size: 0.26" Process Connection: 3/4" NPT U length: 2.5" Total length: 4" Manufacturer: Ashcroft Model: 75W0250HT260	2			
VXC 501, 502	3300 XL NSv Armed Extension Cable for 990 Vibration Transmitter 4m length Class I, Div II, Groups C & D, FM Explosion Approval Manufacturer: Bently Nevada Model: 330930-040-05-05	2			
VXE-501, 502	3300 XL NSv Vibration probe, For 990 Vibration Transmitter 3/8” – 24 thread mounting Class I, Div II, Groups C & D, FM Explosion Approval Pressure Rated: 1200 Psig Manufacturer: Bently Nevada Model: 330909-10-60-10-11-05 Mod # 165449 Certification Required	2			
VXT-501, 502	Vibration transmitter 990 series, For 3300XL NSv Vibration Probe Range - 5 mils System length - 5 meters, Class I, Div II, Groups C & D, FM Explosion Approval Manufacturer: Bently Nevada Model: 990-05-50-01-05 Certification Required	2			
JB-1	PLC Control Station: Refer to: LAT574EC-20-A41	1			

AS BUILT

Ref:	Description	Qty.	Part №	Drawing №	Rev:
	LAT574EC-20-D4 LAT574EC-20-D5				
JB-2	NEMA 4 Junction Box 14" X 12" X 6" MMC With Mounting Pan and Manufacturer: McMaster Model: Hoffman or equal Note: For 990 Vibration Transmitters	1			
TM	Temperature element mounting Swagelok Tubing fitting, Bore-Through Male connector 1/4" Tube OD x 1/2" male NPT Manufacturer: Swagelok Model: SS-400-1-8BT	5			
TF	Compression Fitting PTFE 1/4" Ferrule Set Manufacturer: Swagelok Model: T-400-SET	5			
VXN	Vibration probe seal nut Hydra-Lok seal nut for 3/8"-24 UNF thread Manufacturer: Abbott-Interfast Model: F21NUS-624	2			
SEN	Speed probe seal nut Hydra-Lok seal nut for 3/4"-20 UNEF thread Manufacturer: Abbott-Interfast Model: 3/4-20 UNEF-2B	1			
HTS-1	Heat Tracing System Includes: 125 Feet Constant Wattage Heating (SR) Cable Class1, Div. II, Group C&D 8W/ft,240 Volt AC Manufacture: Chromalox Model: SRL8-2CT P/N: 383478	1			
	Ambient Air Sensing RBF-RTD	2			



Ref:	Description	Qty.	Part №	Drawing №	Rev:
	Class1, Div. II, Group C&D Manufacture: Chromalox Model: RBF-RTD P/N: 317315				
	UPC Power Connection Kit Class1, Div. II, Group C&D Manufacture: Chromalox Model: UPC P/N: 393553	2			
	Dual Loop Panel 240 VAC With 240VAC Space Heater Inside Class1, Div. II, Group C&D Approved Drawing Required (Final Drawing in AUTOCAD) Factor Internal FAT Certification Required Certification Required Manufacture: Chromalox Model: HTLS-C1D2-21001 Ref DWG LAT574EC-20-D38	1			
	Fiber Glass Tape For Cable Attachment Model: FT-3, P/N: 389941	3			
	Caution Labels Apply Every 10 Feet to Insulation to Alert Personnel Model: CL-1 (5PCS) P/N: 382424	1			
	End Seal Kits For SRL8-1CT Cable Model: RTES, P/N: 389570	2			

AS BUILT

Notes:
The Heat Trace/Insulation also includes the following items:

1. Labor and Material for the insulation of the two tubing lines and one interconnecting line
2. Install heat cable as needed
3. Insulate heat trace lines using 1” thick fiberglass textile tape finished with water proofing mastic
4. Provide and install one removable insulation cover/blanket for one accumulator

Refer to: LAT574EC-20-D3

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASE FOR FABRICATION	10-17-16	SB

NOTE: FOR ITEMS MARKED WITH "*" , THE DRAWINGS CAN BE FOUND AT V:\GENERIC FOLDER\MACHINE DESIGN-CORE

CUSTOMER	**UOP RUSSELL, LLC**
FOR	**TBD**
PROJECT	**60 MMSCFD CRYO PLANT (J447XX)**
LOCATION	**TBD**
P.O. NO.	**4500743460/J447XX**
ITEM NO.	**EC-101**
SERVICE	**TURBOEXPANDER / RECOMPRESSOR**

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THIS DRAWING IS A DUPLICATE OF LAT573-20-A9-R0(LAT573)

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28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, if not indicated, according to: ANSI Y 14.5M 1982
Machined Surfaces: N/A √
DECIMALS .XXX ± XXX, .XX ± XXX
FRACTIONS ± XX
ANGLES ± XX
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name	PARTS LIST				Material - Class	N/A
Material	N/A				Job Number	LAT574
File Location	V:\LAT574\MACHINE DESIGN-CORE					
Scale	N/A		Prev. Dwg.	N/A	Orignated from	LAT573
Drawn by	TINH	Date 10-17-16	Next Dwg	N/A	Dwg/Part No.	LAT574-20-A9
Std. Chk.	LT	Date 10-17-16	Blank Wt. N/A Kg Lbs	Finished Wt. --- Kg Lbs		Rev 0
Design Chk.	SB	Date 10-17-16	Approved H. SH.	Date 10-17-16		

LAT574
PARTS LIST
DRAWING NO. LAT574-20-A9
REVISION: 00

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PRODUCTION

IT.	PART/DWG. NO.	DESCRIPTION	QUANTITY
100	7770006232	EXPANDER CASE	1
104	7770006234	EXPANDER CASE DIFFUSER	1
105	7770006235	EXPANDER CASE DIFFUSER EXTENSION	1
110	LAT574-20-D110	NOZZLE ACTUATOR ASSEMBLY	1
*112	7770000269	LOWER NOZZLE ACTUATOR ROD	1
*120	7770002026	LABYRINTH HOUSING SPACER	1
130	7770006237	NOZZLE COVER	1
131	7770006238	NOZZLE SEGMENTS	4
132	7770006239	NOZZLE ADJUSTING RING & PIN	1
133	7770006240	NOZZLE FIXED RING	1
134	7770006241	GASKET-NOZZLE FIXED RING	1
135	7770006242	PISTON RING	1
136	7770006243	NOZZLE CLAMPING RING	1
137	7770006244	SEAL RING	1
138	7770006245	SHIM SET-BELLEVILLE SPRING	4
200	7770006246	BEARING HOUSING	1
210	7770006248	EXPANDER WHEEL	1
211	7770006249	RETAINING SCREW EXP. SIDE	1
212	7770006250	RETAINING WASHER EXP./COMP. SIDE	1
213	7770006251	KEY – EXPANDER SIDE	6
220	7770006252	EXPANDER WHEEL BACK SEAL	1
221	7770006253	HEAT BARRIER WALL	1

LAT574
PARTS LIST
DRAWING NO. LAT574-20-A9
REVISION: 00

CONTROLLED COPY
RELEASED FOR
PRODUCTION

IT.	PART/DWG. NO.	DESCRIPTION	QUANTITY
230	7770006254	SHAFT	1
231	7770006255	BEARING THRUST WASHER & PINS	2
250	7770006256	EXPANDER END BEARING	1
251	7770006257	COMPRESSOR END BEARING	1
270	7770006258	COMPRESSOR SEAL	1
280	7770006259	COMPRESSOR WHEEL	1
281	7770006261	RETAINING SCREW COMP. SIDE	1
282	7770006250	RETAINING WASHER EXP./ COMP. SIDE	1
283	7770006263	KEY – COMPRESSOR SIDE	6
290	7770006264	COMPRESSOR WHEEL BACK SEAL	1
300	7770006265	COMPRESSOR CASE	1
310	7770006267	COMPRESSOR FOLLOWER	1
311	7770006268	SHIM-COMPRESSOR FOLLOWER	1
330	7770006269	COMPRESSOR INLET SPACER	1
901	7760001287	1 1/8-8 UN x 6” LG STUD FULL THD ASTM A193 GR. B7 C. STL.	16
901a	7760000349	1 1/8-8 UN HEAVY HEX NUT ASTM A194 GR 2H C. STL.	16
902	7760000029	O-RING 2-458 NITRILE 70	1
904	7760000030	1/4-20 UNC x 1 5/8” LG HEX SOC HD CAP SCREW ASTM 574 ALLOY STL	12
910	7760000031	O-RING 2-384 NITRILE 70	1
911	7760001656	1/4-20 UNC x 2 1/4” LG HEX SOC FLAT HD SCREW ASTM F835 ALLOY STL.	16

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PRODUCTION

IT.	PART/DWG. NO.	DESCRIPTION	QUANTITY
912	7760000033	O-RING 2-010 NITRILE 70	1
914	7760000034	O-RING 2-271 NITRILE 70	1
918	7760000035	1/4-20 UNC x 1” LG HEX SOC HD CAP SCREW ASTM 574 ALLOY STL	6
919	7760000036	FLAT WASHER AN960-416L (1/4 SCR) .032 THK C.STL.	6
920	7760000037	O-RING 2-014 NITRILE 70	1
921	7760000037	O-RING 2-014 NITRILE 70	1
922	7760000037	O-RING 2-014 NITRILE 70	1
923	7760000037	O-RING 2-014 NITRILE 70	1
924	7760000037	O-RING 2-014 NITRILE 70	1
925	7760000037	O-RING 2-014 NITRILE 70	1
926	7760000037	O-RING 2-014 NITRILE 70	1
927	7760000035	1/4-20 UNC x 1” LG HEX SOC HD CAP SCREW ASTM 574 ALLOY STL	6
928	7760000036	FLAT WASHER AN960-416L (1/4 SCR) .032 THK C.STL.	6
932	7760000037	O-RING 2-014 NITRILE 70	1
933	7760000037	O-RING 2-014 NITRILE 70	1
934	7760000037	O-RING 2-014 NITRILE 70	1
935	7760000077	O-RING 2-024 NITRILE 70	1
936	7760000038	O-RING 2-274 NITRILE 70	1
937	7760000039	1/4-20 UNC x 1 5/8” LG HEX SOC HD CAP SCREW ASTM F837 GR 1 ST. STL.	16

CONTROLLED COPY
RELEASED FOR
PRODUCTION

IT.	PART/DWG. NO.	DESCRIPTION	QUANTITY
938	7760000040	FLAT WASHER AN960-C416L (1/4 SCR) .032 THK ST. STL.	16
942	7760000195	#10-24 UNC x 3/4” LG HEX SOC HD CAP SCREW ASTM F837 GR 1 ST. STL.	6
943	7760000042	1-8 UNC x 5” LG STUD FULL THD ASTM A193 GR 7 C.ST	16
943a	7760000043	1-8 UNC HEAVY HEX NUT ASTM A194-2H C.STL.	16
944	7760001657	1 1/8 -8UN x 5 1/2 ” LG STUD FULL THD ASTM A193- B8M CLASS II STRAIN HARDENED	16
944a	7760001161	1 1/8-8UN HEAVY HEX NUT ASTM A194 GR 8M	16
949	7760001286	SPIRAL WOUND GASKET FOR 8"-600# ASME B16.20 FLANGE- SS WINDING/NON ASBESTOS FILLER; SS CENTERING & INNER RING.	2
950	7760000046	1/4 DIA. x 3/8” LG HEX SOC HD SHOULDER SCREW (#10-24 UNC x .375) ASTM F837 GR 1 ST. STL.	3
951	7760001658	3/8 DIA. x 1 1/2” LG HEX SOC HD SHOULDER SCREW (5/16-18UNC x .500) INCONEL 718 DIMS PER ASME B18.3	4
952	7760000681	1/4-20 UNC x 5/8” LG HEX SOC HD CAP SCREW ASTM F837 GR 1 ST. STL.	8
952a	7760000049	1/4-20 UNC x 1” LG HEX SOC HD CAP SCREW ASTM F837 GR 1 ST. STL.	6
953	7760000050	BELLEVILLE SPRING WASHER SPEC CATALOG NO. B0750-028-S OR 3/4” OD x .380” ID x .028 THK. x .051 FREE HEIGHT AMS 5906 TYPE 302	4
954	7760000051	1/4-20 UNC x 1 1/4” LG HEX SOC FLAT HD SCREW ASTM F879 GR 1 ST. STL.	1

LAT574
PARTS LIST
DRAWING NO. LAT574-20-A9
REVISION: 00

IT.	PART/DWG. NO.	DESCRIPTION	QUANTITY
954a	7760000052	1/4 -20UNC HEX JAM NUT ASTM F594 GR 1	1
955	P1000-1170-501	RACO SEAL	1
955a	P1000-1170-501	RACO SEAL	1
956	P1000-1171-324	RACO SEAL	1
957	P1000-1170-055	RACO SEAL	1

NOTE: FOR CROSS SECTION DRAWING SEE LAT574-20-D1

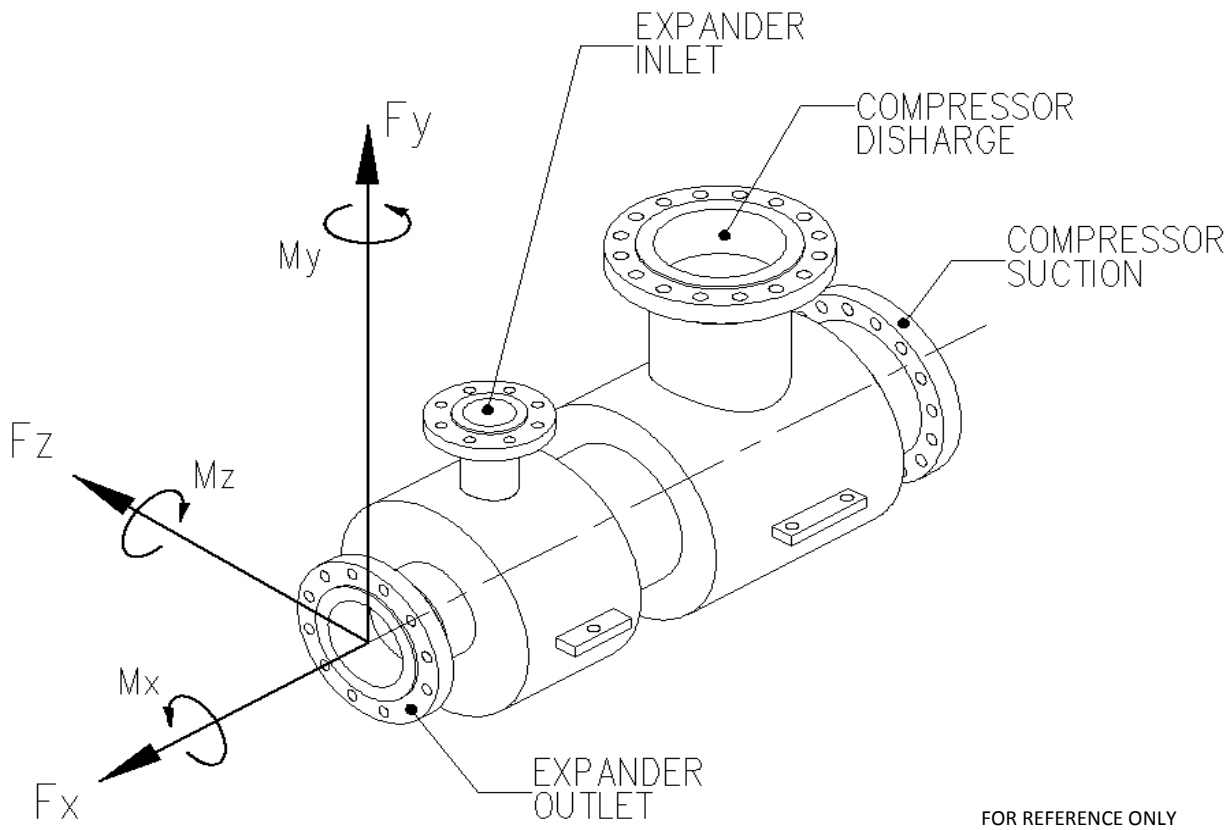
FOR ASSEMBLY CLEARANCE DRAWING SEE 7770006270

SPECIAL TOOLS LIST:

501	7760001178	SCREW HEX. HD CAP 1”-8 UNC x 3 1/2” LG. GR. 5 OR EQUIVALENT	2
502	7760000054	FORGING EYE BOLT 3/8-16 UNC x 1 1/4” SHANK LENGTH C. STL.	2
503	7760000974	FORGING EYE BOLT 5/8-11 UNC x 1 3/4” SHANK LENGTH C. STL.	2

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MAXIMUM PIPE NOZZLE LOADS



FOR REFERENCE ONLY

CUSTOMER	**UOP RUSSELL, LLC**
FOR	**TBD**
PROJECT	**60 MMSCFD CRYO PLANT (J447XX)**
LOCATION	**TBD**
P.O. NO.	**4500743460/J447XX**
ITEM NO.	**EC-101**
SERVICE	**TURBOEXPANDER / RECOMPRESSOR**

AS BUILT

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	INITIAL RELEASE	10/14/16	H.SH.
1	AS BUILT	5/9/17	SB

DO NOT SCALE DRAWING

L.A. Turbine Corporation

28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, if not indicated, according to: ANSI Y14.5M 1982

Machined Surface 125 UNLESS NOTED

DECIMALS .XXX N/A .XX N/A

FRACTIONS ± N/A

ANGLES ± N/A

Units = Inches

BREAK ALL SHARP CORNERS AND DEBURRS .005

Name: PIPE NOZZLE LOADS					
Material: N/A				Material Class N/A	
File Location: V:\LAT574EC\MACHINE DESIGN-CORE				Job Number: LAT574	
Scale: N/A		Prev Dwg: N/A		Originated from: LAT573	
Drawn By: S.B.	Date: 10/14/16	Next Dwg: N/A		Dwg/Part No. LAT574EC-20-A10	REV 1
Std. Chk: S.B.	Date: 10/14/16	Blank Wt. N/A	Finished Wt. N/A		
Design Chk: R.G	Date: 10/14/16	Approved: H. Sh.	Date: 10/14/16		PAGE 1 OF 4

Maximum Allowable Forces and Moment

Per API Standard 617, 7th Edition July 2002

Job#: LAT574

NEMA	1.85

	Diameter D [in]	Diameter (Nominal) De [in]	Equivalent Diameter Dc [in]	Maximum Force (when the moment is zero) (lb) US Customary			Maximum Moments (when the force is zero) (ft-lbs) US Customary		
				Fx	Fy	Fz	Mx	My	Mz
Expander Inlet	6	10.00	9.33	863.33	2,158.33	1,726.67	4,316.67	2,158.33	2,158.33
Expander Outlet	8			863.33	2,158.33	1,726.67	4,316.67	2,158.33	2,158.33
Compressor Inlet	12	15.62	11.21	1,036.63	2,591.58	2,073.26	5,183.16	2,591.58	2,591.58
Compressor Outlet	10			1,036.63	2,591.58	2,073.26	5,183.16	2,591.58	2,591.58

Calculated by: SB Date: 10/14/16



E.1 General

E.1.1 The April 1988, November 1979, and October 1973 issues of this standard referred nozzle forces and moments calculations to appropriate NEMA documents, with the stipulation that the constants in the equations be multiplied by 1.85. Experience has shown that there has not been a uniform interpretation of "1.85 times NEMA." Therefore, the equations have been adapted to expander-compressors by identifying all the constants and clarifying that the equivalent of the exhaust nozzle in the NEMA calculation is the largest expander or compressor nozzle. This is usually, but not necessarily, the outlet nozzle.

E.1.2 For expanders designed for driving separate gearboxes or generators, which require high tolerance of alignment between the expanders and the gearboxes/generators, the vendor shall identify the maximum allowable forces and moments.

Note: 0.2 times NEMA is often required for this type of the arrangement.

E.2 Equations

The design of each expander-compressor body must allow for limited piping loads on the various casing nozzles. For maximum system reliability, nozzle loads imposed by piping should be as low as possible regardless of the expander-compressor load-carrying capability. For single stage expander-compressors, the forces and moments acting on expander or compressor due to the inlet and discharge connections should be limited by the following:

a. The total resultant force and total resultant moment imposed on the compressor at any connection should not exceed the values shown in Equations 4.E-1a or 4.E-1b.

In SI units:

$$F_r + 1.09\ M_r \le 54.1 D_e \qquad \text{(4.E-1a)}$$

In U.S. Customary units:

$$3F_r + M_r \le 927\ D_e \qquad \text{(4.E-1b)}$$

where

F_r = resultant force, in Newtons (lb.) (see Figure 4.E-1),

M_r = resultant moment, in Newton-meters (ft-lb.) from Figure 4.E-1.

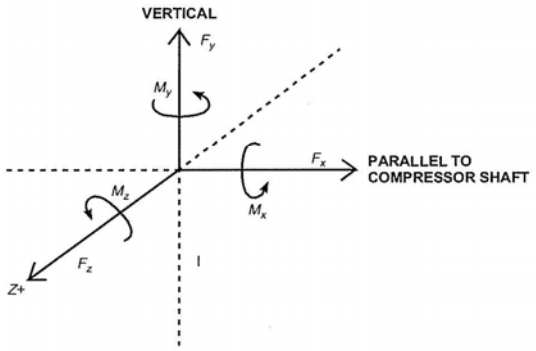


Figure 4.E-1—Combined Resultants of the Forces and Moments of Corrections

For sizes up to 200 mm (8 in.) in diameter:

$$(M_t = \sqrt{M_x + M_y + M_z}) \qquad \text{(4.E-2)}$$

D_e = Nominal pipe diameter of the connection, in mm (in.).

For sizes greater than 200 mm (8 in.), use a value of:

In SI units:

$$D_e = \frac{400 + D_{nom}}{3}\ \text{(mm)} \qquad \text{(4.E-3a)}$$

In U.S. Customary units:

$$D_e = \frac{16 + D_{nom}}{3}\ \text{(in.)} \qquad \text{(4.E-3b)}$$

where

D_c = equivalent pipe diameter of the connection, in mm (in.),

D_{nom} = nominal pipe diameter, in mm (in.).

b. The combined resultants of the forces and moments of the inlet, sidestream, and discharge connections resolved at the centerlines of the largest connection should not exceed the following:

1. The resultants shall not exceed:

In SI units:

$$F_c + 1.64 M_c \le 40.4\ D_c \qquad \text{(4.E-4a)}$$

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In U.S. Customary units:

$$2F_c + M_c \le 462D_c \qquad \text{(4.E-4b)}$$

where

F_c = combined resultant of inlet, sidestream, and discharge forces, in Newtons (lb.),

M_c = combined resultant of inlet, sidestream, and discharge moments, and moments resulting from forces, in Newton-meters (ft-lb.),

D_c = diameter (in mm [in.]) of one circular opening equal to the total areas of the inlet, sidestream, and discharge openings. If the equivalent nozzle diameter is greater than 230 mm (9 in.), use a value of D_c equal to:

In SI units:

$$= \frac{(400 + \text{Equivalent Diameter})}{3} \text{(mm)}$$

In U.S. Customary units:

$$= \frac{(18 + \text{Equivalent Diameter})}{3} \text{(in.)}$$

2. The individual components (Figure 4.E-1) of these resultants should not exceed:

In SI units:

$$F_x = 16.1D_c \qquad M_x = 24.6D_c$$

$$F_y = 40.5D_c \qquad M_y = 12.3D_c$$

$$F_z = 32.4D_c \qquad M_z = 12.3D_c$$

In U.S. Customary units:

$$F_x = 92D_c \qquad M_x = 462D_c$$

$$F_y = 231D_c \qquad M_y = 231D_c$$

$$F_z = 185D_c \qquad M_z = 231D_c$$

where

F_x = horizontal component of F_c parallel to the compressor shaft, in Newtons (lb.),

F_y = vertical component of F_c, in Newtons (lb.),

F_z = horizontal component of F_c at right angles to be compressor shaft, in Newtons (lb.),

M_x = component of M_c around the horizontal axis, in Newton-meters (ft-lb.),

M_y = component of M_c around the vertical axis, in Newton-meters (ft-lb.),

M_z = component of M_c around the horizontal axis at right angles to the compressor shaft, in Newton-meters (ft-lb.).

c. These values of allowable forces and moments pertain to the turbo-expander structure only. They do not pertain to the forces and moments in the connecting pipes, flanges, and flange bolting, which should not exceed the allowable stress as defined by applicable codes and regulatory bodies.

Loads may be increased by mutual agreement between the purchaser and vendor; however, it is recommended that expected operating loads be minimized.

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REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	Issued for Production.	10/11/16	HS
1	Changed tag no. for C-101vibration transmitter, p2. Revised P-101/102 part no. and motor descriptions as noted, p4. Added AutoCalibrate requirement for PV-101, p9. Decreased qty. of MV3T-.5 from (3) to (2), p11. Changed PSV-001 vendor, added model no. and updated description as noted, p13.	10/31/16	HS
2	Updated C-101 motor electrical connection size, p2. Revised PSV-001 descriptions as noted, p13.	11/29/16	HS
3	Changed C-101 fan motor electrical connection size, p2. Changed P-101/102 part no. and added space heater wattage, p4. Corrected drawing number in description for R-001, p6. Corrected FI-001 part no., p8. Changed IGV actuator tag number, p9. Corrected PDCV-101 part no., p11. Revised PSV-001 description as noted and changed manufacturer and part number, p13.	01/30/17	HS
4	Added C-101 fan motor space heater wattage, p2.	03/10/17	TA
5	Corrected accumulator charge kit tag no., p7. As-built.	04/17/17	TA

The quantities listed within are total for job 574
Current revisions are identified in Bold font.

CUSTOMER	**UOP RUSSELL, LLC**
FOR	**TBD**
PROJECT	**60 MMSCFD CRYO PLANT (J447XX)**
LOCATION	**TBD**
P.O. NO.	**4500743460/J447XX**
ITEM NO.	**EC-101**
SERVICE	**TURBOEXPANDER / RECOMPRESSOR**

AS BUILT

L.A. Turbine Corporation

28557 INDUSTRY DRIVE,
VALENCIA, CA 91355

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Name	**SYSTEM BILL OF MATERIAL**			FG N/A	
Material	N/A			Material – Class N/A	
File Location	V:\LAT574\PID&BOM			Job Number LAT574	
Scale N/A		Prev. Dwg. N/A		Originated from LAT573 duplicate	
Drawn by RLG	Date 10/11/16	Next Dwg. N/A		Dwg/Part No. LAT574EC-20-A11	Rev 5
STD Check JB	Date 10/11/16	Blank Wt. Kg N/A Lbs	Finished Wt. Kg N/A Lbs		
Design Check SB	Date 10/11/16	Approved HS	Date 10/11/16	PAGE 1 OF 18	

Tag No.:	Description	Qty.
C-101, FM-101, VT-101	HEAT EXCHANGER, AIR/OIL, FAN COOLED, SINGLE 100%, FORCED VERTICAL DRAFT, DIRECT DRIVE, CARBON STEEL HEADERS, FLANGES AND STRUCTURE, SEAMLESS CARBON STEEL TUBES, ALUMINUM FINS, HEADER SHALL BE BOX TYPE (WITH SHOULDER PLUGS OPPOSITE EACH TUBE END), DESIGNED IN ACCORDANCE WITH ASME SECTION VIII, DIV 1, ASME CODE STAMPED, NATIONAL BOARD REGISTERED, 2”-600# ANSI RFWN FLANGED INLET/OUTLET OIL CONNECTIONS ON BOTTOM OF THE SAME HEADER, WITH PLUGGED VENT AND DRAIN CONNECTIONS ON EACH HEADER, VENDOR TO MARK FLOW DIRECTION FOR INLET AND OUTLET NOZZLES, HYDROTEST TO 1.5 X MAWP FOR 30 MINUTES MINIMUM, FLUSHED IN ACCORDANCE WITH API 614, OIL FLOW: 21 GPM ISO VG 32: 150 SSU @ 100F, HEAT LOAD: 140,000 BTU/HR OPERATING PRESSURE: 285/370 PSIG MAWP: 850 PSIG @ -20/200 F, OIL IN/OUT TEMP: 152/120F AT MAX AMBIENT TEMPERATURE, PRESSURE DROP: 12.3 PSID, COOLER AMBIENT DESIGN TEMPERATURE: -20/110F, ELEVATION: 2,900 FT ASL, MOTOR, TECO-WESTINGHOUSE INDUCTION TYPE, TEFC, 460V/60HZ/3PH, 5 HP, 900 RPM, FRAME 254T, 1” NPT(F) ELECTRICAL CONNECTION, WEATHERPROOF TERMINAL BOX, TERMINAL BOX SHALL BE ON RIGHT SIDE OF MOTOR WHEN FACING DRIVE END, CLASS F INSULATION, CLASS B TEMP RISE, S.F. 1.15, DESIGNED IAW NEMA MG-1 AND IEEE 841 LATEST EDITION, NON-SPARKING FAN, WITH SPACE HEATER, 115 VAC, 1PH, 60HZ, 60 WATTS,	1

AS BUILT

Tag No.:	Description	Qty.
	FM OR CSA/US CERTIFIED AND LABELED CLASS 1, DIV 2, GRPS C,D AMBIENT TEMPERATURE: -20/110F, ELEVATION: 2,900 FT ASL, WITH QTY (1) SEISMIC VELOCITY TRANSMITTER MOUNTED ON MOTOR SUPPORT, METRIX ST5484E-121-020, FULL SCALE RANGE: 1.0 IN/SEC PEAK, 4-20mA OUTPUT SIGNAL, NEMA 4X, ENCLOSURE, FLYING LEADS, CSA US/C CERTIFIED AND LABELED EXPLOSION PROOF, CLASS I, DIV 1, GRPS B,C,D DOCUMENTATION: COOLER DATASHEET (WITH PROPOSAL), APPROVAL DRAWING (4 WEEKS ARO), MOTOR DATA SHEET, MOTOR ROUTINE TEST CERTIFICATE, FM OR CSA US/C CERTIFICATES (MOTOR AND VIBRATION TRANSMITTER), ASME CODE CALCULATIONS, FORM U-1A, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS (PRESSURE PARTS), IOM, MANUFACTURER: AXH MODEL NO: 42-ZF	
P-101 PM- 101, P-102 PM- 102 CPL- 101	PUMP/MOTOR/COUPLING ASSEMBLY: 3 SCREW ROTARY PUMP, 1800 RPM, LUBE OIL SERVICE (ISO VG 32), CARBON STEEL CASING, STEEL ROTOR, WITH MECHANICAL SEAL: ANTIMONY FILLED CARBON ROTATING FACE VS SILICONE CARBIDE STATIONARY FACE, 3”-300# ANSI RF FLANGED INLET AND 2”-600# ANSI RF FLANGED OUTLET CONNECTIONS, NO INTERNAL RELIEF MAWP (IN/OUT): 650/850 PSIG, 1.5 X MAWP HYDROTEST, OPERATING CASE 1: RATED FLOW: 21 GPM SUCTION PRESSURE: 160/245 PSIG,	2

AS BUILT

Tag No.: Description Qty.

DIFFERENTIAL PRESSURE AT RATED
FLOW: 125 PSID
VISCOSITY 65 SSU @ 150F
CALCULATED INPUT POWER: 2.2 HP

OPERATING CASE 2:
RATED FLOW: 21 GPM
SUCTION PRESSURE: 160/245 PSIG,
DIFFERENTIAL PRESSURE AT RATED
FLOW: 200 PSID
VISCOSITY 150 SSU @ 100F
CALCULATED INPUT POWER: 3.4 HP

COUPLING (CPL-1, CPL-2):
RPM: 1800, SF: 1.5
LOVEJOY JAW TYPE

MOTOR: WEG INDUCTION
TYPE, TEFC, 460V/60HZ/3PH, 5 HP,
1800 RPM, FRAME 184TC, 1" NPT(F)
ELECTRICAL CONNECTION, WEATHERPROOF
TERMINAL BOX, TERMINAL BOX SHALL BE
ON RIGHT SIDE OF MOTOR WHEN FACING
DRIVE END, CLASS F INSULATION, CLASS B
TEMP RISE, S.F. 1.15, DESIGNED IAW NEMA MG-1
AND IEEE 841 LATEST EDITION, NON-SPARKING FAN,
WITH SPACE HEATER, 115 VAC, 1PH, 60HZ,
22 WATTS,
FM OR CSA/US CERTIFIED AND
LABELED CLASS 1, DIV 2, GRPS C,D

AMBIENT TEMPERATURE: -20/110F,
ELEVATION: 2,900 FT ASL,

AS BUILT

DOCUMENTATION:
APPROVAL DRAWING (4 WEEKS ARO)
PUMP DATASHEET,
MATERIAL CERTIFICATE OF CONFORMANCE
(PRESSURE PARTS),
IOM,
MOTOR DATASHEET,
MOTOR ROUTINE TEST REPORT,
MOTOR FM OR CSA/US CERTIFICATE,

PUMP MANUFACTURER: LEISTRITZ
MODEL: L3MG-38/76 IFOGNO-G

Tag No.:	Description	Qty.
F-101		1
V-.5, V-.25	FILTER, DUPLEX ASSEMBLY, CARBON STEEL BODY, STAINLESS STEEL INTERNALS, VITON SEALS, 1 1/2”-600# ANSI RF FLANGES IN/OUT, 316 STAINLESS STEEL VALVED VENTS AND DIRTY DRAINS WITH 1/2” NPT(F) PLUGGED OUTLETS, 1/2” NPT(F) PLUGGED CLEAN DRAINS, VENTS AND DRAINS TO BE ON OPPOSITE SIDE OF PROCESS CONNECTIONS, WITH ORIFICE & BLOCK VALVE ON EQUALIZATION LINE, TUBING AND VALVE SHALL BE STAINLESS STEEL, MAWP: 1360 PSIG @ -20/200F, 1.5 X MAWP HYDROTEST, FILTRATION LEVEL SHALL BE PER API 614, 5TH EDITION, CHAPTER 2, (CARTRIDGE NO. INR-Z-00220-API-PF25-V) WITH CONTINUOUS FLOW TRANSFER VALVE, CARBON STEEL BODY, STAINLESS STEEL TRIM, MAX CLEAN PRESSURE DROP FOR ASSEMBLY: <5 PSID WITH 21 GPM LUBE OIL FLOW, OPERATING PRESSURE: 285/370 PSIG DOCUMENTATION: DIMENSIONAL DRAWING, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS (PRESSURE PARTS), PARTS LIST, HYDROTEST CERTIFICATE, IOM, MANUFACTURER: INDUFIL. MODEL NO: IDCL-2-220-1 1/2” ANSI 600LB RF	
LAT FLUSHING	ELEMENT, FILTER, LUBE OIL, 10 MICRON NOMINAL, POLYFIBER, WITH O-RING AND COVER GASKET INDUFIL PART NO: INR-Z-0220-API-PF25-V	2

AS BUILT

Tag No.:	Description	Qty.
F-201		1

FILTER, SIMPLEX,
316 STAINLESS STEEL BODY,
STAINLESS STEEL INTERNALS,
VITON SEALS, 1”-600# ANSI RF
FLANGES IN/OUT, 1/2” NPT(F) PLUGGED
VENTS AND DRAINS, INLET/OUTLET
CONNECTIONS TO BE 180 DEGREES APART,
MAWP: 1200 PSIG @ -20/200F
1.5 X MAWP HYDROTEST,
WITH 5 MICRON NOMINAL DISPOSABLE
FILTER ELEMENT,
(CARTRIDGE NO. INR-S-00085-BAS-GF3-V)

FLUID: HYDROCARBON GAS,
MW=16.24 TO 18.13,
OPERATING PRESSURE: 400/800 PSIG,
OPERATING TEMPERATURE: 90 F,
FLOW: 90/200 SCFM (MIN/MAX)

DOCUMENTATION:
MATERIAL-CHEMICAL AND MECHANICAL
TEST REPORTS (PRESSURE PARTS)
HYDROTEST CERTIFICATE,
IOM,

MANUFACTURER: INDUFIL. MODEL NO:
ISSH-1-00085-1” ANSI 600LB RF

R-001		1

OIL RESERVOIR, PRESSURIZED,
28” OD, 56” S/S, 5 MINUTE RETENTION
TIME BASED ON 15 GPM OIL FLOW,
CARBON STEEL SHELL STRUCTURE AND
INTERNALS, ALL FLANGES EXCEPT THERMOWELL
FLANGE CONNECTION SHALL BE ASTM A105
ANSI 300# RF SLIP ON, THERMOWELL FLANGE
CONNECTION SHALL BE ASTM A105 ANSI 600# RF
SLIP ON, ALL NOZZLES SHALL BE SEAMLESS,
MAWP: 650 PSIG @ -20/200 F
DESIGNED IN ACCORDANCE WITH
ASME SECTION VIII DIV 1,
ASME CODE STAMPED,
NATIONAL BOARD REGISTERED,
MANUFACTURED IN ACCORDANCE
LAT DRAWING LAT574EC-20-D66

AS BUILT

Tag No.:	Description	Qty.
	DOCUMENTATION: APPROVAL DRAWING (2 WEEKS ARO) ASME CODE CALCULATIONS (2 WEEKS ARO), FORM U-1A, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS (PRESSURE PARTS) HYDROTEST CERTIFICATE, MANUFACTURER: SOUTH GATE ENGINEERING	
AC-101	ACCUMULATOR, BLADDER TYPE, CAPACITY: 15 GALLONS BUNA “N” BLADDER, LUBE OIL SERVICE, CARBON STEEL BODY, BOTTOM REPAIRABLE, 2” NPT(F) STAINLESS STEEL PORT, ASME SECTION VIII DIVISION 1 CODE STAMPED, NATIONAL BOARD REGISTERED, MAWP: 3000 PSIG @ -20/200F DOCUMENTATION: MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS (PRESSURE PARTS) FORM U-1A, IOM, MANUFACTURER ACCUMULATORS, INC. MODEL: A153100CS	1
ACK-1	ACCUMULATOR CHARGE KIT, GAUGE RANGE: 0–600 PSIG MANUFACTURER: ACCUMULATORS, INC. MODEL: AI-CG3-1.5KT-SS	1
ATB-1.0	AUTOMATIC THRUST BALANCING ASSEMBLY CONSISTING OF THE FOLLOWING THREE ITEMS: 1 HYDRAULIC CYLINDER, DOUBLE ACTING, BORE SIZE: 2 1/2”, PORT CONN.: 3/8" NPT(F), ROD DIAMETER: 1",	1

AS BUILT

Tag No.: Description Qty.

ROD CONNECTION: 3/4"-16 UNF;
TRAVEL:1.375”,
CENTER LINE, LUG MOUNTED
MANUFACTURER: PARKER
MODEL: 2.50KE3LLU14A14A 1.375

2 CONTROL VALVE BODY, GLOBE
STYLE, 1”-300# ANSI RF END
CONNECTIONS CARBON STEEL
BODY, STAINLESS STEEL TRIM,
EQUAL PERCENTAGE CHARACTERISTIC,
1” PORT, 3/4” TRAVEL,
3/8”-24 UNF STEM CONNECTION,
2-1/8” YOKE BOSS,
MAWP: 680 PSIG @ -20/200F
MATERIAL-CHEMICAL AND MECHANICAL TEST
REPORTS (PRESSURE PARTS)
MANUFACTURER: FISHER
MODEL: 1” EZ

AS BUILT

3 COUPLING AND SUPPORT
MANUFACTURER: LAT

CV1.0-SW 3
CHECK VALVE, PISTON TYPE,
1” SW END CONNS, A105 CARBON
STEEL BODY, 13% CHROMIUM TRIM,
BOLTED BONNET,
MAWP: 1800 PSIG @ -20/200F,
MATERIAL-CHEMICAL AND MECHANICAL TEST
REPORTS
BONNEY FORGE 1”HL-41-SW

FI-001 1
SIGHT FLOW INDICATOR, CARBON
STEEL BODY, NO FLAPPER,
2”-300# ANSI RF FLANGE CONN.
MATERIAL CERTIFICATE OF CONFORMANCE,
MAWP: 680 PSIG @ -20/200F

MANUFACTURER: JACOBY-TARBOX
MODEL: 910-HPA (NF)

HP-001 1
HAND PUMP, HYDRAULIC

MANUFACTURER: T.R. ENGINEERING
MODEL: 100-12

Tag No.:	Description	Qty.
PCV-101,		1
PR-1	IGV ACTUATOR, FISHER MODEL 667 SIZE 45, DIAPHRAGM TYPE, REVERSE ACTING, AIR TO RETRACT, SPRING TO EXTEND, RATED TRAVEL: 1 1/2” SPRING RATE: 1670 LBS/IN, CALIBRATED STROKE: 1.098”, WITH SMART POSITIONER, FISHER DVC 6200HC WITH HART MODULE, WITH AUTOCALIBRATE ENABLED, 4-20 mA INPUT SIGNAL, AIR SUPPLY PRESSURE: 35 PSIG, GAUGE UNITS IN PSIG/BARG, SUITABLE FOR USE IN 185 F MAX AMBIENT TEMPERATURE, NEMA 4 DEGREE OF PROTECTION, 1/2” NPT(F) ELECTRICAL CONNECTION, FM OR CSA/US CERTIFIED AND LABELED CLASS 1, DIV 2, GRPS A,B,C,D, WITH YOKE NUT AND 1/2”-20 UNF SPLIT NUT, WITH LOCAL POSITION INDICATOR, WITH FILTER REGULATOR, FISHER FS67CFR, DOCUMENTATION: APPROVAL DRAWING (4 WEEKS ARO), FM OR CSA/US CERTIFICATE, MANUFACTURER: FISHER MODEL: 667-45	
LG-001		1
	LEVEL GAUGE, REFLEX TYPE 1/2” NPTF GAGE CONNECTION STANDARD FEMALE UNION, 320 VALVE, VESSEL CONN.: 3/4” NPT(M) WITH VENT & DRAIN, 1/2” NPT(F) HORIZONTAL LOWER & UPPER GAGE COCKS, INTEGRAL SEAT, HAND WHEEL WITH STANDARD PITCH THREADS MAWP: 2400 PSIG @ 100F, MATERIAL CERTIFICATE OF CONFORMANCE, MANUFACTURER: PENBERTHY P/N: 2RL9+320J	

AS BUILT

Tag No.: Description	Qty.
ME-003 3” MIST ELIMINATOR, 304 S.S. 7” LONG (PART OF R-001) MANUFACTURER: MISTER MESH MODEL: 3BF	1
NV.5-FP NEEDLE VALVE, W/O BLEED, 1/2” NPT(M)X 1/2” NPT(F) CONNS, ZINC PLATED CARBON STEEL BODY, STAINLESS STEEL TRIM, DELRIN SEATS, PTFE STEM PACKING MAWP: 3000 PSIG @ -20/200F, MATERIAL CERTIFICATE OF CONFORMANCE, MANUFACTURER: AGCO P/N: H1VDC–44Q	1
NV-.5 NEEDLE VALVE, WITH BLEED, 1/2” NPT(M) INLET X 1/2” NPT(F) OUTLET CONN, ZINC PLATED CARBON STEEL BODY, STAINLESS STEEL TRIM, DELRIN SEATS, PTFE STEM PACKING, MAWP: 3000 PSIG @ -20/200F, MATERIAL CERTIFICATE OF CONFORMANCE, MANUFACTURER: AGCO P/N: M9VDC–44	13
MV2T-.5 2 VALVE INSTRUMENT MANIFOLD, ROSEMOUNT COPLANAR INSTRUMENT CONN, 1/2” NPT(F) PROCESS CONNS, STAINLESS STEEL BODY AND TRIM, INTEGRAL SEAT, PTFE STEM PACKING MAWP: 3000 PSIG @ -20/200F MATERIAL CERTIFICATE OF CONFORMANCE, MANUFACTURER: AGCO P/N: MC2VIS-4	4

AS BUILT

Tag No.: Description	Qty.
MV3T-.5	2
3 VALVE INSTRUMENT MANIFOLD, ROSEMOUNT COPLANAR INSTRUMENT CONN, 1/2" NPT(F) PROCESS CONNS, STAINLESS STEEL BODY AND TRIM, INTEGRAL SEAT, PTFE STEM PACKING MAWP: 3000 PSIG @ -20/200F MATERIAL CERTIFICATE OF CONFORMANCE, MANUFACTURER: AGCO P/N: MC3VIS-4	
PDCV-101	1
REGULATOR, DIFFERENTIAL BACK PRESSURE, LUBE OIL SERVICE, VISCOSITY: 150 SSU @100F (ISO VG32) OIL FLOW: 6/27 GPM (NOR/MAX) INLET PRESSURE (P1): 260/345 PSIG OUTLET PRESSURE (P2): 160/245 PSIG LOAD (CHAMBER REFERENCE) PRESSURE: 160/245 PSIG CARBON STEEL BODY & SPRING CHAMBER, STAINLESS STEEL TRIM, 1"-600# ANSI RF FLANGED END CONNECTIONS, SPRING RANGE: 65-160 PSIG SPRING SETTING: 100 PSID MAWP: 1360 PSIG @ -20/200F OUTLINE DRAWING (4 WEEKS ARO) MATERIAL CERTIFICATE OF CONFORMANCE, MANUFACTURER: CASHCO MODEL: 123-1+6+S (PN: 9S6-54S7-HB**X**32935C)	
PDCV-201	1
REGULATOR, DIFFERENTIAL PRESSURE, REDUCING TYPE, CARBON STEEL BODY & SPRING CHAMBER, STAINLESS STEEL TRIM 1"-600# ANSI RF FLANGE CONNECTIONS, HYDROCARBON GAS SERVICE, MW=16.24 TO 18.13 GAS FLOW: 90/200 SCFM (MIN/MAX) INLET PRESSURE (P1): 400/800 PSIG, OUTLET PRESSURE (P2): 240/310 PSIG CHAMBER REFERENCE (LOAD) PRESS: 220/290 PSIG, SPRING RANGE: 10 - 40 PSID	

AS BUILT

Tag No.:	Description	Qty.
	SPRING SETTING: 20 PSID MAWP: 1360 PSIG @ -20/200F OUTLINE DRAWING (4 WEEKS ARO) MATERIAL CERTIFICATE OF CONFORMANCE, MANUFACTURER: CASHCO MODEL: HP-1+6(PN: 3B6-5367-81080000A)	
PDI-101, 202	GAUGE, PRESSURE DIFFERENTIAL, 2 1/2” DIAL, STAINLESS STEEL CASE, BODY AND WETTED PARTS, SCALE RANGE: 0-40 PSID, BLACK ON WHITE DIAL, 1/4” NPT(M) BACK CONNECTIONS, MANUFACTURER: ASHCROFT MODEL: 25-1132SD-25B-40 PSID,	2
PI-101, 102	GAUGE, PRESSURE, 4 1/2” DIAL, PHENOLIC CASE, 316 SS BOURDON TUBE AND 1/2” NPT BACK CONNECTION, BLACK ON WHITE DIAL, SHATTERPROOF GLASS, PERFORMANCE PLUS, OVERLOAD STOP, STAINLESS STEEL TAG, CALIBRATED RANGE: 0-800 PSIG, CALIBRATION CHART, MANUFACTURER: ASHCROFT MODEL NO.: 45-1279SS-04B-XLLOSSGNHC4-800#	2
PI-201, 503, 504	GAUGE, PRESSURE, 4 1/2” DIAL, PHENOLIC CASE, 316 SS BOURDON TUBE AND 1/2” NPT BACK CONNECTION, BLACK ON WHITE DIAL, SHATTERPROOF GLASS, OVERLOAD STOP, STAINLESS STEEL TAG, CALIBRATED RANGE: 0-600 PSIG CALIBRATION CHART, MANUFACTURER: ASHCROFT MODEL NO.: 45-1279SS-04B-XOSSGNHC4-600#	3

AS BUILT

Tag No.:	Description	Qty.
PI- 501, 502	GAUGE, PRESSURE, 4 1/2" DIAL, PHENOLIC CASE, 316 SS BOURDON TUBE AND 1/2" NPT BACK CONNECTION, BLACK ON WHITE DIAL, SHATTERPROOF GLASS, OVERLOAD STOP, STAINLESS STEEL TAG, CALIBRATED RANGE: 0-800 PSIG CALIBRATION CHART, MANUFACTURER: ASHCROFT MODEL NO.: 45-1279SS-04B-XOSSGNHC4-800#	2
PSV-001	SAFETY RELIEF VALVE, DIRECT ACTING CARBON STEEL BODY, STAINLESS STEEL TRIM, INLET CONN:1"-300# ANSI RF FLG, OUTLET CONN: 2"-150# ANSI RF FLG, SCREWED CAP, HC GAS SERVICE, OPERATING CONDITIONS: MW=16.24 TO 18.13, K=1.31, Z=0.97 PRESSURE: 160/245 PSIG, TEMPERATURE: 135 F, VARIABLE BACK PRESSURE <20 PSIG, MAX FLOW: 500 SCFM, ASME ORIFICE SIZE "D" (0.1279 SQIN), MAWP: 650 PSIG @ -20/200F, SET PRESSURE: 650 PSIG, DESIGNED IAW ASME SECTION VIII, SIZING CALCULATIONS (2 WEEKS ARO) SETPOINT CERTIFICATE, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS (PRESSURE PARTS), MANUFACTURER: CONSOLIDATED MODEL: 1910-00D-2-CC-MS-31-RF-GS-HP	1
STR2-F3	STRAINER, Y-TYPE, CARBON STEEL BODY, WITH STAINLESS STEEL SCREEN BASKET AND 100 MESH SCREEN, 2"-300# ANS RF CONNECTIONS MAWP: 680 PSIG @ -20/200 F, MATERIAL CERTIFICATE OF CONFORMANCE, MANUFACTURER: KECKLEY, MODEL: SA-7	2

AS BUILT

Tag No.:	Description	Qty.
RV- 101 102	RELIEF VALVE, OIL SERVICE VISCOSITY: 150 SSU @100 F 1”-600# ANSI RF FLANGED CONNECTIONS, CARBON STEEL BODY, STAINLESS STEEL TRIM, 507-YS SPRING: 150-350 PSIG, SPRING SET BY LAT, MAWP: 1360 PSIG @ -20/200F, MATERIAL CERTIFICATE OF CONFORMANCE, MANUFACTURER: FULFLO MODEL: VSF-5-600AR/SS/YS	2
TCV-101	TEMPERATURE CONTROL VALVE, 3 WAY CONVERGING TYPE CARBON STEEL BODY, STAINLESS STEEL TRIM, 1 1/2”-600# ANSI RF FLANGED CONNECTIONS, TEMPERATURE SETTING: 120F, MAWP: 1050 PSIG @ -20/200F MATERIAL CERTIFICATE OF CONFORMANCE, MANUFACTURER: AMOT MODEL: 1 1/2 CFSK12001	1
TW-101	THERMOWELL, 304 SS BARSTOCK CONSTRUCTION, 0.260” BORE, 12” STEM “S” LENGTH, 10” INSERTION “U” LENGTH, 1 1/2”-600# PROCESS CONN, 1/2” NPT(F) INSTRUMENT CONN, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS, MANUFACTURER: ASHCROFT MODEL NO.: 15W1000HF260S-R600	1
V.5-B	BALL VALVE, BARSTOCK OR CAST 316 SS BODY, 316 SS BALL AND STEM, PTFE STEM PACKING, 1/2” NPT(F) CONNS, MAWP: 1000 PSIG @ 100F, MATERIAL CERTIFICATE OF CONFORMANCE, IOM, MANUFACTURER: APOLLO MODEL NO. 76-103-01A	1

AS BUILT

Tag No.: Description	Qty.
V.75-SW VALVE, GATE, 3/4” SOCKET WELD CONNS, A105 CARBON STEEL BODY, 13% CHROMIUM TRIM, BOLTED BONNET & GLAND, PTFE PACKING, MAWP: 1800 PSIG @ -20/200F, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS, BONNEY FORGE 3/4”HL-11-SW,	1
V1-SW VALVE, GATE, 1” SOCKET WELD CONNS, A105 CARBON STEEL BODY, 13% CHROMIUM TRIM, BOLTED BONNET & GLAND, PTFE PACKING, MAWP: 1800 PSIG @ -20/200F, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS, BONNEY FORGE 1”HL-11-SW,	3
V1.5-SW VALVE, GATE, 1 1/2” SOCKET WELD CONNS, A105 CARBON STEEL BODY, 13% CHROMIUM TRIM, BOLTED BONNET & GLAND, PTFE PACKING, MAWP: 1800 PSIG @ -20/200F, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS, BONNEY FORGE 1 1/2”HL-11-SW,	1
V.75-F3 VALVE, GATE, 3/4”-300# ANSI RF FLANGES, A105 CARBON STEEL BODY, 13% CHROMIUM TRIM, BOLTED BONNET & GLAND, PTFE PACKING, MAWP: 680 PSIG @ -20/200F, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS, BONNEY FORGE 3/4”L3-11-RF	4

AS BUILT

Tag No.: Description	Qty.
V2-F3 VALVE, GATE, 2”-300# ANSI RF FLANGES, A105 CARBON STEEL BODY, 13% CHROMIUM TRIM, BOLTED BONNET & GLAND, PTFE PACKING, MAWP: 680 PSIG @ -20/200F, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS, BONNEY FORGE 2”L3-11-RF	2
VGL.75ST - VALVE, GLOBE, 3/4” SW X THREADED CONNS, A105 CARBON STEEL BODY, 13% CHROMIUM TRIM, BOLTED BONNET& GLAND, PTFE PACKING, MAWP: 1800 PSIG @ -20/200F, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS, BONNEY FORGE 3/4”HL-31-SW/T	1
VGL1-SW VALVE GLOBE, 1” SOCKET WELD CONNS, A105 CARBON STEEL BODY, 13% CHROMIUM TRIM, BOLTED BONNET& GLAND PTFE PACKING, MAWP: 1800 PSIG @ -20/200F, MATERIAL-CHEMICAL AND MECHANICAL TEST REPORTS, BONNEY FORGE 1”HL-31-SW	2

AS BUILT

Tag No.: Description Qty.

PIPING MATERIALS

Seal Gas Supply Piping: MAWP: 1200 PSIG @ -20/200F

- Piping to be schedule 80S, seamless stainless steel per ASTM A312, Dual Grade TP304/TP-304L.
- Pipe fittings to be seamless butt-weld stainless steel per ASTM A403, Dual Grade WP-S304/WP-S304L. Schedule to match pipe.
- Flanges to be 600# ANSI RF weld neck, stainless steel per ASTM A182, Dual Grade F304/F304L. Bore to match pipe schedule.
- Flange bolting shall be: Studs, ASTM A193 Grade B7. Nuts, ASTM A194 Grade 2H (heavy hex). Bolting shall be zinc plated per ASTM B633.
- Gaskets shall have stainless steel winding, carbon steel centering ring, non-asbestos filler.

Lube Oil Reservoir Piping: MAWP: 650 PSIG @ -20/200F

- Piping to be schedule 80, seamless carbon steel per ASTM A106, Grade B.
- Pipe fittings to be 3000# socket weld carbon steel per ASTM A105.
- Flanges to be 300# ANSI RF, slip-on, carbon steel per ASTM A105.
- Flange bolting shall be: Studs, ASTM A193 Grade B7. Nuts, ASTM A194 Grade 2H (heavy hex). Bolting shall be zinc plated per ASTM B633.
- Gaskets shall have stainless steel winding, carbon steel centering ring, non-asbestos filler.

Lube Oil Pump Discharge Piping Upstream of Filter: MAWP: 850 PSIG @ -20/200F

- Piping to be schedule 80, seamless carbon steel per ASTM A106, Grade B.
- Pipe fittings to be 3000# socket weld carbon steel per ASTM A105.
- Flanges to be 600# ANSI RF, slip-on, carbon steel per ASTM A105.
- Flange bolting shall be: Studs, ASTM A193 Grade B7. Nuts, ASTM A194 Grade 2H (heavy hex). Bolting shall be zinc plated per ASTM B633.
- Gaskets shall have stainless steel winding, carbon steel centering ring, non-asbestos filler.

Lube Oil Pump Discharge Piping Downstream of Filter: MAWP: 850 PSIG @ -20/200F

- Piping to be schedule 80S, seamless stainless steel per ASTM A312, Dual Grade TP304/TP-304L.
- Pipe fittings to be seamless butt-weld stainless steel per ASTM A403, Dual Grade WP-S304/WP-S304L. Schedule to match pipe.
- Flanges to be 600# ANSI RF weld neck, stainless steel per ASTM A182, Dual Grade F304/F304L. Bore to match pipe schedule.
- Flange bolting shall be: Studs, ASTM A193 Grade B7. Nuts, ASTM A194 Grade 2H (heavy hex). Bolting shall be zinc plated per ASTM B633.
- Gaskets shall have stainless steel winding, carbon steel centering ring, non-asbestos filler.

AS BUILT

PIPING MATERIALS (cont'd)

Compressor ATB Piping: MAWP: 650 PSIG @ -20/200 F

- Piping to be schedule 80, seamless carbon steel per ASTM A106, Grade B.
- Pipe fittings to be 3000# socket weld carbon steel per ASTM A105.
- Flanges to be 300# ANSI RF, slip-on, carbon steel per ASTM A105.
- Flange bolting shall be: Studs, ASTM A193 Grade B7. Nuts, ASTM A194 Grade 2H (heavy hex). Bolting shall be zinc plated per ASTM B633.
- Gaskets shall have stainless steel winding, carbon steel centering ring, non-asbestos filler.

Expander Drain Nozzles: MAWP: 1100 PSIG @ -150/150 F

- Piping to be schedule 80S, seamless stainless steel per ASTM A312, Dual Grade TP304/TP-304L.
- Pipe fittings to be 3000# socket weld per ASTM A182, Dual Grade F304/F304L.
- Flanges to be 600# ANSI RF slip-on, stainless steel per ASTM A182, Dual Grade F304/F304L.
- Flange bolting shall be: Studs, ASTM A320 Grade 8 Class 2 stainless steel. Nuts, ASTM A194 Grade 8 stainless steel (heavy hex).
- Gaskets shall have stainless steel winding, carbon steel centering ring, non-asbestos filler.

INSTRUMENTATION TUBING REQUIREMENTS

Tubing

- 3/8" OD X 0.035" wall, annealed seamless stainless steel per ASTM A239, Type 304 with a maximum hardness of Rb 80.

Fittings

- Swagelok double compression type, ASTM A276 and A182, Type 316 stainless steel with a minimum hardness of Rb 90.

PIPING RADIOGRAPHIC EXAMINATION REQUIREMENT

A MINIMUM OF 5% RADIOGRAPHY OF ALL LUBE OIL AND SEAL GAS PIPING BUTT-WELDS SHALL BE PERFORMED AND EXAMINED FOR THIS JOB.

RADIOGRAPHIC INSPECTION AND ACCEPTANCE CRITERIA SHALL BE PER ASME B31.3, 2014 EDITION, NORMAL FLUID SERVICE, AND ASME SECTION V, ARTICLE 2, 2015 EDITION w/2011a ADDENDUM.

AS BUILT

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	Issued for Production	10/18/16	RS
1	Revised tag numbers as noted. Revised data and added "TBD" values for FIT-101 and VT-101.	03/16/17	RS
2	As-built.	04/17/17	RS

CUSTOMER	**UOP RUSSELL, LLC**
FOR	**TBD**
PROJECT	**60 MMSCFD CRYO PLANT (J447-XX)**
LOCATION	**TBD**
P.O. NO.	**4500743460**
ITEM NO.	**EC-101**
SERVICE	**TURBOEXPANDER / RECOMPRESSOR**

AS BUILT

L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Name:	INSTRUMENT SETPOINT LIST					Material Class	N/A
Material:	N/A					Job Number:	LAT574
File Location:	V:\LAT574EC\ELECTRICAL					Originated from:	LAT573
Scale:	N/A		Prev Dwg:	N/A		Dwg/Part No.	Rev
Drawn By:	RG	Date: 10/18/16	Next Dwg:	N/A		LAT574EC-20-C16	2
Std. Chk:	JB	Date: 10/18/16	Blank Wt.	N/A	Finished Wt. N/A		
Design Chk:	SB	Date: 10/18/16	Approved:	RS	Date: 10/18/16	PAGE 1 OF 3	

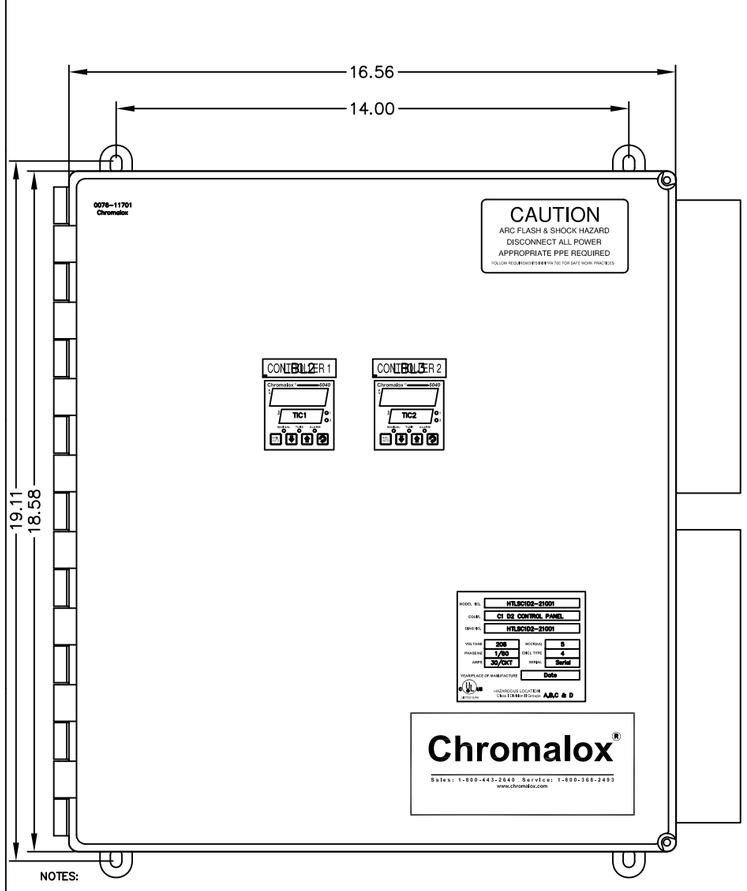
INSTRUMENT SETPOINT LIST								
Inst. Tag	Instrument Description	Range	Output	Scaled	Normal	Alarm	Trip	Rev
PDIT-501	THRUST BEARING DIFFERENTIAL PRESSURE	-300 0 +300 PSID	4-20 mA	-300 0 +300 PSID	PDI-501E/C <50 PSID (EXP/COMP)	PDAH-501E PDAH-501C 160 PSID↑	PDAHH-501E PDAHH-501C 200 PSID↑	
PIT-001	LUBE OIL RESERVOIR PRESSURE	-14.2 - 2000 PSIG	4-20 mA	0 - 1000 PSIG	PI-001 160-245 PSIG	N/A	N/A	
PIT-102	LUBE OIL SUPPLY PRESSURE	-14.2 - 2000 PSIG	4-20 mA	0 - 1000 PSIG	PI-102 260-345 PSIG	N/A	N/A	
PDI-102 (PIT-102 minus PIT-001 in PLC)	LUBE OIL DIFFERENTIAL PRESSURE	N/A	4-20 mA	0 - 500 PSID	PDI-102 100 PSID	PDAL-102 80 PSID↓	PDALL-102 65 PSID ↓	
PDI-101	LUBE OIL FILTER DIFFERENTIAL PRESSURE	0 -30 PSID	4-20 mA	0 - 30 PSID	PDI-101 <5 PSID	CHANGE ELEMENT 15 PSID↑	N/A	
PDI-201	SEAL GAS FILTER DIFFERENTIAL PRESSURE	0 -30 PSID	4-20 mA	0 - 30 PSID	PDI-201 <5 PSID	CHANGE ELEMENT 15 PSID↑	N/A	
PDIT-201	SEAL GAS DIFFERENTIAL PRESSURE	0 -300 PSID	4-20 mA	0 - 50 PSID	PDI-201 20 PSID	PDAL-201 16 PSID ↓	PDALL-201 12 PSID ↓	
TE-101	LUBE OIL RESERVOIR TEMPERATURE	0 - 200 F	4-20 mA	0 - 200 F	TI-101 135 to150 F	N/A	N/A	
TE-102	LUBE OIL SUPPLY TEMPERATURE	0 - 200 F	4-20 mA	0 - 200 F	TI-102 120 F	TAH-102 130 F ↑	N/A	
TE-103	LUBE OIL DRAIN TEMPERATURE	0 - 200 F	4-20 mA	0 - 200 F	TI-103 150 F	TAH-103 160 F ↑	N/A	
ST-501	SHAFT SPEED (2 PULSES/REV)	0 - 60000 RPM (2000Hz)	4-20 mA	0 - 60000 RPM (2000Hz)	SI-501 40,000 RPM (1333.3 Hz)	SAH-501 42,000 RPM ↑ (1400.0 Hz ↑)	SAHH-501 44,100 RPM ↑ (1470.0 Hz ↑)	
VXT-501	EXPANDER BEARING VIBRATION	0 - 5 MILS (200mV/mil)	4-20 mA	0 - 5 MILS (200mV/mil)	VI-501 0.5 MIL	VAH-501 0.8 MIL ↑	VAHH-501 1.0 MIL ↑	
VXT-502	COMPRESSOR BEARING VIBRATION	0 - 5 MILS (200mV/mil)	4-20 mA	0 - 5 MILS (200mV/mil)	VI-502 0.5 MIL	VAH-502 0.8 MIL ↑	VAHH-502 1.0 MIL ↑	
TE-501	EXPANDER BEARING TEMPERATURE	0 - 200 F	4-20 mA	0 - 200 F	TI-501 150 F	TAH-501 175 F ↑	TAHH-501 185 F↑	
TE-502	COMPRESSOR BEARING TEMPERATURE	0 - 200 F	4-20 mA	0 - 200 F	TI-502 150 F	TAH-502 175 F↑	TAHH-502 185 F↑	
HIC-101 PCV-101	EXPANDER IGV CONTROL	0- 100 % OPEN (0 to 1.098" stroke)	4-20 mA	0- 100 % OPEN (0 to 1.098" stroke)	N/A	N/A	N/A	
PIT-101F	COMPRESSOR DISCHARGE PRESSURE	-14.2 - 2000 PSIG	4-20 mA	0 - 1000 PSIG	PI-101F 197-310 PSIG	N/A	N/A	
PIT-101	COMPRESSOR SUCTON PRESSURE	-14.2 - 2000 PSIG	4-20 mA	0 - 1000 PSIG	PI-101 160-245 PSIG	N/A	N/A	
PDI-101 (PIT-101F minus PIT-101 in PLC)	COMPRESSOR DIFFERENTIAL PRESSURE	0 - 200 PSID	4-20 mA	0 - 200 PSID	PDI-101 53-67 PSID	N/A	N/A	
FIT-101 (supplied by Customer)	COMPRESSOR SUCTION FLOW	0 - 250" WC	4-20 mA	0 - 36.813" WC	FIC-101 84,073 LBS/HR @ 26.597" WC (norm) 98,909 LBS/HR @ 36.813" WC (max)	N/A	N/A	
VT-101	AIR COOLER FAN/MOTOR VIBRATION	0 - 1.0 IN/SEC	4-20 mA	0 - 1.0 IN/SEC	VI-101 < 0.10 IN/SEC	VAH-101 0.20 IN/SEC↑	VAHH-101 0.50 IN/SEC↑ (FAN MOTOR TRIP ONLY)	

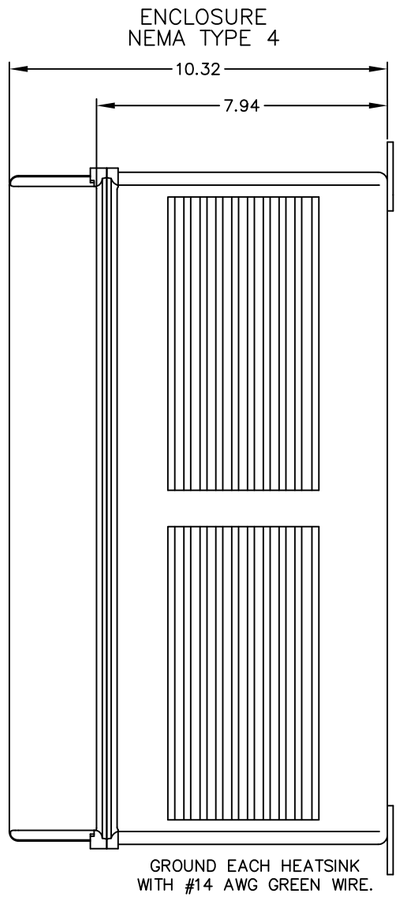
AS BUILT

INSTRUMENT SETPOINT LIST								
Inst. Tag	Instrument Description	Range	Output	Scaled	Normal	Alarm	Trip	Rev
MANUALLY ADJUSTED INSTRUMENTS								
PDCV-101	LUBE OIL DIFFERENTIAL BACK PRESSURE CONTROL	65 to 160 PSI	N/A	65 to 160 PSI	100 PSID as read at PDI-102	N/A	N/A	
PDCV-201	SEAL GAS DIFFERENTIAL PRESSURE CONTROL	10 to 40 PSI	N/A	10 to 40 PSI	20 PSID as read at PDI-201	N/A	N/A	
RV-101 RV-102	LUBE OIL PUMP RELIEF	150 to 350 PSI	N/A	150 to 350 PSI	200 PSID with blocked discharge and full pump flow.	N/A	N/A	
PR-1	INSTRUMENT AIR REGULATOR	N/A	N/A	N/A	Set at 35 PSIG	N/A	N/A	
AC-101	LUBE OIL ACCUMULATOR	N/A	N/A	N/A	Charge to 160 PSIG with accumulator blocked from header and drained.	N/A	N/A	

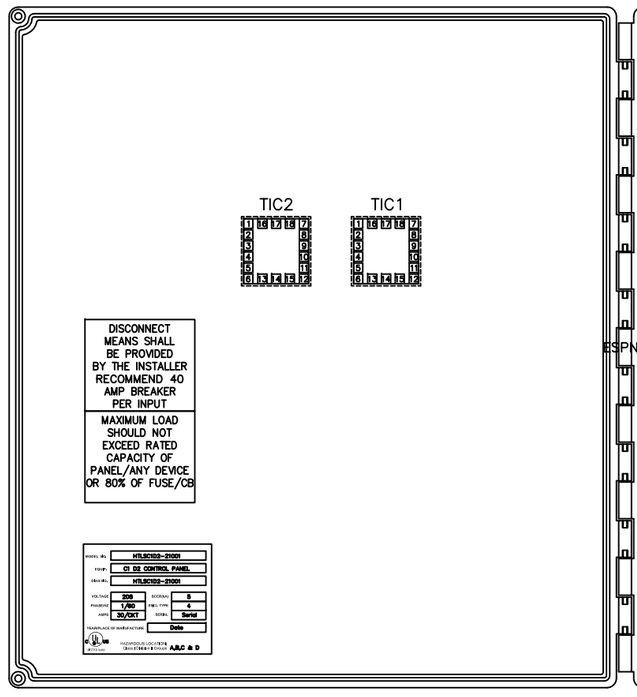
AS BUILT

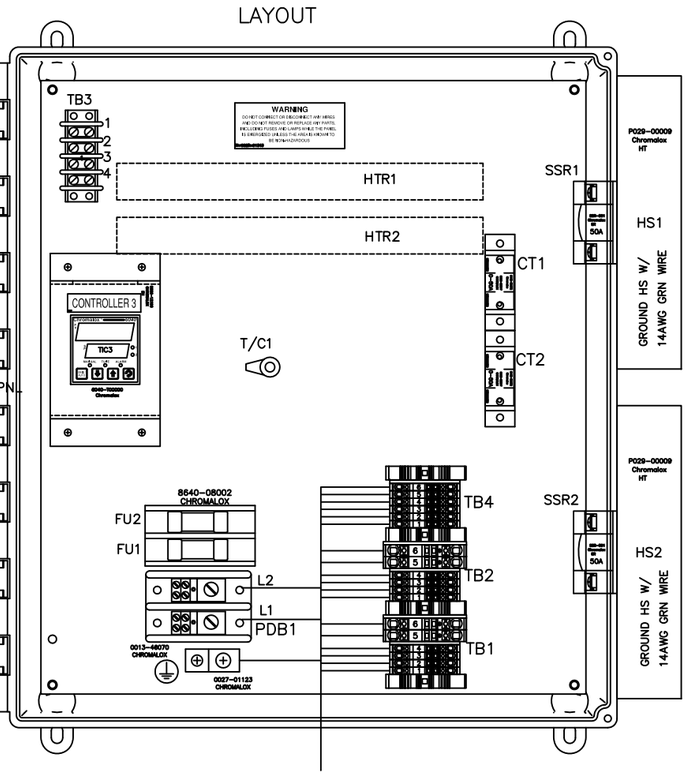
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	2/08/17	R.S.
1	AS BUILT	4/03/17	R.S.





GROUND EACH HEATSINK
WITH #14 AWG GREEN WIRE.





CUSTOMER CONNECTIONS
(SEE SCHEMATIC)

AS BUILT

NOTES:

1. DASHED LINES INDICATE USER FIELD WIRING CONNECTIONS.
2. GROUND CONNECTIONS/WIRING NOTES :
   PANEL FAB: SEE S.O.P. TN-QAD-20-0008 PARAGRAPH 5.7.
   PANEL INSTALLER: GROUND ACCORDING TO NEC ARTICLE 250.
3. CONSULT ALL APPLICABLE INSTRUCTION MANUALS.
4. ALWAYS RUN DC CONTROL, AC CONTROL, AND AC POWER WIRES SEPARATELY.
5. CUSTOMER INTERLOCKS ARE PROVIDED FOR USE OF EXTERNAL SHUTDOWN DEVICE. USE OF INTERLOCKS REQUIRE CONTACTS THAT OPEN TO TRIP OR SHUTDOWN.
6. THIS PANEL IS DESIGNED TO FACILITATE THE COMPLIANCE WITH THE NATIONAL ELECTRICAL CODE (NEC), HOWEVER IT IS THE RESPONSIBILITY OF INSTALLER(S) AND END USER(S) TO MAKE SURE THAT THE INSTALLATION WIRING AND ALL EQUIPMENT INCLUDING THIS PANEL FULFILL THE NEC AND ANY OTHER LOCAL REQUIREMENTS.

   INCOMING AND OUTGOING BRANCH CIRCUIT CONDUCTORS MAY NOT BE PROTECTED WITH FUSES IN THIS PANEL. CONSULT NEC AND MANUFACTURERS SPECIFICATIONS FOR SELECTIVE COORDINATION. IN ADDITION, LOW-LEVEL GROUND FAULT PROTECTION, IF REQUIRED, SHOULD ALSO BE PROVIDED.
7. CONTACTS ARE SHOWN IN THE NORMAL (DEENERGIZED) STATE. CONTACTS SHOWN IN THE CONTROLLERS ARE INTERNAL WITHIN THE CONTROLLER. MOST OF THESE CONTACTS ARE PROGRAMMABLE TO SUIT MODE OF OPERATION. CONSULT USER MANUALS.
8. COMPONENT LAYOUT TO BE FOLLOWED IN GENERAL, HOWEVER SOME VARIATION MAY OCCUR TO FACILITATE ASSEMBLY AND WIRING.
9. CONDUIT OPENINGS IN ENCLOSURE ARE USER INSTALLED. SIZE AND LOCATE TO SUIT NEEDS. HUBS OR FITTINGS MUST BE OF SAME ENVIRONMENTAL RATING AS ENCLOSURE TO MAINTAIN INTEGRITY.
10. DIMENSIONS ARE FOR REFERENCE ONLY OR ARE NOMINAL. NO TOLERANCES SPECIFIED.
11. DO NOT PLACE THIS EQUIPMENT IN DIRECT SUNLIGHT. MAXIMUM AMBIENT TEMPERATURE AROUND ENCLOSURE IS 40°C (104°F).

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	200 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

C.A.D. REF NO. HTLSC1D2-21001-3013-1 NOTES:

REVISED SIZE OF PENL	02/03/17	DLS	DLS	02
REVISED LAYOUT FROM TWO POWER INPUTS, ADDED TERMINALS FOR SENSORS, PER CUSTOMER COMMENTS.	01/27/17	DLS	DLS	01
ORIGINAL (NEW DRAWING)				0
DESCRIPTION OF CHANGE	DATE	APPD	DR.	REV.

DR. BY: DLS 01-30-17
CHK. BY:
APPD. BY:

Chromalox®
1347 Heil Quaker Blvd.
LaVergne, TN 37086

TITLE: Assembly/Wire Dwg #1

EQUIP NAME: CLASS 1 DIVISION 2 CONTROL PANEL
VOLTS 240
PHASE/HZ 1/60
AMPS 30/CKT
MR
ENCL. TYPE 4
CIRCUITS 2
TEMP.

EQUIP NO./PO NO.: VALMI CORPORATION 1381615

STOCK NO. HTLSC1D2-21001-3013
DRAWING NO. HTLSC1D2-21001-3013-1
SHEET 1 OF 2
REV. 02

PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY

DO NOT SCALE THE DRAWING

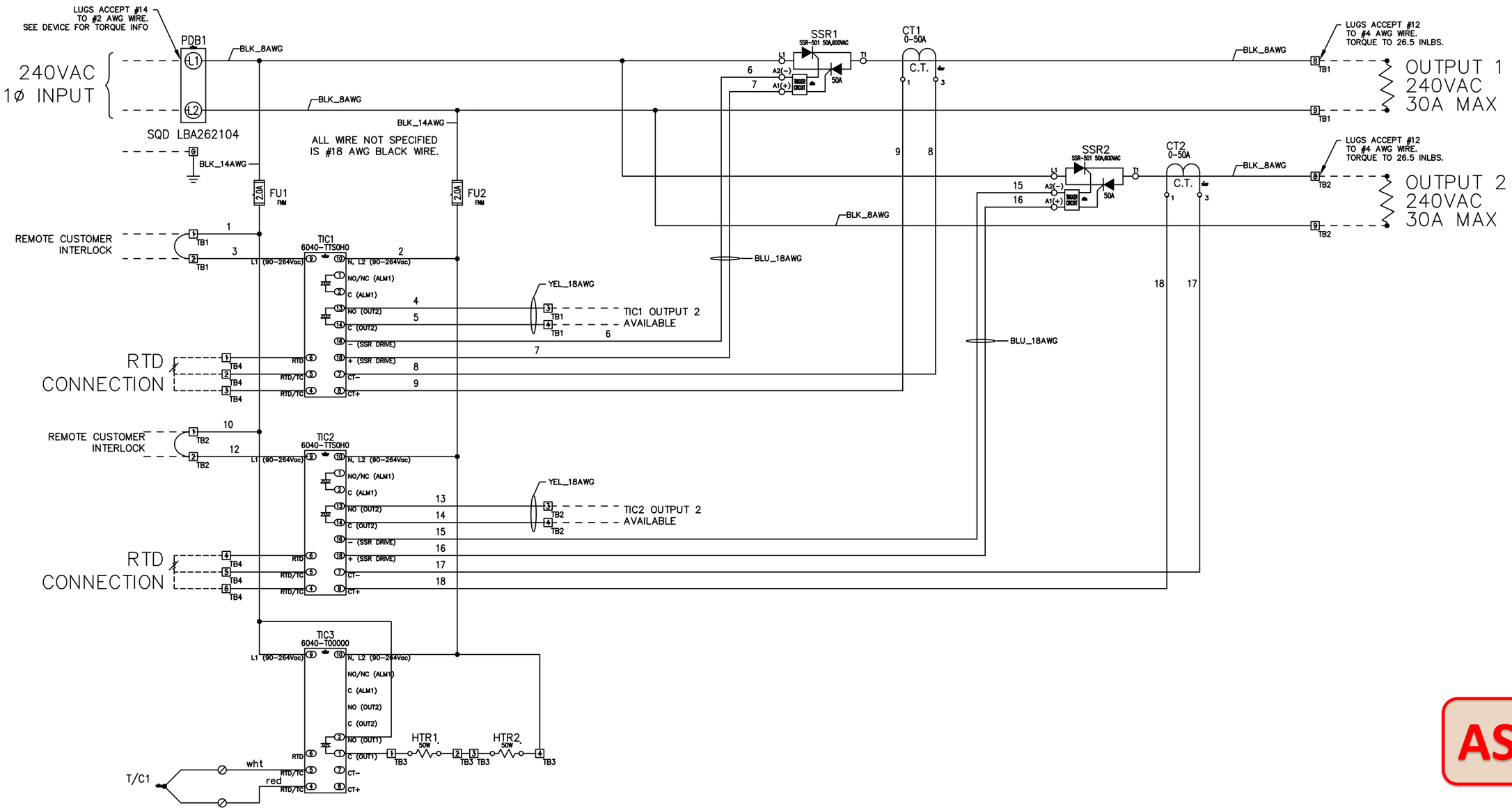
L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, if not indicated, according to ANSI Y 14.5M 1982
Machined Surfaces 125 √ UNLESS NOTED
DECIMALS XXX ± .005 XX ± .01
FRACTIONS ± 1/8" ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name: HEAT TRACING CONTROL PANEL
Material: N/A
Material - Class: N/A
File Location: V:\VAULT\LAT574\ELECTRICAL
Job Number: STL 001-D4 R1
Scale: XX
Prev. Dwg.: N/A
Drawn by: J.B. Date: 10/18/16
Next Dwg: N/A
Std. Chk. JBR Date: 10/18/16
Blank Wt. N/A Kg Lbs
Finished Wt. XXX Kg Lbs
Design Chk. R.S. Date: 10/18/16
Approved R.S. Date: 10/18/16
Dwg/Part No. LAT574EC-20-D38
Rev 1
Originated from N/A
SHEET 1 OF 2

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	2/08/17	R.S.
1	AS BUILT	4/03/17	R.S.



AS BUILT

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C.A.D. REF NO. HTLSC102-21001-3013-2 NOTES:

DESCRIPTION OF CHANGE	DATE	APPD	DR.	REV.
REVISED BRANCHING OF POWER CIRCUITS.	02/03/17	DLS	DLS	02
REVISED FROM TWO POWER INPUTS, ADDED TERMINALS FOR SENSORS, PER CUSTOMER COMMENTS.	01/27/17	DLS	DLS	01
ORIGINAL (NEW DRAWING)				0

DR. BY: DLS 01-20-17
CHK. BY:
APPD. BY:

Chromalox®
1347 Heil Quaker Blvd.
LaVergne, TN 37086

TITLE: Assembly/Wire Dwg #2
EQUIP NAME: CLASS 1 DIVISION 2 CONTROL PANEL
VOLTS: 240 SCCR(kA): 5
PHASE/AC 1/60 ENCL TYPE: 4
AMPS: 30/CKT CIRCUITS: 2
MIN TEMP:
EQUIP NO./PO NO: VALIN CORPORATION 1381815
STOCK NO. HTLSC102-21001-3013
DRAWING NO. HTLSC102-21001-3013-2
SHEET 2 OF 2
REV. 02

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Tolerances, if not indicated, according to ANSI Y 14.5M 1982
Machined Surfaces 125 √ UNLESS NOTED
DECIMALS XXX ± 0.005 XX ± 0.01
FRACTIONS ± 1/64 ANGLES ± 1/4°
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name	HEAT TRACING CONTROL PANEL				
Material	N/A			Material - Class	N/A
File Location	V:\VAULT\LAT574\ELECTRICAL			Job Number	STL 001-04 R1
Scale	XX		Prev. Dwg.	N/A	Originated from N/A
Drawn by	J.B.	Date 10/18/16	Next Dwg	N/A	Dwg/Part No. LAT574EC-20-D38 Rev 1
Std. Chk.	JBR	Date 10/18/16	Blank Wt. N/A Kg Lbs	Finished Wt. XXX Kg Lbs	
Design Chk.	R.S.	Date 10/18/16	Approved R.S.	Date 10/18/16	SHEET 2 OF 2

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT	:	200 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER / RECOMPRESSOR

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR PRODUCTION	08/30/16	R.S.
1	AS BUILT	02/08/17	R.S.
2	REPLACED MODULE TYPE ITEMS#36 & 37	4/03/17	R.S.

CUSTOMER	**:**	**UOP RUSSELL LLC**
FOR	**:**	**TBD**
PROJECT NO.	**:**	**60 MMSCFD CRYO PLANT (J447XX)**
LOCATION	**:**	**TBD**
P.O. NO,	**:**	**4500743460**
ITEM NO.	**:**	**EC-101**
SERVICE	**:**	**TURBOEXPANDER/RECOMPRESSOR**

AS BUILT

DO NOT SCALE THE DRAWING

L.A. Turbine Corporation

28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, If not indicated, according to ANSI Y14.5M-1982 UNLESS NOTED

Machined Surfaces

DECIMALS .XXX ± 0.005 .XX ± 0.01

FRACTIONS ± 1/8" ± ¼"

Units = Inches

BREAK ALL SHARP CORNERS & DEBURR .005R

Name: **ELECTRICAL BILL OF MATERIALS**

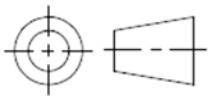
FG: N/A

Material: N/A

Material – Class: N/A

File Location: V:\ LAT574\ELECTRICAL

Job Number: STL 001-D4 R1



Scale: N/A

Prev. Dwg.: N/A

Originated from

Drawn by: J.Byik

Date: 8/29/16

Next Dwg.: N/A

Dwg/Part No.: LAT574EC-20-A41

Rev: 2

STD Check

Date

Blank Wt. Kg N/A Lbs

Finished Wt. Kg N/A Lbs

Design Check: J.B.

Date: 8/29/16

Approved: R.S.

Date: 8/29/16

AS BUILT

L.A. Turbine Corporation

ELECTRICAL BILL OF MATERIAL FOR CONTROLS – REV 2

Drawing Number: LAT574EC-20-A41

item	rev	tag	uom	qty	description	Mfr	part#
1	0	HS101	EA	1	Pushbutton, (GREEN) (1) NO SEALED CONTACT, Approved: Class 1,Division 2, Group D	Allen-Bradley	800H-AR1-D1P
2	0	HS103, 104	EA	2	Pushbutton, (BLK) (1) NO SEALED CONTACT, Approved: Class 1,Division 2, Group D	Allen-Bradley	800H-AR2-D1P
3	0	HS108,109, 110	EA	3	Selector switch, 2 position maint. Non illum, (1) NO & (1) NC SEALED CONTACTS Approved: Class 1,Division 2, Group D	Allen-Bradley	800H-HR2AP
4	0	HS106, 107,	EA	2	Selector switch, 3 position maint. Non illum, (1) NO (1) NC SEALED CONTACTS Approved: Class 1,Division 2, Group D	Allen-Bradley	800H-JR2AP
5	0	XL101	EA	1	Pilot Light, 24VDC Full Voltage, GREEN, Approved: Class 1,Division 2, Group D	Allen-Bradley	800H-QRH2G
6	0	XL102, 104	EA	2	Pilot Light, 24VDC Full Voltage, RED, Approved: Class 1,Division 2, Group D	Allen-Bradley	800H-QRH2R
7	0	XL103, 105	EA	2	Pilot Light, 24VDC Full Voltage, AMBER Approved: Class 1,Division 2, Group D	Allen-Bradley	800H-QRH2A
8	0	XL-8	EA	1	Pilot Light, 110Vac Full Voltage, GREEN, Approved: Class 1,Division 2, Group D	Allen-Bradley	800H-QRH2G
9	0	TERMINALS	EA	25	1492-J IEC Terminal Block, One-Circuit Feed-Through Block, 4 mm (# 22 AWG - # 10 AWG) or 2.5 mm (# 22 AWG - # 12 AWG), Standard Feedthrough, Gray (Standard)	Allen-Bradley (or equal)	1492-J4
10	0	TERMINALS	EA	5	1492-J IEC Terminal Block, One-Circuit Feed-Through Ground Block, 4 mm (# 22 AWG - # 10 AWG), Standard Feedthrough, Green / Yellow Stripe (Standard),	Allen-Bradley (or equal)	1492-JG4
11	0	TERMINALS	EA	6	End Barrier, Gray (Standard)	Allen-Bradley (or equal)	1492-EBJ3
12	0	TERMINALS	EA	10	1492-J IEC Terminal Block, Three-Circuit Feed-Through Block, 4 mm (# 22 AWG - # 12 AWG) or 2.5 mm (# 26 AWG - # 12 AWG), Ground Point, Gray (Standard),	Allen-Bradley (or equal)	1492-JT3M
13	0	TERMINALS	EA	1	End Barrier, Gray (Standard)	Allen-Bradley (or equal)	1492-EBJ3TM
14	0	TERMINALS	EA	48	1492-J IEC Terminal Block, Two-Level Block, 2.5 mm (# 22 AWG - # 12 AWG), Hinged-arm fuse circuit, Gray (Standard), 500V/600V AC/DC	Allen-Bradley (or equal)	1492-JD3FB

15	0	TERMINALS	EA	4	END PLATE KDKS 1/35	Allen-Bradley (or equal)	1492-EBJD3FB
16	0	TERMINALS	EA	24	1492-J IEC Terminal Block, Three-Level Feed-Through Block, 4 mm (# 22 AWG - # 12 AWG) or 2.5 mm (# 26 AWG - # 12 AWG), Hinged-arm fuse circuit, Gray (Standard), 500V/600V AC/DC	Allen-Bradley (or equal)	1492-JDG3FB
17	0	TERMINALS	EA	2	End Barrier, Gray (Standard)	Allen-Bradley (or equal)	1492-EBJD3FB
18	0	TERMINALS	EA	17	1492-J IEC Terminal Block, Two-Circuit Feed-Through Block, 4 mm (# 26 AWG - # 10 AWG), Standard Feedthrough, Gray (Standard),	Allen-Bradley (or equal)	1492-JD4
19	0	TERMINALS	EA	3	End Barrier, Gray (Standard)	Allen-Bradley (or equal)	1492-EBJD4
20	0	TAGS	EA	15	PRE-PRINTED TAGS HORISONTAL CONSECUTIVE 1-10 (PRINT 1….10)	Allen-Bradley (or equal)	1492-M6X5
21	0	TAGS	EA	15	PRE-PRINTED TAGS HORISONTAL CONSECUTIVE 11-20(PRINT11.20)	Allen-Bradley (or equal)	1492-M6X5
22	0	TERMINALS	EA	15	End brackets	Allen-Bradley (or equal)	1492-EAJ35
23	0	CRA1,CRS1, CRP1, CRP2, CRF, CRL, CRE, XA11 CRX1, CRSH1	EA	10	PLC RELAY FOR CLASS 1, DIV2 HAZARDOUS LOCATION UL LISTED PLC-RSC-24DC/21-21/ATEX	PHOENIX CONTACT	2980461
24	0	TERMINALS	EA	1	19" SNAP-IN JUMPER (GRAY) FBST-500-PLC GY	PHOENIX CONTACT	2966838
25	0	WIRING DUCTS	EA	1	PANDUCT® Type G, 2" Wide Slot Wiring Duct Base with Adhesive Back, 6' length	PANDUIT	G2X2LG6-A
26	0	WIRING DUCTS	EA	1	COVER for PANDUCT® Type G, 2" Wide Slot, 6' length	PANDUIT	C2LG6
27	0	WIRING DUCTS	EA	2	PANDUCT® Type G, 1.5" Wide Slot Wiring Duct Base with Adhesive Back, 6' length	PANDUIT	G1.5X2LG6-A
28	0	WIRING DUCTS	EA	2	COVER for PANDUCT® Type G, 1.5" Wide Slot, 6' length	PANDUIT	C1.5LG6
29	0	WIRING DUCTS	EA	1	PANDUCT® Type G, 1" Wide Slot Wiring Duct Base with Adhesive Back, 6' length	PANDUIT	G1X2LG6-A
30	0	WIRING DUCTS	EA	1	COVER for PANDUCT® Type G, 1" Wide Slot, 6' length	PANDUIT	C1LG6
31	0	PLC	EA	1	CONTROL LOGIX LOGIX5571 PROCESSOR	Allen-Bradley	1756-L71
32	0	PLC	EA	1	CONTROLLOGIX POWER SUPPLY	Allen-Bradley	1756-PB75
33	0	PLC	EA	2	DC INPUT MODULE, 16 POINTS	Allen-Bradley	1756-IB16I

34	0	PLC	EA	1	DC module,16 isolated outputs	Allen-Bradley	1756-OB16I
35	0	PLC	EA	1	ANALOG INPUT MODULE, 16 POINTS	Allen-Bradley	1756-IF16
36	2	PLC	EA	1	ANALOG OUTPUT MODULE, 8 POINTS	Allen-Bradley	1756-OF8I
37	2	PLC	EA	1	RTD INPUT MODULE,8 INDIVIDUALLY ISOLATED RTD INPUTS	Allen-Bradley	1756-IRT8I
38	0	PLC	EA	6	36 PIN SCREW CLAMP BLOCK	Allen-Bradley	1756-TBCH
39	0	PLC	EA	1	CLX ETHERNET/IP BRIDGE MODULE	Allen-Bradley	1756-EN2T
40	0	PLC	EA	1	10 SLOT CONTROL CHASSIS	Allen-Bradley	1756-A10
41	0	HMI	EA	1	PANELVIEW PLUS 1000 KEYPAD (Mounted on Operator Panel)	Allen-Bradley	2711P-K10C4D8
42	0	PLC	EA	1	Prosoft MVI56E Modbus TCP/IP Client/Server Enhanced Communication Module	PROSOFT	MVI56E-MNET
43	0	ST	EA	1	Speed Switch/Transmitter, 2 sealed set point relays. Approvals: CSA: Class 1,Division 2, Group D ,	DYNALCO	SST-7200-Q1
44	0	PWS	EA	1	SINGLE PHASE POWER SUPPLY 120VAC/24VDC 10A,Class 1,DIV 2, Group A,B,C,D	ALLEN BRADLEY	1606-XLE240E
45	0	Hex Nuts for nameplates	PKG	2	Stainless Steel Machine Screw Hex Nuts MS35649-244 (PKG OF 25)	MCMASTER & CARR	91240A005
46	0	Ethernet Switch	EA	1	Industrial Ethernet unmanaged switch, 5 ports FL SWITCH SFNB STX	PHOENIX CONTACT	2891001
47	0	Electronic Fuse	EA	12	ELECTRONIC FUSE FAST ACTING, 5X20MM, 1.0A	littlefuse	216.001.
48	0	Electronic Fuse	EA	65	ELECTRONIC FUSE FAST ACTING, 5X20MM, 160MA	littlefuse	216.160
49	0	Fuse Block	EA	2	Fuse block, 1pole	Allen-Bradley	1492-FB1C30
50	0	Fuse	EA	1	Fuse time delay, class CC, 5 amp	BUSSMAN	FNQ-R-5
51	0	Fuse	EA	1	Fuse time delay, class CC, 10 amp	BUSSMAN	FNQ-R-10
52	0	Electronic Fuse	EA	3	ELECTRONIC FUSE FAST ACTING, 5X20MM, 4.0A	littlefuse	216.004.
53	0	Nameplates	EA	17	17 nameplates size & engraving per drawing LAT574-30-D5 SHT1of4		
54	0	ENCLOSURE	EA	1	ENCLOSURE 36X36X12 NEMA 4 CARBON STEEL, with NEMA 4 Window Kit CARBON STEEL, cutouts for an HMI ,		

					holes for pilot lights, switches, pushbuttons & nameplates per dwg: LAT574-20-D5Sheet_2 of 4.dwg		
55	0	PANEL	EA	1	PANEL ONLY 17X13 FOR HMI INSTALLATION. Cutout per dwg: LAT574-20-D5sheet_2 of 4.dwg		
56	0	space heater	EA	2	HEF' Enclosure Space Heater for Hazardous Areas 100w 120vac	EXHEAT	HEF100
57	0	RTD PROBE	EA	1	RTD SENSOR	6568T43	McMASTER & CARR
58	0	CONVERTER	EA	1	UNIVERSAL CONVERTER 4-20mA IN/4-20 Ma 0ut, installation in class 1 ,div2	PR ELECTRONCS	9116B1
59	0	HS102	EA	1	Pushbutton, (RED) (1) NC SEALED CONTACT Approved: Class 1,Division 2, Group D	Allen-Bradley	800H-AR6-D2P
60	0	HS105	EA	1	Pushbutton, (BLK) (1) NC SEALED CONTACT, Approved: Class 1,Division 2, Group D	Allen-Bradley	800H-AR2-D2P
61	0	Electronic Fuse	EA	2	ELECTRONIC FUSE FAST ACTING, 5X20MM, 0.5A	littlefuse	216.500

AS BUILT



HMI OPERATION INSTRUCTION MANUAL

TURBOEXPANDER WITH COMPRESSOR LOAD

DESIGNED AND MANUFACTURED FOR:

UOP RUSSELL LLC

LAT PROJECT: LAT574EC

MAY, 2017

LAT574EC-20-A42 REV 0

AS BUILT

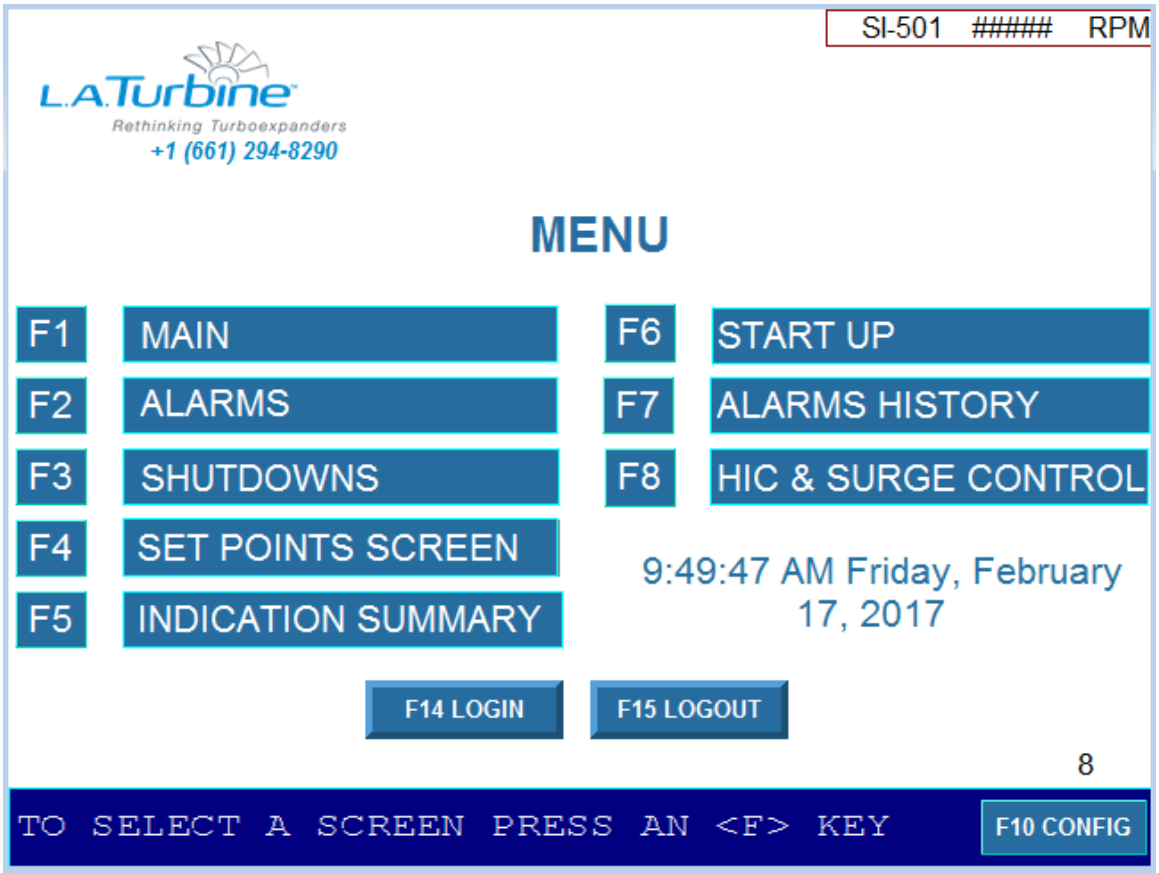
HMI Operating Instruction (LAT574)

Display Select (Menu) screen:

The Display Select screen is the navigation page from where all other screens can be accessed.
It also includes login & logout functions to enable a set points entry screen.

F1 MAIN
F2 ALARMS
F3 SHUTDOWNS
F4 SET POINTS SCREEN
F5 INDICATION SUMMARY
F6 START UP
F7 ALARMS HISTORY
F8 HIC & SURGE CONTROL

F10 button allows access to HMI internal configuration.
The user name and password are the same: **0574**

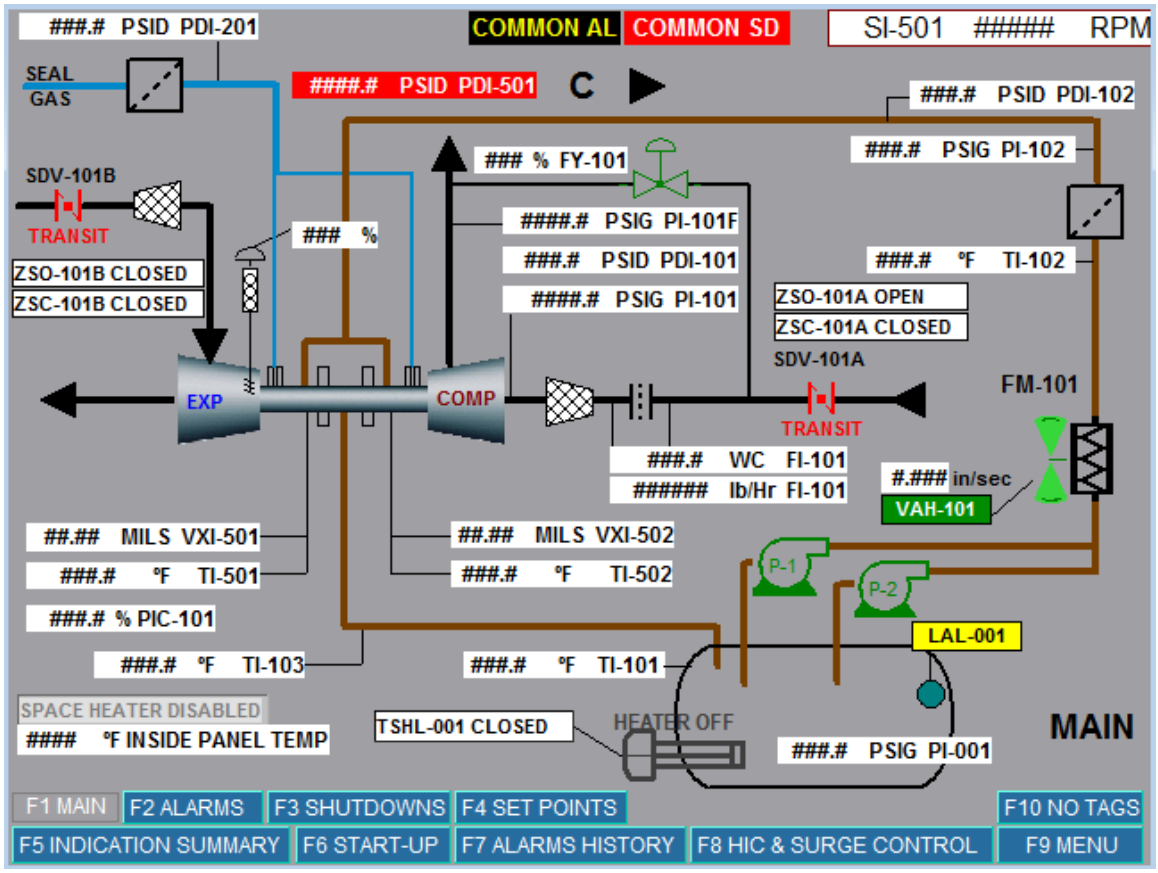


AS BUILT

MAIN:

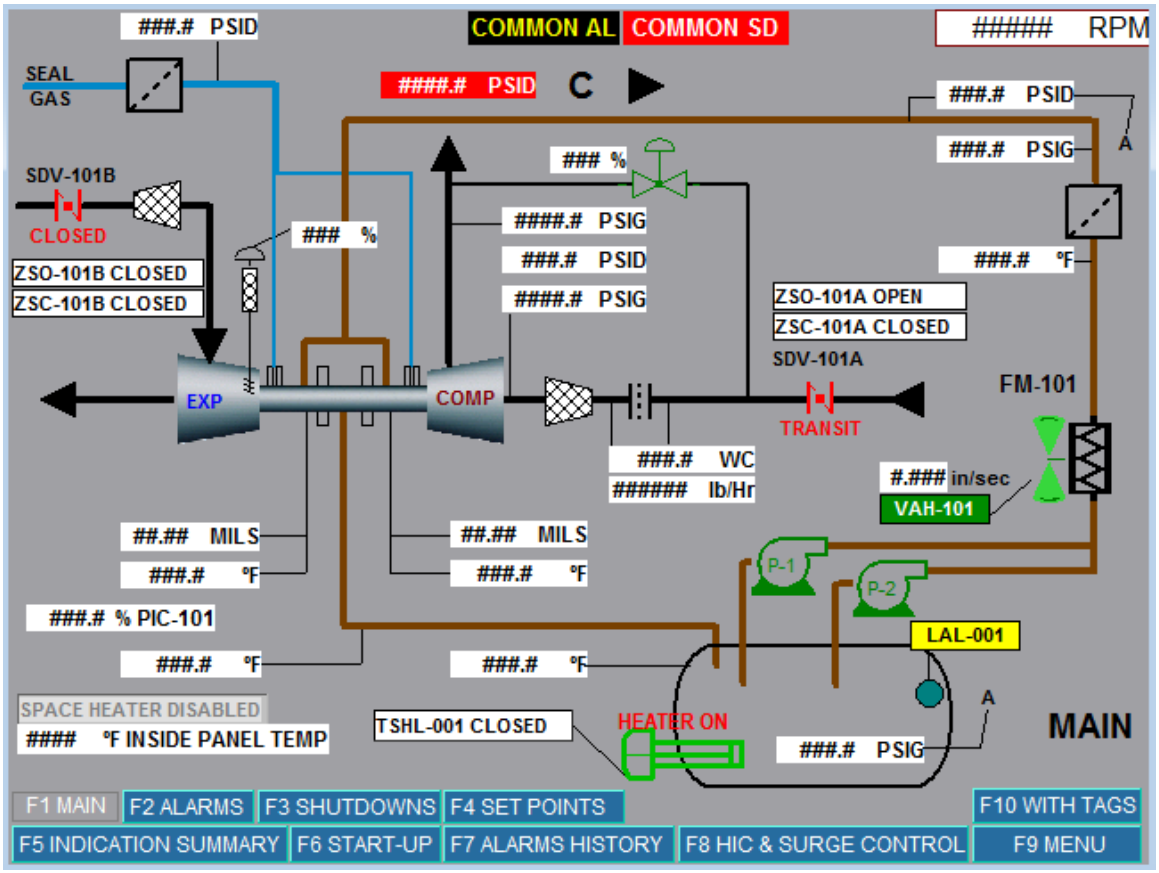
The screen below displays current pressure & temperature values for lube oil & seal gas systems. The screen also shows status indications for: lube oil cooler, heater & pumps.

No control is possible from this screen.



AS BUILT

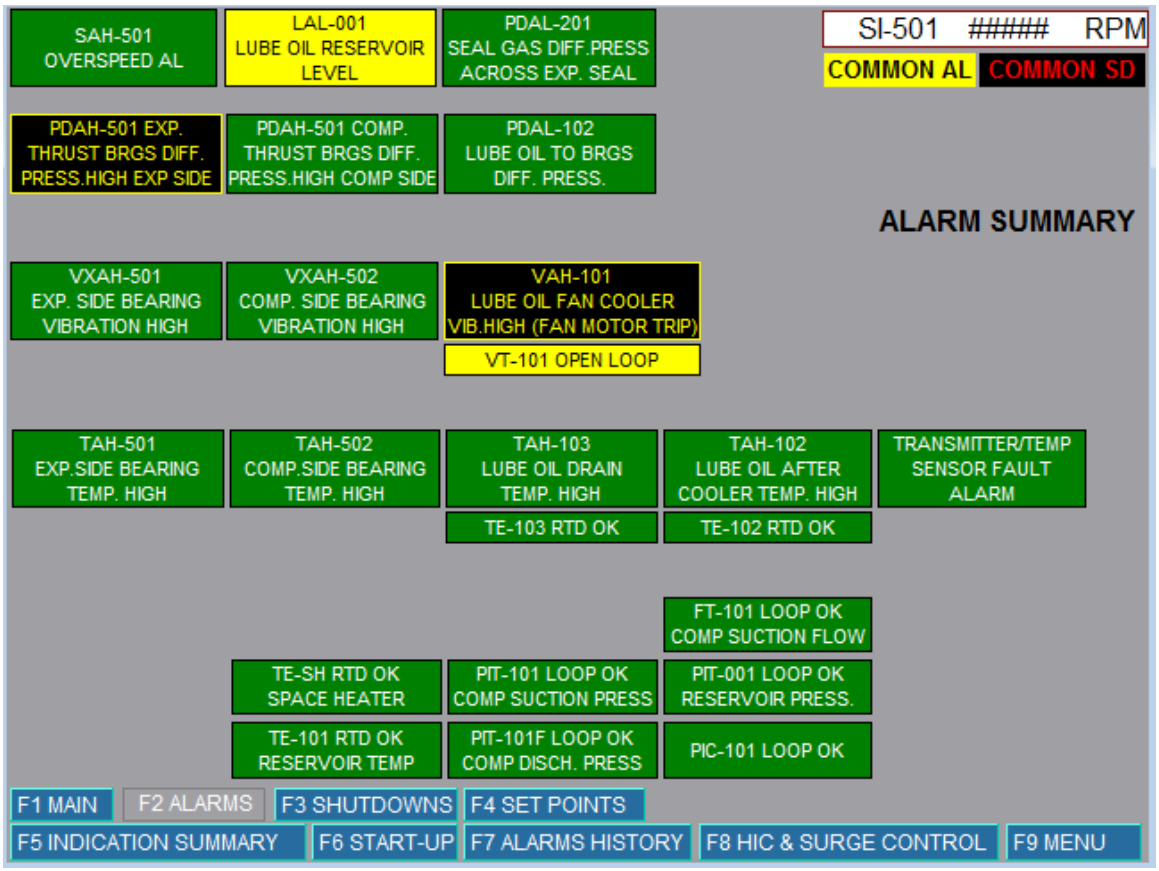
LAT574EC-20-A42 REV.0



AS BUILT

Alarms:

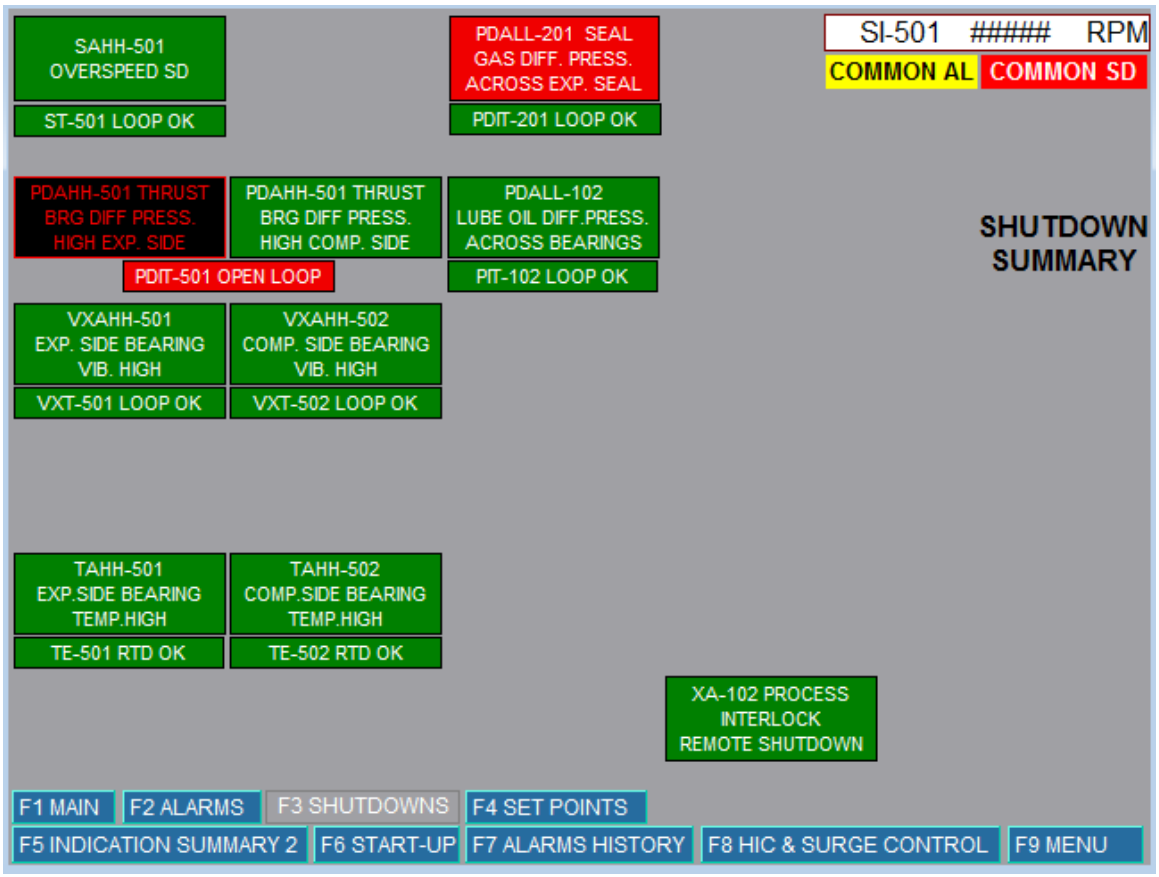
The status of each individual alarm point is shown on this screen.
All cleared alarms will be shown as a white text on a green background. The “first out” alarm points will be shown as a flashing yellow text on a black background.
Acknowledged alarms will be indicated as a solid black text on a yellow background. All alarm points can be acknowledged with the local “Ack/Reset” pushbutton installed on the door of the control panel.



AS BUILT

Shutdowns (Trips) :

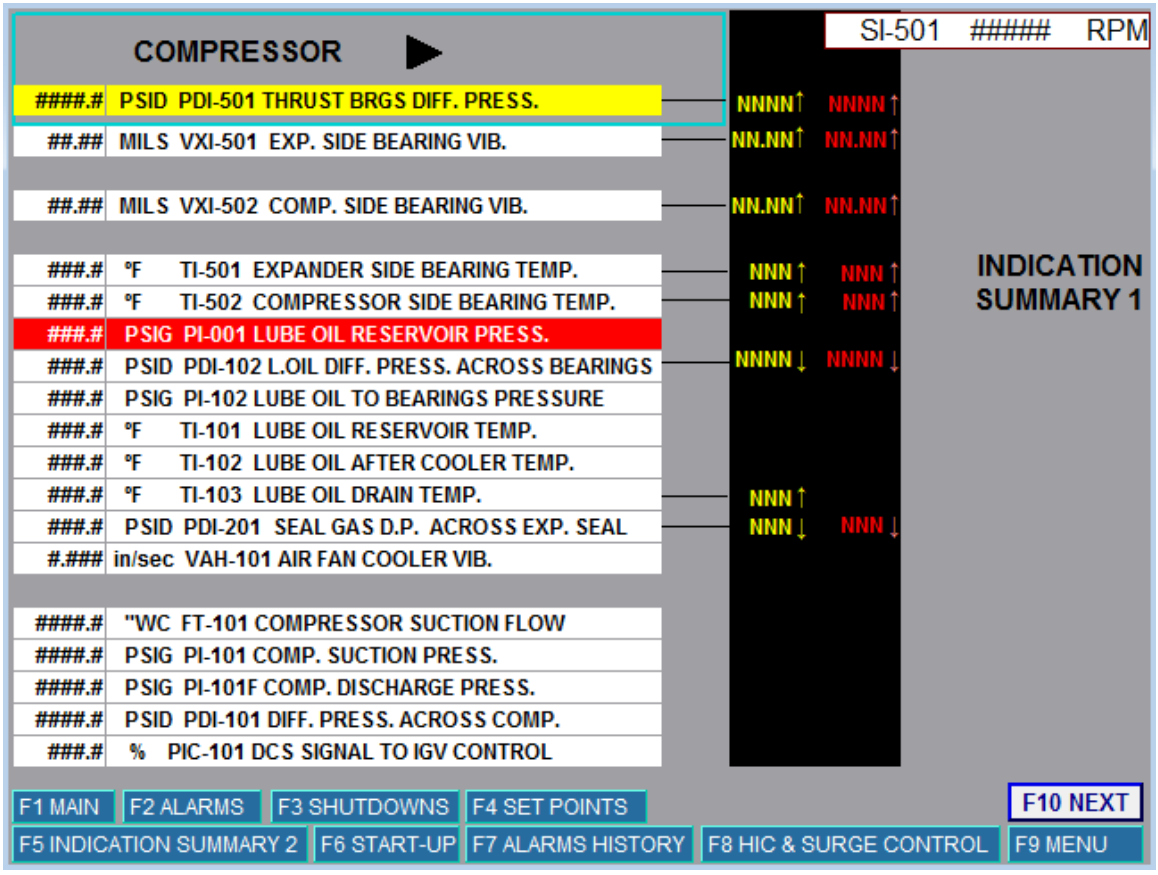
The status of each individual shutdown point is shown on this screen.
All cleared shutdowns will be shown as a white text on a green background. The “first out” trip points will be shown as a flashing red text on a black background.
Acknowledged shutdowns will be indicated as a solid white text on a red background. All trip points can be acknowledged with the local “Ack/Reset” pushbutton installed on the door of the control panel.



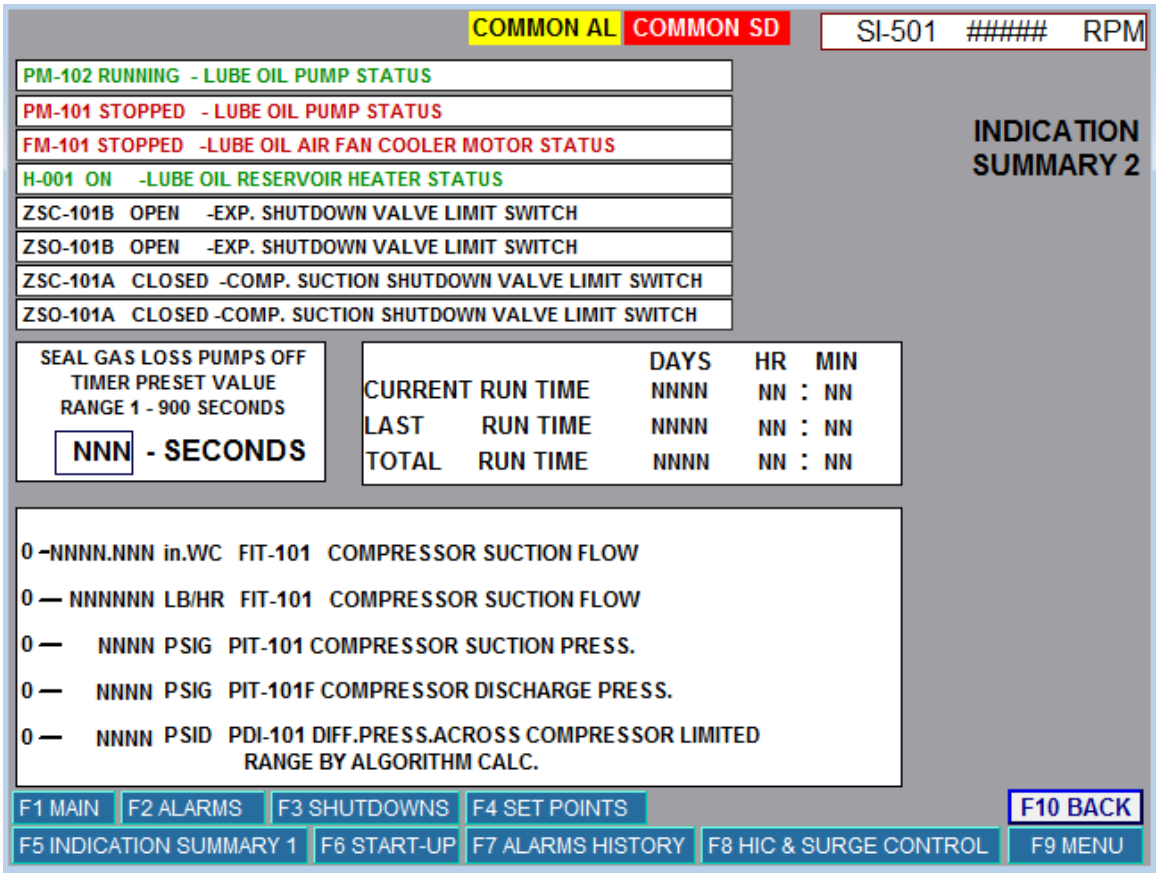
AS BUILT

Indication Summary:

All analog input signals for the unit are displayed in engineering units as a black text on a white background. The background may change if the corresponding alarm or shutdown has been activated.



AS BUILT

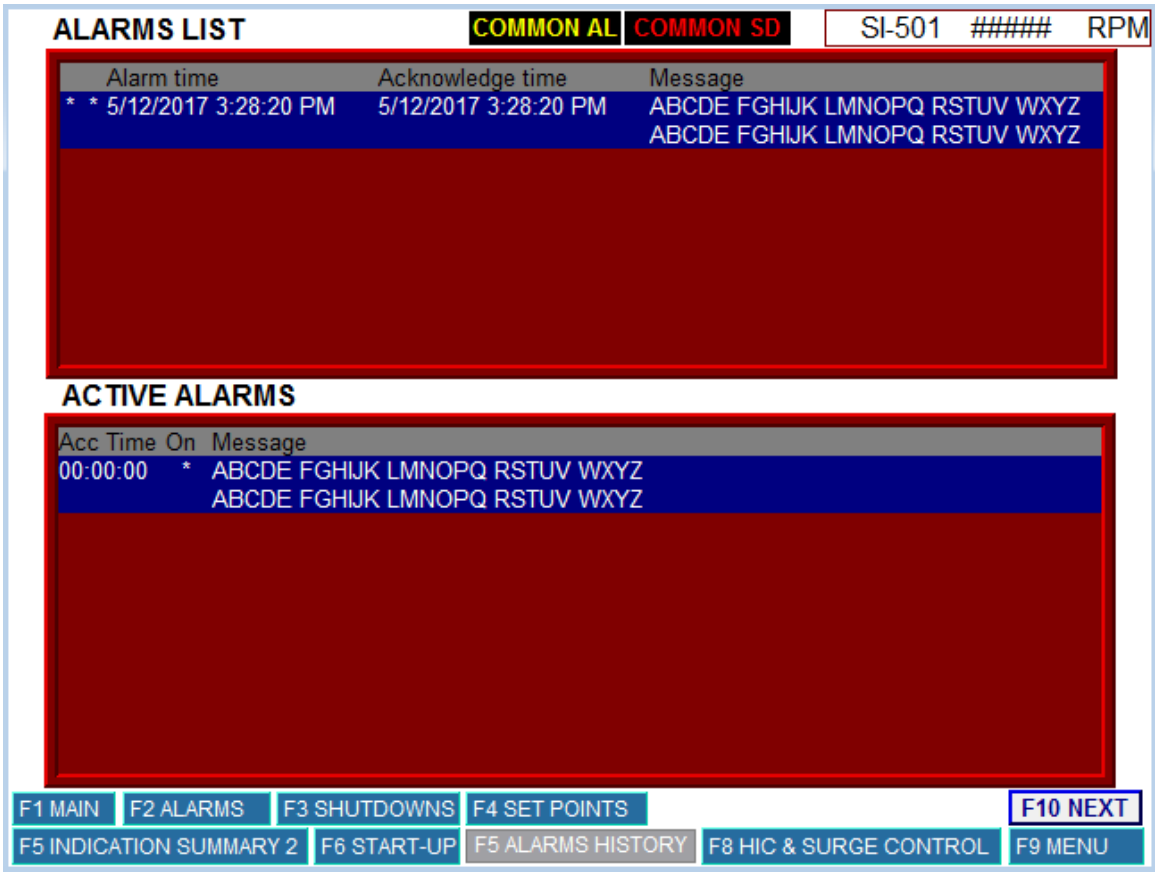


To access and change the timer, type the Number Part and press Enter key
The number field for the SECONDS will be changed accordingly.

AS BUILT

Alarms & Shutdowns History:

Alarms & Shutdowns History Screen lists all the Alarm / Shutdown events. The list is 100 entries long & displays time & date for each AL/SD.



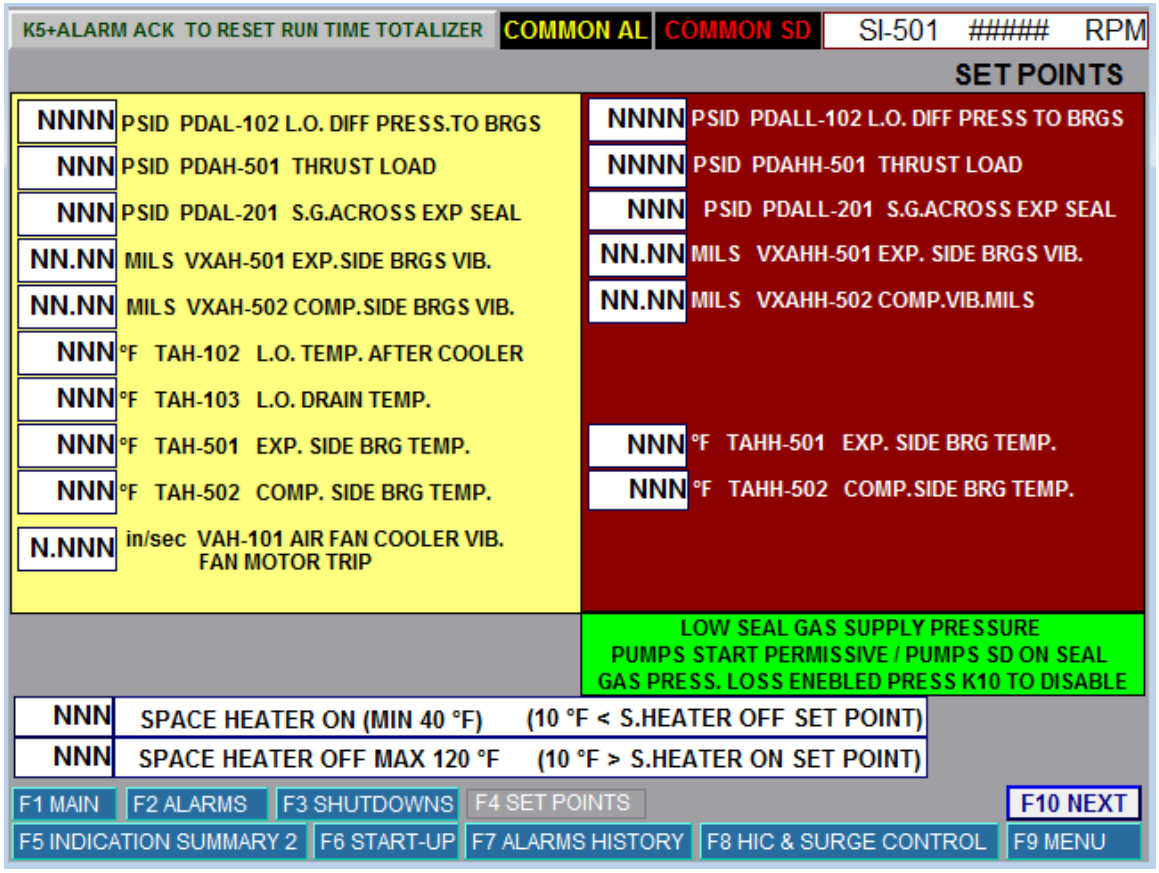
AS BUILT

Set Point Screen:

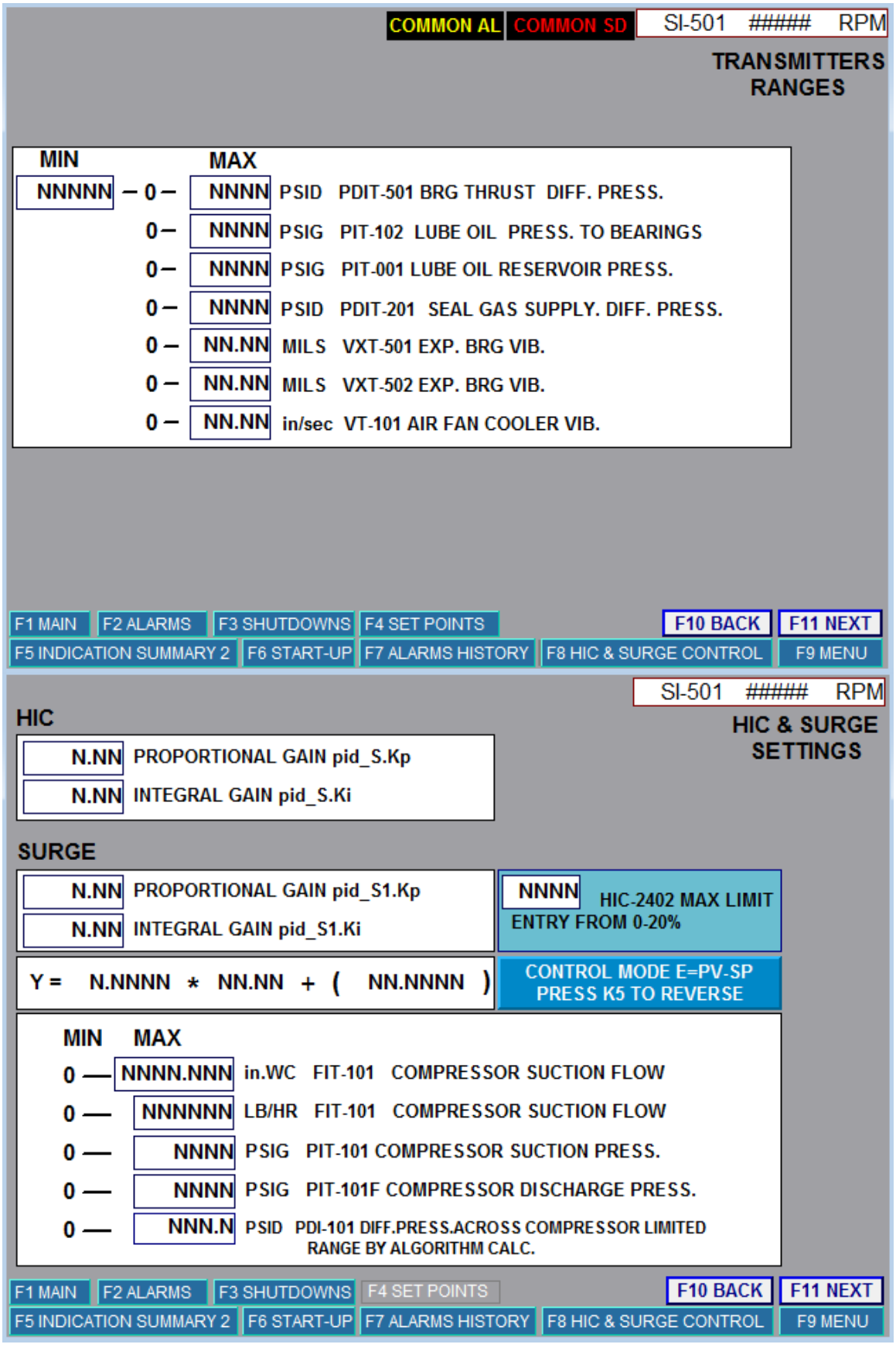
All alarms and shutdowns set points can be set from this screen. The operator has access to these settings after login at the “Menu” screen. Use F10 and F11 (screen below) to scroll back and forth.

Use Tab key  to select these points.

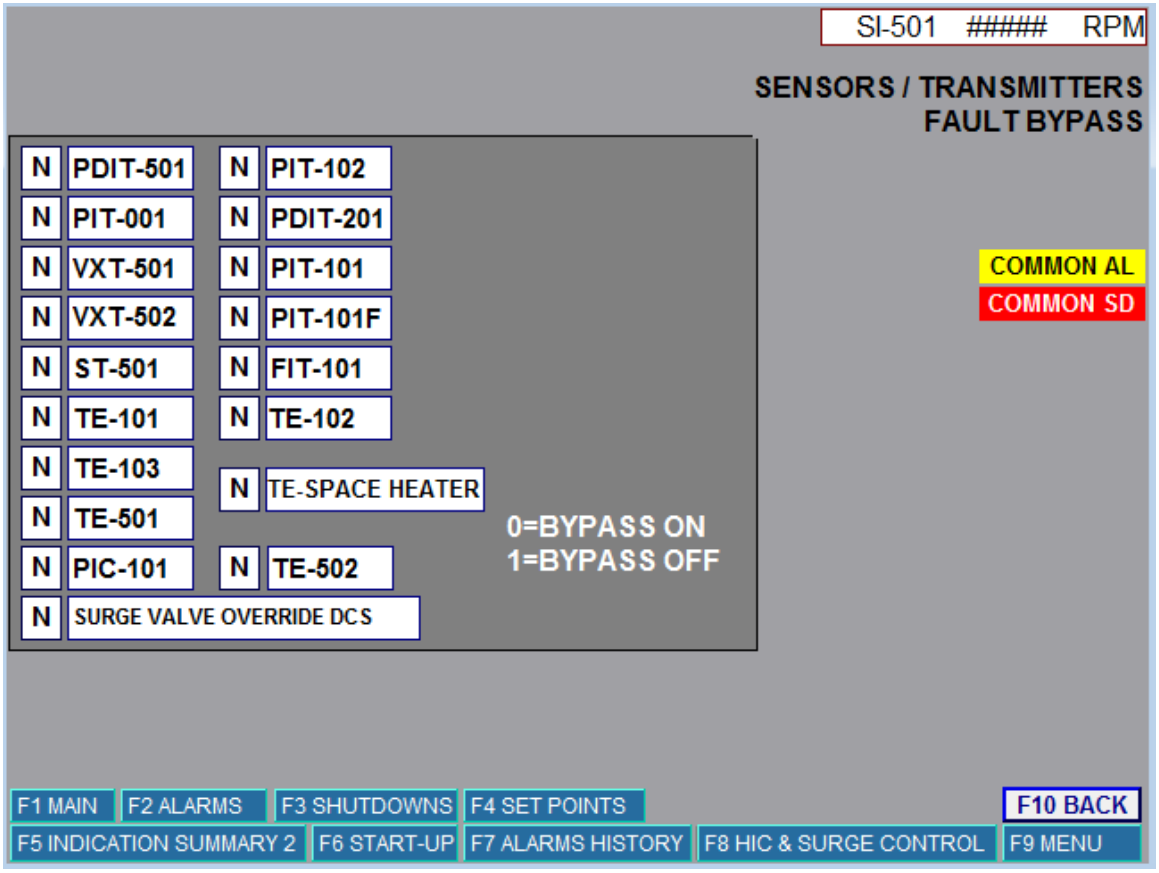
Start typing the number on the number key to enter or change the value.



AS BUILT


COMMON AL
COMMON SD
SI-501 ##### RPM
TRANSMITTERS RANGES
MIN
MAX
NNNNN – 0 – NNNN PSID PDIT-501 BRG THRUST DIFF. PRESS.
0 – NNNN PSIG PIT-102 LUBE OIL PRESS. TO BEARINGS
0 – NNNN PSIG PIT-001 LUBE OIL RESERVOIR PRESS.
0 – NNNN PSID PDIT-201 SEAL GAS SUPPLY. DIFF. PRESS.
0 – NN.NN MILS VXT-501 EXP. BRG VIB.
0 – NN.NN MILS VXT-502 EXP. BRG VIB.
0 – NN.NN in/sec VT-101 AIR FAN COOLER VIB.
F1 MAIN
F2 ALARMS
F3 SHUTDOWNS
F4 SET POINTS
F10 BACK
F11 NEXT
F5 INDICATION SUMMARY 2
F6 START-UP
F7 ALARMS HISTORY
F8 HIC & SURGE CONTROL
F9 MENU
SI-501 ##### RPM
HIC & SURGE SETTINGS
HIC
N.NN PROPORTIONAL GAIN pid_S.Kp
N.NN INTEGRAL GAIN pid_S.Ki
SURGE
N.NN PROPORTIONAL GAIN pid_S1.Kp
N.NN INTEGRAL GAIN pid_S1.Ki
NNNN HIC-2402 MAX LIMIT ENTRY FROM 0-20%
Y = N.NNNN * NN.NN + (NN.NNNN)
CONTROL MODE E=PV-SP PRESS K5 TO REVERSE
MIN MAX
0 — NNNN.NNN in.WC FIT-101 COMPRESSOR SUCTION FLOW
0 — NNNNNN LB/HR FIT-101 COMPRESSOR SUCTION FLOW
0 — NNNN PSIG PIT-101 COMPRESSOR SUCTION PRESS.
0 — NNNN PSIG PIT-101F COMPRESSOR DISCHARGE PRESS.
0 — NNN.N PSID PDI-101 DIFF.PRESS.ACROSS COMPRESSOR LIMITED RANGE BY ALGORITHM CALC.
F1 MAIN
F2 ALARMS
F3 SHUTDOWNS
F4 SET POINTS
F10 BACK
F11 NEXT
F5 INDICATION SUMMARY 2
F6 START-UP
F7 ALARMS HISTORY
F8 HIC & SURGE CONTROL
F9 MENU

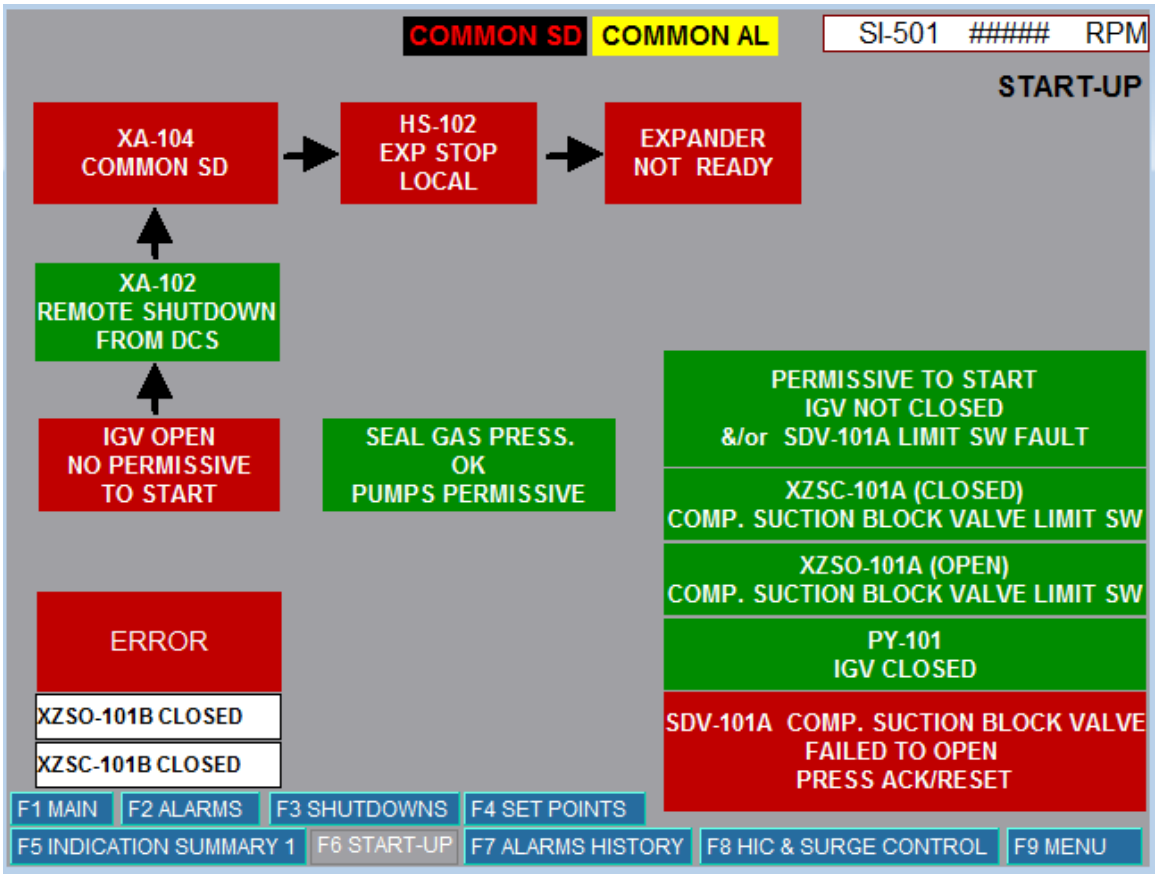
AS BUILT


SI-501 ##### RPM
SENSORS / TRANSMITTERS FAULT BYPASS
N PDIT-501
N PIT-001
N VXT-501
N VXT-502
N ST-501
N TE-101
N TE-103
N TE-501
N PIC-101
N SURGE VALVE OVERRIDE DCS
N PIT-102
N PDIT-201
N PIT-101
N PIT-101F
N FIT-101
N TE-102
N TE-SPACE HEATER
N TE-502
0=BYPASS ON
1=BYPASS OFF
COMMON AL
COMMON SD
F1 MAIN
F2 ALARMS
F3 SHUTDOWNS
F4 SET POINTS
F10 BACK
F5 INDICATION SUMMARY 2
F6 START-UP
F7 ALARMS HISTORY
F8 HIC & SURGE CONTROL
F9 MENU

AS BUILT

System Startup:

The Startup Screen displays general information about the expander status.



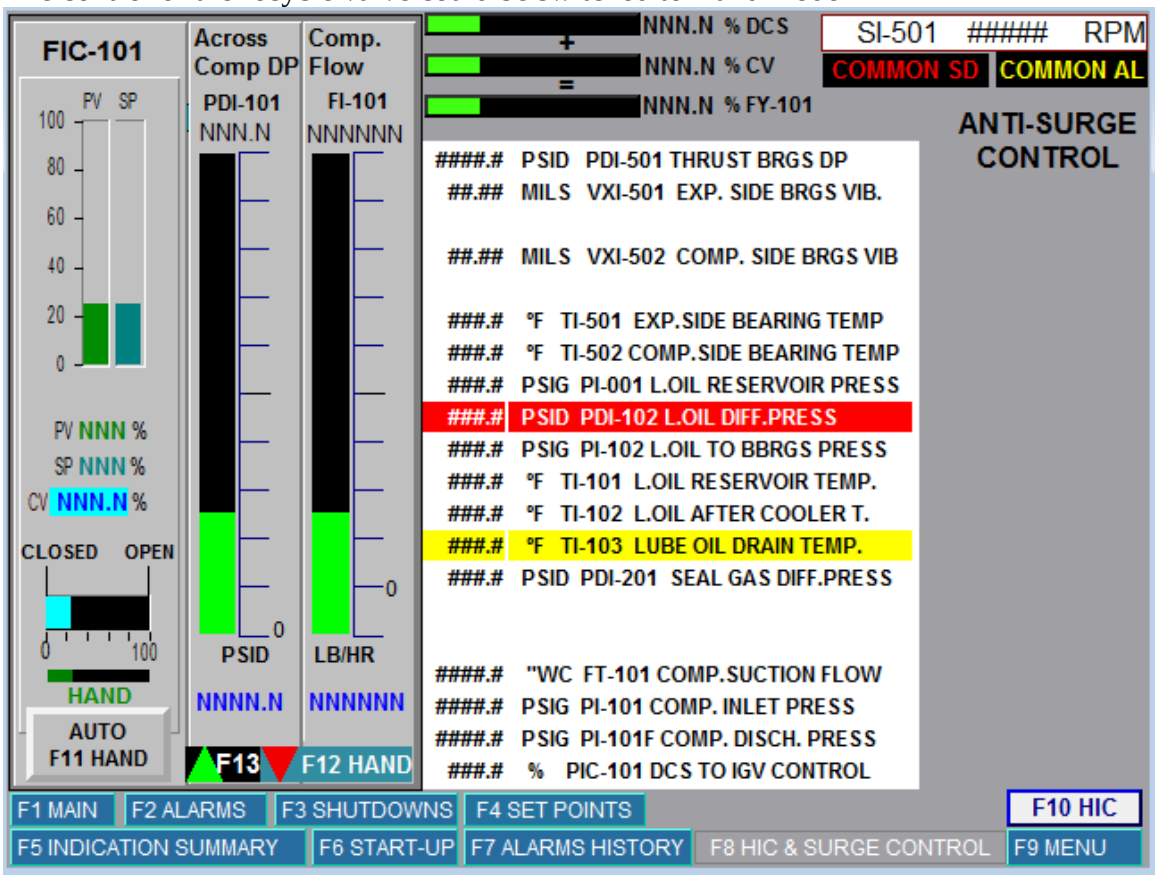
AS BUILT

SURGE CONTROL & HIC

The Surge Control & HIC Screens displays information about anti surge & speed controllers.

Surge control:

The process value is the differential pressure across compressor.
The set point is the calculated value derived from algorithm supplied by LA Turbine.
The control output is the PID function outcome directed to the recycle valve.
The control of the recycle valve could be switched to Hand mode



To switch between Hand and Auto, use F11 - Hand/Auto mode selection

To adjust the output in Hand mode, use F13 and F12
F13 Increase value using hand mode
F12 Decrease value using hand mode

NOTE:
F13/F12 are not visible during auto mode.

AS BUILT

HIC:

The HMI has a speed limiter enable/disable function. As seen in the clip below the enable/disable button is shown circled in red.

By depressing the K15 button at the right side of the screen, you can enable/disable the speed limiter function. When the speed limiter is ENABLED the operator no longer have the ability to change IGV setting from the HMI when the HIC station is in MANUAL mode. As a reminder the HIC station will by default change to manual each time the unit is stopped. The speed limiter should always be left in the ENABLED MODE.

Starting the expander.

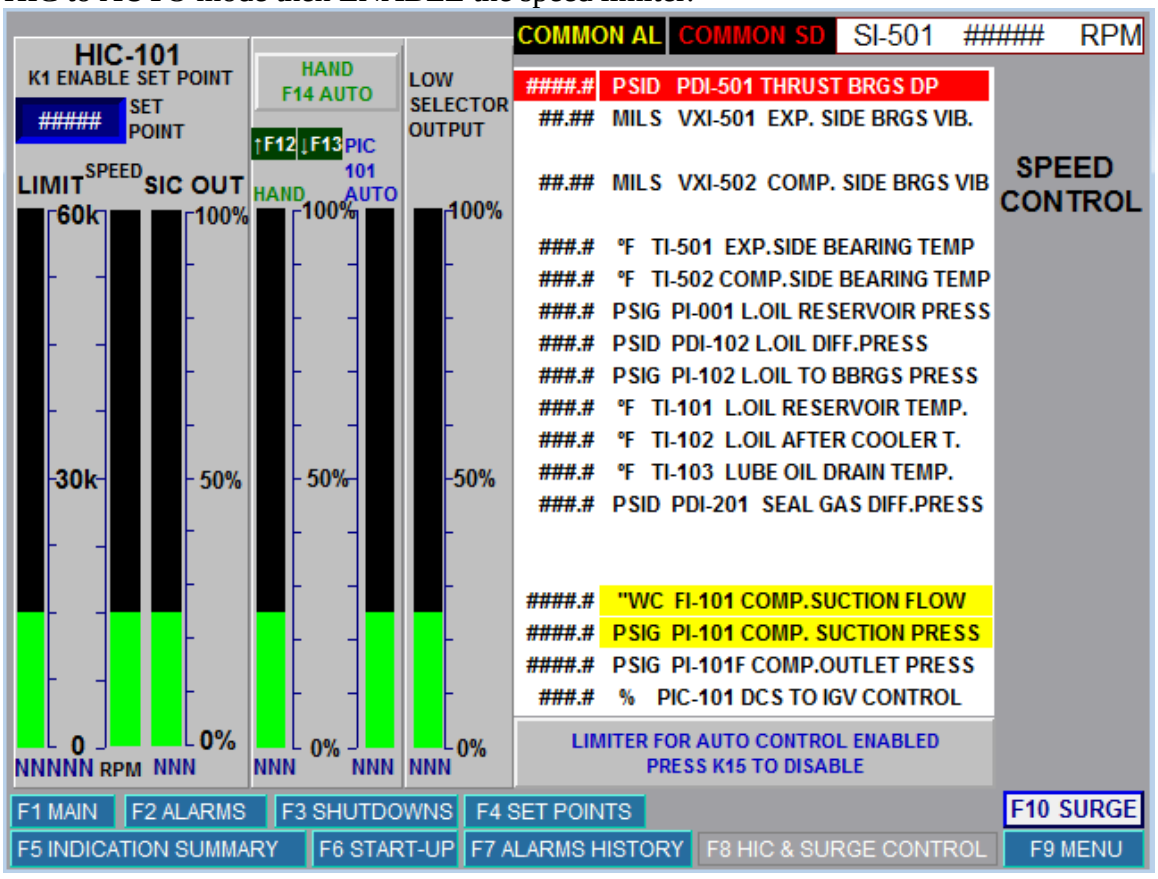
1. Check the HIC and assure that it is in MANUAL MODE and that signal output is at ZERO. If the output is not at zero, you will not be able to start the expander.

2.Push the expander start button, a signal will be sent to the expander inlet trip valve to open. Then the expander is in RUN mode.

3.Check to assure that the DCS input is close to ZERO and then change the HIC to AUTO mode.

4.Ramp up the IGV's from DCS as required.

If you need to operate the IGV's in MANUAL mode, it will be required to change the speed limiter mode to DISABLED mode, then switch the HIC to manual. Then you will be able to adjust output via the F12 & F13 keys. To go back to AUTO mode, switch the HIC to AUTO mode then ENABLE the speed limiter.



AS BUILT

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	Issued for Approval.	11/03/16	R.S.
1	Added motor space heater voltages and wattages.	03/10/17	R.S.
2	As-built.	04/17/17	R.S.

CUSTOMER	**UOP RUSSELL, LLC**
FOR	**TBD**
PROJECT	**60 MMSCFD CRYO PLANT (J447XX)**
LOCATION	**TBD**
P.O. NO.	**4500743460**
ITEM NO.	**EC-101**
SERVICE	**TURBOEXPANDER / RECOMPRESSOR**

AS BUILT

L.A. Turbine Corporation

28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Name	**UTILITY CONSUMPTION LIST**			FG N/A	
Material	N/A			Material – Class N/A	
File Location	V:\LAT574\ELECTRICAL			Job Number LAT574	
Scale N/A		Prev. Dwg. N/A		Originated from LAT573 DUPLICATE	
Drawn by RLG	Date 11/03/16	Next Dwg. N/A		Dwg/Part No. LAT574EC-20-A62	Rev 2
STD Check JB	Date 11/03/16	Blank Wt. Kg N/A Lbs	Finished Wt. Kg N/A Lbs		
Design Check SB	Date 11/03/16	Approved RS	Date 11/03/16	PAGE 1 OF 2	

SEAL GAS SUPPLY (at skid edge)

Type	: Hydrocarbon Gas
M.W.	: 16.24/18.13
Pressure	: 400/800 PSIG (min/max)
Temperature	: 90/120 F
Flow	: 90/200 SCFM (min/max)

INSTRUMENT AIR SUPPLY

Flow Rate (Approx.)	: 1 SCFM (IGV actuator positioner)
Pressure (Min. / Max.)	: 80/150 PSIG
Temperature (Min. / Max.)	: 60/120 F (-40 F dewpoint)

LOCAL PANEL POWER SUPPLY

Power Supply	: 120 VAC, 1 Phase, 60 Hz,
Load	: 800 Watts

LUBE OIL PUMP MOTORS POWER SUPPLY

Main Power Supply	: 460 VAC, 3 Phase, 60 Hz
Load	: 5 HP per motor
Space Heater Power Supply	: 115 VAC, 1 Phase, 60 Hz
Load	: 22 Watts per motor

LUBE OIL COOLER FAN MOTOR POWER SUPPLY

Main Power Supply	: 460 VAC, 3 Phase, 60 Hz
Load	: 5 HP
Space Heater Power Supply	: 115 VAC, 1 Phase, 60 Hz
Load	: 60 Watts

LUBE OIL RESERVOIR HEATER POWER SUPPLY

Power Supply	: 460 VAC, 3 Phase, 60 Hz
Load	: 3 kW

AS BUILT

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	INITIAL RELEASE	8/25/2016	B. PARRELLI
1	AS BUILT	5/10/2017	B. PARRELLI

CUSTOMER	:	UOP RUSSELL, LLC
FOR	:	TBD
PROJECT	:	60 MMSCFD CRYO PLANT J447XX
LOCATION	:	TBD
P.O. NO.	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	Turbo-Expander/Compressor

AS BUILT

DO NOT SCALE DRAWING

L.A. Turbine Corporation

28557 Industry Drive
Valencia, Ca. 91355

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Tolerances, if not indicated, according to: ANSI Y14.5M 1982

Machined Surface: 125 UNLESS NOTED

DECIMALS .XXX N/A .XX N/A

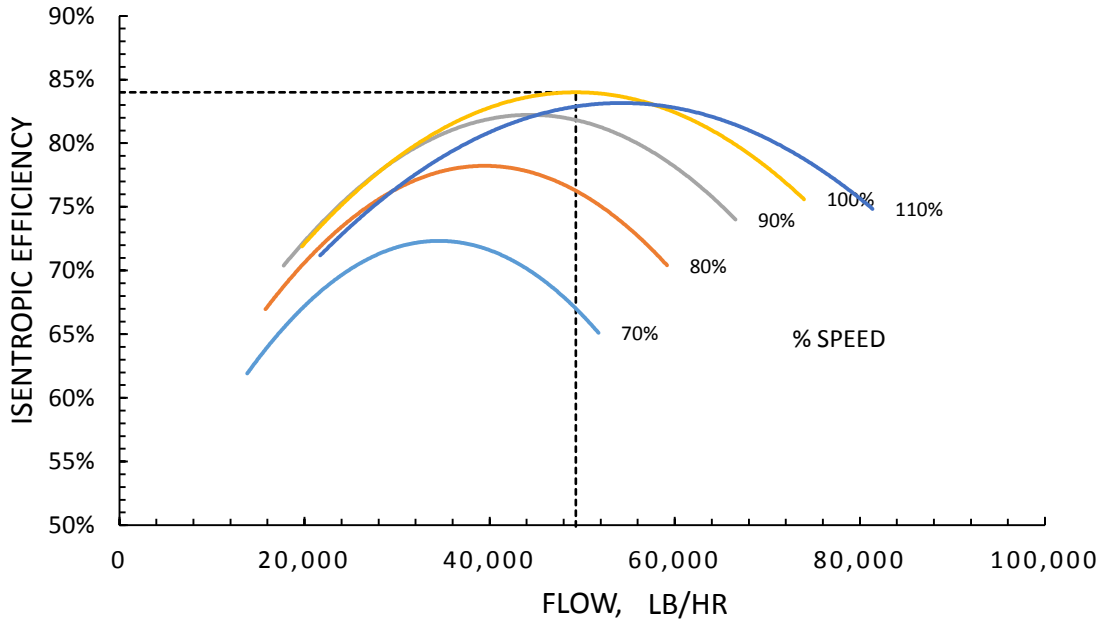
FRACTIONS ± N/A ANGLES ±

Units = Inches
BREAK ALL SHARP CORNERS AND DEBURRS .005

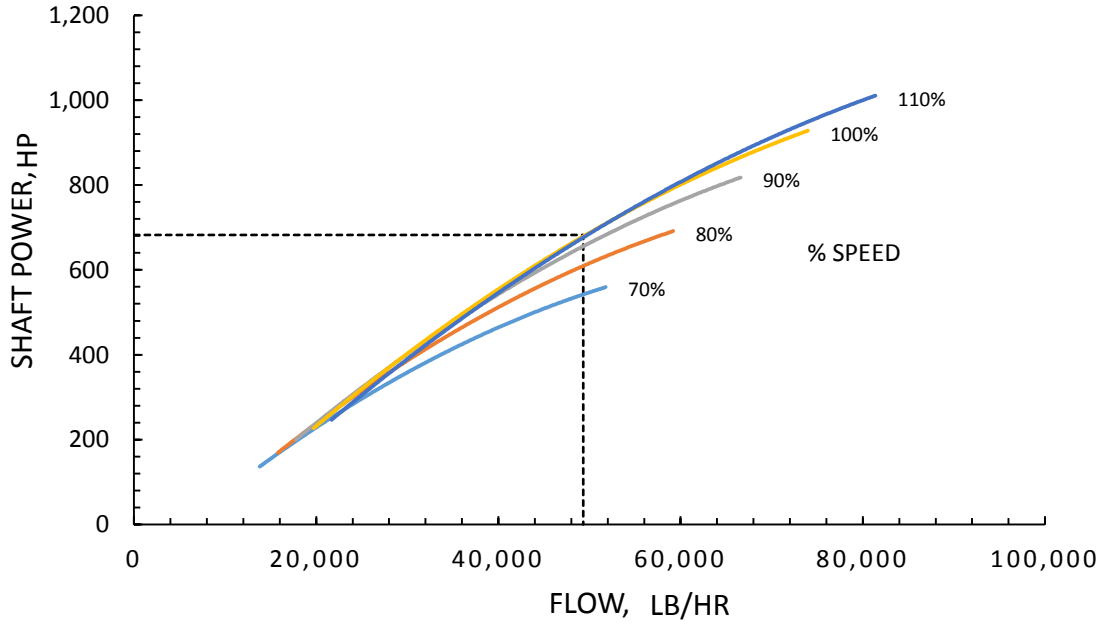
Name:	EXPECTED PERFORMANCE CURVES						
Material:	N/A					Material Class	N/A
File Location:	V:\LAT574\GAS DYNAMICS					Job Number:	LAT574
Scale:	N/A		Prev Dwg:	N/A		Originated from:	
Drawn By:	-	Date: 8/25/16	Next Dwg:	N/A		Dwg/Part No.	Rev
Std. Chk:	-	Date: 8/25/16	Blank Wt.	N/A	Finished Wt. N/A	LAT574EC-20-A81	1
Design Chk:	B.P	Date: 8/25/16	Approved:	B.P.	Date: 8/25/16		

JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	DESIGN CASE	**DATE:**	8/25/2016
SPEED:	40,000 RPM	**BY:**	B. PARRELLI

ESTIMATED EXPANDER EFFICIENCY VS FLOW

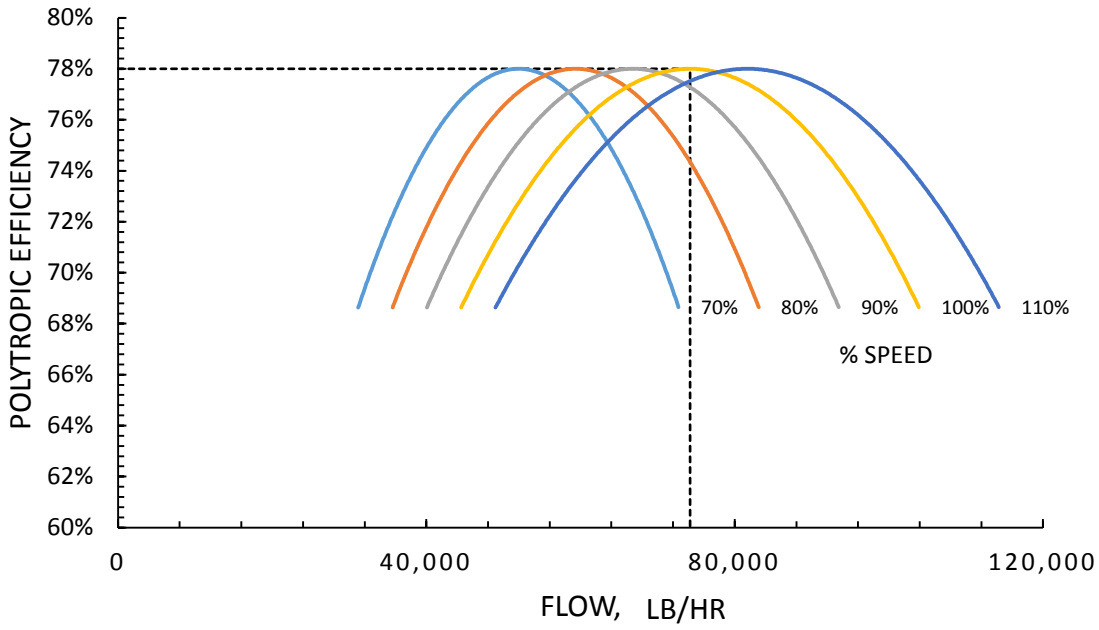


ESTIMATED EXPANDER POWER VS FLOW

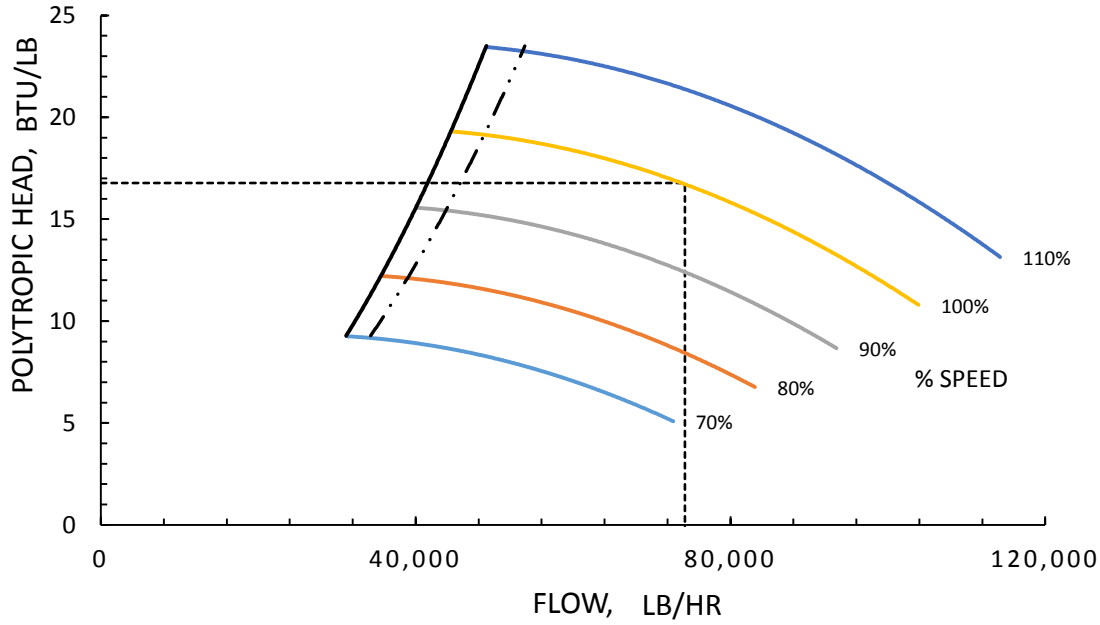


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	DESIGN CASE	**DATE:**	8/25/2016
SPEED:	40,000 RPM	**BY:**	B. PARRELLI

ESTIMATED COMPRESSOR EFFICIENCY VS FLOW

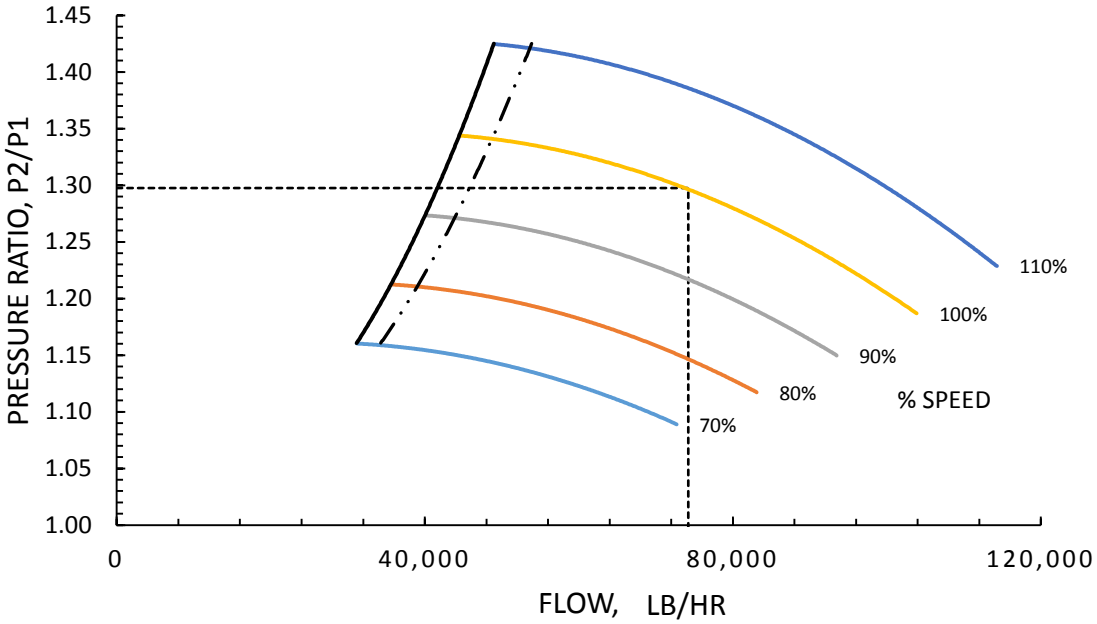


ESTIMATED COMPRESSOR HEAD VS FLOW

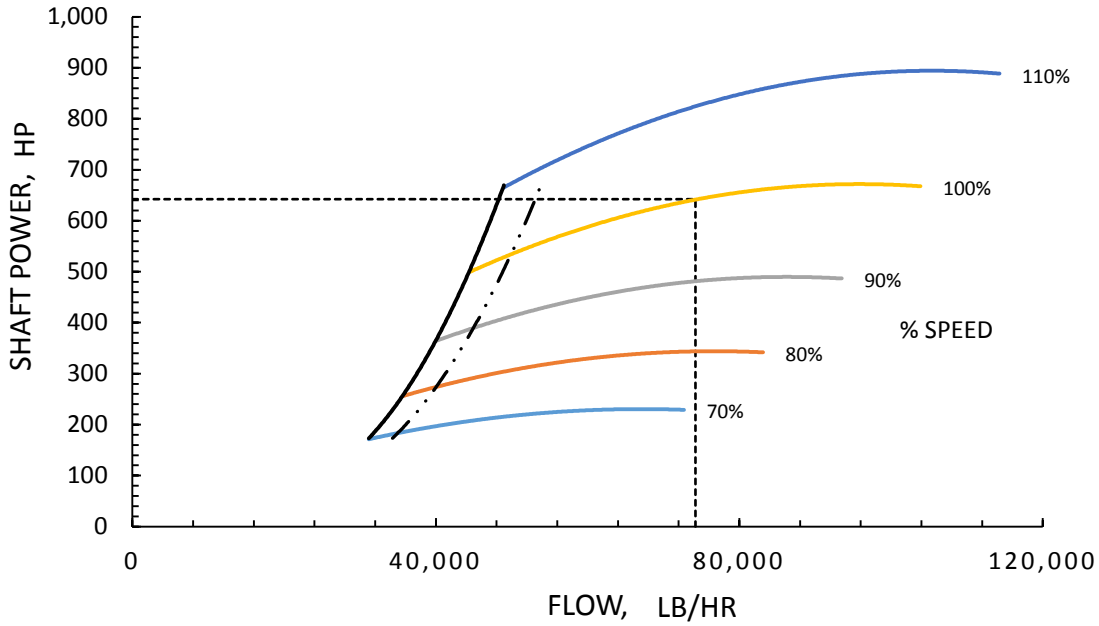


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	DESIGN CASE	**DATE:**	8/25/2016
SPEED:	40,000 RPM	**BY:**	B. PARRELLI

ESTIMATED COMPRESSOR PRESSURE RATIO VS FLOW

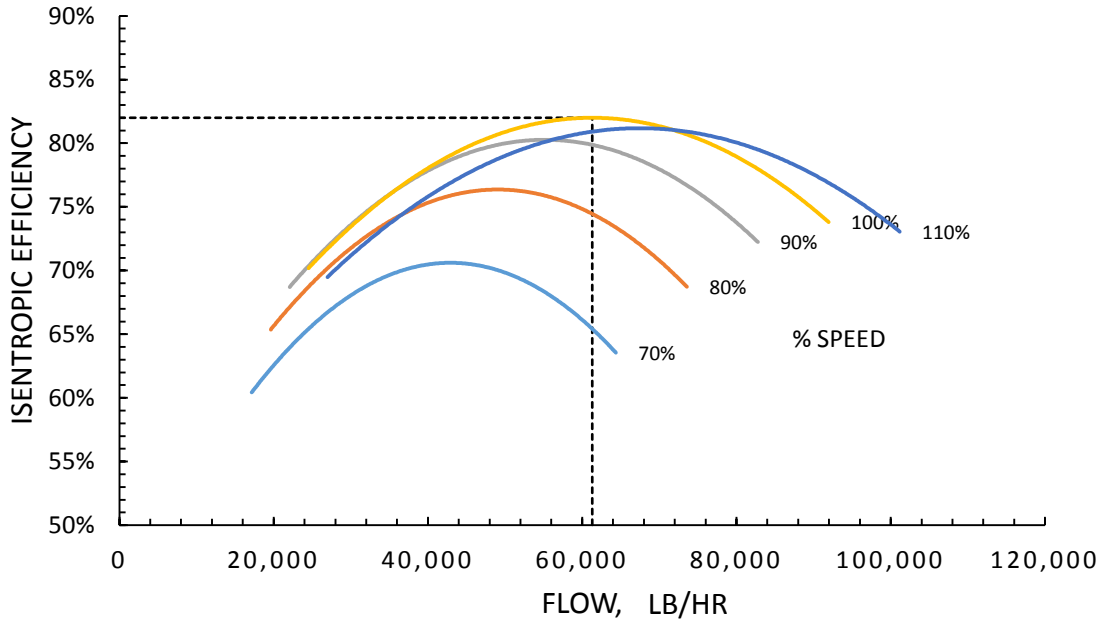


ESTIMATED COMPRESSOR POWER VS FLOW

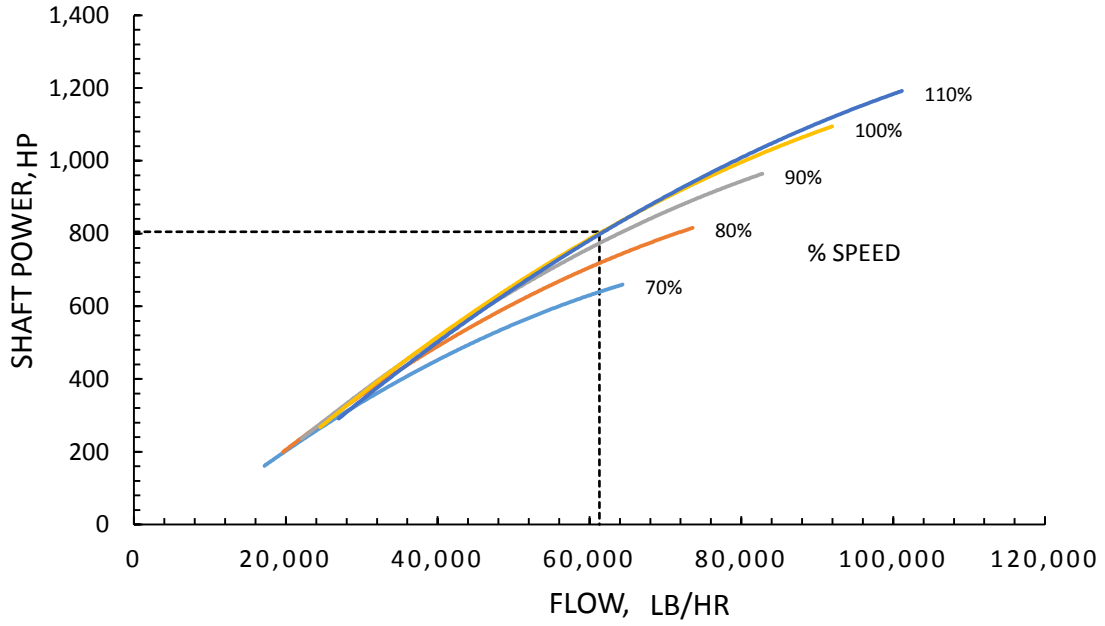


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD1	**DATE:**	8/25/2016
SPEED:	39,410 RPM	**BY:**	B. PARRELLI

ESTIMATED EXPANDER EFFICIENCY VS FLOW

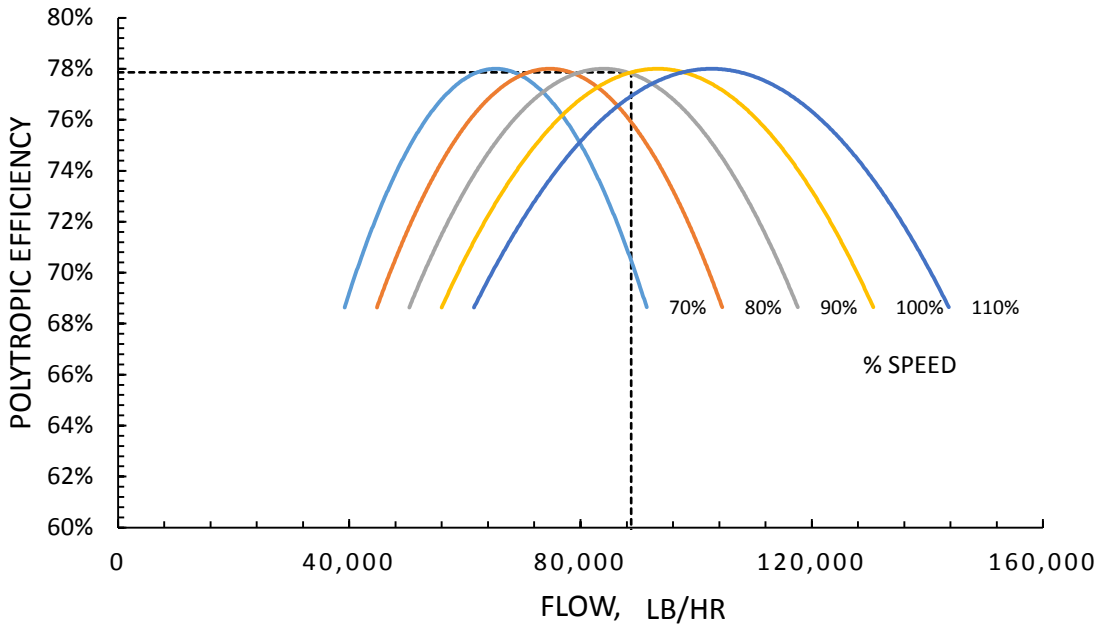


ESTIMATED EXPANDER POWER VS FLOW

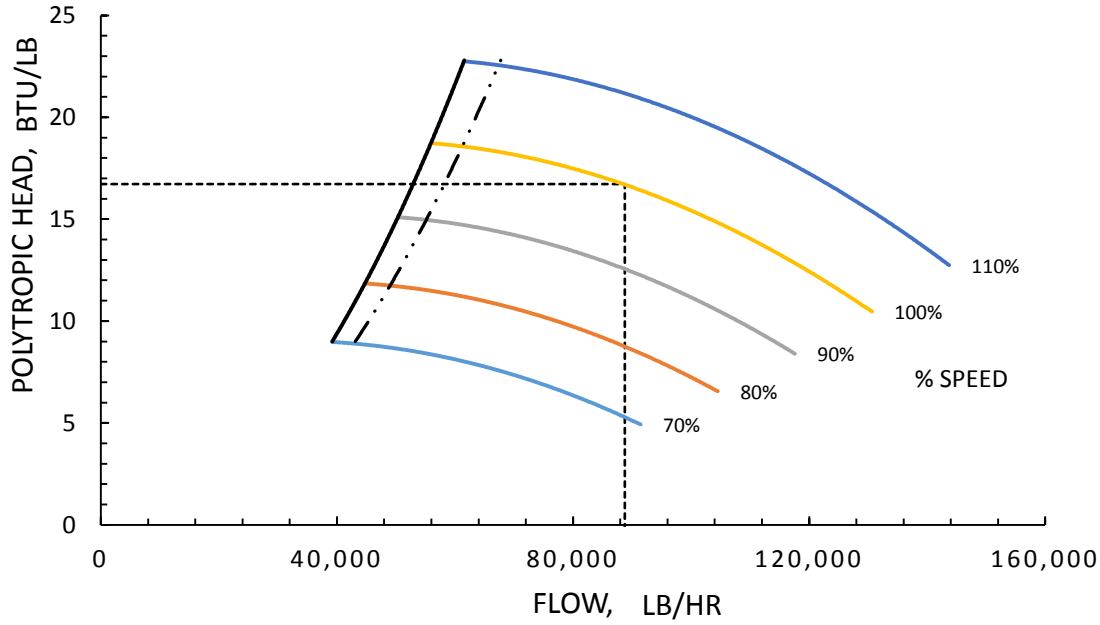


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD2	**DATE:**	8/25/2016
SPEED:	39,410 RPM	**BY:**	B. PARRELLI

ESTIMATED COMPRESSOR EFFICIENCY VS FLOW

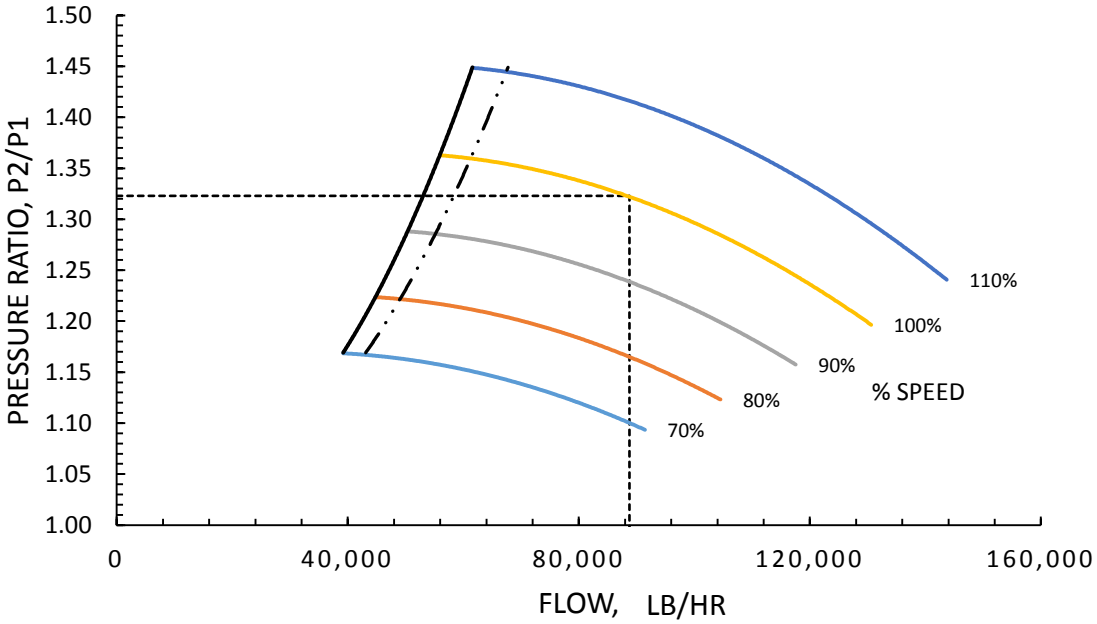


ESTIMATED COMPRESSOR HEAD VS FLOW

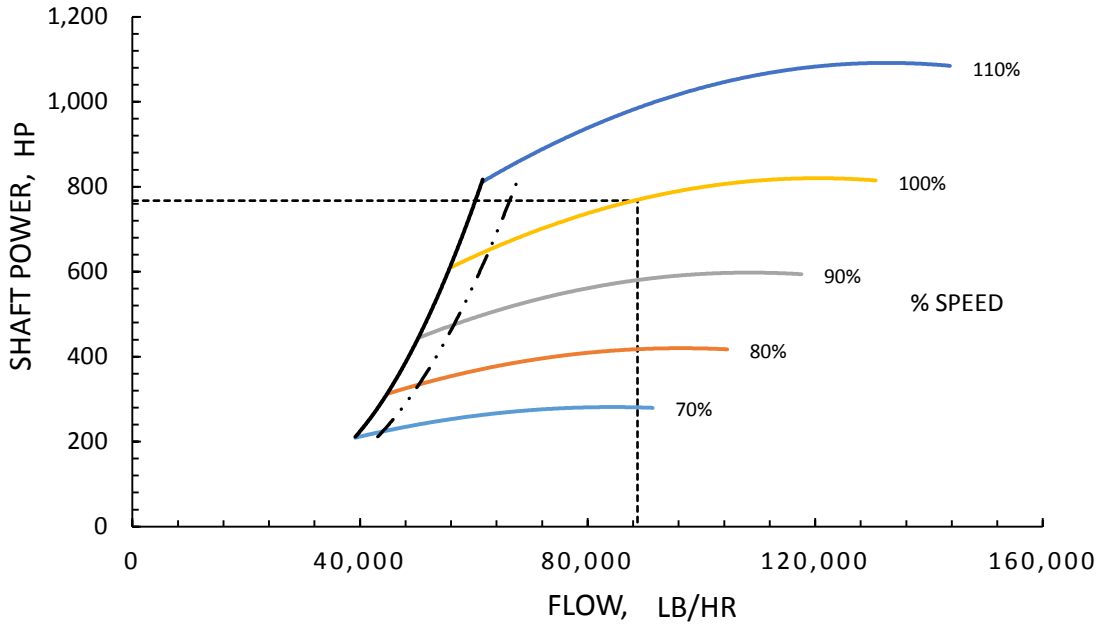


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD2	**DATE:**	8/25/2016
SPEED:	39,410 RPM	**BY:**	B. PARRELLI

ESTIMATED COMPRESSOR PRESSURE RATIO VS FLOW

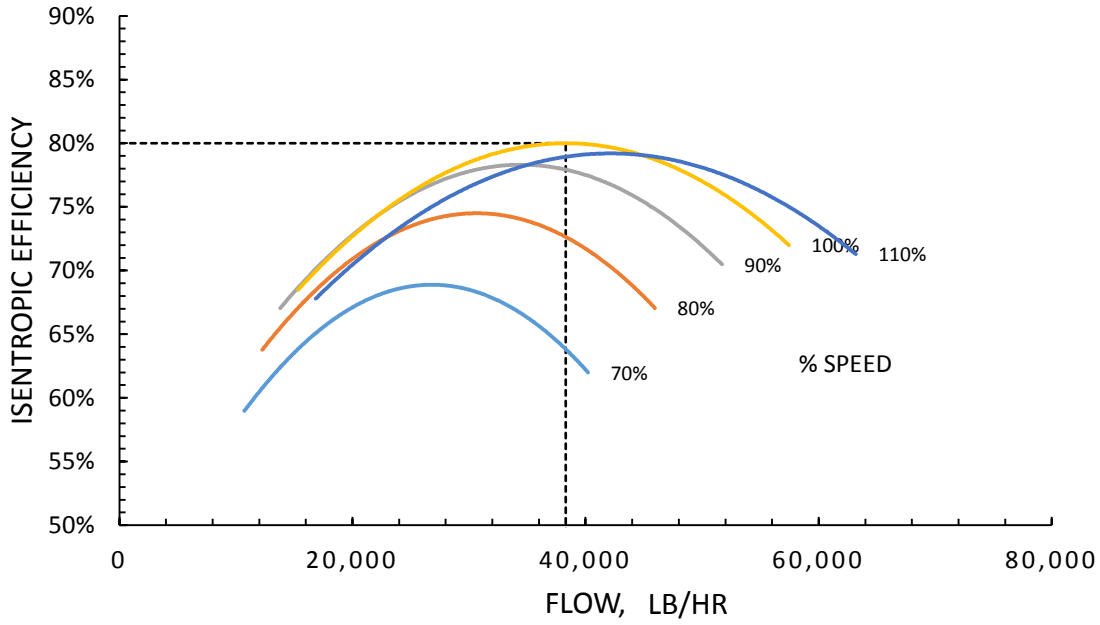


ESTIMATED COMPRESSOR POWER VS FLOW

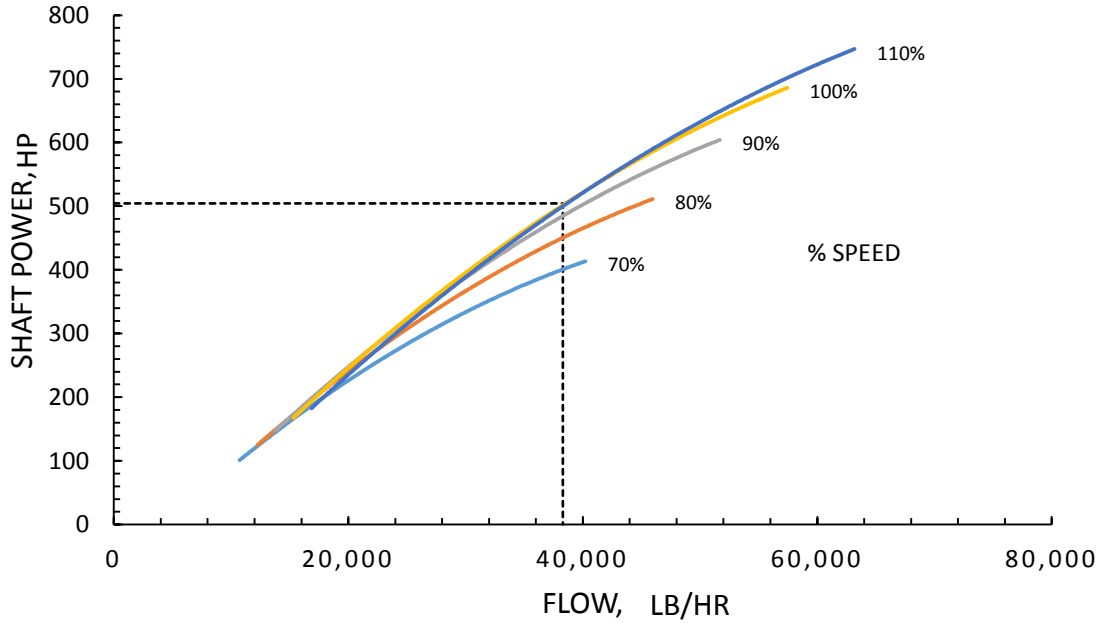


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD2	**DATE:**	8/25/2016
SPEED:	35,740 RPM	**BY:**	B. PARRELLI

ESTIMATED EXPANDER EFFICIENCY VS FLOW

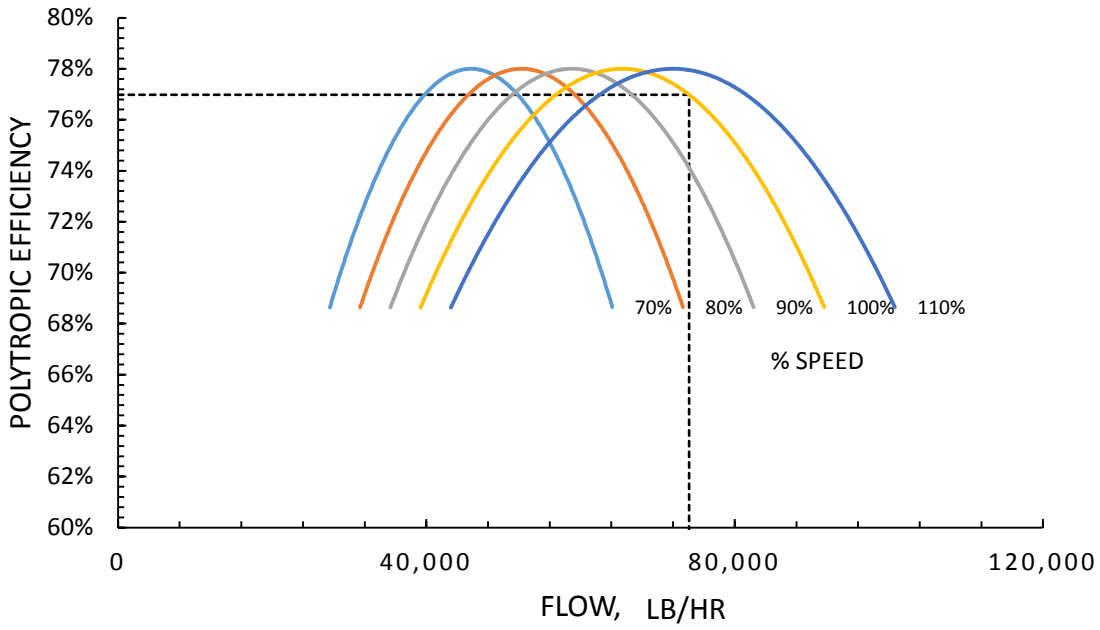


ESTIMATED EXPANDER POWER VS FLOW

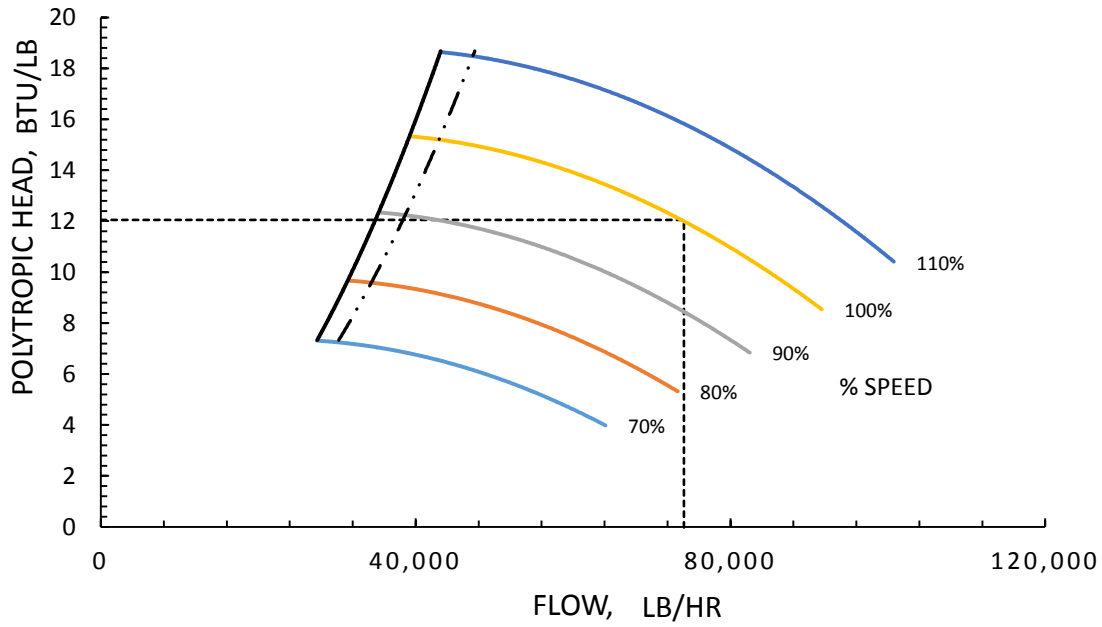


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD2	**DATE:**	8/25/2016
SPEED:	35,740 RPM	**BY:**	B. PARRELLI

ESTIMATED COMPRESSOR EFFICIENCY VS FLOW

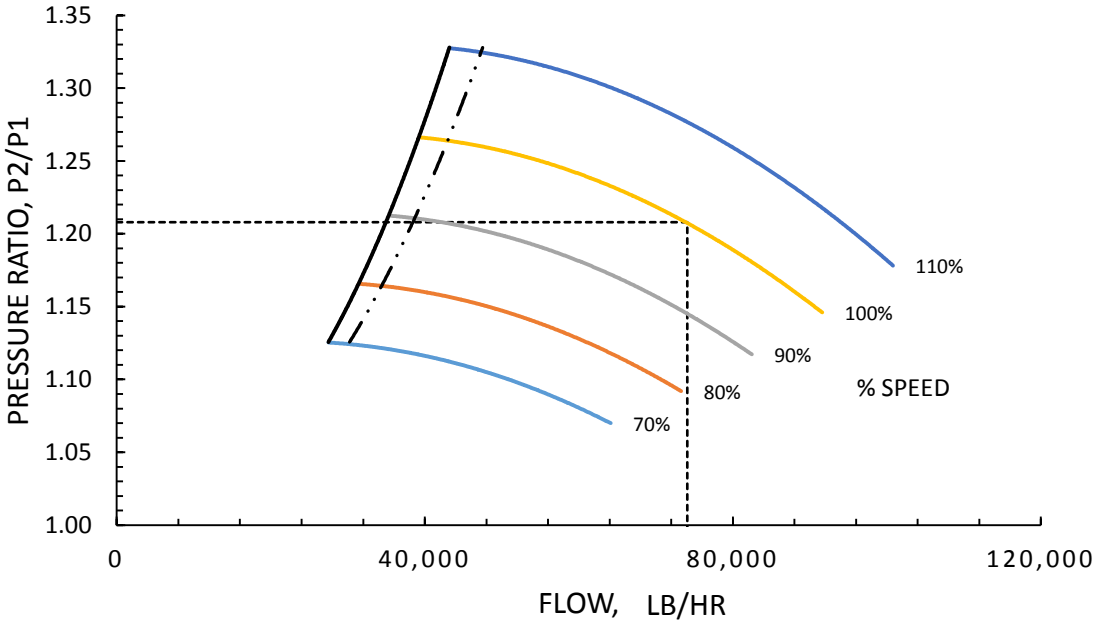


ESTIMATED COMPRESSOR HEAD VS FLOW

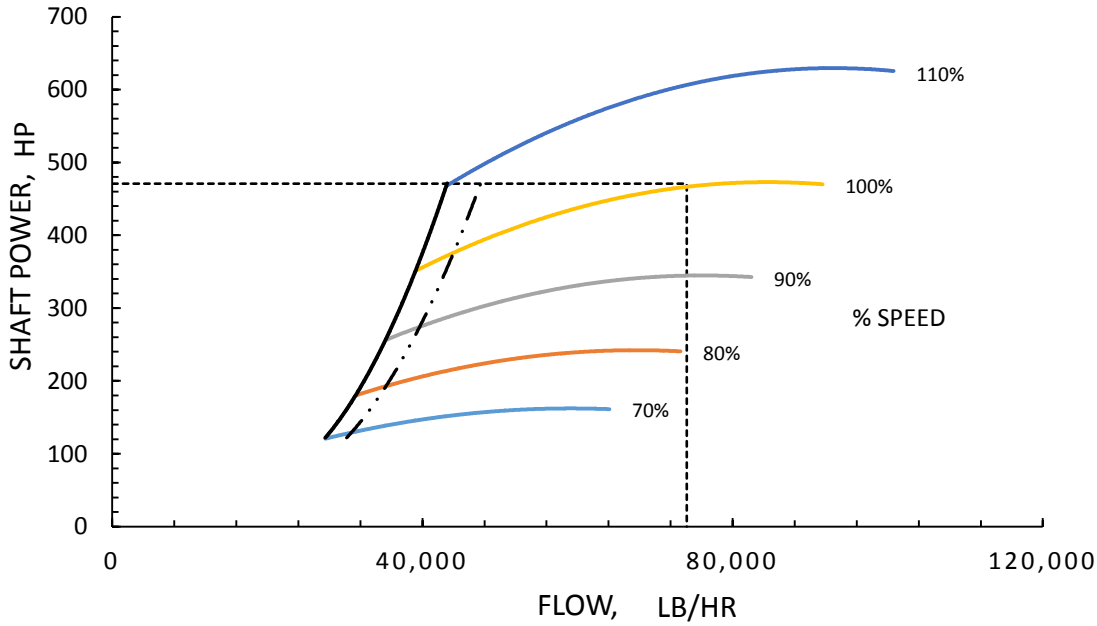


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD2	**DATE:**	8/25/2016
SPEED:	35,740 RPM	**BY:**	B. PARRELLI

ESTIMATED COMPRESSOR PRESSURE RATIO VS FLOW

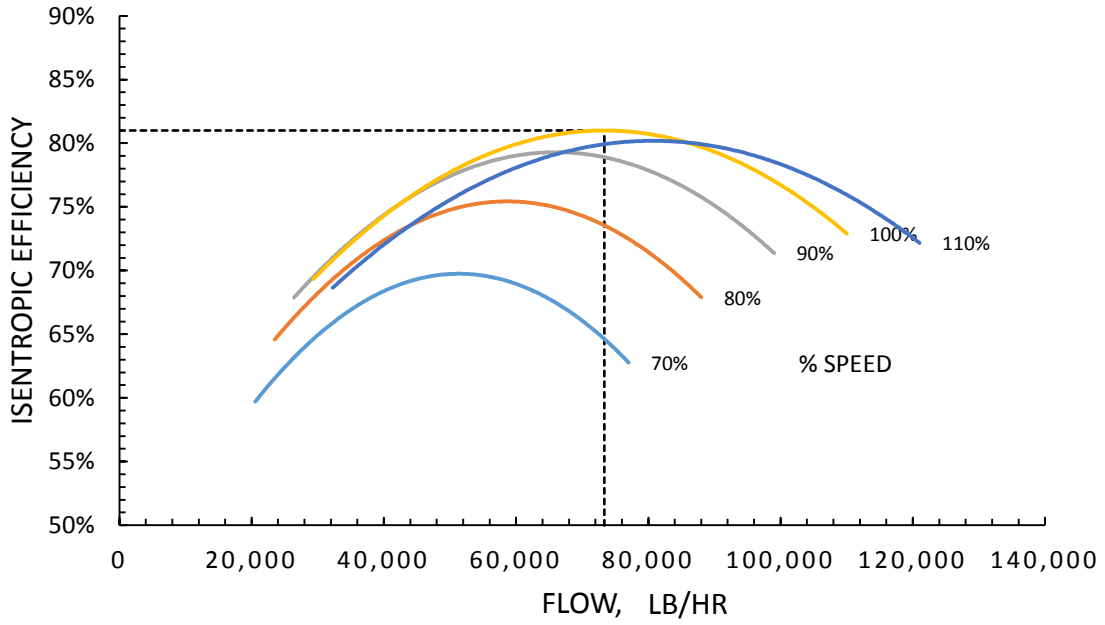


ESTIMATED COMPRESSOR POWER VS FLOW

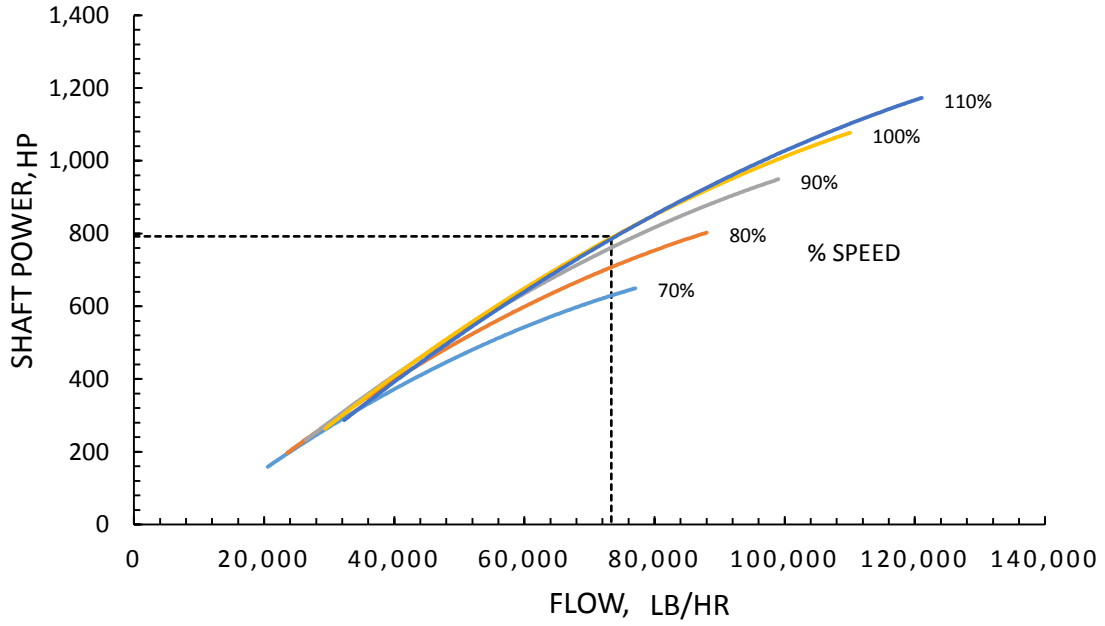


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD3	**DATE:**	8/25/2016
SPEED:	38,870 RPM	**BY:**	B. PARRELLI

ESTIMATED EXPANDER EFFICIENCY VS FLOW

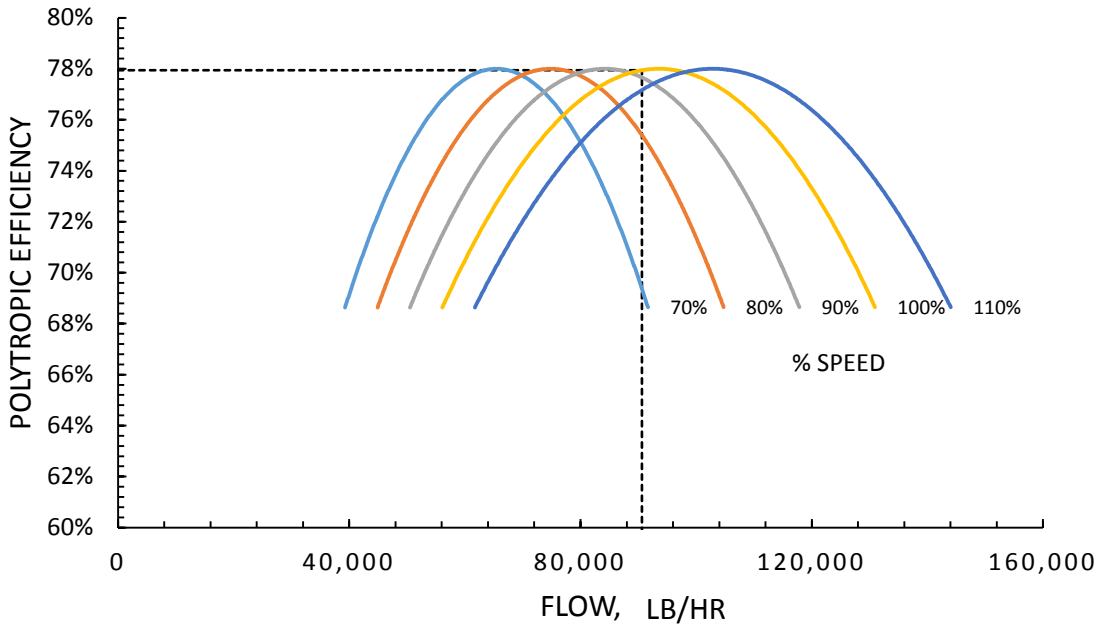


ESTIMATED EXPANDER POWER VS FLOW

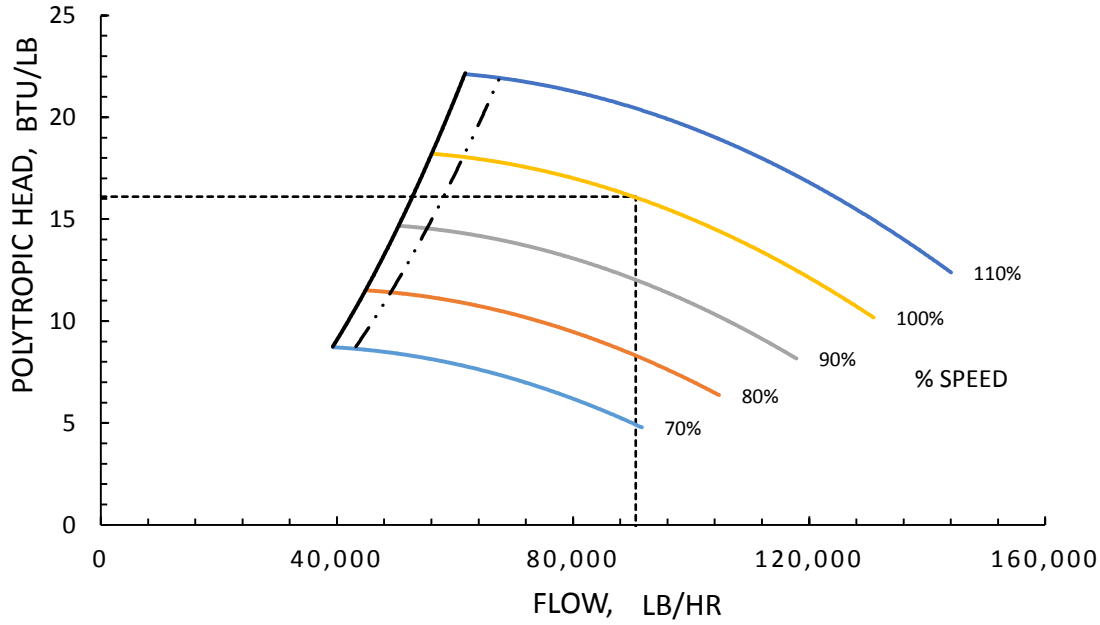


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD3	**DATE:**	8/25/2016
SPEED:	38,870 RPM	**BY:**	B. PARRELLI

ESTIMATED COMPRESSOR EFFICIENCY VS FLOW

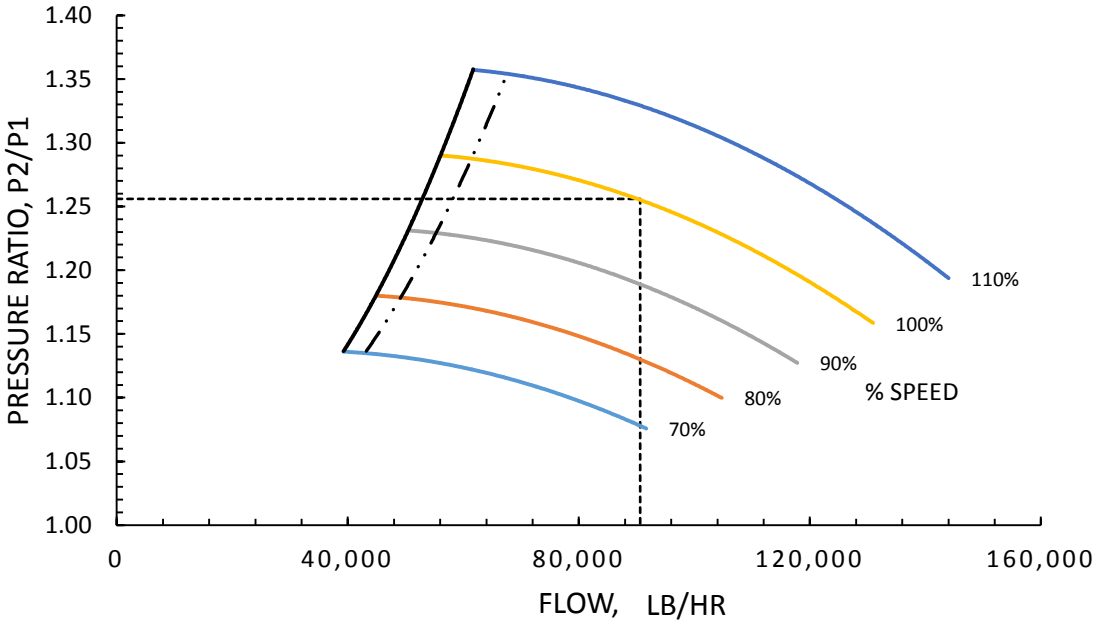


ESTIMATED COMPRESSOR HEAD VS FLOW

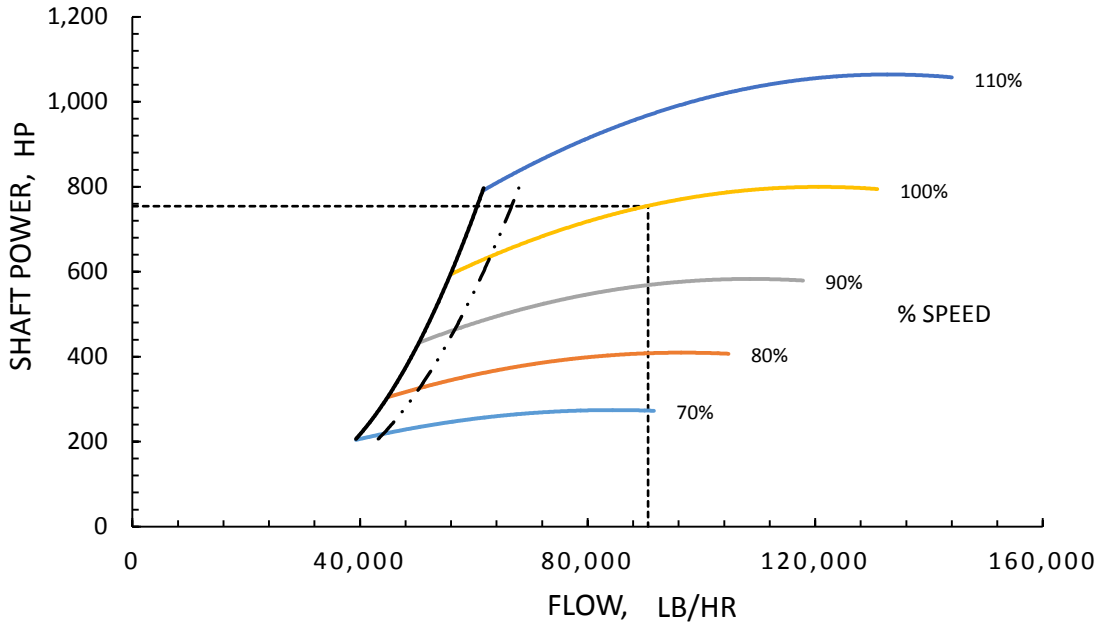


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD3	**DATE:**	8/25/2016
SPEED:	38,870 RPM	**BY:**	B. PARRELLI

ESTIMATED COMPRESSOR PRESSURE RATIO VS FLOW

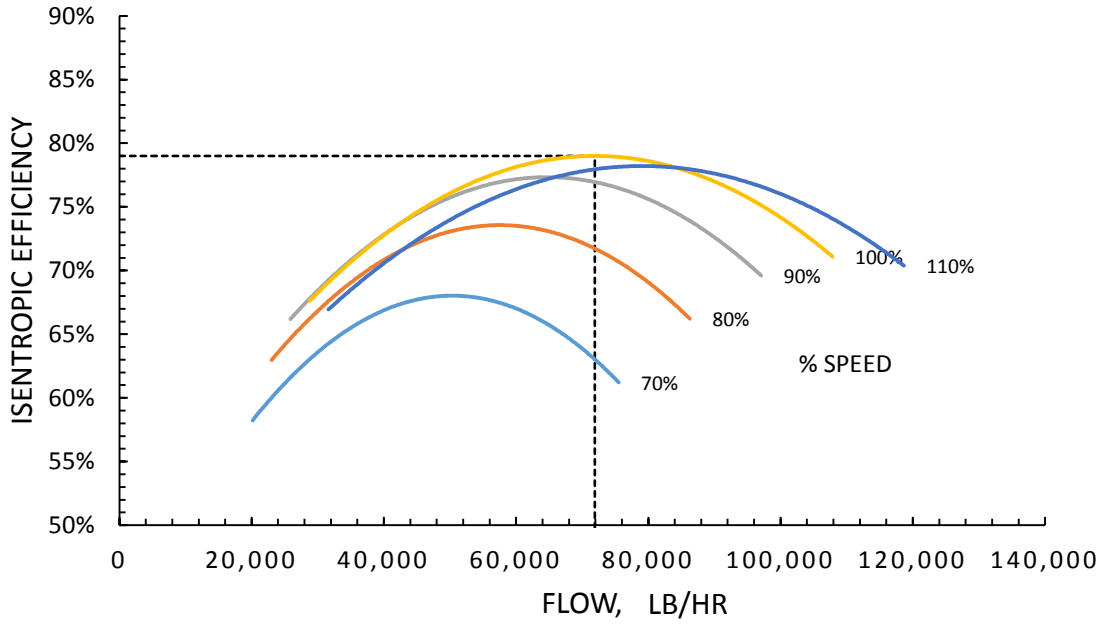


ESTIMATED COMPRESSOR POWER VS FLOW

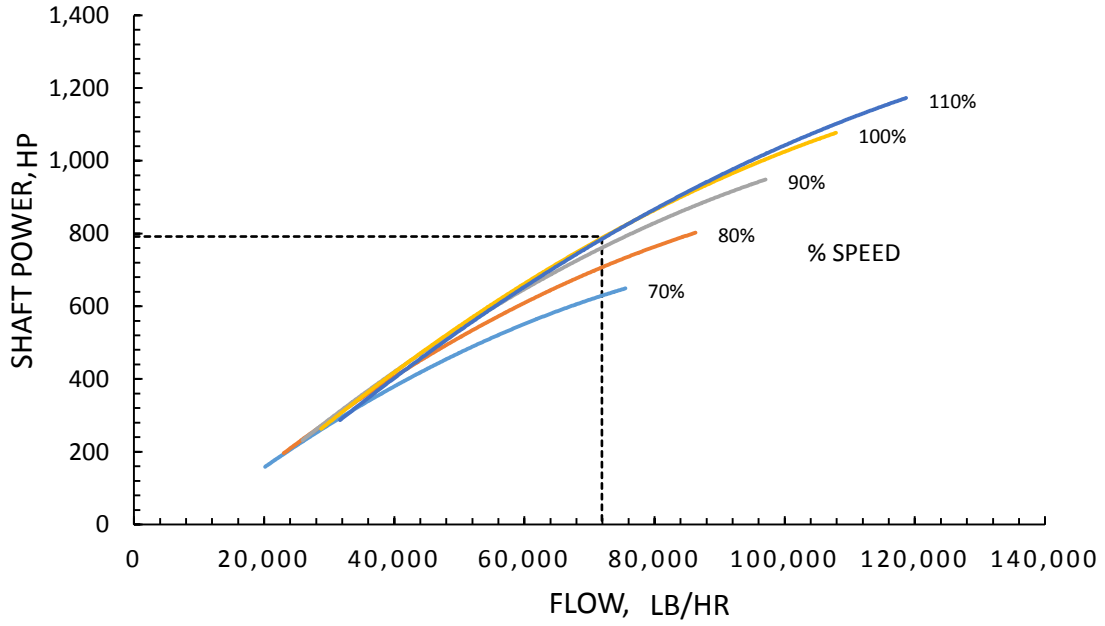


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD4	**DATE:**	8/25/2016
SPEED:	36,880 RPM	**BY:**	B. PARRELLI

ESTIMATED EXPANDER EFFICIENCY VS FLOW

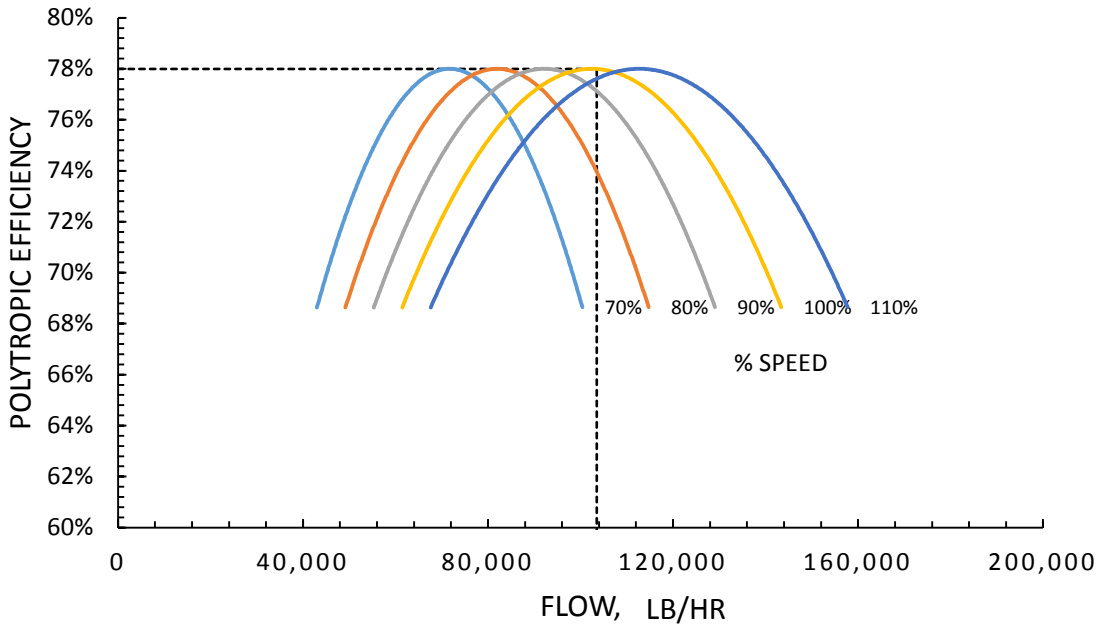


ESTIMATED EXPANDER POWER VS FLOW

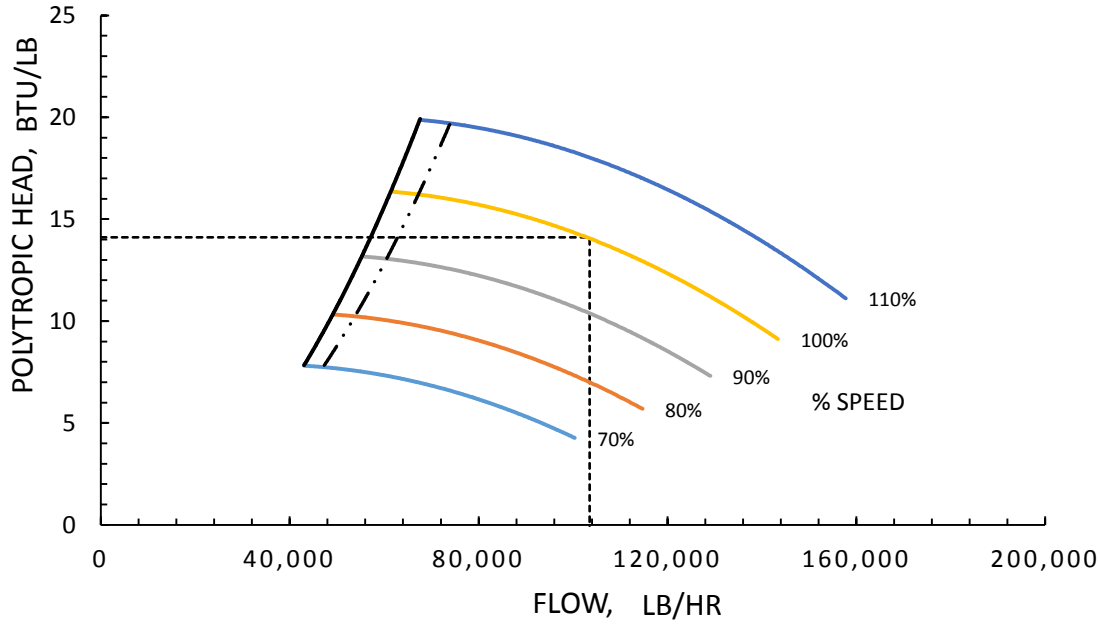


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD4	**DATE:**	8/25/2016
SPEED:	36,880 RPM	**BY:**	B. PARRELLI

ESTIMATED COMPRESSOR EFFICIENCY VS FLOW

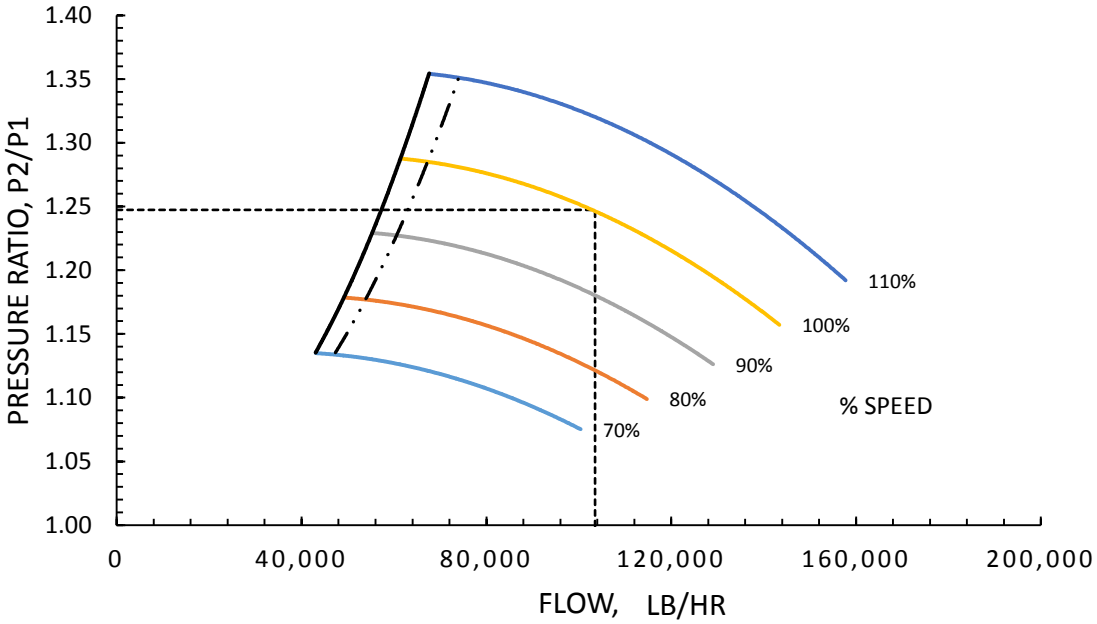


ESTIMATED COMPRESSOR HEAD VS FLOW

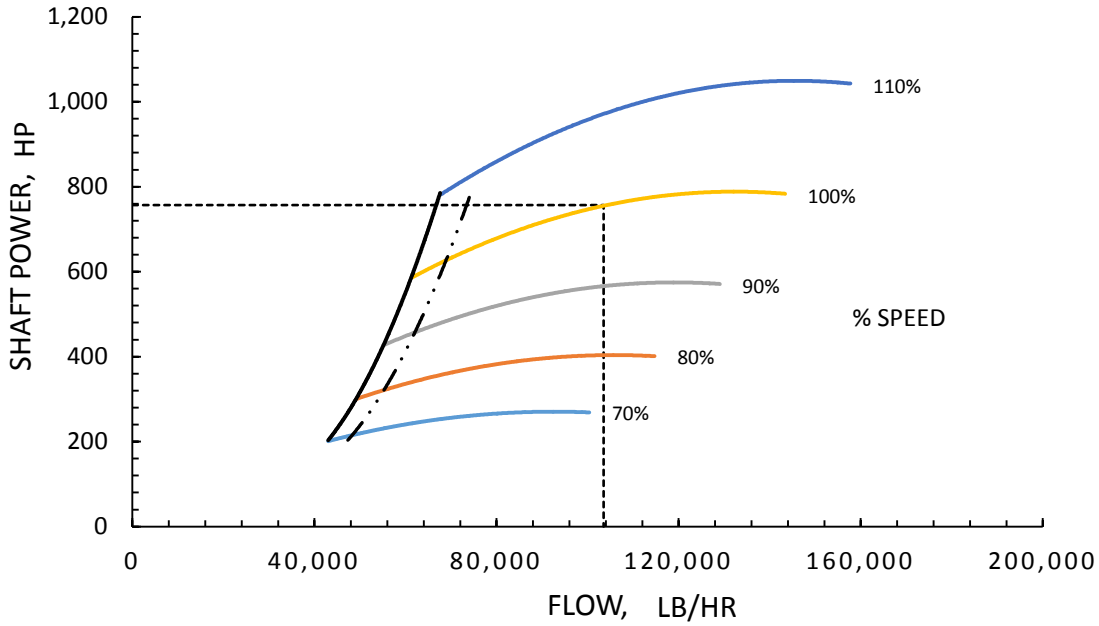


JOB NUMBER:	LAT574EC	**REVISION:**	0
CASE:	OD4	**DATE:**	8/25/2016
SPEED:	36,880 RPM	**BY:**	B. PARRELLI

ESTIMATED COMPRESSOR PRESSURE RATIO VS FLOW



ESTIMATED COMPRESSOR POWER VS FLOW



LAT574

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASE FOR FABRICATION	04-07-2017	T.A

AS BUILT

DO NOT SCALE THE DRAWING

L.A. Turbine Corporation

28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, if not indicated, according to: ANSI Y 14.5M 1982

Machined Surfaces: N/A

DECIMALS .XXX ± XXX, .XX ± XXX

FRACTIONS ± XX

ANGLES ± XX

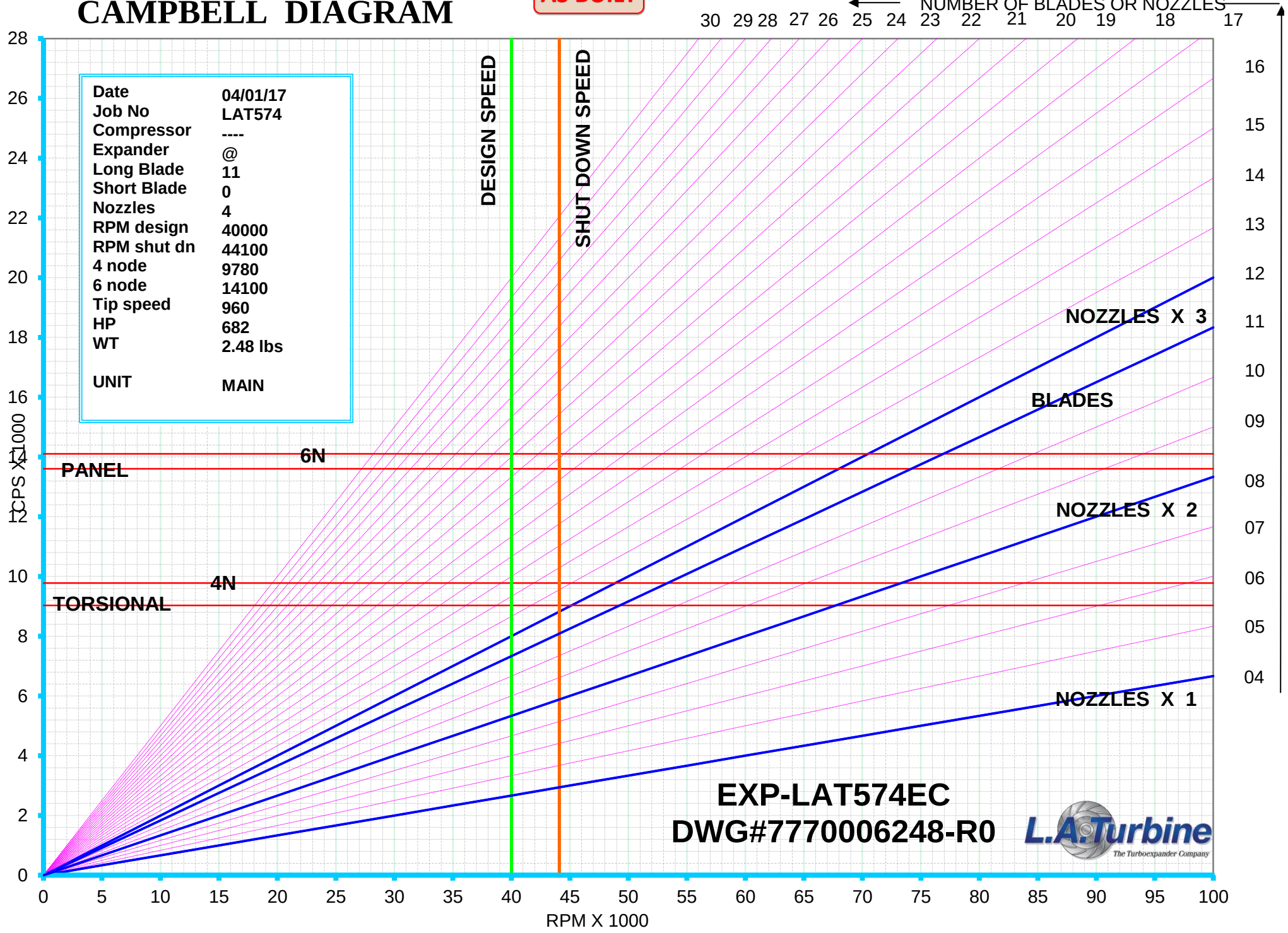
Units = Inches

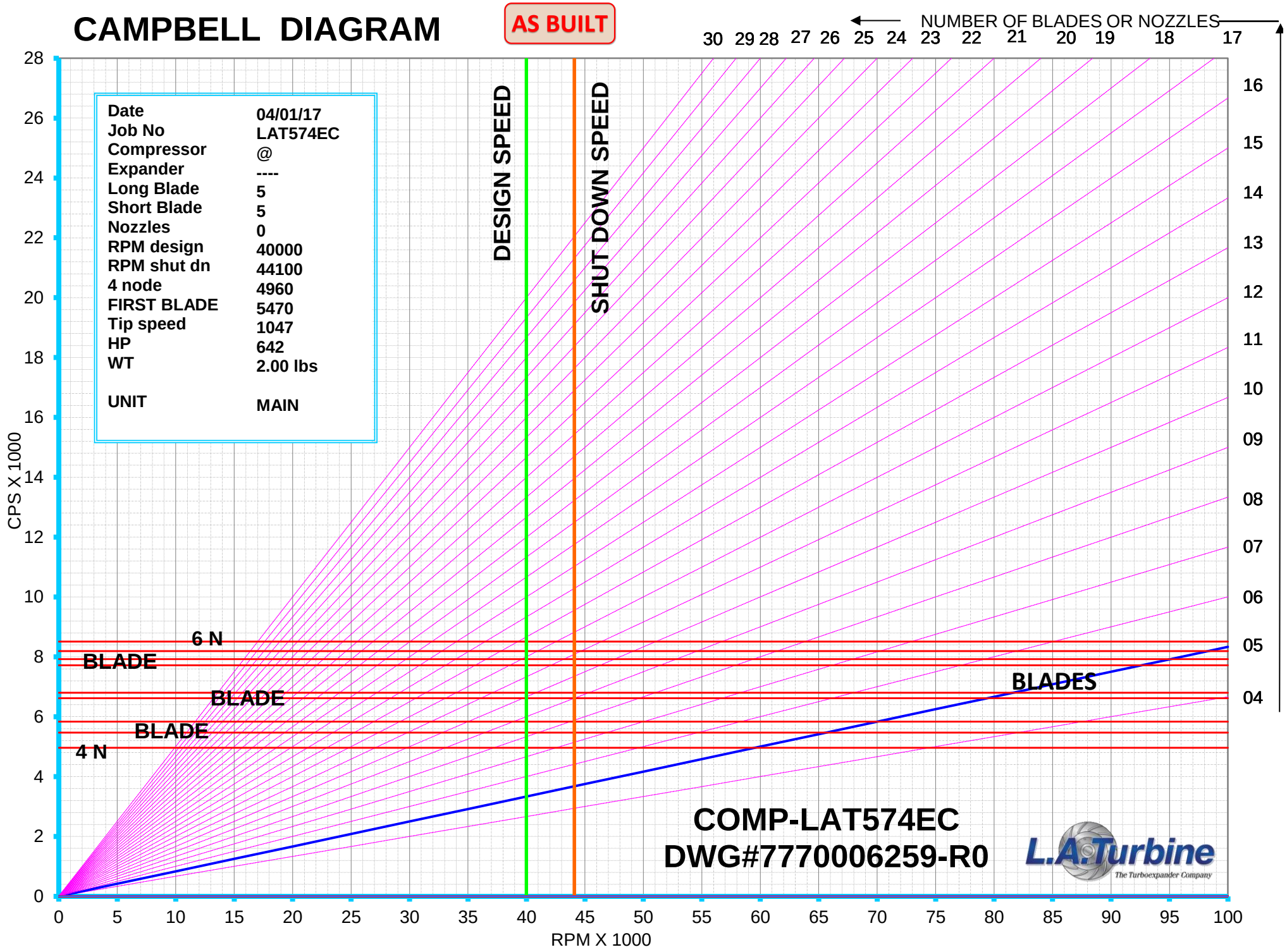
BREAK ALL SHARP CORNERS & DEBURR .005R

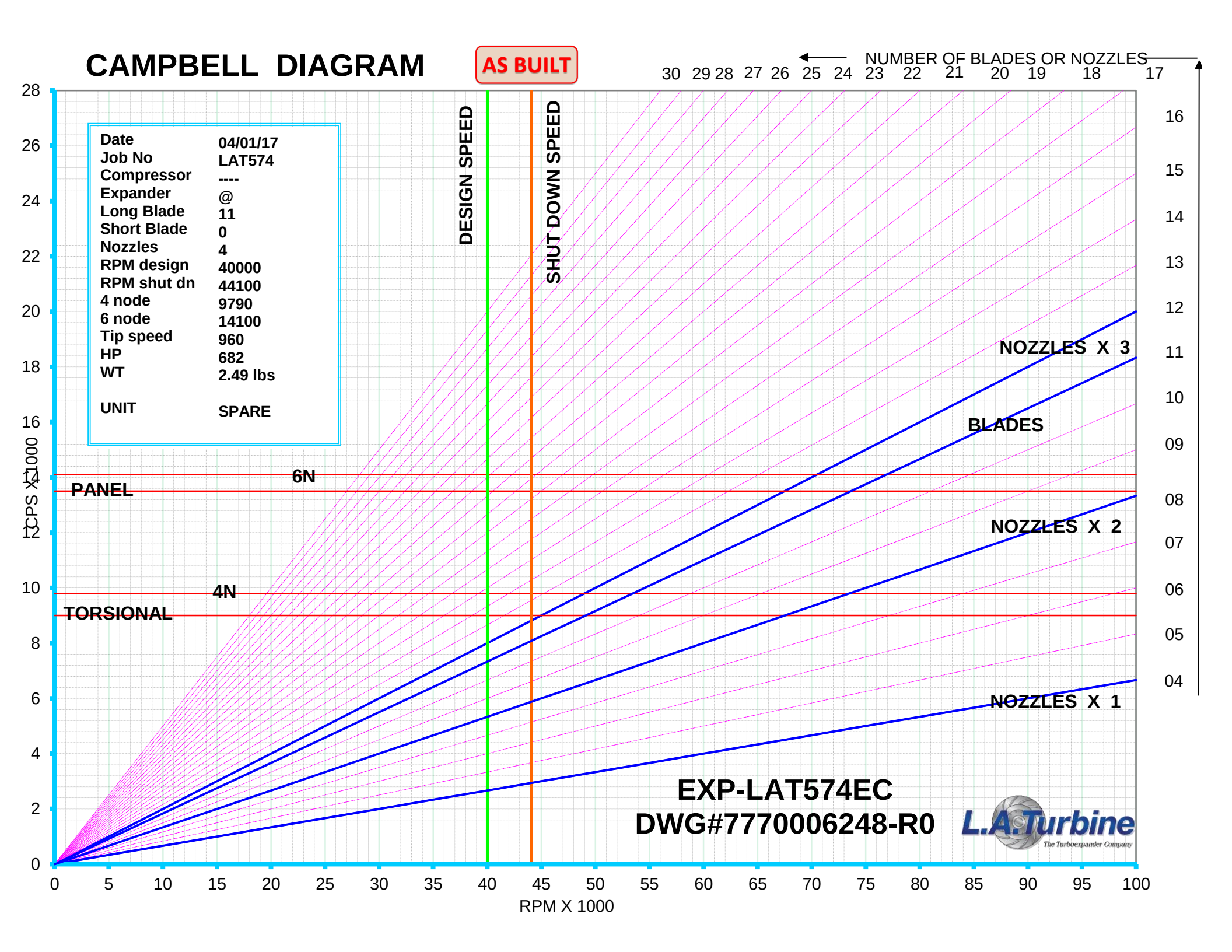
Name	CAMPBELL DIAGRAM				
Material	N/A			Material - Class	N/A
File Location	V:\LAT574\CAMPBELL DIAGRAM			Job Number	LAT574
Scale	N/A		Prev. Dwg. N/A	Orignated from:	LAT573
Performed by	J.D	Date 04-01-17	Next Dwg N/A	Dwg/Part No.	LAT574EC-20-A82
Std. Chk.	S.B	Date 04-04-17	Blank Wt. N/A Kg Lbs	Finished Wt. --- Kg Lbs	Rev 0
Design Chk.	B.P	Date 04-04-17	Approved T.A	Date 04-07-17	SHEET 1 OF 5

CAMPBELL DIAGRAM

AS BUILT

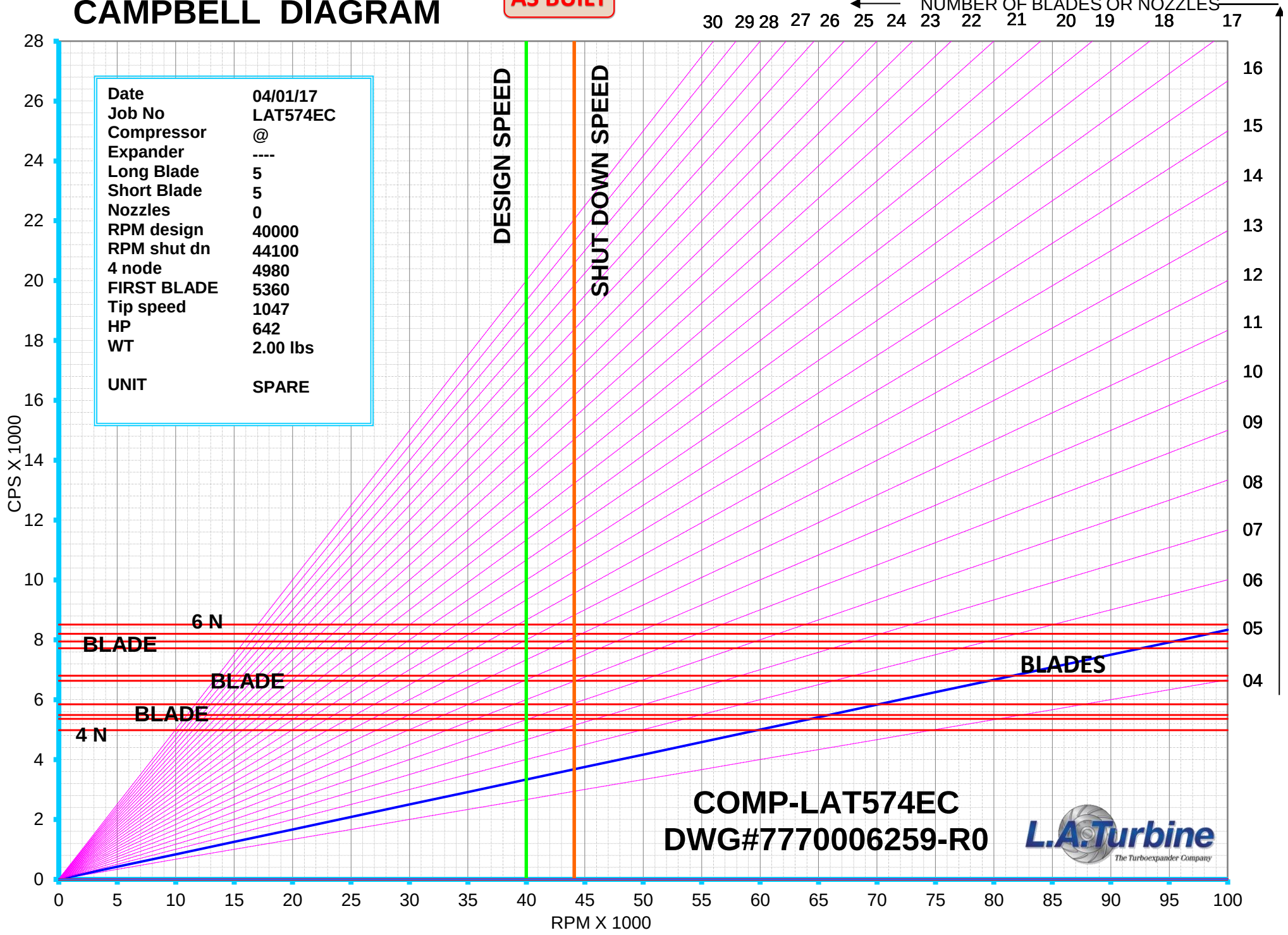



CAMPBELL DIAGRAM
AS BUILT
NUMBER OF BLADES OR NOZZLES
30 29 28 27 26 25 24 23 22 21 20 19 18 17
Date 04/01/17
Job No LAT574EC
Compressor @
Expander ----
Long Blade 5
Short Blade 5
Nozzles 0
RPM design 40000
RPM shut dn 44100
4 node 4960
FIRST BLADE 5470
Tip speed 1047
HP 642
WT 2.00 lbs
UNIT MAIN
DESIGN SPEED
SHUT DOWN SPEED
6 N BLADE
BLADE
BLADE
4 N
BLADES
COMP-LAT574EC
DWG#7770006259-R0
L.A.Turbine
The Turboexpander Company
CPS X 1000
RPM X 1000
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
16 15 14 13 12 11 10 09 08 07 06 05 04


CAMPBELL DIAGRAM
AS BUILT
NUMBER OF BLADES OR NOZZLES
30 29 28 27 26 25 24 23 22 21 20 19 18 17
16 15 14 13 12 11 10 09 08 07 06 05 04
Date 04/01/17
Job No LAT574
Compressor ----
Expander @
Long Blade 11
Short Blade 0
Nozzles 4
RPM design 40000
RPM shut dn 44100
4 node 9790
6 node 14100
Tip speed 960
HP 682
WT 2.49 lbs
UNIT SPARE
DESIGN SPEED
SHUT DOWN SPEED
NOZZLES X 3
BLADES
NOZZLES X 2
NOZZLES X 1
6N
PANEL
4N
TORSIONAL
EXP-LAT574EC
DWG#7770006248-R0
L.A.Turbine
The Turboexpander Company
CPS X 1000
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
RPM X 1000

CAMPBELL DIAGRAM

AS BUILT



REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	INITIAL RELEASE, DUPLICATE OF LAT 573EC	8/26/2016	H.S.H
1	AS BUILT, DUPLICATE OF LAT 573EC	5/10/2017	T.A.

CUSTOMER	**:**	**UOP RUSSELL LLC**
FOR	**:**	**TBD**
PROJECT	**:**	**J447XX**
LOCATION	**:**	**TBD**
P.O. NO.	**:**	**4500743460**
ITEM NO.	**:**	**EC-101**
SERVICE	**:**	**TURBOEXPANDER / RECOMPRESSOR**

AS BUILT

DO NOT SCALE DRAWING

L.A. Turbine Corporation

28557 Industry Drive
Valencia, Ca. 91355

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Tolerances, if not indicated, according to: ANSI Y14.5M 1982

Machined Surface: 125 UNLESS NOTED

DECIMALS: .XXX N/A, .XX N/A

FRACTIONS: ± N/A, ANGLES ± N/A

Units = Inches
BREAK ALL SHARP CORNERS AND DEBURRS .005

Name:	MECHANICAL DATASHEET						
Material:	N/A					Material Class	N/A
File Location:	V:\LAT574EC\GAS DYNAMICS					Job Number:	LAT574EC
Scale:	N/A		Prev Dwg:	N/A		Originated from:	
Drawn By:	-	Date: 8/26/16	Next Dwg:	N/A		Dwg/Part No.	Rev
Std. Chk:	J. Yeh	Date: 8/26/16	Blank Wt.	N/A	Finished Wt. N/A	LAT574EC-20-A83	1
Design Chk:	J. Yeh	Date: 8/26/16	Approved:	H.S.H	Date: 8/26/16	PAGE 1 OF 9	

L.A. Turbine — The Turboexpander Company

JOB NO. J447XX ITEM NO. EC-101
LAT JOB NO. LAT574EC
SPECIFICATION NO.
REVISION NO. 0 DATE 26-Aug-16
PAGE 2 OF 9 BY J. YEH
REV

TURBOEXPANDER/COMPRESSOR DATA SHEET ENGLISH UNITS

APPLICABLE TO: ○ PROPOSAL ● PURCHASE ○ AS-BUILT
SERVICE TURBOEXPANDER-COMPRESSOR NO. REQUIRED One (1)
MANUFACTURER L.A. Turbine MODEL L2000 END USER TBD
FOR: UOP Russell LLC SITE TBD
NOTE: INFORMATION TO BE COMPLETED:
○ BY PURCHASER ☐ BY MANUFACTURER ▽ EITHER, BUT BY VENDOR IF NOT BY PURCHASER

OPERATING CONDITIONS

(ALL DATA ON PER UNIT BASIS)

		DESIGN CASE		OD1		OD2	
		Exp	Comp	Exp	Comp	Exp	Comp
		EC-101		EC-101		EC-101	
INLET CONDITIONS:							
● MMSCFD (14.7 psia & 60 F DRY)		**23.80**	**40.20**	**28.10**	**44.60**	**18.40**	**40.10**
● WEIGHT FLOW, (EXP: DRY; COMP: DRY)	LB/HR	**49,313**	**74,211**	**61,306**	**88,763**	**38,297**	**74,084**
☐ RECYCLE FLOW	%						
● PRESSURE	PSIA	**865**	**175.0**	**865**	**205.0**	**1015**	**175.0**
● TEMPERATURE	°F	**-28.0**	**73.5**	**0**	**73.5**	**-28.0**	**79.5**
● MOLECULAR WEIGHT		**18.88**	**16.82**	**19.85**	**18.13**	**18.98**	**16.81**
■ INLET VOLUME FLOW	ACFM	149	2338	199	2191	87	2365
■ COMPRESSORBILITY (Z1/Zavg)		0.64	0.970	0.680	0.960	0.570	0.970
DISCHARGE CONDITIONS:							
■ PRESSURE	PSIA	**190.0**	227.6	**220.0**	271.9	**190.0**	211.7
■ TEMPERATURE	°F	-123.9	117.7	-88.2	119.6	-132.6	111.9
■ WEIGHT PERCENT LIQUID	%	18.4		17.3		22.6	
■ GAS POWER	HP	682	642	805	766	504	471
■ SPEED	RPM	40,000		39,410		35,740	
■ ADIABATIC/POLYTROPIC HEAD (Exp/Comp)	BTU/LBM	41.9	17.2	40.7	17.1	41.9	12.5
■ ADIABATIC/POLYTROPIC EFFICIENCY (Exp/Comp)	%	84.0%	78.0%	82.0%	78.0%	80.0%	77.0%
■ COMPRESSORBILITY (Z2/Zavg)		0.77	0.970	0.790	0.960	0.74	0.970
● GUARANTEE CASE (check one case)		**X**	**X**				

VARIABLE INLET GUIDE VANE PROCESS CONTROL SIGNAL SOURCE:
TYPE: ● ELECTRONIC RANGE: 4-20 mA
○ PNEUMATIC PSIG

CASING CONNECTIONS:

CONNECTION	■ SIZE NPS/RATING	■ FACING	■ POSITION	■ FLANGED OR STUDDED	● MATING FLG & GASKET BY VENDOR	■ GAS VELOCITY ft/sec
EXPANDER INLET	6 " - 600#	RF	HORIZONTAL	FLANGED	N/A	13
EXPANDER DISCHARGE	8 " - 600#	RF	HORIZONTAL	FLANGED	N/A	30
COMPRESSOR INLET	12 " - 300#	RF	HORIZONTAL	FLANGED	N/A	50
COMPRESSOR DISCHARGE	10 " - 300#	RF	VERTICAL	FLANGED	N/A	60

REMARKS:

L.A. Turbine — The Turboexpander Company

JOB NO. J447XX ITEM NO. EC-101
LAT INQUIRY NO. LAT574EC
SPECIFICATION NO.
REVISION NO. 0 DATE 8/26/2016
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TURBOEXPANDER/COMPRESSOR DATA SHEET ENGLISH UNITS

APPLICABLE TO: ○ PROPOSAL ● PURCHASE ○ AS-BUILT
SERVICE TURBOEXPANDER-COMPRESSOR NO. REQUIRED One (1)
MANUFACTURER L.A. Turbine MODEL L2000 END USER TBD
FOR: UOP Russell LLC SITE TBD
NOTE: INFORMATION TO BE COMPLETED:
○ BY PURCHASER ☐ BY MANUFACTURER ▽ EITHER, BUT BY VENDOR IF NOT BY PURCHASER

OPERATING CONDITIONS

(ALL DATA ON PER UNIT BASIS)

		OD3		OD4			
		Exp	Comp	Exp	Comp		
		EC-101		EC-101			
INLET CONDITIONS:							
● MMSCFD (14.7 psia & 60 F DRY)		**37.10**	**50.80**	**35.40**	**54.70**		
● WEIGHT FLOW, (EXP: DRY; COMP: DRY)	LB/HR	**73,355**	**90,619**	**71,906**	**103,509**		
☐ RECYCLE FLOW	%						
● PRESSURE	PSIA	**820**	**250.0**	**820**	**260.0**		
● TEMPERATURE	°F	**-30.0**	**109.10**	**-8.0**	**90**		
● MOLECULAR WEIGHT		**18.01**	**16.24**	**18.50**	**17.23**		
■ INLET VOLUME FLOW	ACFM	256	2201	272	2178		
■ COMPRESSORBILITY (Z1/Zavg)		0.67	0.970	0.71	0.960		
DISCHARGE CONDITIONS:							
■ PRESSURE	PSIA	**265.0**	314.5	**275.0**	324.8		
■ TEMPERATURE	°F	-109.8	149.6	-85.9	127.4		
■ WEIGHT PERCENT LIQUID	%	13.0		12.0			
■ GAS POWER	HP	792	754	792	757		
■ SPEED	RPM	38,870		36,880			
■ ADIABATIC/POLYTROPIC HEAD (Exp/Comp)	BTU/LBM	33.9	16.5	35.5	14.5		
■ ADIABATIC/POLYTROPIC EFFICIENCY (Exp/Comp)	%	81.0%	78.0%	79.0%	78.0%		
■ COMPRESSORBILITY (Z2/Zavg)		0.77	0.97	0.80	0.96		
○ GUARANTEE CASE (check one case)							

GAS ANALYSIS: ■ **MOL %** ☐ **WT %**

HYDROGEN	2.0159						
METHANE	16.043	89.28	98.53	87.41	91.65		
ETHANE	30.07	7.12	0.63	7.86	7.36		
PROPANE	44.097	2.30	0.02	3.10	0.21		
I-BUTANE	58.123	0.18		0.29			
N-BUTANE	58.123	0.26		0.45			
I-PENTANE	72.15	0.04		0.07			
N-PENTANE	72.15	0.02		0.05			
N-HEXANE	86.177	0.01		0.02			
N-HEPTANE	100.204						
N-OCTANE	114.231						
NITROGEN	28.0134	0.76	0.80	0.73	0.75		
OXYGEN	31.9988						
CARBON MONOXIDE	28.01						
CARBON DIOXIDE	44.01	0.03	0.02	0.03	0.03		
HYDROGEN SULFIDE	34.08						
WATER / STEAM	18.0153						
AIR	28.9625						
TOTAL		100.00	100.00	100.01	100.00		

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TURBOEXPANDER / COMPRESSOR
DATA SHEET
ENGLISH UNITS

JOB NO. J447XX ITEM NO. EC-101
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OPERATING CONDITIONS (Continued)

GAS ANALYSIS: ● MOL % ○ WT %		DESIGN CASE		OD1		OD2		SEAL GAS	REMARKS:
	MW	Exp	Comp	Exp	Comp	Exp	Comp		
HYDROGEN	2.0159							External Dry, Lean & Warm Gas by Purchaser	
METHANE	16.043	83.32	94.65	78.94	85.76	83.05	94.73		
ETHANE	30.07	10.38	2.05	13.13	10.79	10.13	1.99		
PROPANE	44.097	2.51	0.03	4.09	0.23	2.73	0.03		
I-BUTANE	58.123	0.12		0.22		0.14			
N-BUTANE	58.123	0.24		0.47		0.31			
I-PENTANE	72.15	0.02		0.04		0.03			
N-PENTANE	72.15	0.02		0.04		0.03			
N-HEXANE	86.177			0.01		0.01			
N-HEPTANE	100.204								
N-OCTANE	114.231								
N-NONANE									
BZ									
TOL									
NITROGEN	28.0134	2.81	2.70	2.42	2.44	3.00	2.70		
OXYGEN	31.9988								
CARBON MONOXIDE	28.01								
CARBON DIOXIDE	44.01	0.59	0.57	0.65	0.77	0.57	0.55		
HYDROGEN SULFIDE	34.08								
WATER / STEAM	18.0153								
AIR	28.9625								
TOTAL		100.01	100.00	100.01	99.99	100.00	100.00		
AVG. MOL. WT.		18.88	16.82	19.85	18.13	18.98	16.81		

SITE DATA

● ELEVATION 2900 FT
○ BAROMETER: PSIA
● RANGE OF AMBIENT TEMPS:
NORMAL °F
MAXIMUM 110 °F
MINIMUM -20 °F

LOCATION:

○ INDOOR ● OUTDOOR ○ GRADE
○ HEATED ○ UNDER ROOF ○ MEZZANINE
○ UNHEATED ○ PARTIAL SIDES ○
● AREA CLASSIFICATION NEC X IEC
CLASS 1 GROUP D DIV. 2
ZONE GROUP TEMP CLASS

UNUSUAL CONDITIONS: ○ DUST
● WINTERIZATION REQ'D. 1) ○ TROPICALIZATION REQ'D.
○ OTHER

REMARKS: 1) Winterization on Accumulator & Thrust Line

APPLICABLE SPECIFICATIONS:

● LAT STANDARD
○ API 617, 7TH EDITION (LAT EXCEPTIONS)
○ OTHER:

NOISE SPECIFICATIONS:

● LAT STANDARD
○ PURCHASER SPECIFICATION
○ SEE SPECIFICATION

ACOUSTIC COVERING: ○ YES ● NO

PAINTING:

● LAT STANDARD
○ OTHER

SHIPPING PREPARATION:

● DOMESTIC PACKING (LAT STANDARD)
○ EXPORT PACKING (LAT STANDARD)
○ SPECIAL:

DELIVERY:

○ FCA-Valencia ○ FOB SITE (DOMESTIC ONLY)
● OTHER: Ex Works (EXW) per Incoterms 2010 from Valencia, CA

SPARE ROTATING ASSEMBLY:

● WOODEN SHIPPING CONTAINER
○ METAL SHIPPING CONTAINER W/ PURGE PROVISION

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TURBOEXPANDER / COMPRESSOR DATA SHEET ENGLISH UNITS

JOB NO. J447XX ITEM NO. EC-101
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CONSTRUCTION FEATURES

■ **SPEEDS:**

MAX. CONT.	42,000	RPM
TRIP	44,100	RPM
TIP SPEEDS: EXPANDER	1054	ft/SEC @ MCS
COMPRESSOR	1099	ft/SEC @ MCS

☐ **LATERAL CRITICAL SPEEDS (DAMPED)**
FIRST CRITICAL TBD RPM
○ UNDAMPED CRITICAL SPEED MAP
○ COMPLETE ROTORDYNAMIC ANALYSIS

■ **CASINGS:**
MODEL **L2000**

	EXP	BRG HSG	COMP
■ CASING SPLIT	RADIAL	RADIAL	RADIAL
■ MATERIAL			
☐ ASTM A-351 CF8 or Equival			
☐ ASTM A-352 LC3 or Equival			
☐ ASTM A-352 LCC			
■ CARBON STEEL		X	X
■ 304 STAINLESS STEEL	X		
● DESIGN PRES PSIG	1100	650	650
● MAX DESIGN TEMP ℉	150	200	200
● MIN. DESIGN TEMP ℉	-150	-20	-20
○ VISUAL INSPECTION			
● ULTRASONICE TEST	X		
● MAGNETIC PARTICLE			X
○ LIQUID PENETRANT			
○ CRITICAL AREA X-RAY			
○			
○			

■ HYDROTEST PRESS ■ 1.5 X DESIGN

○ CASING LEAK TEST ☐
○ 100% NITROGEN
○ NITROGEN / HELIUM MIX (90 / 10)
○ 100% HELIUM

■ **IMPELLERS:**

		EXP	COMP
■ DIAMETER	inch	5.50	6.00
■ TYPE (OPEN, ENCLOSED)		CLOSED	OPEN
■ TYPE FABRICATION		MILLED	
■ EXPANDER WHEEL MATERIAL		ALUMINIUM	
■ COMPRESSOR WHEEL MATERIAL		ALUMINIUM	

■ MATERIAL PROPERTY

		AL-7050	
YIELD STRENGTH (PSI)		68000	
HARDNESS RB (MAX / MIN):		90 / 82	

■ **SHAFT:**
■ MATERIAL 17-4 PH SS
SHAFT END: ☐ TAPERED ■ CYLINDRICAL
■ YIELD STRENGTH (N/mm2) 900
■ SHAFT HARDNESS (Rc) 39 / 34

■ **SHAFT SEALS:**
■ SINGLE PORT BUFFERED LABYRINTH
☐ DOUBLE PORT BUFFERED LABYRINTH
☐ TRIPLE PORT BUFFERED LABYRINTH
BLEED PRESSURE: PSIG
☐ DRY GAS SEAL:
○ TYPE BUFFER GAS
○ BUFFER GAS SUPPLY PRESSURE PSIG
☐ OTHER

SEAL GAS REQUIREMENTS :
■ TYPE: External Dry, Lean & Warm Gas by Purchaser
■ NORMAL SUPPLY PRESS. 400 PSIG
■ MAXIMUM SUPPLY PRESS 800 PSIG
■ MIN SUPPLY TEMP. 90 ℉
■ MAX SUPPLY TEMP. 120 ℉
■ NORMAL FLOW 90 SCFM 20 PSI DP
■ MAX FLOW 200 SCFM 20 PSI DP
○ NOTE: PURCHASER TO SUPPLY SEAL GAS COMPOSITION ON SHEET 2.

NOTE 1:

L.A.Turbine — The Turboexpander Company

TURBOEXPANDER / COMPRESSOR
DATA SHEET
ENGLISH UNITS

JOB NO. J447XX ITEM NO. EC-101
LAT INQUIRY NO. LAT574EC
REVISION NO. 0 DATE 26-Aug-16
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CONSTRUCTION FEATURES (CONTINUED)

BEARINGS:

RADIAL:

■ TYPE:
- ■ SLEEVE BEARING
- ☐ TILTING PAD BEARING
- ☐ ACTIVE MAGNETIC BEARING
- ☐ OTHER

■ MATERIAL:
- ☐ ALUMINUM (BABBITTED)
- ■ BRASS / BRONZE(BABBITTED)
- ☐ CARBON STEEL (BABBITTED)
- ☐ OTHER

■ SHAFT DIA. (INCH) 1.5"
■ MANUFACTURER LAT OR EQUAL

BEARING TEMPERATURE DEVICES:

● **TYPE**
- ○ THERMOCOUPLES TYPE:
- ● RESISTANCE TEMP DETECTORS
  - ● RESISTANCE MAT'L PLAT ● 100 OHMS

● **LOCATION / QTY**
- ■ SINGLE DUAL ELEMENT (MAIN & SPARE) 1 PER BRG

● **TEMPERATURE PROTECTION LOGIC DEVICE:**
- ○ TEMPERATURE MONITOR ○ DCS
- ● PLC ○ OTHER
- ● LOGIC DEVICE SUPPLIED BY: ● VENDOR ○ PURCH
- ● LOCATION OF TEMPERATURE PROTECTION LOGIC DEVICE:
- ● LOCAL CONTROL PANEL ○ REMOTE CONTROL PANEL
- ○ MAIN CONTROL ROOM ○ OTHER

● **BEARING TEMPERATURE DISPLAY TYPE:**
- ○ TEMPERATURE MONITOR ☐ MODEL
- ○ ALPHANUMERIC DISPLAY
- ● HMI
- ○ PURCHASER
- ○ OTHER

● DISPLAY DEVICE PROVIDED BY: ● VENDOR ○ PURCH
- ● LOCATION OF TEMPERATURE DISPLAY DEVICE:
- ● LOCAL CONTROL PANEL ○ REMOTE CONTROL PANEL
- ○ MAIN CONTROL ROOM ○ OTHER

SPEED PROBES:

● **TYPE:** ● ELECTROMAGNETIC ○ EDDY CURRENT
● **QUANTITY** ONE

○ **MACHINE PROTECTION LOGIC DEVICE:**
- ○ SWITCH ○ SPEED MONITOR ○

● **LOCATION OF SPEED DISPLAY:**
- ● LOCAL PANEL ○ REMOTE DISPLAY

THRUST:

■ TYPE:
- ■ TAPERED LAND THRUST BEARING
- ☐ TILTING PAD THRUST BEARING
- ☐ ACTIVE MAGNETIC THRUST BEARING
- ☐ OTHER

■ MANUFACTURER LAT OR EQUAL
LUBRICATION: ☐ FLOODED ■ DIRECTED ☐ N/A
THRUST COLLAR / DISK: ☐ INTEGRAL ■ SEPARATE

VIBRATION DETECTORS:
TYPE: ■ EDDY CURRENT ☐ INDUCTIVE ☐
- ● MFR BENTLY NEVADA
- ■ MODEL TRANSMITTER 990

● **LOCATION AND QUANTITY:**
- ● NO. PER JOURNAL BEARING 1 TOTAL NO. 2
- ○ IF REQ'D, OSCILLATOR-DEMODULATORS SUPPLIED BY:
  - ○ VENDOR ○ MODEL
  - ○ PURCHASER ○ MODEL

● **MACHINE VIBRATION PROTECTION LOGIC DEVICE:**
- ○ VIBRATION MONITOR ○ DCS
- ● PLC ○ OTHER
- ● LOGIC DEVICE PROVIDED BY: ● VENDOR ○ PURCH
- ● LOCATION OF VIBRATION PROTECTION LOGIC DEVICE:
- ● LOCAL CONTROL PANEL ○ REMOTE CONTROL PANEL
- ○ MAIN CONTROL ROOM ○

● **VIBRATION AMPLITUDE DISPLAY**
- ○ VIBRATION MONITOR ☐ MODEL
- ○ ALPHANUMERIC DISPLAY
- ● HMI
- ○ OTHER
- ● DISPLAY DEVICE PROVIDED BY: ● VENDOR ○ PURCH
- ● LOCATION OF DISPLAY DEVICE:
- ● LOCAL CONTROL PANEL ○ REMOTE CONTROL PANEL
- ○ MAIN CONTROL ROOM ○

● KEY PHASOR ○ YES ● NO

MAGNETIC BEARING CONTROL CABINET
○ UPS SUPPLIED BY: ○ VENDOR ○ PURCHASER
○ **LOCATION OF CONTROL CABINET:**
- ○ LOCAL PANEL ○ REMOTE PANEL
- ○ MAIN CONTROL ROOM ○

○ CABLE LENGTH FROM MACHINE SKID TO CONTROL CABINET: m
○ **POWER AND SIGNAL CABLES:**
- ○ SUPPLIED BY PURCHASER ○ SUPPLIED BY VENDOR

○ **COMUNICATION PROTOCOL**
- ○ MODBUS ○ OTHER:

☐ POWER CONSUMPTION: Max: KW Min: KW

L.A. Turbine — The Turboexpander Company

TURBOEXPANDER / COMPRESSOR
DATA SHEET
ENGLISH UNITS

JOB NO. J447XX ITEM NO. EC-101
LAT INQUIRY NO. LAT574EC
REVISION NO. 0 DATE 26-Aug-16
PAGE 7 OF 9 BY J. YEH

REV

■ **OTHER CONNECTIONS**

SERVICE:	NO.	SIZE	TYPE
LUBE-OIL INLET			
LUBE OIL OUTLET			
SEAL GAS INLET			
SEAL GAS OUTLET			
CASING DRAINS, EXP / COMP			
INTERMEDIATE BLEED			
THRUST PRESSURES			
WHEEL PRESSURES, EX / COM			
BEARING HOUSING PRES			

Refer to P&ID

● **ALLOWABLE PIPING FORCES AND MOMENTS:**
- ● 1.85 X NEMA SM23
- ○ 3 X NEMA SM23
- ○ OTHER:

CASING DRAINS:
- ● PLUGGED (Comp)
- ● FLANGED (Exp)
- ○ FLANGED AND VALVED
- ○ FLANGED, VALVED, AND MANIFOLDED

ACCESSORIES

○ **EXPANDER INLET TRIP VALVE:**
- ○ TYPE:
  - ○ BUTTERFLY VALVE ○ SIZE: ____ ○ RATING: ____ ○ ALLOWABLE PRESSURE DROP: ____ PSID
  - ○ OTHER: ____
- ○ DESIGN PRESSURE: ____ PSIG ○ DESIGN TEMPERATURE (MIN / MAX) ____ / ____ °F
- ○ MATERIAL:
  - ○ STAINLESS STEEL ○ LOW TEMP CARBON STEEL ○ CARBON STEEL ○ OTHER: ____
- ● TRIP VALVE SUPPLIED BY: ○ VENDOR ● PURCHASER

○ **INLET SCREENS AND PIPE SPOOLS:**

INLET SCREENS:		EXP	COMP
TYPE: (CONE, BASKET, OTHER)			
SIZE	(DIA. IN)		
MESH SIZE			
PRESSURE DROP	PSID		
MATERIAL:			
STAINLESS STEEL		○	○
OTHER ____		○	○

INLET SCREENS SUPPLIED BY:
- ○ VENDOR
- ● PURCHASER

INLET SPOOLS FOR INLET SCREENS:		EXP	COMP
SIZE			
RATING			
FACING			
DESIGN PRESSURE:	PSIG		
DESIGN TEMPERATURE (MIN)	°F		
DESIGN TEMPERATURE (MAX)	°F		
MATERIAL:			
STAINLESS STEEL		○	○
LOW TEMP CARBON STEEL		○	○
CARBON STEEL		○	○
OTHER:			
SPOOL CONSTRUCTION:			
SLIP-ON / SOCKETWELD		○	○
SOCKETWELD		○	○
WELDNECK / BUTTWELD		○	○

PIPE SPECIFICATION: ____

INLET SPOOLS PIECES SUPPLIED BY:
- ○ VENDOR
- ● PURCHASER

● **COMPRESSOR ANTI-SURGE SYSTEM**
- ● CONTROLLER: ○ PID CONTROLLER ● PLC ○ OTHER: ____
- ○ RECYCLE VALVE TYPE: ____ MTL: ____ NOISE LIMIT: ○ VENDOR STD ○ SPECIAL: ____
  - ○ DESIGN PRESSURE: ____ PSIG ○ DESIGN TEMPERATURE (MIN/MAX) ____ / ____ °F
  - ● BY: PURCHASER
- ● INLET FLOW DEVICE TYPE: ORIFICE PLATE w/ FLANGES ● BY: LAT
- ● COMP. INLET FLOW TRANSMITTER ● COMP. PRESSURE TRANSMITTER

REMARKS: ____

L.A. Turbine
The Turboexpander Company

TURBOEXPANDER / COMPRESSOR
DATA SHEET
ENGLISH UNITS

JOB NO. J447XX ITEM NO. EC-101
LAT INQUIRY NO. LAT574EC
REVISION NO. 0 DATE 26-Aug-16
PAGE 8 OF 9 BY J. YEH

REV

SHOP INSPECTION AND TESTS:

	REQ'D	OBSRV	WTNS
CLEANLINESS	●	❍	❍
HYDROSTATIC	●	❍	❍
LOW SPEED BALANCE (ISO 1940 G2.5)	●	❍	❍
IMPELLER OVERSPEED (115% OF MCS)	●	❍	❍
IMPELLER RESONANCE TEST	●	❍	❍
MECHANICAL RUN (1 Hr)	●	❍	❍

● MAIN ● SPARE

● CONTRACT PROBES ○ SHOP PROBES

VARY LUBE & SEAL OIL PRESSURES AND TEMPERATURES	❍	❍	❍
POLAR FORM VIB DATA	❍	❍	❍
TAPE RECORD VIB DATA	❍	❍	❍
TAPE DATA TO PURCHASER	❍	❍	❍
PERFORMANCE TEST (AIR)	●	❍	❍
COMPLETE UNIT TEST	❍	❍	❍
CASING LEAK TEST	❍	❍	❍
SOUND LEVEL SURVEY	❍	❍	❍
FULL POWER TEST	❍	❍	❍

● UTILITY CONDITIONS:

INSTRUMENT AIR:

NOMRAL PRESS 70 PSIG MAX PRESS 90 PSIG

MIN TEMP 60 °F MAX TEMP 90 °F

With minus 40 °F dew point

■ UTILITY CONSUMPTIONS

PUMP MOTOR	5 each	HP
AIR FAN COOLER MOTOR	5	HP
LUBE OIL HEATER	3	kW
INSTRUMENTATION	800	Watt
INSTRUMENTS AIR	~2 max	SCFM

MISCELLANEOUS:

■ RECOMMENDED STRAIGHT RUN OF PIPE DIAMETERS
AT EXPANDER DISCHARGE: 3-5 x
AT COMPRESSOR INLET: 3-5 x

○ VENDOR TO REVIEW & COMMENT ON PURCHASER'S PIPING & FOUNDATION

○ VENDOR TO REVIEW & COMMENT ON PURCHASER'S CONTROL SYSTEMS

○

○

■ WEIGHTS (lb):

Refer to General Arrangment

■

REMARKS:

L.A. Turbine — The Turboexpander Company

TURBOEXPANDER / COMPRESSOR INSTRUMENTATION DATA SHEET

JOB NO. J447XX ITEM NO. EC-101
LAT INQUIRY NO. LAT574EC
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REV

PANEL MOUNTING DETAILS:

USE THE FOLLOWING CODE LETTER TO SHOW DETAILS

S - SWITCHES | G - GAUGE | P - SUPPLIED BY PURCHASER
T - BLIND TRANSMITTER | E - ELECTRONIC INDICATOR | V - VENDOR SUPPLY AND MOUNT (BY LAT)
TI - INDICATING TRANSMITTER | TE - TEMPERATURE ELEMENT (RTD) | M - MOUNT BY VENDOR OF PURCHASER'S ITEM
E/S - ELECTRICAL SWITCH | AMB - ACTIVE MAG. BEARING CABINET

PANEL INDICATION

L - LOCALLY MOUNTED ON PIPING/MACHINE SUPPORT | B=LOCAL EQUIPMENT PANEL /Gauge Board | C=REMOTE UNIT CONTROL PANEL

	L	B	C
	V	V	N/A
PRESSURE INDICATION:			
❍ LUBE OIL PUMP INLET PRESSURE			
● LUBE OIL PUMP OUTLET PRESSURE	G		
● LUBE OIL SUPPLY PRESSURE		Ti	
● LUBE OIL RESERVOIR		Ti	
● SEAL GAS PRESSURE TO EXPANDER		G	
● THRUST PRESSURE, Exp/Comp	G		
● EXPANDER BACKWHEEL	G		
● COMPRESSOR BACKWHEEL	G		
❍ EXPANDER INLET			
❍ EXPANDER OUTLET			
● COMPRESSOR INLET (SURGE)	Ti*		
● COMPRESSOR OUTLET (SURGE)	Ti*		
❍			
DIFFERENTIAL PRESSURE INDICATION:			
❍ EXPANDER INLET SCREEN			
❍ COMPRESSOR INLET SCREEN			
❍ COMPRESSOR (SURGE CONTROL)			
● EXPANDER/COMPRESSOR THRUST	Ti		
● SEAL GAS FILTER	G		
● SEAL GAS ACROSS MACHINE		Ti	
● LUBE OIL FILTER	G		
❍ BOUNDARY HOUSING			
TEMPERATURE INDICATION:			
● LUBE OIL BEARING DRAIN	TE		
● LUBE OIL RESERVOIR	TE		
● OIL COOLER DISCHARGE	TE		
❍ EXPANDER DISCHARGE			
❍ COMPRESSOR INLET			
❍ COMPRESSOR DISCHARGE			
❍ SEAL GAS SUPPLY			
● BEARING TEMPERATURE	TE		
PUSH BUTTON / HAND SWITCH:			
● EXPANDER START		E/S	
● EXPANDER STOP		E/S	
● EXPANDER RESET		E/S	
● MAIN/STBY PUMP HOA		E/S	
● LAMP TEST		E/S	
MISCELLANEOUS:			
● TURBOEXPANDER TACHOMETER		V	
❍ SEAL GAS FLOW INDICATION			
● LUBE OIL RESERVOIR LEVEL INDICATOR		V	
● COMPRESSOR FLOW INDICATOR (SURGE)	Ti*		
● HAND INDICATION CONTROLLER		V	
❍ INLET GUIDE VALVE POSITION INDICATOR			
❍ TRIP VALVE LIMIT SWITCHES			

PANEL INDICATION (SIGNAL SOURCE)

ALARM & SHUT DOWN:

ALAR	TRIP	FUNCTION	L	B	C
●	●	LUBE OIL DRAIN-HIGH TEMP.		V	
❍	❍	LUBE OIL FILTER-HIGH DIFF. PRESS.			
❍	❍	LUBE OIL COOLER-HIGH TEMP.			
●	●	LUBE OIL COOLER-HIGH VIB. Note 1		V	
●	❍	STANDBY OIL PUMP START-UP		V	
●	❍	LUBE OIL RESERVOIR-LOW LEVEL		V	
●	●	LOW DIFF. PRESS ACROSS BEARING		V	
●	●	SEAL GAS-LOW DIFF. PRESS. ACROSS EXP		V	
❍	❍	SEAL GAS FILTER-HIGH DIFF. PRESS.			
❍	❍	SEAL GAS-LOW TEMP.			
●	●	VIBRATION - HIGH		V	
●	●	BEARING -HIGH TEMP.		V	
●	●	BEARING THRUST - HIGH PRESS.		V	
●	●	SHAFT SPEED - HIGH		V	
❍	❍	REMOTE SIGNAL			
❍	❍	BOUNDARY HOUSING DIFF. PRESS.			
❍	❍	PRESSURE ACROSS INLET SCREENS - HIGH			

ANNUCIATION LOCATION:

❍ ❍ INDIVIDUAL			
● ● COMMON		V	

PROBES:

● TEMPERATURE: TYPE: D-RTD
QTY PER BEARING : 1 TOTAL: 2

● VIBRATION:
QTY PER BEARING : 1 TOTAL: 2

● SPEED:
TOTAL: 1
VOTING: ● 1oo1 ❍ 2oo2 ❍ 2oo3

❍ KEY PHASOR

CONTROL DEVICE:

TYPE: ● PLC ❍ DCS
● SIMPLEX ❍ REDUNDANT
● Allen-Bradley ControlLogix

LOCATION: ● SKID-MOUNTED ❍ REMOTE (CONTROL ROOM)

REMARKS: 1. Shutdown Cooler Motor Only

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	AS-BUILT	3/16/2017	R.S.

CUSTOMER	:	**UOP RUSSELL LLC**
FOR	:	**TBD**
PROJECT	:	**J447XX**
LOCATION	:	**TBD**
P.O. NO.	:	**4500732023**
ITEM NO.	:	**EC-101**
SERVICE	:	**TURBOEXPANDER / RECOMPRESSOR**

AS BUILT

DO NOT SCALE DRAWING

L.A. Turbine Corporation

28557 Industry Drive
Valencia, Ca. 91355

Tolerances, if not indicated, according to: ANSI Y14.5M 1982

Machined Surface: 125 UNLESS NOTED

DECIMALS: .XXX N/A, .XX N/A

FRACTIONS: ± N/A

ANGLES ±

Units = Inches

BREAK ALL SHARP CORNERS AND DEBURRS .005

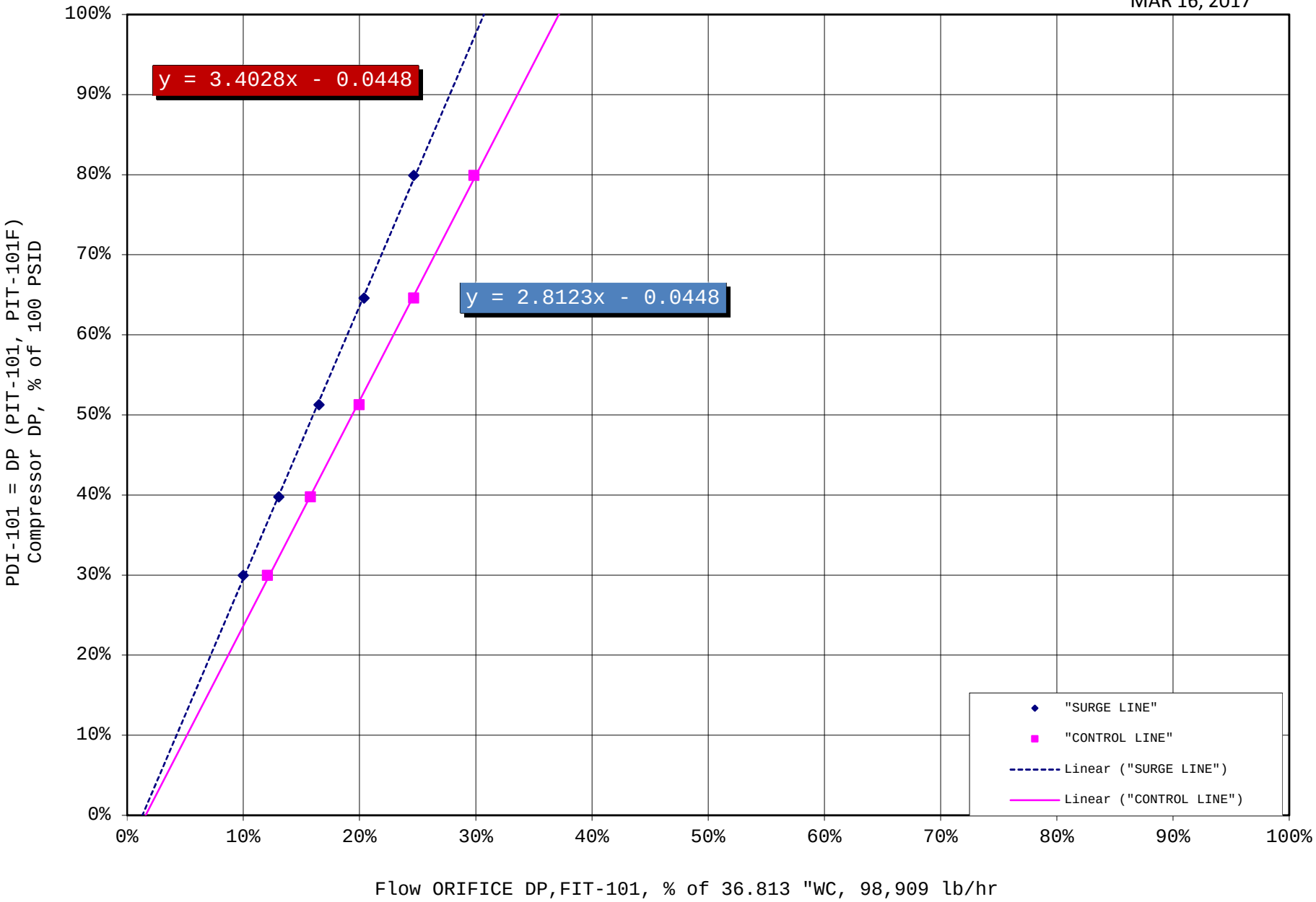
Name:	ANTI-SURGE ALGORITHM						
Material:	N/A				Material Class	N/A	
File Location:	V:\LAT574EC\GAS DYNAMICS				Job Number:	LAT574EC	
Scale:	N/A		Prev Dwg:	N/A	Originated from:		
Drawn By:	J. Yeh	Date: 3/16/17	Next Dwg:	N/A	Dwg/Part No.		Rev
Std. Chk:	J. Yeh	Date: 3/16/17	Blank Wt.	N/A	Finished Wt.	N/A	LAT574EC-20-A86 / 0
Design Chk:	R.S.	Date: 3/16/17	Approved:	R.S.	Date:	3/16/17	PAGE 1 OF 4

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AS BUILT

LAT574EC DESIGN Anti-Surge Algorithm

MAR 16, 2017



ROSEMOUNT INC.
3051SFA - Annubar Flowmeter
CALCULATION DATA SHEET

EMERSON Process Management

GENERAL DATA

Customer:	
Project:	Patrick Quinn FY 2016
S. O. No:	
P. O. No:	
Calc. Date:	
Model No:	3051SFADG100CCHPS2T100052AA1A2E5M5
Tag No:	FE-101

PRODUCT DESCRIPTION

Product Type:	Pak-Lok	Instrument Valve:	
Sensor Size:	Sensor Size 2	Valve Material:	
Wetted Material:	316 Stainless Steel	Line Size:	10-in. (250 mm)
Transmitter Conn.:	Direct-mount 5-valve Manifold	Pipe Sch.:	40
Mounting Conn. Material:	Carbon Steel (A105)	Pipe Orientation:	Horizontal
Mounting Type:	Compression/Threaded Connection		

INPUT DATA

Fluid Type:	Custom Gas		Wall:	0.365	inch
Fluid Name:	HC Vapor				
Pipe I.D. (Span):	10.020	inch			
Body I.D.:	10.020	inch	Base Pressure:		
Duct Width:		inch	Base Temperature:		
Pressure at Flow:	185.000	psig			
Temperature at Flow:	104.00	F			
Absolute Viscosity:	0.01200	cP	Base Density:	0.0000	lb/ft3
Isentropic Exponent:	1.300		Atmospheric Pressure:	14.696	psia
Compressibility at Flow:	0.9900				
Density at Flow:	0.6181	lb/ft3	[Primary Dimension]:		

Flow Rates

Minimum:	0.00	lb/hr	←*See Warnings
Normal:	84073.00	lb/hr	
Maximum:	98909.00	lb/hr	
Full Scale:	98909.00	lb/hr	

CALCULATED DATA

(Calculation Performed at Normal Conditions.)

DP at Min Flow:		inH2O@68F	Flow Coefficient:	0.5754	
DP at Normal Flow:	26.597	inH2O@68F			
DP at Max Flow:	36.813	inH2O@68F	Rod Reynolds Number (Minimum):		
DP at Full Scale Flow:	36.813	inH2O@68F	Rod Reynolds Number (Normal):	466975	
Resonant Frequency:	468	Hz	Gas Expansion Factor:	0.9995	
Wake Frequency:	156	Hz	Permanent Pressure Loss:		
Blockage:	0.13		at Normal Flow:	3.58	inH2O@68F
			at Maximum Flow:	4.96	inH2O@68F
			Velocity at Max Flow:	81.14	ft/sec

GUIDELINES

Primary Element Min Limit:	5157.76	lb/hr		Recommended Min Rod Reynolds Number:	12500		
Structural Limit (Flow):	410948.60	lb/hr		Recommended Min DP:	0.100	inH2O@68F	
Structural Limit (DP):	635.5	inH2O@68F					
Max. Allow. Pressure@Temp.:	1432.0	psig	104 F	Max. Allow. Temp.:	500	F	
Design Pressure/Temperature:	185.00	psig	104.00 F				

WARNINGS

*** Flowrate is below recommended minimum value of 5157.757614 lb/hr.**

NOTES

This report is provided according to the terms and conditions of the Instrument Toolkit(TM) End-Use Customer License Agreement.

Version: 3.0 (Build199C) **Printed On:** 1-Nov-2016

AS BUILT

FISHER

Sliding Stem Valve Specification

Customer: UOP RUSSELL LLC		Vinson Process Controls	
Contact: Dennis Paden		Contact: Ron Berte	
Customer Reference: JOB 445, UOP RUSSELL, SC6 STD PLANT		Sales Office Reference: VVES	Lead Time: 10 WKS
Item: 9	Rev:	Qty: 1	Quote: 027D-RCB-160811-0184180	Rev: A
Tags: FCV-101			Date Last Modified: 08/11/2016	
Description: NPS 3 ET 657 Size 45i DVC6200 TopWorx Switches				
Service Description:				

Service:	
Size and Type:	NPS 3 ET
Body Style:	Globe
Design Temp:	250 deg F
Design Press:	500 psig
End Connect/In/Out:	CL300/RF Flg/RF Flg
Material:	WCC Steel
Ports:	1
Flow Directn:	Down
Trim Number:	1
Cage Matl:	CB7Cu-1 SST
Retainer Matl:	
Bushing Matl:	
Seat Ring Matl:	S41600 SST
VALVE PLUG	
Material:	S41600 SST
Guiding:	Cage
Balance:	Balanced
Shutoff Class:	ANSI CL IV
Port Size:	3 7/16 Inch
Characteristic:	Linear
Stem Material:	S31600 SST
Stem Size:	1/2 Inch
Bonnet Style:	Plain
Boss Size:	2 13/16
Packing:	Single PTFE
Access:	No
Bolt, Bonnet:	SA-193-B7 Studs/2H Nuts
PackFlg/Bltg:	SST Pkg Flg, SST Studs & Nuts
Actuator:	Spring & Diaphragm
Type/Size:	657/45i
Travel:	1 1/2 Inch
Bench Set:	6-22 psi
Push Down To:	PDTC
Supply:	Air
To Actuator:	0 to 33 psig
Fails Valve:	Open
Handwheel:	None

Positioner Type:	DVC6200,HART Communicating-HC
Input Signal:	4 to 20 mA dc
Access:	67CFR Filter/Regulator
Gauges:	0-60 psig/0-4 bar
Action:	Direct
Certification:	FM,Explosion Proof/Intrinsic Safe/Nonincendive
Controller Type:	
Action:	
Measure Element:	
Range:	
Output:	
Mounting:	
Airset:	
Mounting:	
Transducer:	
Input Signal:	
Output Signal:	
Action:	
Mounting:	
Airset:	
Certifications:	
Line In:	3 in, SCH STD
Line Out:	3 in, SCH STD
Insulation:	
Service Cond:	THROTTLING
Process Fluid:	NATURAL GAS (0.65 SG)
Critical Pressure:	669.000 psia
Shutoff Drop:	500 psi
Max Rated Cv:	148.0

Variable Name	Unit	Minimum	Normal	Maximum
Mass Flow Rate Gas (w)	lb/h	16815.000	42037.000	49455.000
Inlet Pressure (P1)	psig	257.000	257.000	257.000
Pressure Change (dP)	psi	72.000	72.000	72.000
Inlet Temperature (T1)	deg F	157.000	157.000	157.000
M / Gg	SG	0.650	0.650	0.650
Specific heats ratio (gamma)		1.280	1.280	1.280
Dynamic Viscosity (Mu)	cP	0.010	0.010	0.010
Sizing Coefficient (Cv)		40.800	101.568	119.781
% Open		24	58	71
Valve LpA(LpAValve1m)	dB(A)	87	95	96

NOTES:
1. SST TUBING & FITTINGS
2. INCLUDES TOPWORX DXP-MX1GN4B STEM POSITION TRANSMITTER & SWITCHES.

AS BUILT

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	AS-TESTED	4/6/2017	B.P.

AS-BUILT / AS-TESTED

L.A. Turbine Corporation

28557 Industry Drive,
Valencia, Ca. 91355

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Name:	PERFORMANCE TEST DATA						
Material:	N/A					Material Class	N/A
File Location:	V:\LAT574EC\TEST					Job Number:	LAT574EC
Scale:	N/A		Prev Dwg:	N/A		Originated from:	
Drawn By:	B.P	Date: 4/6/17	Next Dwg:	N/A		Dwg/Part No.	Rev
Std. Chk:	B.P	Date: 1/0/00	Blank Wt.	N/A	Finished Wt. N/A	LAT574EC-20-A94	0
Design Chk:	B.P	Date: 1/0/00	Approved:	T.A.	Date: 1/0/00	PAGE 1 OF 5	

L.A. Turbine Corp.

Compressor Performance Test

Test No.: 1 Test Date: 04/06/17 Test Engr: B. PARRELLI Job No.: LAT574EC

Time Start: 12:30 PM Witness: Approval: T. AVETIAN Unit No.: MAIN

Design Conditions:

Shaft Speed (RPM): 40,000
Polytropic Head (BTU/lb): 17.18
Flow Rate (ACFM): 2,338
Wheel Diameter (in): 6.000
Polytropic Efficiency (%): 78.0

Test Conditions:

Test Gas: Air
Pipe Diameter (in): 12.000
Orifice Diameter (in): 6.500
Ambient Pressure (in Hg): 30.06
Ambient Temperature (F): 70.00
Relative Humidity (%): 32%

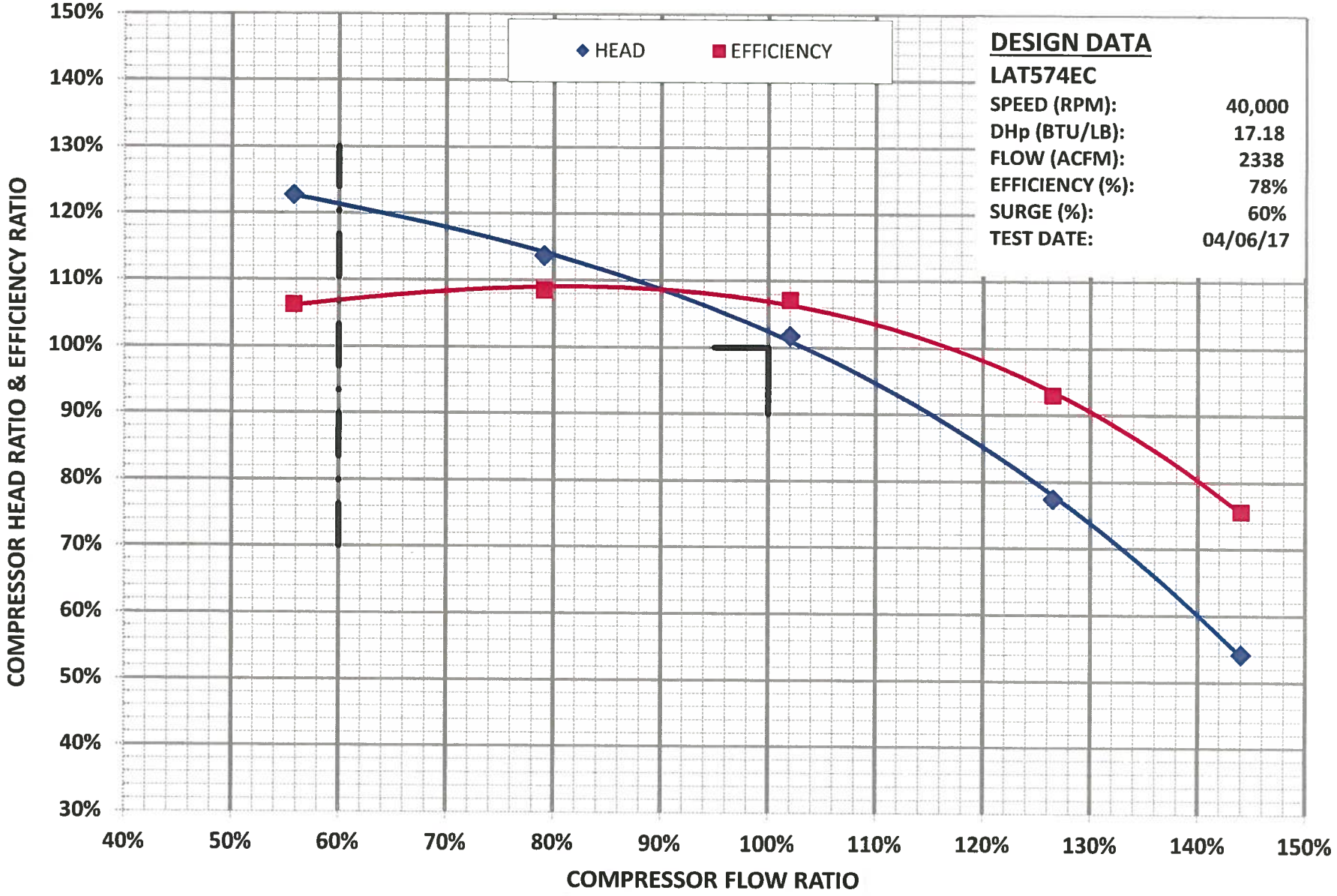
Test Data:		Stonewall Point #1	Point #2	Design Point #3	Point #4	Surge Point #5	
Shaft Speed (RPM)		26,596	26,494	27,109	28,294	29,943	
Orifice Diameter (in)		6.500	6.500	6.500	6.500	6.500	
Orifice ΔP (in H2O)		15.50	12.00	8.25	5.45	3.05	
Inlet Pressure (in H2O)		11.30	8.70	6.00	3.95	2.20	
Discharge Pressure (psig)		1.25	2.10	3.20	4.10	5.15	
Inlet Temperature (F)		74.60	74.60	75.55	75.75	76.70	
Discharge Temperature (F)		103.65	108.15	115.60	123.85	136.10	
Flow Rate (ACFM)		2,239	1,959	1,617	1,309	976	
Polytropic Head (BTU/lb)		4.11	5.84	8.03	9.77	11.81	
Polytropic Efficiency		0.590	0.725	0.835	0.846	0.829	
% Design ACFM		144%	127%	102%	79%	56%	
% Design Head		54%	77%	102%	114%	123%	
% Design Efficiency		76%	93%	107%	108%	106%	

As-tested, the compressor meets the minimum required head and efficiency and consumes 99% of the predicted power at the guaranteed design case. This satisfies the API-617 performance test requirement.

AS-BUILT / AS-TESTED

L.A.Turbine

COMPRESSOR PERFORMANCE



AS-BUILT / AS-TESTED

L.A. Turbine Corp.

Expander Performance Test

Test No.: 1 Test Date: 04/06/17 Test Engr: B. PARRELLI Job No.: LAT574EC

Time Start: 01:30 PM Witness: Approval: T. AVETIAN Unit No.: MAIN

Design Conditions:

Shaft Speed (RPM): 40,000
ΔH,s (BTU/lb): 41.91
Flow Rate (ACFM): 637
Wheel Diameter (in): 5.500
Isentropic Efficiency (%): 84
U/C0: 0.663

Test Conditions:

Test Gas: Air
Pipe Diameter (in): 6.000
Orifice Diameter (in): 4.000
Ambient Pressure (in Hg): 30.06
Ambient Temperature (F): 70
Relative Humidity (%): 32%

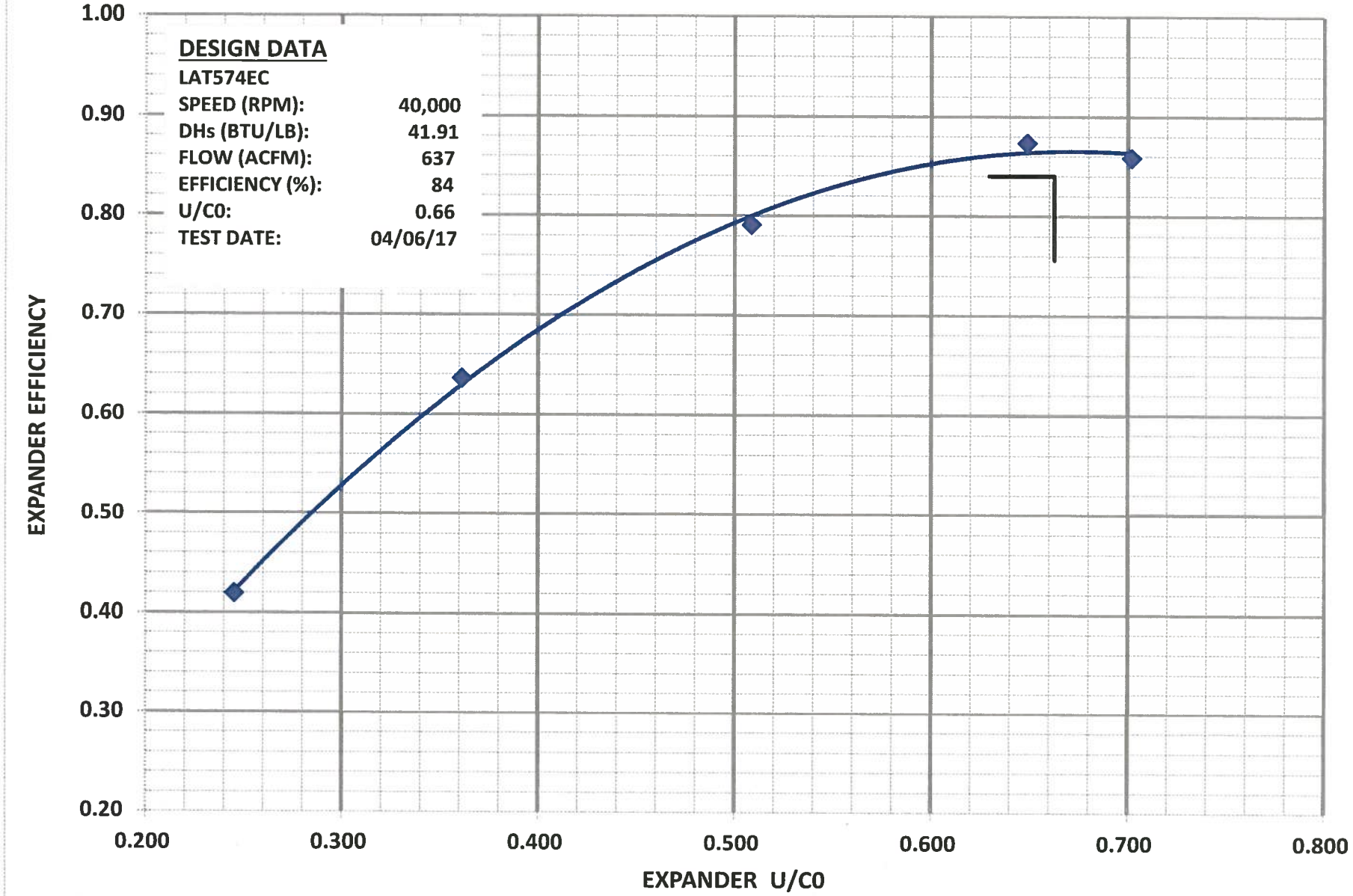
Test Data:		Point #1	Point #2	Point #3	Point #4	Point #5	
Shaft Speed (RPM)		26,796	24,184	21,365	18,129	15,461	
Inlet Pressure (psig)		67.15	66.20	44.50	33.80	53.40	
Discharge Pressure (psig)		37.60	38.20	19.80	7.30	3.40	
Inlet Temperature (F)		122.15	123.10	132.45	138.05	145.70	
Discharge Temperature (F)		62.20	64.95	65.60	61.35	65.85	
Orifice ΔP (in H2O)		7.60	7.60	4.45	2.00	0.70	
Orifice Pressure (psig)		67.20	66.25	44.45	33.65	53.30	
Orifice Temperature (F)		123.55	124.45	134.25	140.85	149.50	
Nozzle Opening (%)		100%	100%	80%	55%	25%	
ΔH,s (BTU/lb)		16.76	15.98	20.29	28.95	45.71	
Isentropic Efficiency		0.858	0.874	0.791	0.636	0.419	
U/C0		0.702	0.649	0.509	0.361	0.245	

As-tested, the expander meets the minimum required efficiency and produces 101% of the predicted power at the guaranteed design case. This satisfies the API-617 performance test requirement.

AS-BUILT / AS-TESTED

L.A.Turbine

EXPANDER PERFORMANCE



AS-BUILT / AS-TESTED

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Valencia, CA 91355

Tel: 661-294-8290

Fax: 888-674-6503

Certificate

COMPRESSOR PERFORMANCE TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS)

THIS IS TO CERTIFY THAT **PERFORMANCE TEST** HAS BEEN SUCCESSFULLY CONDUCTED ON THE **COMPRESSOR** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER. THE TEST RECORDS ARE SHOWN IN THE ATTACHED TEST REPORT AND THEY INDICATE THAT COMPRESSOR'S PERFORMANCE MET THE CONTRACTUAL REQUIREMENTS.

TEST PERFORMED BY: _____ 4-6-17
BRIAN PARRELLI, LAT TEST ENGINEER **DATE**

CERTIFIED BY: _____ 4/6/17
FRANK LOTH, QA MANAGER **DATE**

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate
EXPANDER PERFORMANCE TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS)

THIS IS TO CERTIFY THAT **PERFORMANCE TEST** HAS BEEN SUCCESSFULLY CONDUCTED ON THE **EXPANDER** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER. THE TEST RECORDS ARE SHOWN IN THE ATTACHED TEST REPORT AND THEY INDICATE THAT EXPANDER'S PERFORMANCE MET THE CONTRACTUAL REQUIREMENTS.

TEST PERFORMED BY: _____ 4-6-17
BRIAN PARRELLI, LAT TEST ENGINEER — DATE

CERTIFIED BY: _____ 4/6/17
FRANK LOTH, QA MANAGER — DATE

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	AS-TESTED	4/7/2017	T.A.

AS-BUILT / AS-TESTED

L.A. Turbine Corporation

28557 Industry Drive
Valencia, Ca. 91355

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Name:	MECHANICAL TEST DATA						
Material:	N/A					Material Class	N/A
File Location:	V:\LAT574EC\TEST					Job Number:	LAT574EC
Scale:	N/A		Prev Dwg:	N/A		Originated from:	
Drawn By:	C.M.	Date: 4/7/17	Next Dwg:	N/A		Dwg/Part No.	Rev
Std. Chk:	S.B.	Date: 4/7/17	Blank Wt.	N/A	Finished Wt. N/A	LAT574EC-20-A95	0
Design Chk:	T.A.	Date: 4/7/17	Approved:	T.A.	Date: 4/7/17	PAGE 1 OF 5	

L.A. Turbine Corp.

Mechanical Running Test

Test No.: 1 Test Date: **04/06/17** Test Engr: CM Job No.: **LAT574EC - MAIN**

Time Start: 2:30 PM Witness: No Approval: TA Unit No.: **1203**

Design Data:

Speed (RPM): 40,000 Bearing Diameter (Inches): 1.625

Max. Continuous Speed (RPM): 42,000 Oil Viscosity: 150 SSU @ 100 °F

Test Data:

			Expected Values	1 Hour Mechanical Run							Over Speed Trip
Time				2:40 PM	2:50 PM	3:00 PM	3:10 PM	3:20 PM	3:30 PM	3:40 PM	3:50 PM	4:00 PM
Shaft Speed		RPM	42000	30,000	38,520	42,031	42,008	41,989	42,077	42,004	42,018	42,090
Shaft Vibration	Expander X	mils	< 0.8	0.14	0.11	0.11	0.10	0.09	0.07	0.07	0.08	0.07
	Expander Y	mils	N/A	x	x	x	x	x	x	x	x	x
	Compressor X	mils	< 0.8	0.06	0.06	0.05	0.06	0.06	0.08	0.08	0.07	0.07
	Compressor Y	mils	N/A	x	x	x	x	x	x	x	x	x
Bearing Temperature	Expander Side	°F	<150 °F	125.0	133.1	136.0	137.8	139.9	140.7	141.1	141.0	141.1
	Compressor Side	°F	<150 °F	118.0	130.7	135.3	139.4	143.0	143.8	144.4	144.4	144.7
Reservoir Temperature		°F	135 - 150 °F	122.0	130.4	133.2	137.1	140.6	140.6	141.0	140.9	140.7
L.O. After Cooler Temperature		°F	120 °F	116.0	119.7	120.3	120.6	120.8	120.8	120.8	120.8	120.8
L.O. Drain Temperature		°F	<150 °F	128.6	139.3	144.1	144.9	145.2	145.3	145.3	145.2	145.3
Oil DT		°F	<30 °F	12.6	19.6	23.8	24.3	24.4	24.5	24.5	24.4	24.5
Oil Flow		GPM	13 - 15	12.00	11.50	11.06	11.00	10.98	10.96	10.96	10.96	10.96
Oil DP		PSI	100	105.0	106.7	106.7	106.2	105.4	105.4	105.4	105.8	106.0

Auxilliary System Testing (refer to LAT574EC-20-C16 for Alarm/Trip Setpoints):

1. Verified Duplex Lube Oil Filter changeover w/o dropping below oil DP alarm setting.
2. Verified Aux Lube Oil Pump start at low DP alarm setting.
3. Verified Overspeed Shutdown protection.

AS-BUILT / AS-TESTED

L.A. Turbine Corp.

Mechanical Running Test

Test No.: 1 Test Date: **04/07/17** Test Engr: CM Job No.: **LAT574EC - SPARE w/dummy wheel**

Time Start: 1:30 PM Witness: No Approval: TA Unit No.: **1204**

Design Data:

Speed (RPM): 40,000 Bearing Diameter (Inches): 1.625

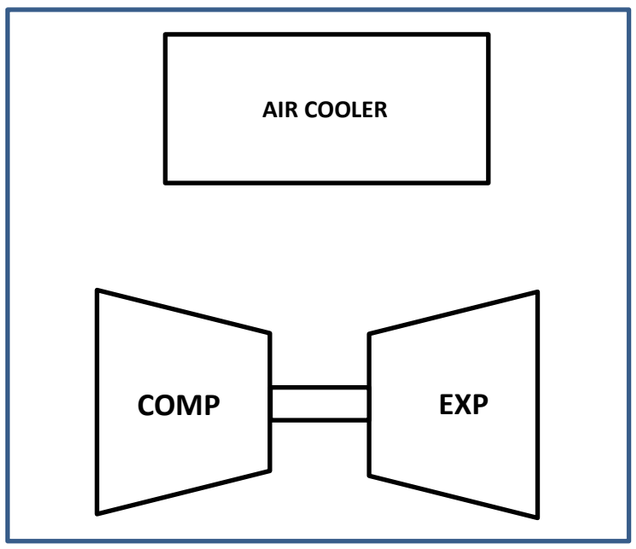
Max. Continuous Speed (RPM): 42,000 Oil Viscosity: 150 SSU @ 100 °F

Test Data:			Expected Values	1 Hour Mechanical Run							Over Speed Trip
Time				1:50 PM	2:00 PM	2:10 PM	2:20 PM	2:30 PM	2:40 PM	2:50 PM	3:00 PM	3:10 PM
Shaft Speed		RPM	42000	35,000	40,000	42,032	41,984	41,975	41,953	41,961	42,120	42,025
Shaft Vibration	Expander X	mils	< 0.8	0.14	0.18	0.18	0.19	0.23	0.24	0.24	0.23	0.22
	Expander Y	mils	N/A	x	x	x	x	x	x	x	x	x
	Compressor X	mils	< 0.8	0.15	0.22	0.23	0.25	0.24	0.23	0.23	0.22	0.22
	Compressor Y	mils	N/A	x	x	x	x	x	x	x	x	x
Bearing Temperature	Expander Side	°F	<150 °F	116.0	122.5	129.9	131.4	132.7	133.6	134.2	134.1	134.6
	Compressor Side	°F	<150 °F	113.0	120.3	128.6	130.4	131.8	132.8	133.5	133.3	133.9
Reservoir Temperature		°F	135 - 150 °F	120.0	128.9	138.1	139.6	140.0	140.2	140.3	140.4	139.9
L.O. After Cooler Temperature		°F	120 °F	116.0	119.8	120.7	120.8	120.9	121.0	121.0	121.0	120.7
L.O. Drain Temperature		°F	<150 °F	131.0	136.4	139.8	140.0	140.2	140.2	140.3	140.2	140.1
Oil DT		°F	<30 °F	15.0	16.6	19.1	19.2	19.3	19.2	19.3	19.2	19.4
Oil Flow		GPM	13 - 15	14.98	14.55	14.29	14.25	14.23	14.23	14.23	14.29	14.25
Oil DP		PSI	100	99.0	99.3	99.8	99.6	99.9	99.8	99.9	100.7	100.8

AS-BUILT / AS-TESTED

L.A. Turbine — The Turboexpander Company	EQUIPMENT NOISE MEASUREMENT (FOR INFORMATION ONLY)	PROJ NO. : LAT574 - S/N - 1203 DOC. NO. : LAT574EC-30-A95

MEASUREMENT LOCATION

113.9 dBA	115.1 dBA	115.4 dBA
113 dBA		117 dBA
113.3 dBA	113.6 dBA	115.4 dBA

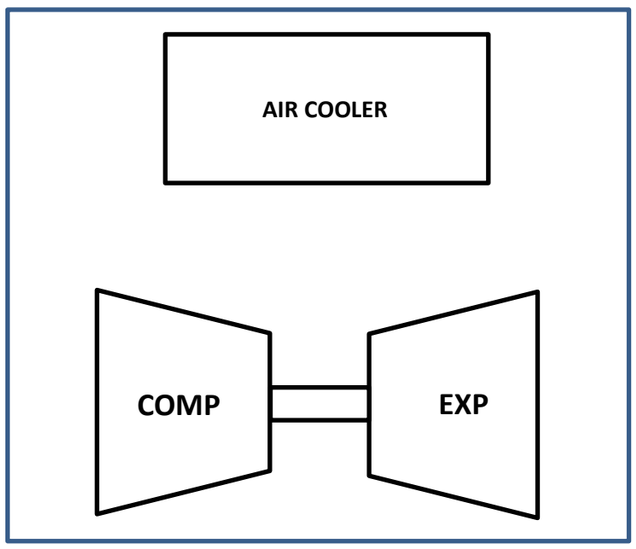
AS-BUILT / AS-TESTED

L.A. Turbine
The Turboexpander Company

EQUIPMENT NOISE MEASUREMENT
(FOR INFORMATION ONLY)
w/Dummy Compressor Wheel

PROJ NO. : LAT574 - S/N - 1204
DOC. NO. : LAT574EC-30-A95

MEASUREMENT LOCATION

91.3 dBA	93.9 dBA	93.3 dBA
87.7 dBA		98.7 dBA
90.5 dBA	91.1 dBA	95.4 dBA

AS-BUILT / AS-TESTED

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

EXPANDER-COMPRESSOR

MECHANICAL RUN TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC (MAIN)

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS)

THIS IS TO CERTIFY THAT MECHANICAL RUN TEST HAS BEEN SUCCESSFULLY CONDUCTED ON THE **EXPANDER-COMPRESSOR** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER. THE TEST RECORDS ARE SHOWN IN THE ATTACHED TEST REPORT. THE MECHANICAL OPERATION OF THE EQUIPMENT WAS FOUND TO BE SATISFACTORY.

TEST PERFORMED BY: (B. Parrell: signing for T. Avetian) 4-6-17
TADEH AVETIAN, LAT TEST ENGINEER — DATE

CERTIFIED BY: 4/6/17
FRANK LOTH, QA MANAGER — DATE

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

EXPANDER-COMPRESSOR

MECHANICAL RUN TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC (SPARE)

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS)

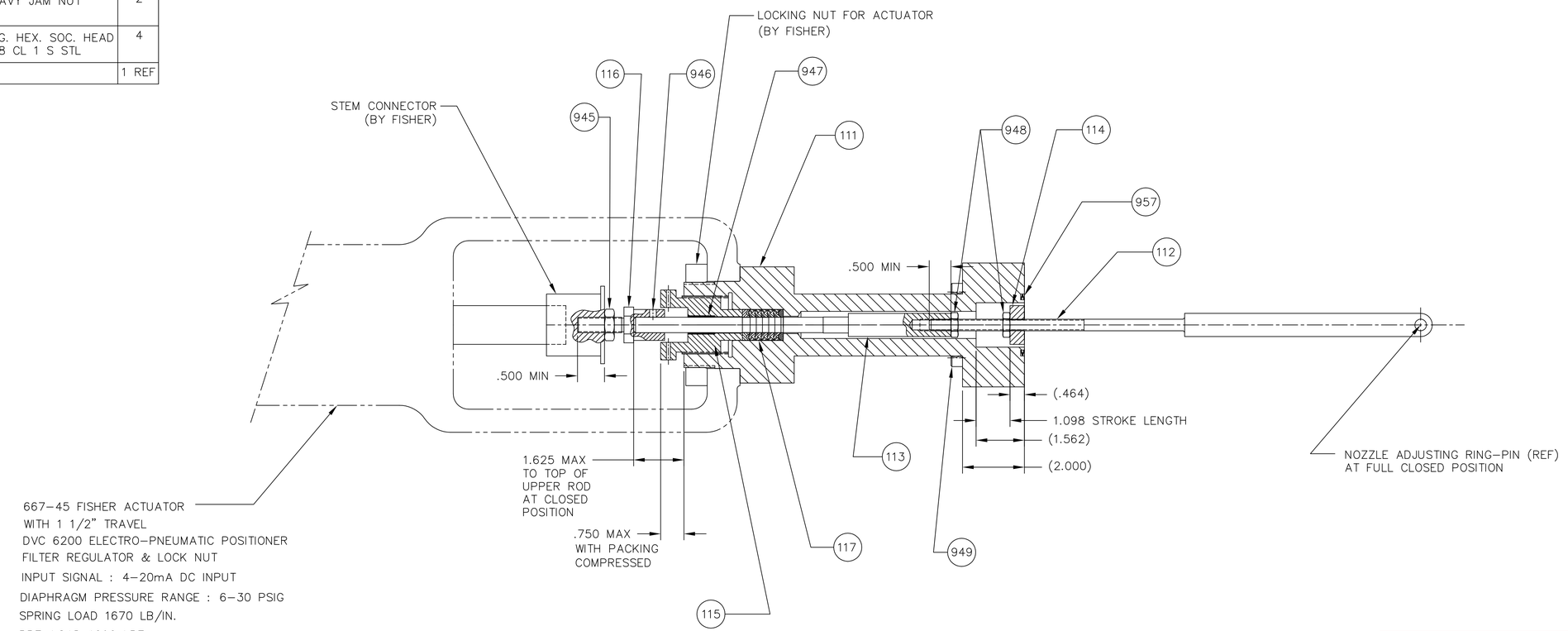
THIS IS TO CERTIFY THAT MECHANICAL RUN TEST HAS BEEN SUCCESSFULLY CONDUCTED ON THE **EXPANDER-COMPRESSOR** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER. THE TEST RECORDS ARE SHOWN IN THE ATTACHED TEST REPORT. THE MECHANICAL OPERATION OF THE EQUIPMENT WAS FOUND TO BE SATISFACTORY.

TEST PERFORMED BY: (Signing for T. Avetian) 4-7-17
TADEH AVETIAN, LAT TEST ENGINEER — DATE

CERTIFIED BY: 4/7/17
FRANK LOTH, QA MANAGER — DATE

BILL OF MATERIALS			
ITEM	PART NUMBER	DESCRIPTION	QTY
111	7770006223	BONNET	1
112	7770000269	NOZZLE ACTUATOR ROD LOWER	1 REF
113	7770006208	UPPER NOZZLE ACTUATOR ROD	1
114	7770000271	STROKE STOP	1
115	7770000272	ACTUATOR PACKING NUT	1
116	7770000273	ACTUATOR ADJUSTMENT NUT	1
117	7770004264	CHEMLON PACKING ASSEMBLY	1
945	7760000059	1/2–20UNF THREAD HEX. THIN JAM NUT ASTM F594 GR. 1 ST. STEEL	1
946	7760000060	7/32" DIA X 1" LG. SEL–LOK PIN (ST. STEEL)	1
947	7760000061	GARLOCK BUSHING DU #08–DU–14 (½" ID X ⅞" LG)	1
948	7760000062	3/8–16 UNC THREAD HEX. HEAVY JAM NUT ASTM A194 GR. 8 ST. STEEL	2
949	7760000063	3/8–16 UNC THD X 2 3/4" LG. HEX. SOC. HEAD CAP SCREW ASTM A193 GR. B8 CL 1 S STL	4
957	P1000–1170–055	RACO SEAL	1 REF

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASE FOR FABRICATION	10-14-16	SB



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THIS DRAWING IS A DUPLICATE OF LAT573–20–D110–R0 (LAT573)

NOTES:

1. VERIFY BENCH SET TO ~ 10 psig WITH 4 mA INPUT.
2. ADJUST POSITIONER FOR FULL STROKE LENGTH OF 1.098" (REFER TO POSITIONER INSTRUCTION MANUAL FOR DETAILS)

DO NOT SCALE THE DRAWING

L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, if not indicated, according to: ANSI Y 14.5M 1982
Machined Surfaces: 125 UNLESS NOTED
FRACTIONS ± ---
ANGLES ± ---
DECIMALS .XXX ± --- .XX ± ---
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name	NOZZLE ACTUATOR ASSEMBLY				
Material	NOTED			Material – Class	N/A
File Location	V:\LAT574EC\MACHINE DESIGN-CORE			Job Number	LAT574
Scale	NONE		Prev. Dwg. N/A	Originated from	LAT573
Drawn by	TINH	Date 10-13-16	Next Dwg N/A	Dwg/Part No.	LAT574-20-D110
Std. Chk.	LT	Date 10-14-16	Blank Wt. N/A Kg Lbs	Finished Wt. – Kg Lbs	Rev 0
Design Chk.	SB	Date 10-14-16	Approved H. SH.	Date 10-14-16	SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASE	3/6/2017	R.S.
1	AS BUILT	5/12/2017	R.S.

IP Addresses for Allen-Bradley ControlLogix PLC

1756-EN2T Ethernet Module

IP Address: 10.0.0.85
Subnet Mask: 255.255.255.0
Default Gateway:

1756-MCM SLAVE Modbus TCPIP

Device ID: 1
IP Address: 192.168.1.177
Subnet Mask: 255.255.255.0

Panelview+ 1000

IP Address: 10.0.0.75
Subnet Mask: 255.255.255.0
Default Gateway:

Studio5000 Logix Designer:V24.01 PLC

Factory Talk:V8.0 HMI

CUSTOMER	:	UOP RUSSELL LLC
FOR	:	TBD
PROJECT NO.	:	60 MMSCFD CRYO PLANT (J447XX)
LOCATION	:	TBD
P.O. NO,	:	4500743460
ITEM NO.	:	EC-101
SERVICE	:	TURBOEXPANDER/RECOMPRESSOR

AS BUILT

DO NOT SCALE DRAWING

L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355

Tolerances, if not indicated, according to: ANSI Y14.5M 1982

Machined Surface: 125 UNLESS NOTED

DECIMALS: .XXX N/A, .XX N/A

FRACTIONS: ± N/A, ANGLES ±

Units = Inches
BREAK ALL SHARP CORNERS AND DEBURRS .005

Name:	COMBINED MODBUS ADDRESS LIST						
Material:	N/A					Material Class	N/A
File Location:	V:\LAT571EC\ELECTRICAL					Job Number:	LAT574EC
Scale:	N/A		Prev Dwg:	N/A		Originated from:	
Drawn By:	J. Byik	Date: 3/6/17	Next Dwg:	N/A		Dwg/Part No.	Rev
Std. Chk:	J. B.	Date: 3/6/17	Blank Wt.	N/A	Finished Wt. N/A	LAT574EC-20-A542	1
Design Chk:	R.S.	Date: 3/6/17	Approved:	R.S.	Date: 3/6/17	PAGE 1 OF 4	

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RCP PLC Address	Type Holding register	Description	min value	max value	units	register type	Tag
F13[0]	40101	PDIT-501 DIFF BEARINGS THRUST PRESS	-3000/10	3000/10	PSID	Integer	PDIT-501
F13[1]	40102	PIT-102 LUBE OIL PRESS. TO BRGS	0	10000/10	PSID	Integer	PIT-102
F13[2]	40103	PIT-001 LUBE OIL RESERVOIR PRESS.	0	10000/10	PSID	Integer	PIT-001
F5[1]	40104	PT-102 - PT-001 LUBE OIL DIFF PRESS. TO BEARINGS PDI-102	0	10000/10	PSID	Integer	PDI-102
F13[3]	40105	PDIT-201 SEAL GAS SUPPLY DIFF. PRESS.	0	5000/100	PSID	Integer	PDIT-201
F13[4]	40106	VXT-501 EXPANDER SIDE BEARINGS VIBRATION	0	500/100	Mils	Integer	VXT-501
F13[5]	40107	VXT-502 COMPRESSOR SIDE BEARINGS VIBRATION	0	500/100	Mils	Integer	VXT-502
F13[6]	40108	ST-501 SHAFT SPEED	0	6000x10	RPM	Integer	ST-501
F13[7]	40109	FIT-101 COMPRESSOR SUCTION FLOW	0	1000/10	in/wc	Integer	FIT-101
F13[8]	40110	PIT-101 COMPRESSOR SUCTION PRESSURE	0	10000/10	PSIG	Integer	PIT-101
F13[9]	40111	PIT-101F COMPRESSOR DISCHARGE PRESS	0	10000/10	PSIG	Integer	PIT-101F
F13[12]	40112	PIC-101 IGV CONTROL FROM DCS 4-20 Ma	0	1000/10	%	Integer	PIC-101
F13[13]	40113	VIT-101 FAN COOLER VIBRATION	0	100/100	in/sec	Integer	VIT-101
F13[14]	40114	SURGE VALVE OVERRIDE	0	1000/10	%	Integer	
F3[0]	40115	TE-101 L.OIL RESERVOIR TEMP	0	read/10	°F	Integer	TE-101
F3[1]	40116	TE-102 L.OIL SUPPLY TEMP.	0	read/10	°F	Integer	TE-102
F3[2]	40117	TE-103 LUBE OIL DRAIN TEMP.	0	read/10	°F	Integer	TE-103
F3[3]	40118	TE-501 EXPANDER BEARING TEMP	0	read/10	°F	Integer	TE-501
F3[4]	40119	TE-501 COMPRESSOR BEARING TEMP	0	read/10	°F	Integer	TE-501
F3[5]	40120	TE-6 SPACE HEATER CONTROL	-read/10	read/10	°F	Integer	space h
F15[20]	40121	SETPOINT (FLOW) in LB/HR		10350x10	LB/HR	Integer	
F5[0]	40122	PDI-101 DIFF. PRESS. ACROSS COMPRESSOR (PIT-101F)-(PIT-101)	0	1000/10	PSID	Integer	PDI-101
F15[10]	40123	BYPASS VALVE CONTROL	0	1000/10	%	Integer	
F15[8]	40124	IGV CONTROL REGISTER	0	1000/10	%	Integer	

AS BUILT

PLC_Discrete Data Address	Type Holding register	Description	Value		register type	Tag
Local:1:I.Data.0	40191 bit 0	HS-101 EXPANDER START	1 = Start (momentary)		integer	HS-101
Local:1:I.Data.1	40191 bit 1	HS-102 EXPANDER STOP	0= Stop (momentary)			HS-102
Local:1:I.Data.2	40191 bit 2	HS-103 ACKNOWLEDGE/RESET	1 = Reset (momentary)			HS-103
Local:1:I.Data.3	40191 bit 3	HS-104 LAMP TEST	1 = ON (momentary)			HS-104
Local:1:I.Data.4	40191 bit 4	HS-105 AUXILIARY PUMP STOP	0= Stop			HS-105
Local:1:I.Data.5	40191 bit 5	HS-106 PUMP #1 IN AUTO PM-101	0= sw open 1= sw closed			HS-106a
Local:1:I.Data.6	40191 bit 6	HS-106 PUMP #1 IN HAND PM-101	0= sw open 1= sw closed			HS-106h
Local:1:I.Data.7	40191 bit 7	HS-107 PUMP #2 IN AUTO PM-102	0= sw open 1= sw closed			HS-107a
Local:1:I.Data.8	40191 bit 8	HS-107 PUMP #2 IN HAND PM-102	0= sw open 1= sw closed			HS-107h
Local:1:I.Data.9	40191 bit 9	HS-109 AIR FAN COOLER ON/OFF SWITCH	0= sw open 1= sw closed			HS-109
Local:1:I.Data.10	40191 bit 10	VSH-101 AIR FAN COOLER VIBRATION	0= sw open 1= sw closed			VSH-101
Local:1:I.Data.11	40191 bit 11	TSHL-001 LUBE OIL HEATER THERMOSTAT	0= sw open 1= sw closed			TSHL-001
Local:1:I.Data.12	40191 bit 12	LSL-001 L.O. RESERVIOR LEVEL SWITCH	1 = OK; 0 = AL			LSL-001
Local:1:I.Data.13	40191 bit 13	SAH-501 OVERSPEED DESIGN 1 ALARM (ST CONTACT)	1 = OK; 0 = SD			SSH-501
Local:1:I.Data.14	40191 bit 14	SAHH-501 OVERSPEED DESIGN 1 SD	0= sw open 1= sw closed			SSHH-501
Local:1:I.Data.15	40191 bit 15	SPARE				
Local:2:I.Data.0	40192 bit 0	ZSO-101B EXPANDER SDV LIMIT SWITCH	1 = ON; 0 = OFF		integer	ZSO-101B
Local:2:I.Data.1	40192 bit 1	ZSC-101B EXPANDER SDV LIMIT SWITCH	1 = ON; 0 = OFF			ZSC-101B
Local:2:I.Data.2	40192 bit 2	ZSO-101A COMP. SDV LIMIT SWITCH	1 = ON; 0 = OFF			ZSO-101A
Local:2:I.Data.3	40192 bit 3	ZSC-101A COMP. SDV LIMIT SWITCH	1 = ON; 0 = OFF			ZSC-101A
Local:1:I.Data.4	40192 bit 4	LUBE OIL PUMP PM-101 ON/OFF STATUS XA-6	1 = ON; 0 = OFF			
Local:2:I.Data.5	40192 bit 5	LUBE OIL PUMP PM-101 ON/OFF STATUS XA-7	1 = ON; 0 = OFF			
Local:2:I.Data.6	40192 bit 6	REMOTE STOP SHUTDOWN	1=OK, 0=TRIP			
Local:2:I.Data.7	40192 bit 7	REMOTE RESET	MOMENTARY 1=RESET			
Local:2:I.Data.8	40192 bit 8	XA-9 LUBE OIL COOLER ON/OFF STATUS	1 = ON; 0 = OFF			
Local:2:I.Data.9	40192 bit 9	XA-10 LUBE OIL HEATER H-001 ON/OFF STATUS	1 = ON; 0 = OFF			
Local:2:I.Data.10	40192 bit 10	SPARE				
Local:2:I.Data.11	40192 bit 11	SPARE				
Local:2:I.Data.12	40192 bit 12	SPARE				
Local:2:I.Data.13	40192 bit 13	SPARE				
Local:2:I.Data.14	40192 bit 14	Spare				
Local:2:I.Data.15	40192 bit 15	Spare				
Local:3:O.Data.0	40193 bit 0	XL-101 EXPANDER READY LIGHT	1 = Ready		integer	XL-101
Local:3:O.Data.1	40193 bit 1	XL-102 EXPANDER RUNNING LIGHT	1= Running			XL-102
Local:3:O.Data.2	40193 bit 2	XL-103 COMMON TROUBLE ALARM LIGHT	1= Alarm			XL-103
Local:3:O.Data.3	40193 bit 3	XL-104 COMMON TROUBLE SHUTDOWN LIGHT	1 = Shutdown			XL-104
Local:3:O.Data.4	40193 bit 4	XL-105 AUXILIARY PUMP RUNING LIGHT	1=ON			XL-105
Local:3:O.Data.5	40193 bit 5	XA-103 COMMON TROUBLE ALARM RELAY	0 = ALARM			XA-103
Local:3:O.Data.6	40193 bit 6	XA-104 COMMON TROUBLE SHUTDOWN RELAY	0 = SHUTDOWN			XA-104
Local:3:O.Data.7	40193 bit 7	SPACE HEATER CONTROL RELAY	1=ON			CRSH-1
Local:3:O.Data.8	40193 bit 8	EXPANDER INLET TRIP SOV-101B VALVE CONTROL RELAY (CRE)	1=OPEN			SOV-101B (CRE-1)
Local:3:O.Data.9	40193 bit 9	LUBE OIL PUMP PM-101 MOTOR CONTROL RELAY	1=PUMP ON			PM-101 (CRP-1)
Local:3:O.Data.10	40193 bit 10	LUBE OIL PUMP PM-102 MOTOR CONTROL RELAY	1=PUMP ON			PM-102 (CRP-2)
Local:3:O.Data.11	40193 bit 11	FM-101 AIR FAN COOLER MOTOR CONTROL RELAY	1=FAN ON			FM-101 (CRF-1)
Local:3:O.Data.12	40193 bit 12	LUBE OIL LEVEL LOW LS-001 CONTROL RELAY HEATER H-001 CUT OFF	1=ENABLE			LS-001 (CRL-1)
Local:3:O.Data.13	40193 bit 13	COMPRESSOR SUCTION BLOCK VALVE SOV-101A VALVE CONTROL RELAY (CRE)	1=OPEN			SOV-101A (CRE-2)
Local:3:O.Data.14	40193 bit 14	SPARE				
Local:3:O.Data.15	40193 bit 15	SPARE				

AS BUILT

PLC_Discrete Data Address	Type Holding register	Description	Value		register type	Tag
B17[0].0	40194 bit 0	SSH-501 OVERSPEED AL	1 = Alarm	AL Bit	integer	SSH-501
B17[0].1	40194 bit 1	VSH-101 AIR FAN COOLER VIB.	1 = Alarm	AL Bit		VSH-101
B17[0].2	40194 bit 2	LSL-001 LUBE OIL RESERVOIR LEVEL	1 = Alarm	AL Bit		LSL-001
B17[0].3	40194 bit 3	SPARE	1 = Alarm	AL Bit		
B17[0].4	40194 bit 4	PDAL-102 LUBE OIL DIFF PRESS.	1 = Alarm	AL Bit		PDAL-102
B17[0].5	40194 bit 5	SPARE	1 = Alarm	AL Bit		
B17[0].6	40194 bit 6	THRUST PDAH-501 EXP SIDE	1 = Alarm	AL Bit		PDAH-501E
B17[0].7	40194 bit 7	THRUST PDAH-502 COMP SIDE	1 = Alarm	AL Bit		PDAH-502C
B17[0].8	40194 bit 8	PDAL-201 SEAL GAS DIFF. PRESS LOW	1 = Alarm	AL Bit		PDAL-201
B17[0].9	40194 bit 9	SPARE	1 = Alarm	AL Bit		PDAH-24956
B17[0].10	40194 bit 10	SPARE	1 = Alarm	AL Bit		VXAH-24914
B17[0].11	40194 bit 11	SPARE	1 = Alarm	AL Bit		VYAH-24915
B17[0].12	40194 bit 12	VXAH-501 EXP SIDE VIBRATION	1 = Alarm	AL Bit		VXAH-501 E
B17[0].13	40194 bit 13	VXAH-502 COMP SIDE BEARINGS VIBRATION	1 = Alarm	AL Bit		VXAH-502 C
B17[0].14	40194 bit 14	SPARE	1 = Alarm	AL Bit		
B17[0].15	40194 bit 15	SPARE	1 = Alarm	AL Bit		
B17[1].0	40195 bit 0	TAH-102 LUBE OIL TEMP AFTER COOLER	1 = Alarm	AL Bit	integer	TAH-102
B17[1].1	40195 bit 1	TAH-103 LUBE OIL DRAIN TEMP.	1 = Alarm	AL Bit		TAH-103
B17[1].2	40195 bit 2	TAH-501 EXPANDER BEARINGS TEMP.	1 = Alarm	AL Bit		TAH-501
B17[1].3	40195 bit 3	TAH-502 COMPRESSOR BEARINGS TEMP.	1 = Alarm	AL Bit		TAH-502
B17[1].4	40195 bit 4	SPARE	1 = Alarm	AL Bit		
B17[1].5	40195 bit 5	SPARE	1 = Alarm	AL Bit		
B17[1].6	40195 bit 6	SPARE	1 = Alarm	AL Bit		
B17[1].7	40195 bit 7	SPARE	1 = Alarm	AL Bit		
B17[1].8	40195 bit 8	SPARE	1 = Alarm	AL Bit		
B17[1].9	40195 bit 9	SPARE	1 = Alarm	AL Bit		
B17[1].10	40195 bit 10	SPARE	1 = Alarm	AL Bit		
B17[1].11	40195 bit 11	SPARE	1 = Alarm	AL Bit		
B17[1].12	40195 bit 12	SPARE	1 = Alarm	AL Bit		
B17[1].13	40195 bit 13	Spare	1 = Alarm	AL Bit		
B17[1].14	40195 bit 14	Spare	1 = Alarm	AL Bit		
B17[1].15	40195 bit 15	Spare	1 = Alarm	AL Bit		
B12[0].0	40196 bit 0	SSHH-501 OVERSPEED SD	1 = Shutdown	SD Bit	integer	SSHH-501
B12[0].1	40196 bit 1	PDALL-102 LUBE OIL DIFF PRESS. TO BRGS LOW	1 = Shutdown	SD Bit		PDALL-102
B12[0].2	40196 bit 2	XA-102 PROCESS INTERLOCK	1 = Shutdown	SD Bit		XA-102
B12[0].3	40196 bit 3	SPARE	1 = Shutdown	SD Bit		
B12[0].4	40196 bit 4	PDALL-201 SEAL GAS DIFF. PRESS.ACROSS EXP. SEAL	1 = Shutdown	SD Bit		PDALL-201
B12[0].5	40196 bit 5	PDAHH-501E THRUST BEARINGS DIFF PRESS EXP SIDE	1 = Shutdown	SD Bit		PDAHH-501 E
B12[0].6	40196 bit 6	PDAHH-501C THRUST BEARINGS DIFF PRESS COMP SIDE	1 = Shutdown	SD Bit		PDAHH-501 C
B12[0].7	40196 bit 7	VXAHH-501 EXPANDER SIDE VIBRATION	1 = Shutdown	SD Bit		VXAHH-501 E
B12[0].8	40196 bit 8	VXAHH-502 COMP. SIDE VIBRATION	1 = Shutdown	SD Bit		VXAHH-502 C
B12[0].9	40196 bit 9	SPARE	1 = Shutdown	SD Bit		
B12[0].10	40196 bit 10	SPARE	1 = Shutdown	SD Bit		
B12[0].11	40196 bit 11	SPARE	1 = Shutdown	SD Bit		
B12[0].12	40196 bit 12	TAHH-501 EXPANDER BEARING TEMP	1 = Shutdown	SD Bit		TAHH-501
B12[0].13	40196 bit 13	TAHH-502 COMPRESSOR BEARING TEMP	1 = Shutdown	SD Bit		TAHH-502
B12[0].14	40196 bit 14		1 = Shutdown	SD Bit		
B12[0].15	40196 bit 15		1 = Shutdown	SD Bit		

AS BUILT

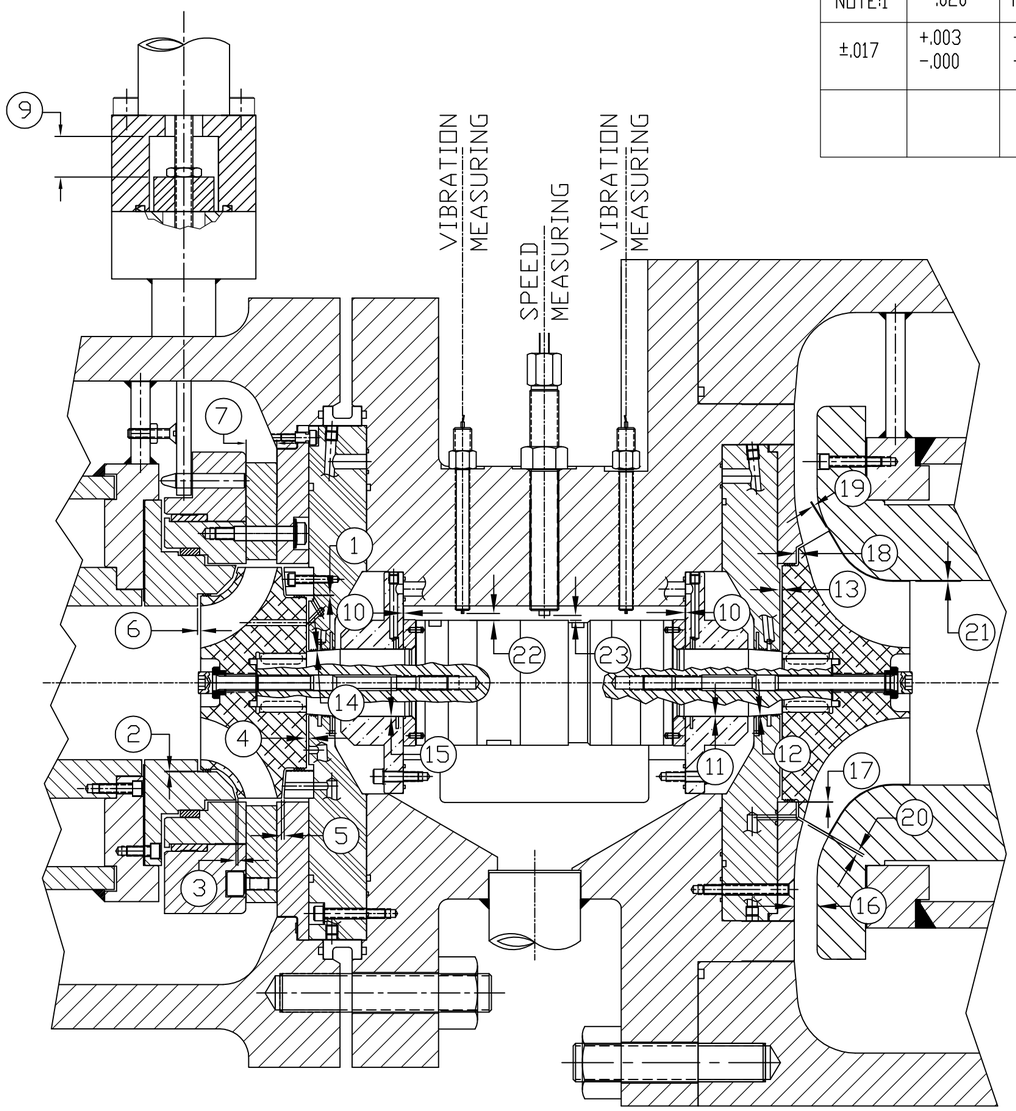
RCP PLC Address	Type Holding register	Description	min value	max value	units	register type	Tag
F13[0]	40201 40202	PDIT-501 DIFF BEARINGS THRUST PRESS	-300	300	PSID	real (floating)	PDIT-501
F13[1]	40203 40204	PIT-102 LUBE OIL PRESS. TO BRGS	0	1000	PSID	real (floating)	PIT-102
F13[2]	40205 40206	PIT-001 LUBE OIL RESERVOIR PRESS.	0	1000	PSID	real (floating)	PIT-001
F5[1]	40207 40208	PT-102 - PT-001 LUBE OIL DIFF PRESS. TO BEARINGS PDI-102	0	500	PSID	real (floating)	PDI-102
F13[3]	40209 40210	PDIT-201 SEAL GAS SUPPLY DIFF. PRESS.	0	50	PSID	real (floating)	PDIT-201
F13[4]	40211 40212	VXT-501 EXPANDER SIDE BEARINGS VIBRATION	0	5	Mils	real (floating)	VXT-501
F13[5]	40213 40214	VXT-502 COMPRESSOR SIDE BEARINGS VIBRATION	0	5	Mils	real (floating)	VXT-502
F13[6]	40215 40216	ST-501 SHAFT SPEED	0	60000	RPM	real (floating)	ST-501
F13[7]	40217 40218	FIT-101 COMPRESSOR SUCTION FLOW	0	100	in/wc	real (floating)	FIT-101
F13[8]	40219 40220	PIT-101 COMPRESSOR SUCTION PRESSURE	0	1000	PSIG	real (floating)	PIT-101
F13[9]	40221 40222	PIT-101F COMPRESSOR DISCHARGE PRESS	0	1000	PSIG	real (floating)	PIT-101F
F13[10]	40223 40224	SAPRE				real (floating)	
F13[11]	40225 40226	SPARE				real (floating)	
F13[12]	40227 40228	PIC-101 IGV CONTROL FROM DCS 4-20 Ma	0	100	%	real (floating)	PIC-101
F13[13]	40229 40230	VIT-101 FAN COOLER VIBRATION	0	1	in/sec	real (floating)	VIT-101
F13[14]	40231 40232	SURGE VALVE OVERRIDE	0	100	%	real (floating)	
F3[0]	40233 40234	TE-101 L.OIL RESERVOIR TEMP	0	200	°F	real (floating)	TE-101
F3[1]	40235 40236	TE-102 L.OIL SUPPLY TEMP.	0	200	°F	real (floating)	TE-102
F3[2]	40237 40238	TE-103 LUBE OIL DRAIN TEMP.	0	200	°F	real (floating)	TE-103
F3[3]	40239 40240	TE-501 EXPANDER BEARING TEMP	0	200	°F	real (floating)	TE-501
F3[4]	40241 40242	TE-501 COMPRESSOR BEARING TEMP	0	200	°F	real (floating)	TE-501
F3[5]	40243 40244	TE-6 SPACE HEATER CONTROL	-200	200	°F	real (floating)	space h
F13[15]	40245 40246	SPARE				real (floating)	
F13[16]	40247 40248	SPARE				real (floating)	
F2[21]	40249 40250	SPARE				real (floating)	
F15[20]	40251 40252	SETPOINT (FLOW) in LB/HR		103509	LB/HR	real (floating)	
F5[0]	40253 40254	PDI-101 DIFF. PRESS. ACROSS COMPRESSOR (PIT-101F)-(PIT-101)	0	100	PSID	real (floating)	PDI-101
F15[10]	40255 40256	BYPASS VALVE CONTROL	0	100	%	real (floating)	
F15[8]	40257 40258	IGV CONTROL REGISTER	0	100	%	real (floating)	
	40259 40260						
	40261 40262						

AS BUILT

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
CLEARANCE	(ø4.300) .002	(ø4.074) .002	.099 NOTE:2	.058 NOTE:1	.057 NOTE:1	.089 NOTE:2	.570 NOTE:5	.532 (OPEN POSITION)	1.098	.005	(ø1.6228) .0011	.0020 NOTE:3	.058 NOTE:2	.0020 NOTE: 3	(ø1.6228) .0011	.531	(ø5.125) .002	.074 NOTE:2	.016 NOTE:1
TOLERANCE	+.001 -.000	+.001 -.000	+.016 -.018	±.006	+.018 -.013	+.016 -.018	+.000 -.001	+.003 -.002	±.005	+.002 -.001	+.0003 -.0000	+.0006 -.0005	±.006	+.0006 -.0005	+.0003 -.0000	+.003 -.002	+.001 -.000	+.018 -.013	+.005 -.000
ACTUAL																			

20	21	22	23		
.075 NOTE:1	(ø4.596) .020	.040 NOTE:4	.017		
±.017	+.003 -.000	+.000 -.003	+.008 -.000		

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
0	RELEASE FOR FABRICATION	10-17-16	SB

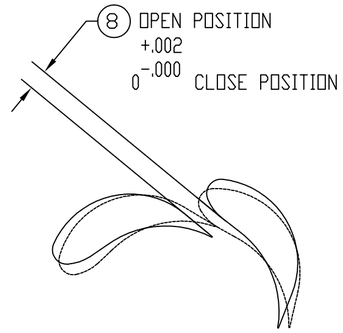


SHIMS ADDED		
LOCATION	MILS	BY/DATE
FIXED RING		
COMP. FOLLOWER		

AFTER MECH. RUN TEST SEAL CLEARANCES					
LOCATION	1	2	12	14	17
CLEARANCE					
CHK'D BY/DATE					

THRUST WASHER REWORK RECORD			
	YES/NO	FINAL THK.	BY/DATE
EXPANDER SIDE			
COMPRESSOR SIDE			

ASSEMBLY NOTES



NOZZLE OPENING & CLOSING

CONTROLLED COPY RELEASED FOR PRODUCTION

THIS DRAWING IS A DUPLICATE OF 7770006207-R0(LAT573)

NOTES:

1. CLEARANCE IS SET INCLUDING THE END PLAY (WHEN ROTOR IS PUSHED ALL THE WAY TO LOAD SIDE)
2. CLEARANCE IS SET INCLUDING THE END PLAY (WHEN ROTOR IS PUSHED ALL THE WAY TO DRIVE SIDE)
3. FOR PHYSICAL MEASUREMENT, AXIAL CLEARANCE RANGE INCLUDING THE END PLAY = .027-.042
4. PROBE READING 7.5-8 V BASED ON 200 MV/MIL
5. MEASUREMENT DOES NOT INCLUDE RELIEF

DO NOT SCALE THE DRAWING

L.A. Turbine Corporation
28557 INDUSTRY DRIVE
VALENCIA, CA 91355

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Tolerances, if not indicated, according to: ANSI Y 14.5M 1982
Machined Surfaces: 125 UNLESS NOTED
DECIMALS .XXX ± XXX, .XX ± XXX
FRACTIONS ± XX
ANGLES ± XX
Units = Inches
BREAK ALL SHARP CORNERS & DEBURR .005R

Name	ASSEMBLY CLEARANCES EXP-COMP (2000 FRAME)		
Material	NOTED	Material - Class	N/A
File Location	V:\LAT574EC\MACHINE DESIGN-CORE	Job Number	LAT574
Scale	NONE	Prev. Dwg.	N/A
		Originated from:	LAT573
Drawn by	TINH	Date	10-17-16
		Next Dwg	N/A
		Dwg/Part No.	7770006270
		Rev	0
Std. Chk.	LT	Date	10-17-16
		Blank Wt.	N/A Kg Lbs
		Finished Wt.	N/A Kg Lbs
Design Chk.	SB	Date	10-17-16
		Approved	HSH
		Date	10-17-16
			SHEET 1 OF 1

SECTION SIX

COMPONENT MANUFACTURER'S DATA

This section contains the names of the vendors who supply the subcomponents not manufactured by L.A. TURBINE. The names have been listed on the following page. For easy reference, the vendors' names and their instruction manuals have been arranged in alphabetical order.

COMPONENT MANUFACTURER'S DATA

(ALPHABETICALLY BY COMPANY NAME)

For the components tag numbers refer to the following documents: System Bill of Materials and Electrical Bill of Materials, Electrical Bill of Materials -Controls

- ABBOTT-INTERFAST
- ACCUMULATOR
- AGCO
- ALLEN-BRADLEY
- AL-TEK
- AMOT
- APOLLO
- ASHCROFT
- AXH
- BENTLY NEVADA
- BONNEY FORGE
- CALORITECH
- CASHCO
- CHROMALOX
- DYNALCO

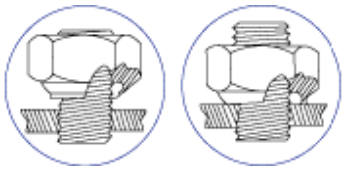
- FISHER
- FULFLO
- GEMS
- INDUFIL
- JACOBY-TARBOX
- KECKLEY
- LEISTRITZ
- MISTER MESH
- PARKER
- PENBERTHY
- PHOENIX CONTACT
- ROSEMOUNT-EMERSON
- SOUTH GATE ENGINEERING
- T.R. ENGINEERING
- THERMO ELECTRIC

Abbott-Interfast

Zero Leakage At Threaded Joints
Seals Liquid Around Threads

At Bearing SurfaceVibration-proof sealing of bolt and nut joints-eliminating washers, surface preparation, packing or other measures. The tough Zytel® nylon sealing insert is mechanically encapsulated within the nut face providing the convenience of a one-piece fastener.

Here's How It Works...
During installation the insert protrusion (1) slips outwardly against the bearing surface. A completed fold effect compresses the insert (2) to seal and lock as metal-to-metal contact is achieved.



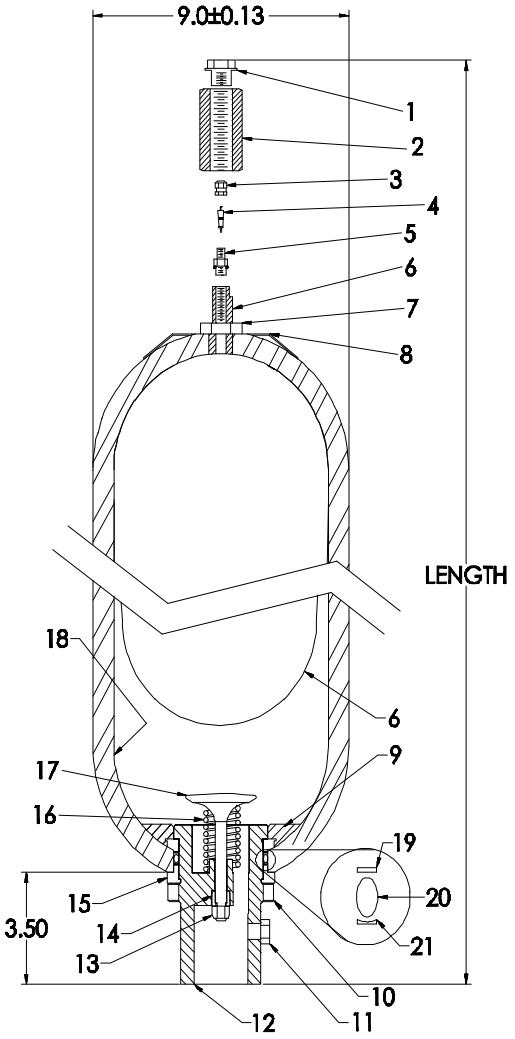
Insert Compression Products:
* 360 sealing pressure around threads and bearing surface.
* Dampens vibrations-maintains preload.

HYDRA-LOK® sealing insert is unexposed and impervious to acids and solvents. When loosened, insert regains its original shape-ready for reinstallation! **HYDRA-LOK**® can be manufactured in special configurations from any commercial metal. All finishes available. Metric or special threads available.

AEROSPACE...HYDRA-LOK® can be made to adhere to Specification Mil-N-85615
Our Technical Advisory Service is at your disposal without obligation, and on request, we will furnish test samples and details of industrial applications already realized.

Accumulators, Inc.®

2.5-15 Gallon 3000 psi
Bottom Repairable Accumulators



List of Component Parts

	Description	Part Number (OS)	Alternate Service[1] WS	SS
1	Safety Cap	AI-S-308		N/A[2]
2	Protective Cap	AI-306	-SS	-4-SS
3	Valve Cap	AI-S-303		
4	Valve Core	AI-S-304		
5	GT Gas Valve	AI-GT3-309		
5	Gas Valve O-Ring	AI-GT3-311		
6	Bladder Kit[3]			
	Buna-Nitrile	AI-X-3KT		-SS
	Butyl	AI-X-3KT-B		-SS
	EPR	AI-X-3KT-E		-SS
	Fluorocarbon	AI-X-3KT-V		-SS
	Hydrin	AI-X-3KT-H		-SS
	Low Temp Buna	AI-X-3KT-L		-SS
7	Hex Jam Nut	AI-S-305	-SS	-SS
8	Name Plate	AI-S-413		
9	Anti-Extrusion Ring			
	Buna-Nitrile	AI-S-407	-WS	-WS
	Butyl	AI-S-407-B	-WS	-WS
	EPR	AI-S-407-E	-WS	-WS
	Fluorocarbon	AI-S-407-V	-WS	-WS
10	Locknut	AI-S-403		-SS
11	Bleed Plug			
	$^1/_4$" NPT	AI-S-418	-SS	-SS
	$^7/_{16}$-20 SAE	AI-S-419	-SS	-SS
12	Oil Port[4]	AI-S3-402	-WS	-SS
13	Stop Nut	AI-S-408	-SS	-SS
14	Piston	AI-S-405	-SS	-SS
15	Spacer	AI-S3-406	-WS	-SS
16	Spring	AI-S-409	-SS	-SS
17	Poppet	AI-S-404	-SS	-SS
18	Shell (3000 psi)	Not For Sale	N/A	N/A
19	Metal Back-Up Ring	AI-S-412	-SS	-SS
20	O-Ring			
	Buna-Nitrile	AI-S-410		
	Butyl	AI-S-410-B		
	EPR	AI-S-410-E		
	Fluorocarbon	AI-S-410-V		
21	Rubber Back-Up Ring	AI-S-411		

Standard Configuration

SA 372 Chrome-moly Steel Shell
2 Piece Replaceable Gas Valve
C-1018 and 4130 or 4140 Components
2" NPT Female Fluid Port
Buna-Nitrile Rubber Components

Optional Configurations (at extra cost)

AN Gas Valve
Electroless Nickel Plating, Internal & External (Special Service)
Resin Coatings, Internal (Water Service)
Stainless Steel Components
Foreign and Domestic Codes
Call Factory for Other Options

Dimensions[5]

Part Number	Length	Weight
A2.53100	21.0"	78 lbs
A53100	33.25"	136 lbs
A103100	54.1"	218 lbs
A113100	59.4"	232 lbs
A153100	76.9"	296 lbs

Oil Port Configurations	
Fluid Port Type	Designation
2" NPT Female	none
$1^1/_4$" NPT Female	-1
Metric Female	-2
$1^7/_8$" SAE Female	-3
2" Code 61 Split Flange	-4
Other	Call
Special Materials	Call

[1] OS-Oil Service, WS-Water Service, SS-Special Service
[2] Special service accumulator uses a solid protective cap.
[3] Insert the size of the accumulator for X. i.e. AI-2.5-3KT for a 2.5 gallon bladder kit. Bladder kits consist of the following parts: 4, 5, 6, 19, 20, and 21.
[4] See Oil Port Configurations for options.
[5] Nominal dimensions. Manufacturing variations will occur.

www.accumulators.com
e-mail: accinc@accumulators.com
9042 Long Point Rd., Houston, TX 77055
(voice) 713-465-0202 (fax) 713-468-1618

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HYDAC INTERNATIONAL
INNOVATIVE FLUID POWER

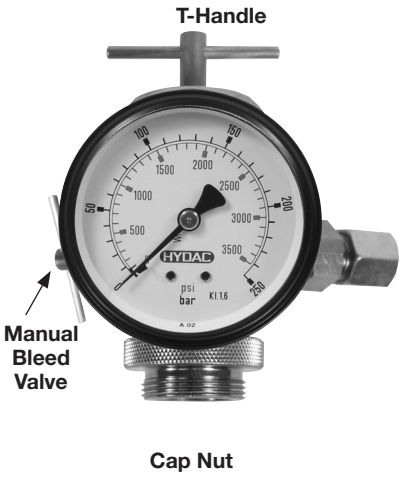
Accumulators

Charging & Gauging Units
FPK / FPS Operating Manual



PN#02068202 • ACU1107-1367 / 09.11

FPS



FPK

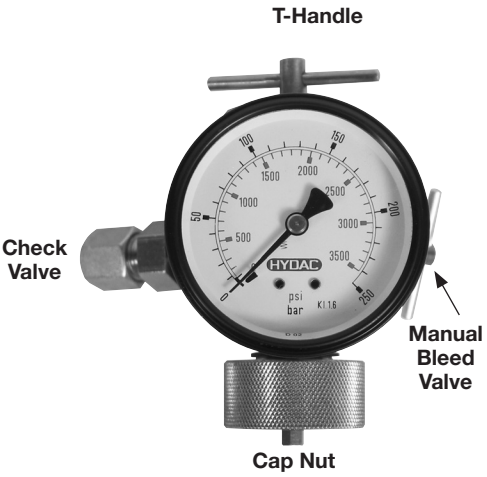
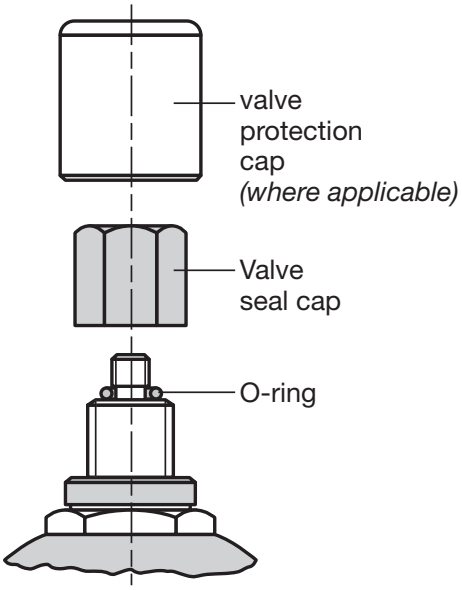


Figure 1

Version 4



Version 1

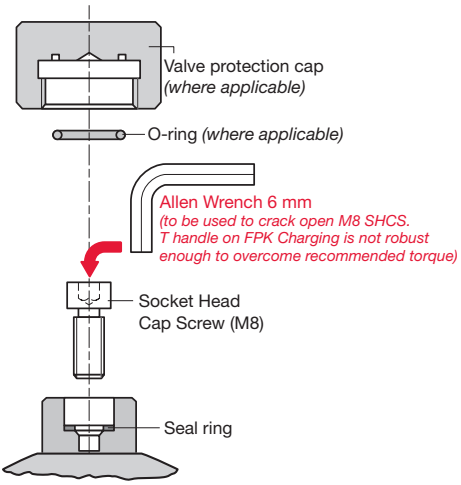


Figure 2

PN#02068202 • ACU1107-1367 / 09.11

General Warning!

Hydraulic accumulators are pressurized vessels and only qualified technicians should perform maintenance. For additional information refer to HYDAC Operating and Installation Instructions and HYDAC Maintenance Instructions. Read all instructions thoroughly before before beginning any type of service or repair.

Tools Required

1. Gas Valve Core Tool.
2. Torque Wrenches.
3. Wrench(es).

Intervals Between Checking Gas Precharge Pressure

The proper gas precharge pressure should be set after each new installation or repair by following the instructions under the Operating and Installation Instructions below. It should be rechecked at least once during the first week of operation. If there is no loss of gas precharge pressure, it should be rechecked again in 3 to 4 months. Thereafter, it should be checked at least once a year. Recharge accumulator when necessary.

Temperature Effect

To ensure that the recommended gas precharge pressure is maintained, even at relatively low of high operating temperatures, the gas precharge pressure should be adjusted for temperature. The formula below relates the precharge temperature (T_0) to the operating temperature (T).

Fahrenheit

$P_{0,T0} = P_{0,T2} \times (T_0 + 460) / (T_2 + 460)$

Celsius

$P_{0,T0} = P_{0,T2} \times (T_0 + 273) / (T_2 + 273)$

T_0 = precharge temperature

T_2 = maximum operating temperature

$P_{0,T0}$ = gas precharge pressure at precharge temperature

$P_{0,T2}$ = gas precharge pressure at maximum operating temperature

Operating and Installation Instruction

Preparation

To check the gas precharge pressure in an accumulator, it must first be isolated from the system shut off, and all hydraulic pressure relieved.

HYDAC gas valve version 4 *(see fig. 2)*
Unscrew the valve protection cap *(where applicable)* and the valve seal cap.

HYDAC gas valve version 1 *(see fig. 2)*
Unscrew the valve protection cap *(where applicable)*. Slightly loosen the socket head cap screw with a 6 mm Allen wrench *(approx. 1/6 turn, see fig. 2)*.

FPS Unit

Prior to connecting the charging and gauging unit to an accumulator, turn T-handle counter-clockwise until resistance is felt. Close manual bleed valve by hand tightening. Connect the unit to the accumulator by screwing cap nut onto HYDAC gas valve version4; hand tighten *(see fig. 1)*.

FPK Unit

Prior to connecting the charging and gauging unit to an accumulator, close manual bleed valve by hand tightening. Connect the unit to the accumulator by screwing cap nut onto HYDAC gas valve version 1; hand tighten *(see fig. 1)*.

FPK Unit *(with adapter FPK/SB)*

Prior to connecting the charging and gauging unit to an accumulator, take adapter FPK/SB and unscrew the socket head cap screw 3 full turns counter clockwise using the 6 mm Allen wrench. This is done to prevent gas valve damage and leakage upon installation. Screw the adapter FPK/SB onto HYDAC gas valve version 4, hand tighten. Close manual bleed valve on the FPK unit hand tight. Connect FPK unit to adapter FPK/SB by screwing cap nut onto the adapter; hand tighten.

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Checking Gas Precharge Pressure

Connect the appropriate charging and gauging unit to the accumulator following the instructions under “Preparation” *(see page 2)*. Note: Temperature affects the gas precharge pressure, please refer to “Temperature Effect” *(see page 2)*.

FPS Unit

Turn T-handle “A” clockwise a maximum of 3 full turns from the full counterclockwise position. The gauge needle should indicate the existing gas precharge pressure. If there is no gas precharge pressure indicated or if it is too low or too high, please follow instructions under the appropriate section, either “Pressure Release” *(see below)* or “Charging” (to right). If desired gas precharge pressure registers, please follow the instructions under “Removal of Charging and Gauging Unit” *(see page 5)*.

FPK Unit

Turn T-handle counter clockwise a maximum of 3 full turns. The gauge needle should indicate the existing gas precharge pressure. If there is no gas precharge pressure indicated or if it is too low or too high, please follow instructions under the appropriate section, either “Pressure Release” *(see page 3)* or “Charging” *(see page 3)*. If desired gas precharge pressure registers, please follow the instructions under “Removal of Charging and Gauging Unit” *(see page 4)*.

Pressure Release

With the appropriate charging and gauging unit attached as previously described, gas precharge pressure can be released by carefully opening manual bleed valve. Release the gas precharge pressure very slowly until the desired gas precharge pressure is reached (this insures that the gas temperature does not fluctuate greatly, providing and accurate gas precharge pressure). Close the manual bleed valve. Allow the gas precharge pressure to stabilize. *(5 to 10 minutes)* recheck, adjust if required. Once the desired gas precharge pressure is reached, please follow the instructions under “Removal of Charging and Gauging Unit” *(see page 5)*.

Charging

Warning!

Never use oxygen or air - this could cause an explosion! Use dry nitrogen or other recommended gases.

HYDAC recommends the use of a pressure regulator on the commercially available nitrogen bottle to regulate pressure to the charging and gauging unit.

Note: Full nitrogen pressure may damage the gauge. Connect the charging hose to a commercially available nitrogen bottle by means of the G4 adapter *(other adapters are available, check with factory for type)*; the adapter connects to the cap screw “G1”. Connect cap nut of the charging hose to check valve of the charging and gauging unit *(see fig. 1)*. Connect the appropriate charging and gauging unit to the accumulator by following the instructions previously described *(see page 2)*.

Initial Charging

When charging an accumulator that has no initial gas precharge, allow 20 to 30 minutes for the gas temperature and thus pressure to stabilize. Recheck the gas precharge pressure and adjust if necessary.

FPS Unit

Turn T-handle clockwise 3 full turns.
Proceed to “Filling”.

FPK Unit

Turn T-handle counter clockwise 3 full turns.
Proceed to “Filling”.

FPK Unit *(with adapter FPK/SB)*

Turn T-handle clockwise 3 full turns.
Proceed to “Filling”.

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Pressure Increase

When charging an accumulator that has an existing gas precharge, allow 5 to 10 minutes for the gas temperature and thus pressure to stabilize.

FPS Unit
Turn T-handle clockwise until the gauge needle begins to deflect, then turn it another full turn. Proceed to “Filling”.

FPK Unit
Turn T-handle counter clockwise until the gauge needle begins to deflect, then turn it another full turn. Proceed to “Filling”.

FPK Unit *(with adapter FPK/SB)*
Turn T-handle clockwise until the gauge needle begins to deflect, then turn it another full turn. Proceed to “Filling”.

Filling

Open the shut-off valve on the commercially available nitrogen bottle and slowly fill the accumulator with dry nitrogen gas.

Precharge very slowly until the pressure in the accumulator reaches 100 psi. Once 100 psi is reached, the charging rate can increase. Charging too quickly may damage the accumulator.

Note: The gauge registers the line pressure, not necessarily the accumulator pressure while charging.

After allowing the appropriate time for the gas temperature and thus pressure to stabilize, adjust the gas precharge pressure as required, refer to “Pressure Increase” *(see page 4)* or “Pressure Release” *(see page 3)*.

Once the desired gas precharge pressure is reached close the shutoff valve on the commercially available nitrogen bottle. Remove the charging and gauging unit from the gas valve as described under “Removal of Charging and Gauging Unit” *(see page 5)*.

Removal of Charging and Gauging Unit

Close the shut-off valve on the commercially available nitrogen bottle before removing the charging and gauging unit.

FPS Unit
Turn T-handle counter clockwise until resistance is felt to close the gas valve. Open manual bleed valve to relieve pressure in the charging and gauging unit. Proceed to “Disconnecting”.

FPK Unit
Turn T-handle clockwise until resistance is felt to close the socket head cap screw, hand tighten. Open manual bleed valve to relieve pressure in the charging and gauging unit. Proceed to “Disconnecting”.

FPK Unit *(with adapter FPK/SB)*
Turn T-handle counter clockwise until resistance is felt to close the gas valve. Open manual bleed valve to relieve pressure in the charging and gauging unit. Proceed to “Disconnecting”.

Disconnection

Unscrew the charging and gauging unit from the gas valve. Note: For FPK unit with adapter FPK/SB it may be necessary to loosen the connection between cap nut and the adapter to remove the charging and gauging unit. Check for leaks. None are permissible.

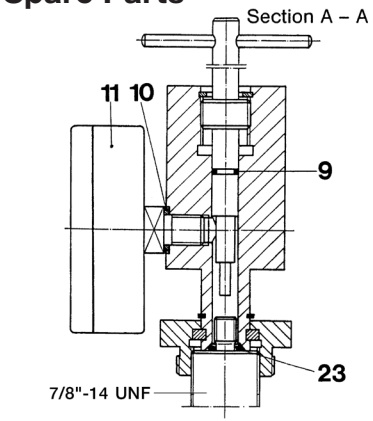
Completion

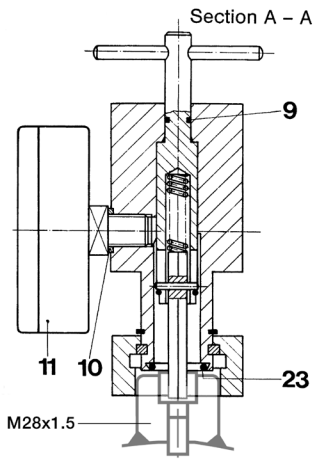
HYDAC gas valve version 1 *(see fig. 1)*
Tighten socket head screw cap to 20 Nm (15 lb-ft), and screw on valve protection cap *(where applicable)*; hand tighten.

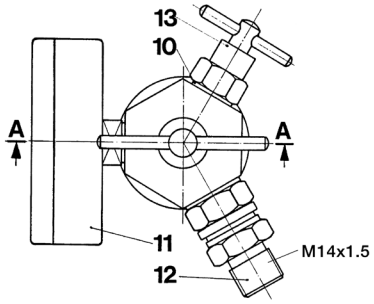
HYDAC gas valve version 4 *(see fig. 1)*
Screw on valve seal cap torquing to 30 Nm (22 lb-ft), and valve protection cap *(where applicable)*; hand tighten.

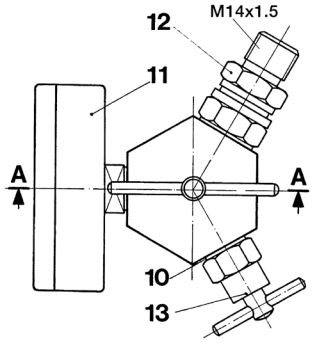
PN#02068202 • ACU1107-1367 / 09.11

Spare Parts







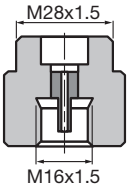


Item	Description	Part No.
9	O-Ring	00601032
10	Seal-Ring	00601228
11	Gauge *(select pressure range below)*	
	10 (0 to 145 psi)	00606759
	25 (0 to 350 psi)	00606760
	100 (0 to 1400 psi)	00606761
	250 (0 to 3500 psi)	00606762
	400 (0 to 5800 psi)	00606763
12	Check Valve	00610004
13	Manual Bleed Valve	00236445
23	O-Ring - FPS	00626488
	O-Ring - FPK	00601049
-	2.5m Hose	00236514
-	4m Hose	00236515
-	10m Hose	00373405
-	ADAPTER G4	02068737
-	ADAPTER A3 (FPK/SB)	00291533
-	O-Ring - ADAPTER A3 (FPK/SB)	00601964

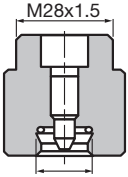
PN#02068202 • ACU1107-1367 / 09.11

A Adapters *(Gauge to Accumulator)*

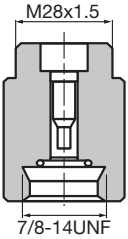
A1
PN 00361619



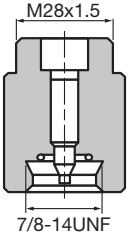
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PN 00361605



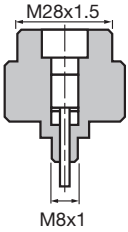
A3 (ADAPTER FPK/SB)
PN 00291533



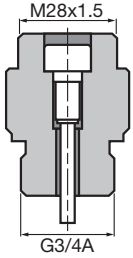
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PN 00291536



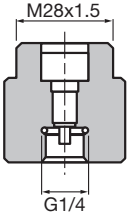
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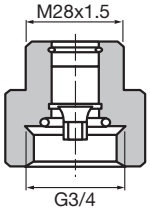
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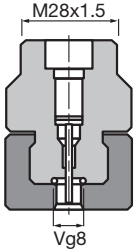
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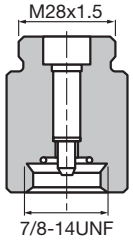
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PN 02124524



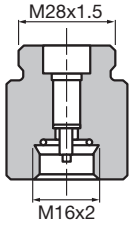
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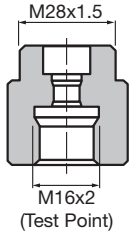
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PN 03018210



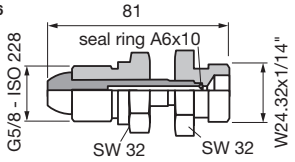
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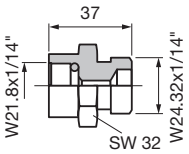
PN#02068202 • ACU1107-1367 / 09.11

G Adapters *(Charging to Accumulator)*

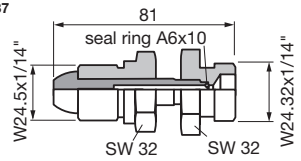
G2
PN 00236376
Australia
Argentina
Great Britain
Vietnam
Others



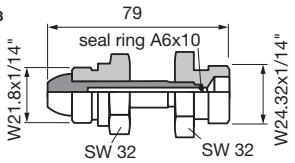
G3
PN 02103421
Egypt
Lebanon
Israel
Others



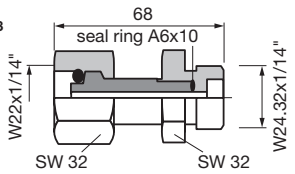
G4
PN 02068737
USA
Canada
Puerto Rico



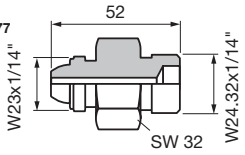
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PN 00236373
Italy



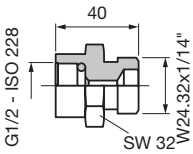
G6
PN 02103423
Japan



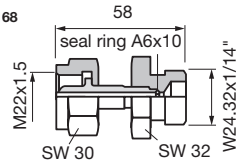
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Korea



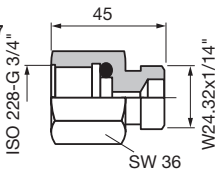
G8
PN 02103425
Brazil
Chile
Columbia
Others



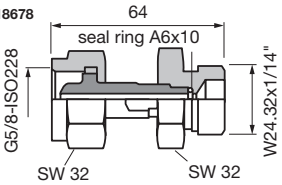
G9
PN 00241168
Taiwan



G10
PN 02103427
Russia
Trinidad
Tobago
Venezeula

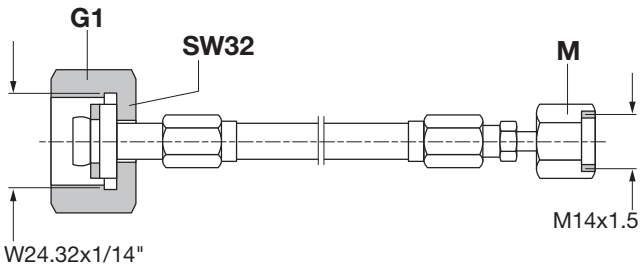


G11
PN 03018678
China



Charging Hoses

Germany
Poland
Others



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FPK & FPS Series
Charging & Gauging Units



Description

To maintain system performance HYDAC recommends that the gas precharge pressure is checked regularly. The inevitable loss of gas precharge pressure due to permeability will change the system effectiveness (performance) and could cause damage to the bladder, diaphragm, or piston accumulator.

HYDAC charging and gauging units allow hydro-pneumatic accumulators to be precharged with dry nitrogen. For these purposes, a charging and gauging unit is connected to a commercially available nitrogen bottle via a flexible charging hose.

These units also allow maintenance personnel to check the current gas precharge pressure of an accumulator. For critical systems, consider the use of a permanent gauging block *(see page 82)* which will provide for continuous monitoring.

All HYDAC charging and gauging units incorporate a gauge and check valve in the charging connection, and a manual bleed valve with a T-handle.

HYDAC offers two types of charging and gauging units:

- FPK for use with HYDAC version 1 gas valve
- FPS for use with HYDAC version 4 gas valve

Model Code

Note: For Oil, Gas & Marine specific charging & gauging units please refer to page 67

FPS 250 F 2.5 - G4 - K

Series
- FPK = for use with Gas Valve Version 1 (M28 x 1.5) for SBO and SK
- FPS = for use with Gas Valve Version 4 (8VI-ISO 4570) for SB, SBO and SK

NOTE: SB Top repairable bladder accumulators must use FPK with Adapter A3 (FPK/SB), PN 291533

Gauge Pressure Range

10	=	0 to 145 psi	(0 to 10 bar)
25	=	0 to 350 psi	(0 to 25 bar)
100	=	0 to 1400 psi	(0 to 100 bar)
250	=	0 to 3500 psi	(0 to 250 bar)
400	=	0 to 5800 psi	(0 to 400 bar)

Charging Hose
- F = with cap screw G1 (thread W24, 32x1/14 - DIN477)

Charging Hose Length
- 2.5 = 8 ft. (2.5 m)
- 4.0 = 13 ft. (4 m)

Adapter
- G4 = USA *(only for CGA 580 gas bottle connections)*
- G4.1 = USA *(only for CGA 680 gas bottle connections)*
  only available with 400 bar Guage and adapter integrated onto 4m high pressure hose
- G1 = Germany *(integral part of charging hose)*
- G2 = Great Britain, India
- G3 = France, Mexico
- G5 = Italy
- G6 = Japan
- G7 = South Korea
- G8 = Brazil, Columbia, Peru
- G9 = Taiwan
- G10 = Russia, Venezula
- G11 = China
- G12 = Australia

Case
- K = plastic carrying case *(standard)*

Additional Accessories:

ADAPTER A3 (FPK/SB) = adapter for using FPK Charging Unit to fit HYDAC gas valve version 4, including top repairable bladder accumulators
NOTE: for other adapters please consult factory.
6mm Allen Wrench *(for HYDAC Gas Valve Version 1, included with FPK Kits)*
14mm Open End Wrench *(for HYDAC gauge, optional)*

Operating and Installation Instructions are included with each charging kit.
This is also available for download in PDF format on our web site: **www.hydacusa.com**

For spare parts see page 77.

PN#02068195 / 04.13 / ACU1102-1326

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Model FPS

For use with gas valve version 4.
(Except for top repairable bladder accumulators)



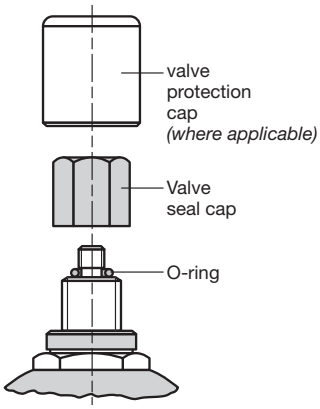
Model FPK

For use with gas valve version 1.



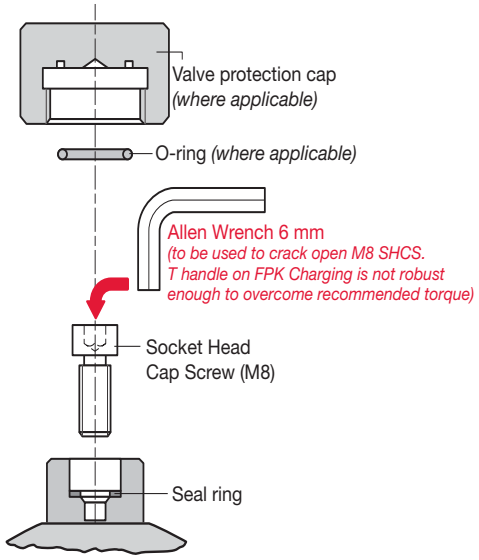
Gas Valve Version 4

On a Bottom Repairable Bladder Accumulator as well as Diaphragm Accumulators with E4 gas valve and piston accumulators with VE Gas Valve.



Gas Valve Version 1

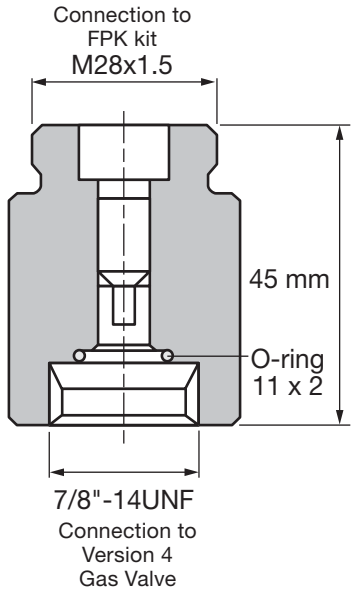
Metric, M28 x 1.5
Used on Diaphragm Accumulators w/ E1 gas valves and Piston Accumulators w/ VA or VB gas valves

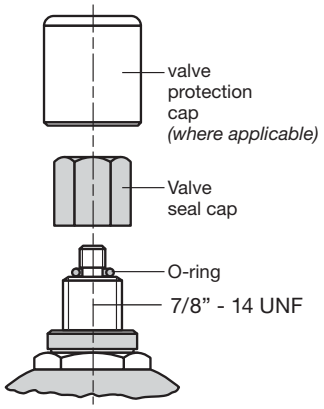


Adapter A3 (FPK/SB)

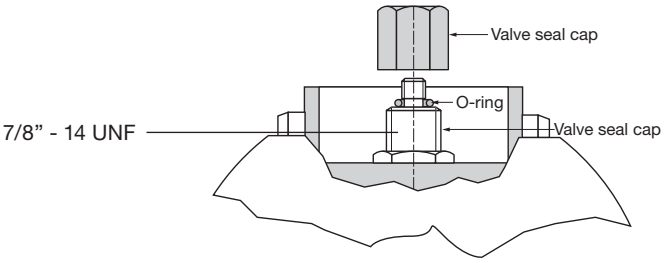
Part No. 291533

The A3 (FPK/SB) adapter can be used with the FPK to connect to any HYDAC version 4 gas valve for both bottom and top repairable bladder accumulators. The A3 adapter also serves as the required spacer for top repairable bladder accumulators.





Bottom Repairable



Top Repairable

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FPO Series
Charging and Gauging Units



Description

To maintain system performance HYDAC recommends that the gas precharge pressure is checked regularly. The inevitable loss of gas precharge pressure due to permeability will change the system effectiveness (performance) and could cause damage to the bladder, diaphragm, or piston accumulator.

HYDAC charging and gauging units allow hydro-pneumatic accumulators to be precharged with dry nitrogen. For these purposes, a charging and gauging unit is connected to a commercially available nitrogen bottle via a flexible charging hose.

These units also allow maintenance personnel to check the current gas precharge pressure of an accumulator. For critical systems, consider the use of a permanent gauging block *(see page 82)* which will provide for continuous monitoring.

All HYDAC charging and gauging units incorporate a gauge and check valve in the charging connection, and a manual bleed valve with a T-handle.

This charging kit is used for oil & gas / offshore type accumulators having the repairable 2 piece gas valve (denoted by "11" in the gas port segment in the accumulator model code.

Model Code

FPO 210 F 3 - K

Charging and Gauging Unit
FPO = for use with Gas Valve Version 4 (8VI-ISO 4570) for SB, SBO and SK

Gauge Pressure Range
210 = 0 to 3000 psi (0 to 210 bar)

Charging Hose
F = with nitrogen bottle connection CGA-580

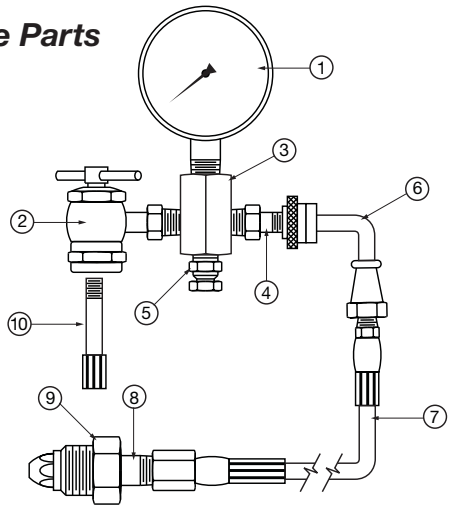
Charging Hose Length
3.0 = 10 ft. (3 m)

Case
K = plastic carrying case *(standard)*

Additional Accessories:
Gas Valve Extension Rod - to be used with top repairable accumulators

Operating and Installation Instructions are included with each charging kit.
This is also available for download in PDF format on our web site: **www.hydacusa.com**

Spare Parts



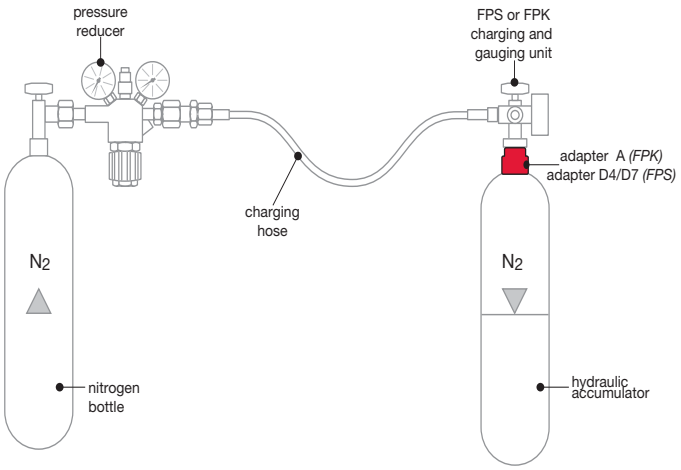
Part Description	Item	Quantity	Part No.
FPO 210 Replacement Kit consists of:			2083385
Pressure Gauge, 3000 PSI	1	1	2701622
T-Handle Lock Chuck	2	1	2701615
Charging Manifold, FPO	3	1	*consult factory*
Tank Valve	4	1	2701617
Bleeder Valve	5	1	*consult factory*
Charging Manifold / Bleeder Valve Assembly	3 / 5		2089952
Hose Assembly FPO 210 (CGA 580) consists of:			2086622
High Pressure Coupling (swivel) 1/8" NPT	6	1	2701590
Hose, FPO 3000 PSI, 3m	7	1	2701621
Nipple Gland, CGA-580	8	1	2701620
Nut, CGA-580	9	1	2701619
Top Repairable Gas Valve Extension	10	1	2701741

PN#02068195 / 04.13 / ACU1102-1326

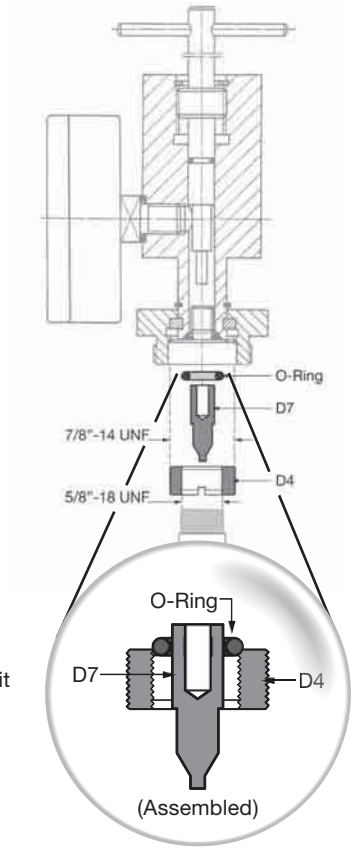
Courtesy of CMA/Flodyne/Hydradyne ▪ Motion Control ▪ Hydraulic ▪ Pneumatic ▪ Electrical ▪ Mechanical ▪ (800) 426-5480 ▪ www.cmafh.com

Adapters

Connecting Charging & Gauging Units to 3000 psi Accumulators



FPS Unit with Adapter D4/D7

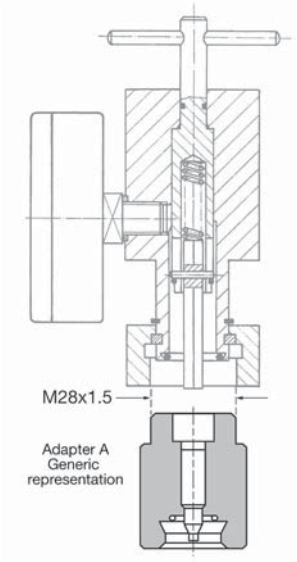


Adapter D4/D7

Part Number 02067646

Used with FPS Charging & Gauging Unit

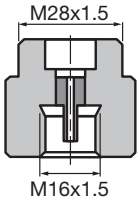
FPK Unit with Adapter A*



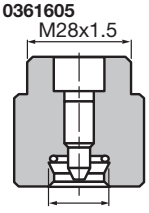
*A Adapters

Used with FPK Charging & Gauging Unit

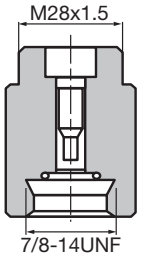
A1
PN 00361619



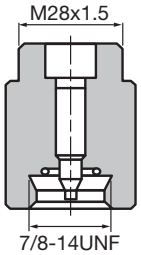
A2
PN 0361605



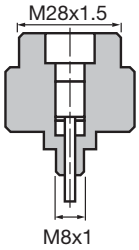
A3 (ADAPTER FPK/SB)
PN 00291533



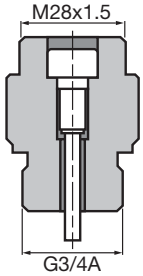
A4
PN 00291536



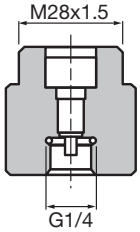
A5
PN 00291531



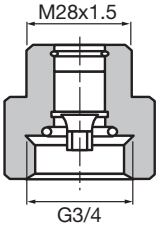
A6
PN 02108819



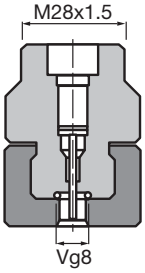
A7
PN 02110629



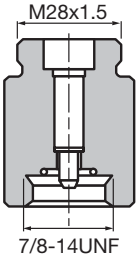
A8
PN 02124524



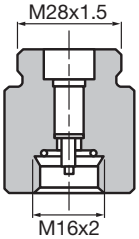
A9
PN 02128638



A10
PN 02128849



A11
PN 03018210

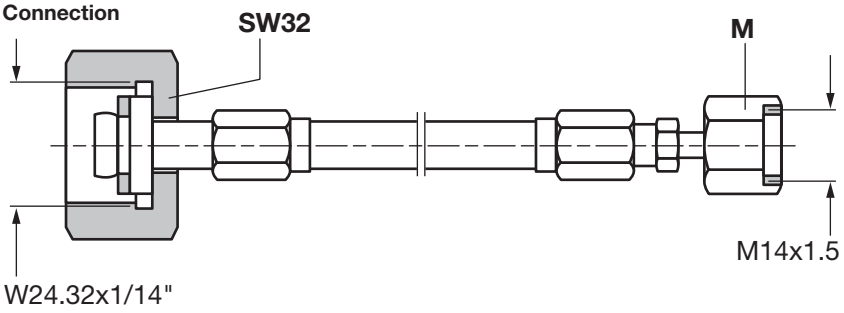


Courtesy of CMA/Flodyne/Hydradyne ▪ Motion Control ▪ Hydraulic ▪ Pneumatic ▪ Electrical ▪ Mechanical ▪ (800) 426-5480 ▪ www.cmafh.com

G Adapters - Connects Charging Hose to Gas Bottle

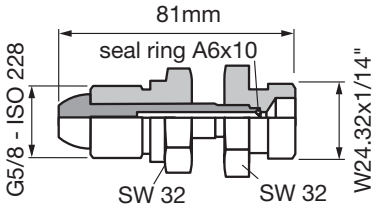
G2 through G11 to be used to adapt from G1 connection on 3000psi hose to N_2 Bottle or regulator

G1
PN Hose Connection

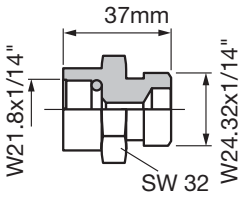


**Included in all charging kits

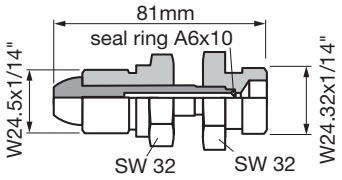
G2
PN 00236376



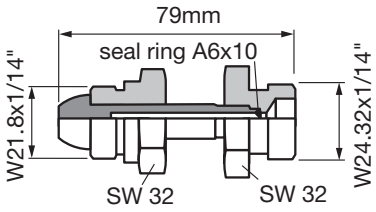
G3
PN 02103421



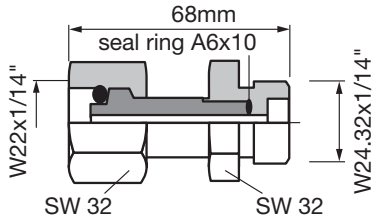
G4
PN 02068737



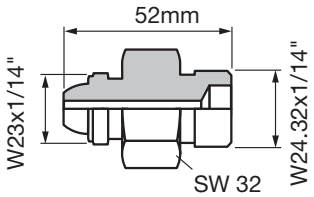
G5
PN 00236373



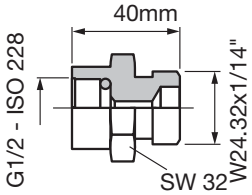
G6
PN 02103423



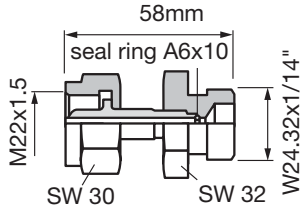
G7
PN 00236377



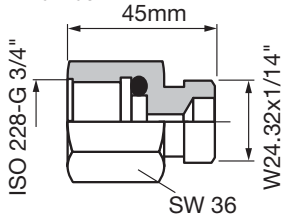
G8
PN 02103425



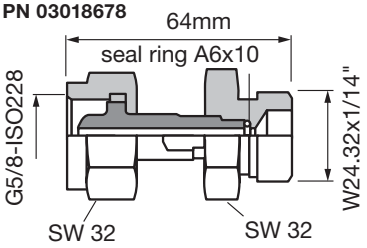
G9
PN 00241168



G10
PN 02103427



G11
PN 03018678

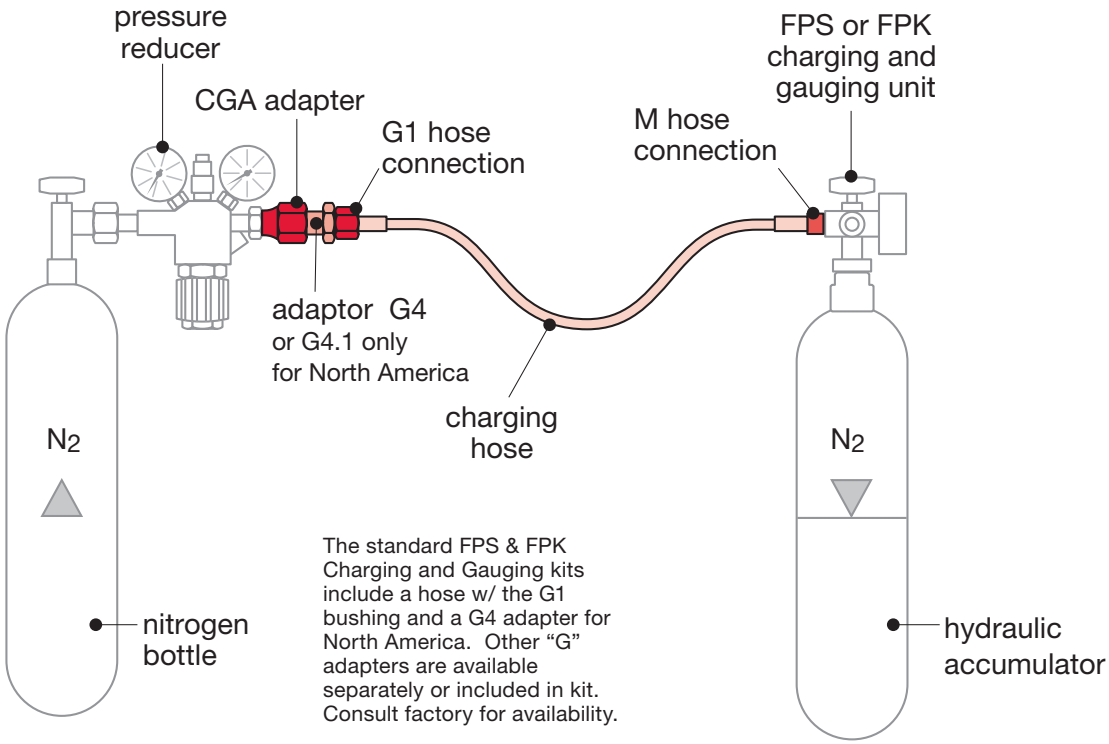


G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11
Germany Poland Others	India Argentina Great Britain Vietnam Indonesia Others	France Egypt Mexico Israel Others	Canada USA	Italy	Japan	Korea	Brazil Peru Columbia Others	Taiwan	Russia Trinidad & Tobago Venezuela	China

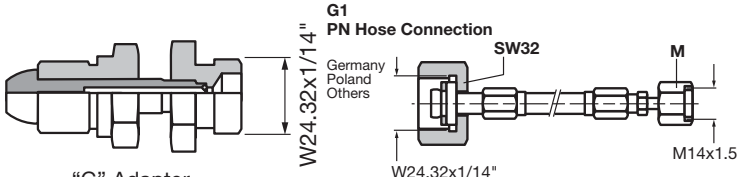
PN#02068195 / 04.13 / ACU1102-1326

Courtesy of CMA/Flodyne/Hydradyne ▪ Motion Control ▪ Hydraulic ▪ Pneumatic ▪ Electrical ▪ Mechanical ▪ (800) 426-5480 ▪ www.cmafh.com

Connecting Charging Hose to Gas Bottle



The standard FPS & FPK Charging and Gauging kits include a hose w/ the G1 bushing and a G4 adapter for North America. Other "G" adapters are available separately or included in kit. Consult factory for availability.



"G" Adapter
(see page 75)

3000 psi Hose Assembly

Charging Hoses

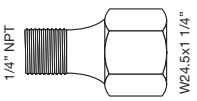
WP	Length	Part No.
3000 psi	2.5 m	236514
	4.0 m	236515
	10.0 m	373405
	15.0 m	2115552
	20.0 m	2109765
	28.0 m	2109574

WP	Length	Part No.
5000 psi	2.5 m	3053703
	4.0 m	3053704
	10.0 m	3117720

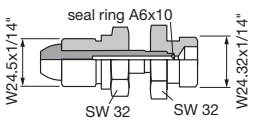
CGA 580 Adapter *(for USA only)*

PN 02701355

From G4 Adapter to Regulator



CGA 580 Adapter

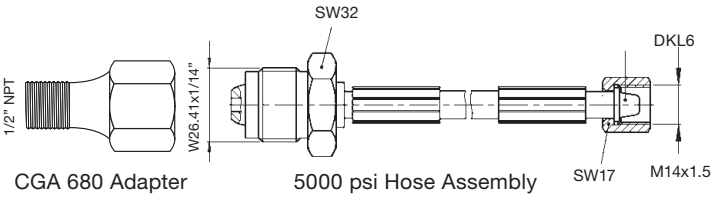


"G4" Adapter

CGA 680 Adapter *(for USA only)*

PN 02701356

From G4.1 Adapter to Regulator



CGA 680 Adapter

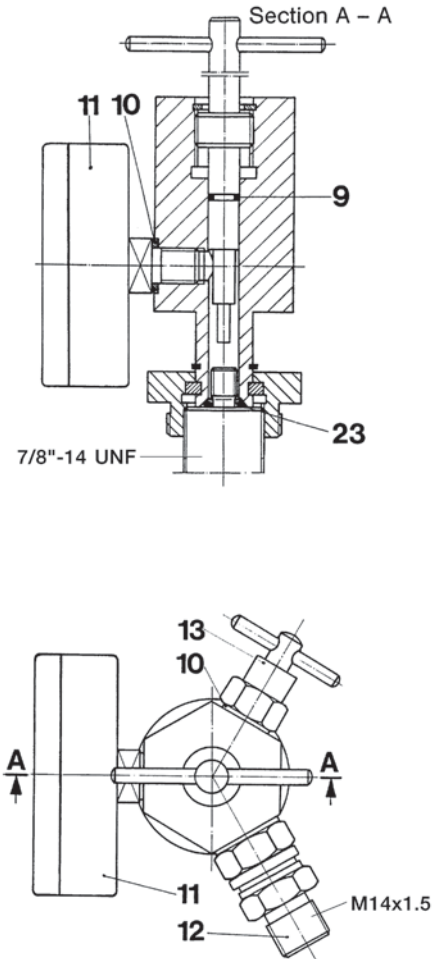
5000 psi Hose Assembly

Courtesy of CMA/Flodyne/Hydradyne ▪ Motion Control ▪ Hydraulic ▪ Pneumatic ▪ Electrical ▪ Mechanical ▪ (800) 426-5480 ▪ www.cmafh.com

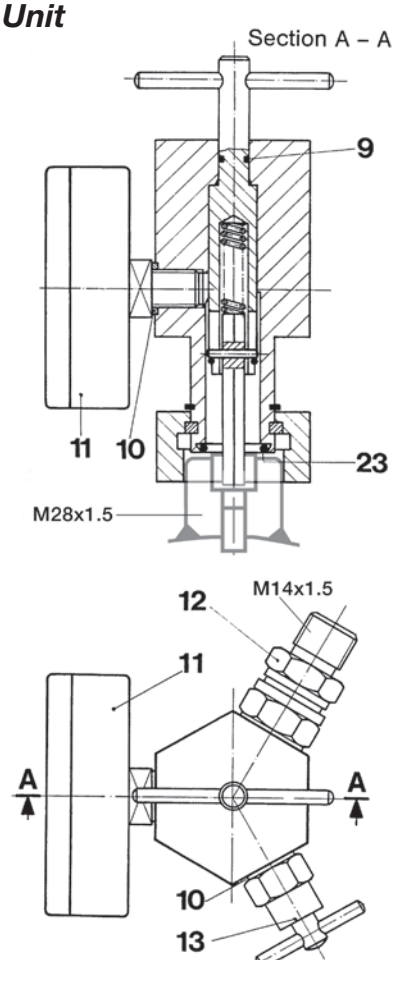
Charging & Gauging Units

Spare Parts

FPS Unit



FPK Unit



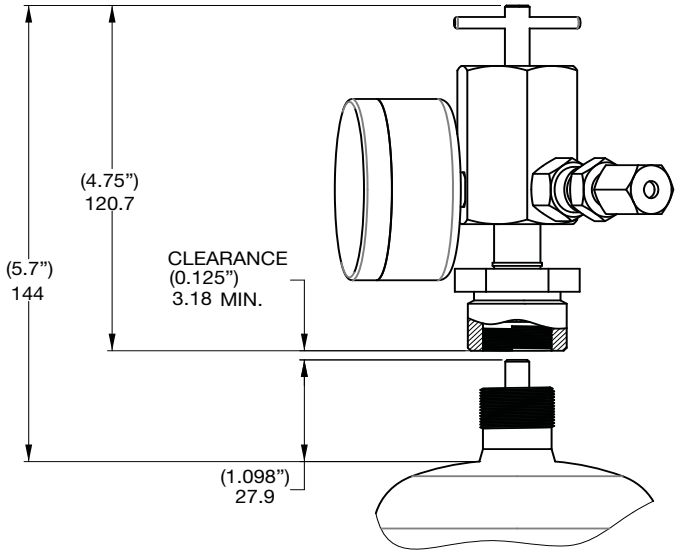
Item	Description	Part No.
9	O-Ring	601032
10	Seal-Ring	601228
11	Gauge *(select pressure range below)*	
	10 (0 to 145 psi)	606759
	25 (0 to 350 psi)	606760
	100 (0 to 1400 psi)	606761
	250 (0 to 3600 psi)	606762
	400 (0 to 5800 psi)	606763
12	Check Valve	610004
13	Manual Bleed Valve	236445
23	O-Ring - FPS	626488
	O-Ring - FPK	601049
-	2.5m Hose	236514
-	4m Hose	236515
-	10m Hose	373405
-	ADAPTER G4	2068737
-	ADAPTER A3 (FPK/SB)	291533
-	O-Ring - ADAPTER A3 (FPK/SB)	601964

WARNING: Only qualified persons should perform maintenance on any type of accumulator. Complete maintenance instructions are available - Contact HYDAC.

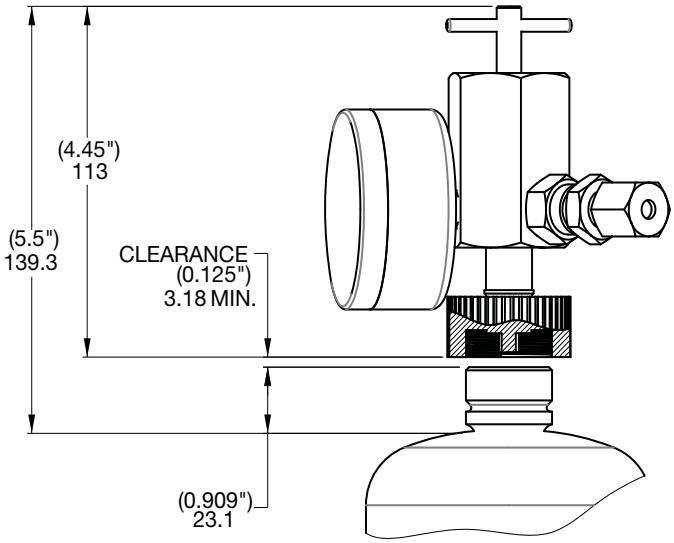
Courtesy of CMA/Flodyne/Hydradyne ▪ Motion Control ▪ Hydraulic ▪ Pneumatic ▪ Electrical ▪ Mechanical ▪ (800) 426-5480 ▪ www.cmafh.com

Minimum Clearances for Charging & Gauging Kits

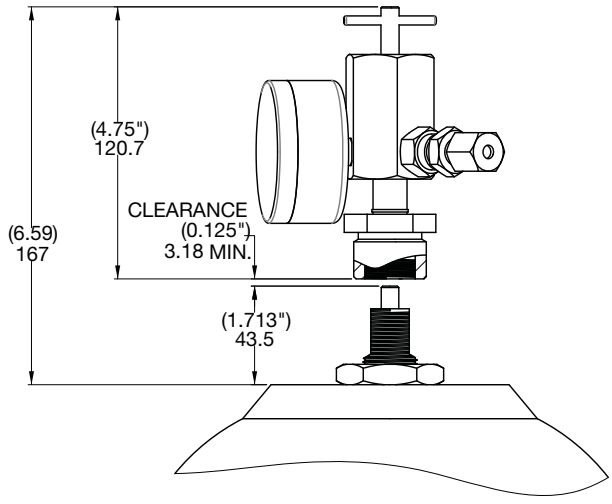
Diaphragm (SBO) and Bladder (SB) Accumulators



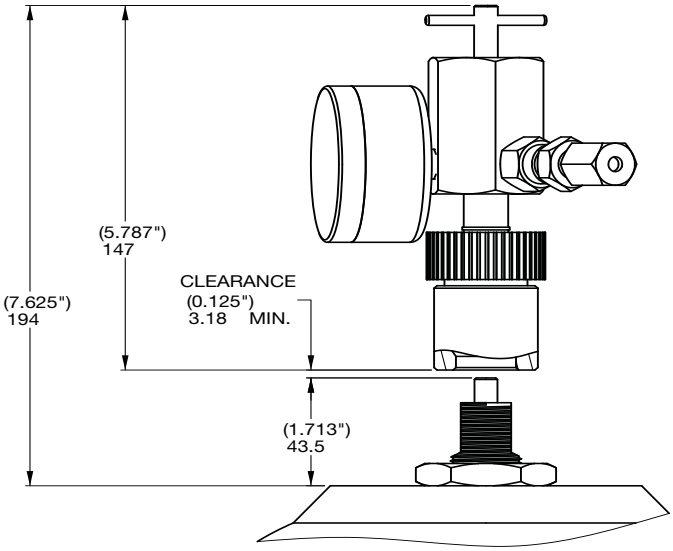
Diaphragm (SBO), Version 4 Gas Valve (8VI-ISO 4570) FPS Charging & Gauging Kit



Diaphragm (SBO), Version 1 Gas Valve (M28 x 1.5) FPS Charging & Gauging Kit



Bladder (SB), Version 4 Gas Valve (8VI-ISO 4570) FPS Charging & Gauging Kit

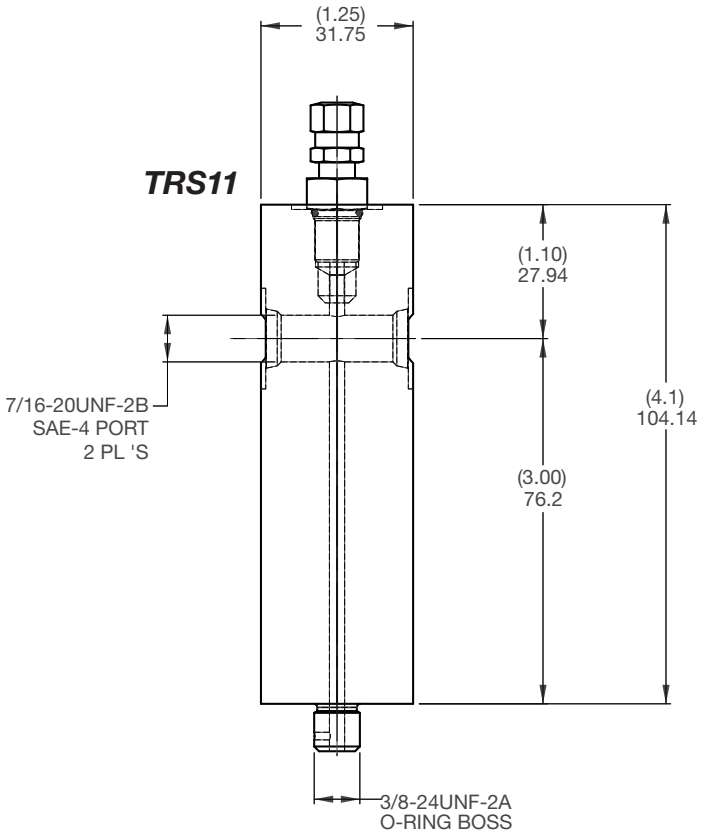


Bladder (SB), Version 4 Gas Valve (8VI-ISO 4570) FPK Charging & Gauging Kit with A3 Adapter

Courtesy of CMA/Flodyne/Hydradyne • Motion Control • Hydraulic • Pneumatic • Electrical • Mechanical • (800) 426-5480 • www.cmafh.com

Permanent Gauging Block





Description

The HYDAC Permanent Gauging Block allows constant monitoring of gas pressure while a system is in operation. This helps users monitor pressure loss, and determine when charging is needed. They are designed to fit bladder, diaphragm, and piston style accumulators with HYDAC Gas Valve Version 4. Use of these blocks facilitates trouble shooting and simplifies maintenance by eliminating the need to attach a charging and gauging unit to monitor pressure. Charging of the accumulator is accomplished by simply attaching a HYDAC charging kit to the gas valve on top of the Permanent Gauging Block in exactly the same manner as attaching to an accumulator without the Permanent Gauging Block.

Special Tools Required

- Charging and Gauging Unit
- Gas Valve Core Tool
- 50 mm Open End Wrench (for bottom repairable accumulator)
- 32 mm Open End Wrench (for top repairable accumulator)
- Torque Wrench(es)

Note: The gas valve core (for Version 4) or the M8 SHCS (for Version 1) gas valves must be removed to allow unrestricted gas flow from the accumulator into the Permanent Gauge Block. Read all instructions thoroughly before beginning any type of service or repair work Refer to additional information contained in the “Operating and Installation Instructions for HYDAC Accumulators.”

Model Code

PERM GAUGING BLOCK VER4 __ 850

Series
Perm Gauging Block

Gas Valve Type
VER1 = HYDAC gas valve version 1 (M28x1.5)
VER4 = HYDAC gas valve version 4 (7/8”-14UNF)

Accumulator Type
(omit) = Bottom Repairable *(standard)*
TR = Top Repairable
TR S11 = Top Repairable *(Oil & Gas / Offshore)*

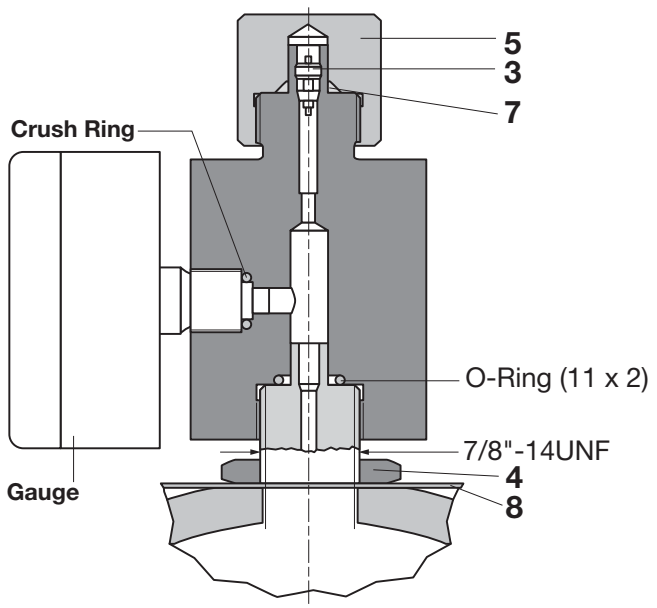
Gauge Pressure Range
850 = 0 to 850 psi
1450 = 0 to 1450 psi
2300 = 0 to 2300 psi
3600 = 0 to 3600 psi
5800 = 0 to 5800 psi

PN#02068195 / 04.13 / ACU1102-1326

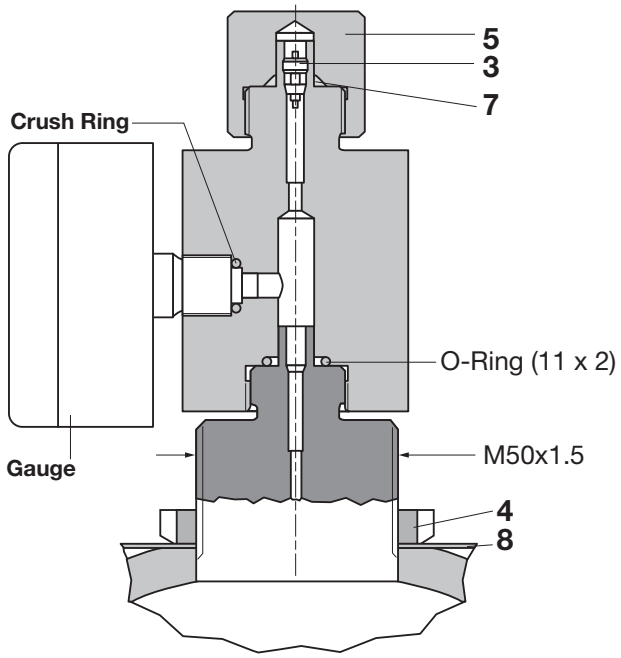
Courtesy of CMA/Flodyne/Hydradyne ▪ Motion Control ▪ Hydraulic ▪ Pneumatic ▪ Electrical ▪ Mechanical ▪ (800) 426-5480 ▪ www.cmafh.com

Installation Drawings
Permanent Gauging Blocks for HYDAC Gas Valve Version 4

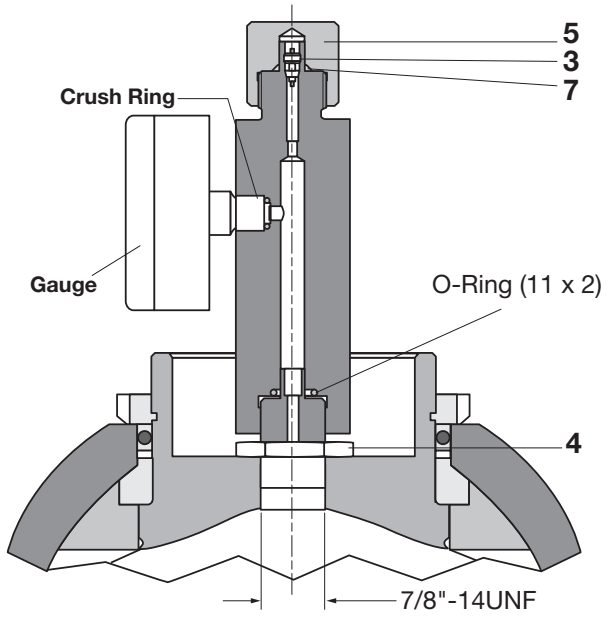
Bottom Repairable Bladder



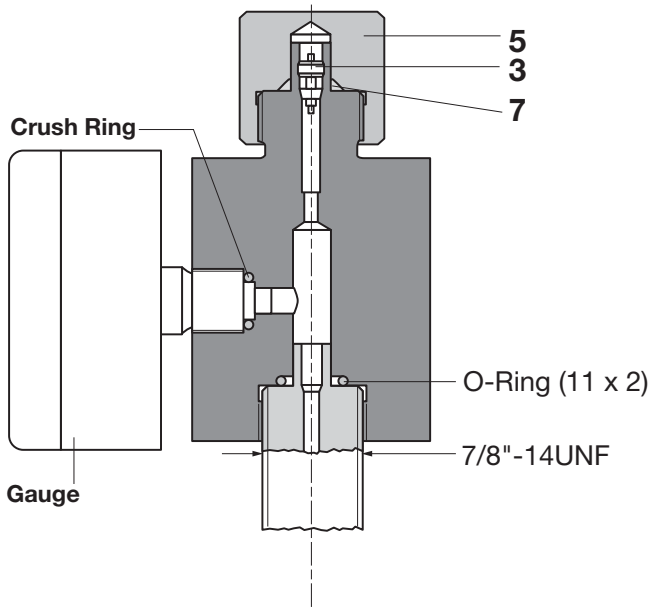
Bottom Repairable Bladder with M50 Gas Valve



Top Repairable Bladder



Piston & Diaphragm



Parts Legend

3	Gas Valve Core
4	Lock Nut
5	Valve Seal Cap
7	O-ring (7.5 x 2)
8	Name Plate

Soft Seated Hand Valves – H1

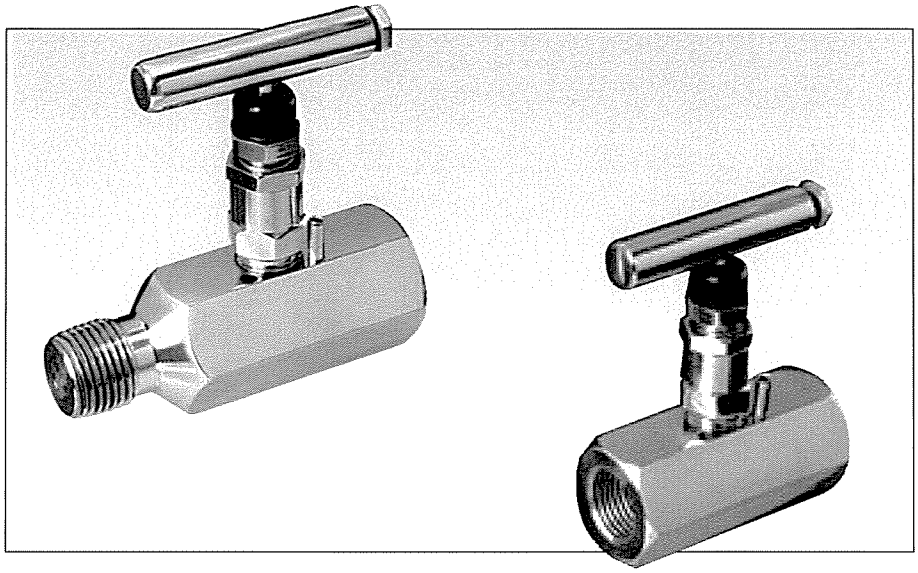
3/16-inch [4.8 mm] and 1/4-inch [6.4 mm] Orifice: 6000 and 10,000 psig [414 and 689 barg]

Product Overview

The H1 Series valves are designed for maximum system reliability. The design criteria includes repetitive bubble-tight closure, safety, and a long, trouble-free life with easy maintenance.

Anderson Greenwood utilizes a replaceable soft seat that gives premium tightness at closure, even in dirty service. The H1's straight-through rising plug design provides good regulation and high capacity with bi-directional flow, and is also roddable for easy cleaning.

These valves are standard with a variety of end connections, seat materials, and stem packing, in SS or CS, and are available to meet the requirements of NACE MR0175-2002. All valves are 100 percent pressure tested with material traceability of the body available on request.



Features and Benefits

- **Replaceable soft seat** allows replacement of the soft seat insert without removing the valve from the line. It operates in dirty service with repetitive bubble-tight shutoff.
- **Packing below threads** prevents lubricant washout, thread corrosion, and keeps solids from entering the thread area, which can cause galling. It also prevents process contamination.
- **Adjustable Teflon® packing** adjusts easily: loosen jam nut, tighten bushing slightly, then retighten jam nut. Decreases packing replacement downtime and increases valve life.
- **Dust cover** prevents lubricant washout and keeps contaminants (dirt, rain, etc.) out of bonnet assembly.
- **Safety back seating** prevents stem blowout or accidental removal while in operation and provides a metal-to-metal secondary stem seal while in the full open position.
- **Chrome plating of 316 SS stem** prevents galling or freezing of stem threads when similar metals mate. CS valves use a 303 SS stem.
- **Rolled threads** provide additional thread strength. The stem, bonnet, and male NPT threads are rolled, not cut.
- **Mirror stem finish** burnished to a 16 RMS finish in the packing area enables smooth stem operation and extends packing life.
- **Straight-through flow path** provides high flow capacity, bi-directional flow, and rodding capabilities.
- **Body-to-bonnet seal** is metal-to-metal in constant compression below the bonnet threads. Prevents bonnet thread corrosion, eliminates possible tensile breakage of bonnet, and gives a reliable seal point.

Note

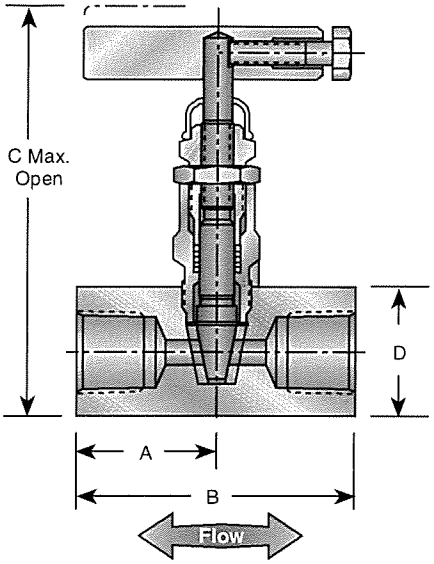
1. Teflon® is a registered trademark of the E.I. duPont de Nemours Company.

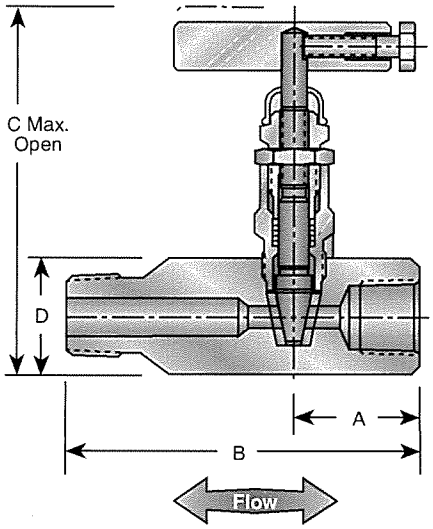
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H1 Specifications[3]

3/16-inch [4.8 mm] and 1/4-inch [6.4 mm] Orifice: 6000 psig [414 barg]

Dimensions, inches [mm]





FNPT by FNPT

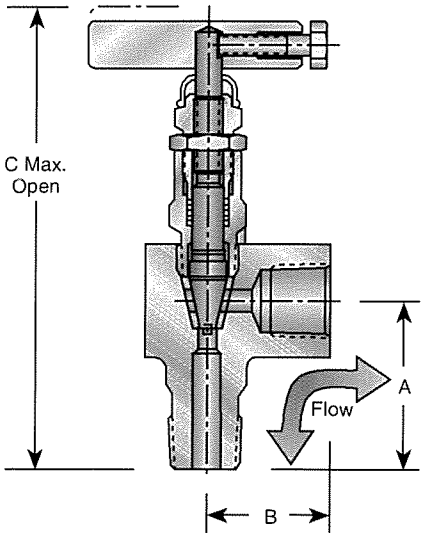
Valve[1]	A	B	C[2]	D
1/4" F x 1/4" F	1.05 [26.7]	2.10 [53.3]	3.70 [94.0]	1.00 [25.4]
1/2" F x 1/2" F	1.35 [34.3]	2.70 [68.6]	3.85 [97.8]	1.25 [31.7]

FNPT by MNPT

Valve[1]	A	B	C[2]	D
1/4" F x 1/4" M	1.18 [30.0]	3.50 [88.9]	3.70 [94.0]	1.00 [25.4]
1/4" F x 1/2" M	1.18 [30.0]	3.50 [88.9]	3.70 [94.0]	1.00 [25.4]
1/2" F x 1/2" M	1.35 [34.3]	3.50 [88.9]	3.85 [97.8]	1.25 [31.7]

Notes

1. Approximate valve weight: 1.3 lb [0.6 kg].
2. Valve C_v maximum
   3/16-inch [4.8 mm] – 0.83.
   1/4-inch [6.4 mm] – 1.40.
3. For Hastelloy® and -SG3 call factory for dimensions and weights.
4. Hastelloy is a registered trademark of Haynes International.



FNPT by MNPT (Angle)

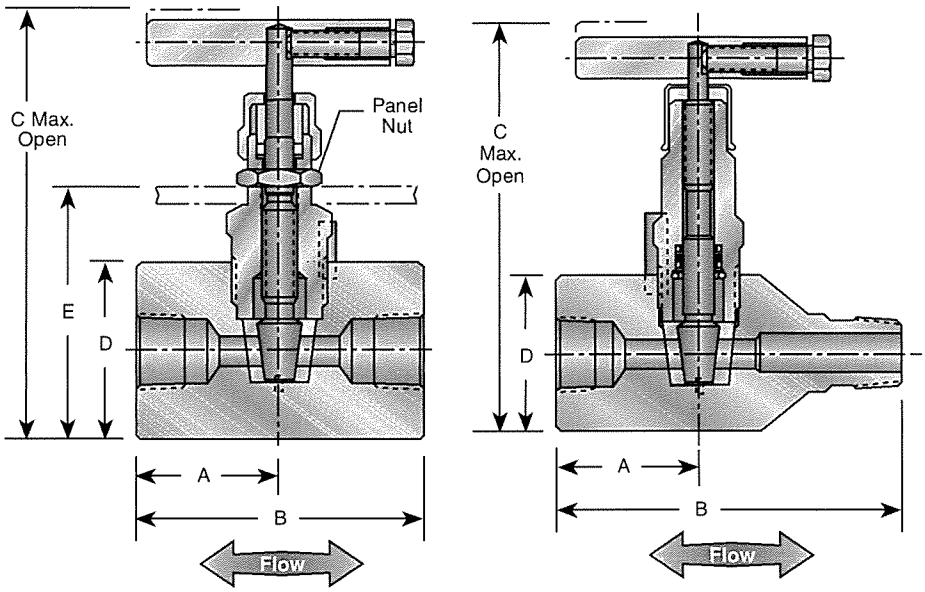
Valve	A	B	C
1/2" F x 1/2" M	1.73 [43.9]	1.40 [35.6]	5.00 [127.0]

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H1 Specifications[3]

1/4-inch [6.4 mm] Orifice: 10,000 psig [689 barg]

Dimensions, inches [mm]



Dimensions

Valve[1]	A	B	C[2]	D	E
O-ring Packed, Teflon® Packed 1/2" F x 1/2" F	1.50 [38.1]	3.00 [76.2]	4.82 [122.4]	1.75 [44.5]	1.98 [50.3]
O-ring Packed 1/2" F x 1/2" M	1.38 [35.1]	3.70 [94.0]	4.82 [122.4]	1.75 [44.5]	— —

Notes

1. Approximate valve weight:
   Female x Female 2.7 lb [1.2 kg].
   Male x Female 3.0 lb [1.3 kg].
2. Valve C_v 1.4 maximum.
3. For Hastelloy® and -SG3 call factory for dimensions and weights.

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H1 Specifications

Standard Materials
H1 – 3/16-inch [4.8 mm] and 1/4-inch [6.4 mm] Orifice: 6000 psig [414 barg]

Valve	Body and Bonnet[1]	Stem	Packing[2]	Seat[3]
CS	A108	A581-303	Teflon® or Viton® O-ring with Teflon® backup ring	Delrin®
SS	A479-316	A276-316 Chrome Plated	Teflon® or Viton® O-ring with Teflon® backup ring	Delrin®
SG[4]	A479-316	Monel® 400	Teflon®	Delrin®
SG3[7]	Hastelloy® C-276	Hastelloy® C-276	Teflon®	Delrin®

Standard Materials
H1 – 1/4-inch [6.4 mm] Orifice: 10,000 psig [689 barg]

Valve	Body and Bonnet[1]	Stem	Packing[2]	Seat[3]
CS	A108	A581-303	Teflon® or Viton® O-ring with Teflon® backup ring	Delrin®
SS	A479-316	Monel® K500	Teflon® or Viton® O-ring with Teflon® backup ring	Delrin®
SG[4]	A479-316	Monel® K500	Teflon® or Viton® O-ring with Teflon® backup ring	Delrin®
SG3[7]	Hastelloy® C-276	Hastelloy® C-276	Teflon® or Viton® O-ring with Teflon® backup ring	Delrin®

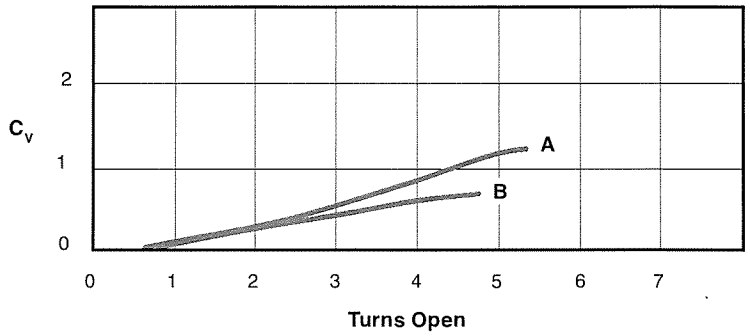
Notes

1. CS is zinc cobalt plated to prevent corrosion.
2. Teflon® packing is patented.
3. PCTFE (Polychlorotrifluoroethylene is the exact equivalent of Kel-F®), PEEK, and Teflon® seats are also available.
4. SG (Sour Gas) meets the requirements of NACE MR0175-2002.
5. Monel® is a registered trademark of International Nickel Company.
6. Delrin® is a registered trademark of the E.I. duPont de Nemours Company.
7. SG3 (Sour Gas) meets the requirements of NACE MR0175-2003.

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H1 Specifications

Flow Characteristics – 3/16-inch [4.8 mm] and 1/4-inch [6.4 mm] Orifice



A = 1/4-inch [6.4 mm] orifice, valve C_V 1.4 maximum
B = 3/16-inch [4.8 mm] orifice, valve C_V .83 maximum

Formulas

Liquids

$$Q_L = C_V \sqrt{\frac{(P_1 - P_2)\,(62.4)}{\rho}}$$

Gases (Where $P_2 > .5P_1$)

$$Q_V = (23.18)\,C_V \sqrt{\frac{(P_1 - P_2)\,P_2}{(S.G.)\,T}}$$

Gases (Where $P_2 < .5P_1$)

$$Q_V = \frac{(11.59)\,P_1 C_V}{\sqrt{S.G.\,(T)}}$$

Where:

Q_L = Flow (gpm)

Q_V = Flow (scfm)

ρ = Density of Liquid (lb/ft³)

P_1 = Upstream Pressure (psia)

P_2 = Downstream Pressure (psia)

T = Flowing Temperature (°R) (°R = °F + 460)

ρ (Water) = 62.4 lb/ft³ @ 60°F [16°C]

S.G. = Specific Gravity of Gas (M.W. of Air/28.96)

S.G. Air = 1.000

S.G. Nitrogen = 0.967

S.G. Oxygen = 1.105

S.G. Helium = 0.138

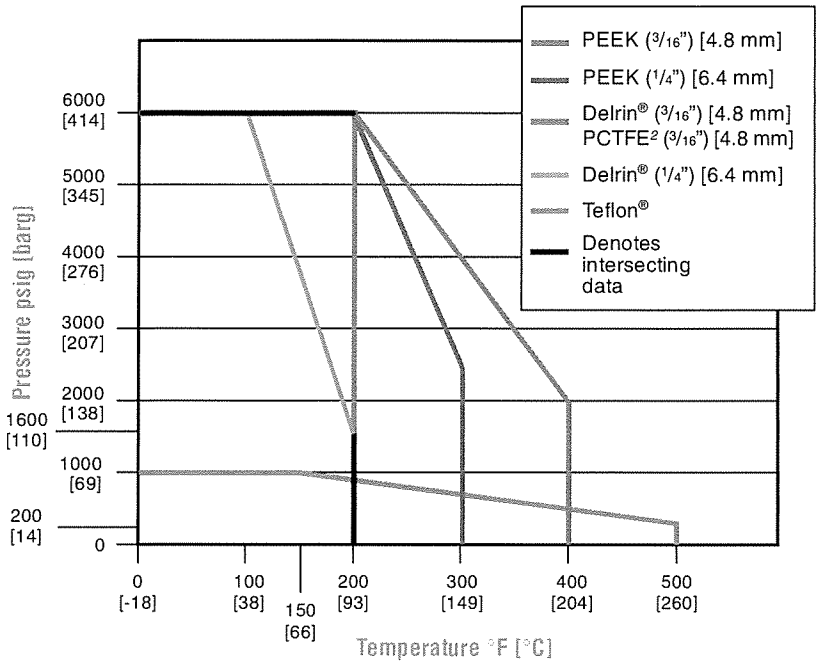
S.G. Hydrogen= 0.0696

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H1 Specifications

3/16-inch [4.8 mm] and 1/4-inch [6.4 mm] Orifice: 6000 psig [414 barg]

Pressure vs. Temperature



Pressure and Temperature Ratings

Valve	3/16-inch [4.8 mm] Orifice	
Delrin® and PCTFE[1] Seat	6000 psig @ 200°F	[414 barg @ 93°C]
PEEK Seat	6000 psig @ 200°F	[414 barg @ 93°C]
	2000 psig @ 400°F	[138 barg @ 204°C]
Teflon® Seat	1000 psig @ 150°F	[69 barg @ 66°C]
	200 psig @ 500°F	[14 barg @ 260°C]

Valve	1/4-inch [6.4 mm] Orifice	
Delrin® Seat	6000 psig @ 100°F	[414 barg @ 38°C]
	1600 psig @ 200°F	[110 barg @ 93°C]
PEEK Seat	6000 psig @ 200°F	[414 barg @ 93°C]
	2500 psig @ 300°F	[172 barg @ 149°C]

Note

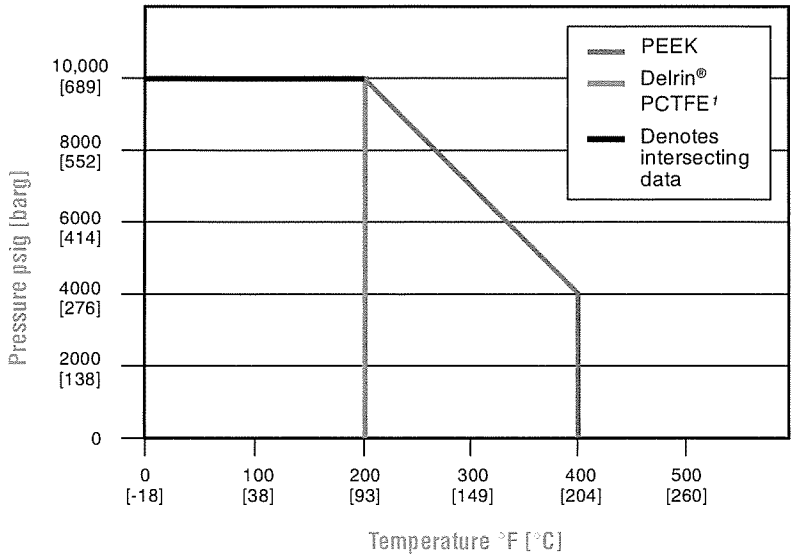
1. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.

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H1 Specifications

¼-inch [6.4 mm] Orifice: 10,000 psig [689 barg]

Pressure vs. Temperature



Pressure and Temperature Ratings

Valve	¼-inch [6.4 mm] Orifice	
Delrin® and PCTFE[1] Seat	10,000 psig @ 200°F	[689 barg @ 93°C]
PEEK Seat	10,000 psig @ 200°F	[689 barg @ 93°C]
	4000 psig @ 400°F	[276 barg @ 204°C]

Note

1. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.

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H1 Specifications

3/16-inch [4.8 mm] and 1/4-inch [6.4 mm] Orifice: 6000 psig [414 barg]

Ordering Information

H1 V D S – 44Q – SG

Packing

V – Teflon®
R – Viton® O-ring with Teflon® backup ring

Seat

D – Delrin® (standard)
K – PCTFE[1]
E – PEEK
V – Teflon®

Material

C – CS
S – 316 SS
M – Monel® (Teflon® packed only)
J – Hastelloy®
Special alloys available on request.

Connections (Bidirectional)

3/16-inch [4.8 mm] Orifice

2 – 1/4-inch F x 1/4-inch F
22 – 1/4-inch F x 1/4-inch M
24 – 1/4-inch F x 1/2-inch M
4Q – 1/2-inch F x 1/2-inch F
44Q – 1/2-inch F x 1/2-inch M
44QA – 1/2-inch F x 1/2-inch M (Angle)

1/4-inch [6.4 mm] Orifice (Delrin® and PEEK Seats only)

4QR – 1/2-inch F x 1/2-inch F
44QR – 1/2-inch F x 1/2-inch M

Options

BL – Bonnet Lock Device (patent protected) (page 21)
PHB – Phenolic Black Round Handle
SG – Sour Gas meets the requirements of NACE MR0175-2002 (316 SS only)
SP – Special Requirements - please specify
SG3 – Sour Gas meets the requirements of NACE MR0175-2003

Note

1. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.

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H1 Specifications

H1 ¼-inch [6.4 mm] Orifice: 10,000 psig [689 barg]

Ordering Information

H1	V	D	C	– 4R10	– SP

Packing

V – Teflon® (Packed bonnet available in CS only)
R – Viton® O-ring with
Teflon® backup ring

Seat

D – Delrin® (standard)
K – PCTFE[2]
E – PEEK

Body Materials

C – CS
S – 316 SS
J – Hastelloy®

Connections (Bidirectional)

4R10 – ½-inch F x ½-inch F
44R10 – ½-inch M x ½-inch F

Options

SG – Sour Gas meets the requirements of NACE MR0175-2002 (316 SS only)
SP – Special Requirements - please specify
SG3 – Sour Gas meets the requirements of NACE MR0175-2003

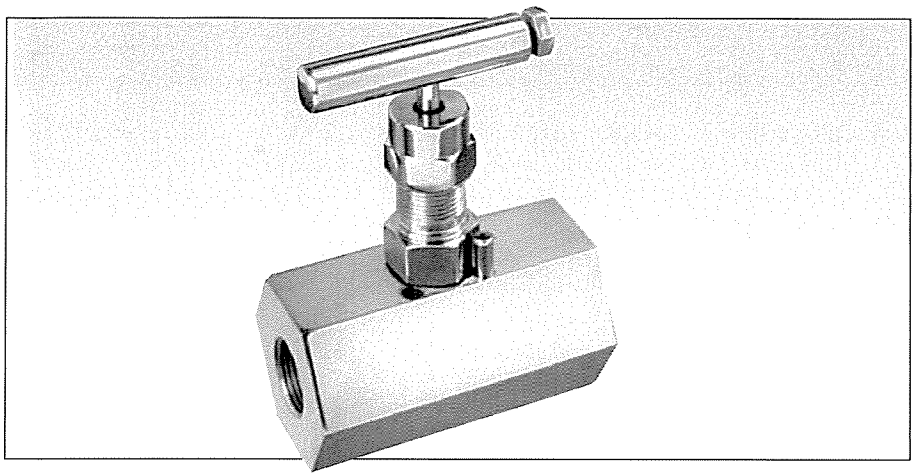
Note

1. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.

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Large Bore Hand Valves – H1

3/8-inch [9.5 mm] Diameter Orifice, General Purpose Valve



Product Overview

The 3/8-inch [9.5 mm] general purpose, soft-seated hand valve is designed for safe, repetitive bubble-tight closure, simple maintenance, and a long, reliable cycle life.

For premium tightness at closure, even in dirty service, a replaceable soft seat is incorporated on these valves. The straight-through, rising-plug design also provides superior regulation and high capacity (with bi-directional flow), and is roddable for easy cleaning.

This valve is standard with a variety of end connections, seat materials, and stem packing, in SS or CS, and is available to meet the requirements of NACE MR0175-2002. All valves are 100 percent pressure tested with material traceability of the body available on request.

Features and Benefits

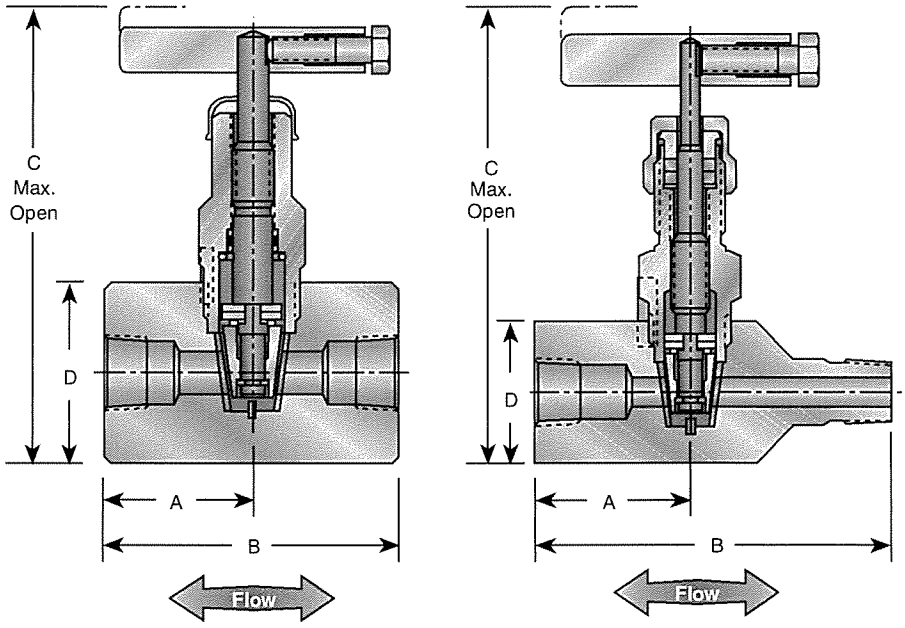
- **Replaceable soft seat** allows replacement of the soft seat insert without removing the valve from the line. It operates in dirty service with repetitive bubble-tight shutoff.
- **Packing below threads** prevents lubricant washout, thread corrosion, and keeps solids from entering the thread area, which can cause galling. It also prevents process contamination.
- **Dust cover** prevents lubricant washout and keeps contaminants (dirt, rain, etc.) out of bonnet assembly.
- **Safety back seating** prevents stem blowout and accidental removal while in operation.
- **Chrome plating of 316 SS stem** prevents galling or freezing of stem threads when similar metals mate. CS valves use a 303 SS stem.
- **Rolled threads** provide additional thread strength. The stem, bonnet, and male NPT threads are rolled, not cut.
- **Mirror stem finish** burnished to a 16 RMS finish in the packing area enables smooth stem operation and extends packing life.
- **Straight-through flow path** provides high flow capacity, bi-directional flow, and rodding capabilities.
- **Body-to-bonnet seal** is metal-to-metal in constant compression, isolating the bonnet threads from process fluid corrosion. Eliminates possible tensile breakage of bonnet, and gives a reliable seal point.

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H1 Specifications[2]

3/8-inch [9.5 mm] Diameter Orifice

Dimensions, inches [mm]



O-ring Bonnet | Teflon® Bonnet

Dimensions

End Connection[1]	A	B	C O-ring	C Teflon®	D	Valve Weight lb [kg]
1/2" F x 1/2" F	1.50 [38.1]	3.00 [76.2]	5.76 [146.3]	5.49 [139.4]	1.75 sq [44.5]	3.6 [1.6]
1/2" M x 1" F	1.88 [47.6]	4.38 [111.3]	5.76 [146.3]	5.49 [139.4]	1.75 sq [44.5]	3.6 [1.6]
3/4" F x 3/4" F	2.00 [50.8]	4.00 [101.6]	6.26 [159.0]	6.00 [152.4]	2.25 hex [57.2]	5.4 [2.5]
3/4" M x 3/4" F	2.00 [50.8]	5.00 [127.0]	6.26 [159.0]	6.00 [152.4]	2.25 hex [57.2]	5.4 [2.5]
1" F x 1" F	2.00 [50.8]	4.00 [101.6]	6.26 [159.0]	6.00 [152.4]	2.25 hex [57.2]	5.4 [2.5]
1" M x 1" F	2.00 [50.8]	5.00 [127.0]	6.26 [159.0]	6.00 [152.4]	2.25 hex [57.2]	5.4 [2.5]

Notes

1. Valve C_V 3.0 maximum.
2. For Hastelloy® and -SG3 call factory for dimensions and weights.

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H1 Specifications

3/8-inch [9.5 mm] Orifice

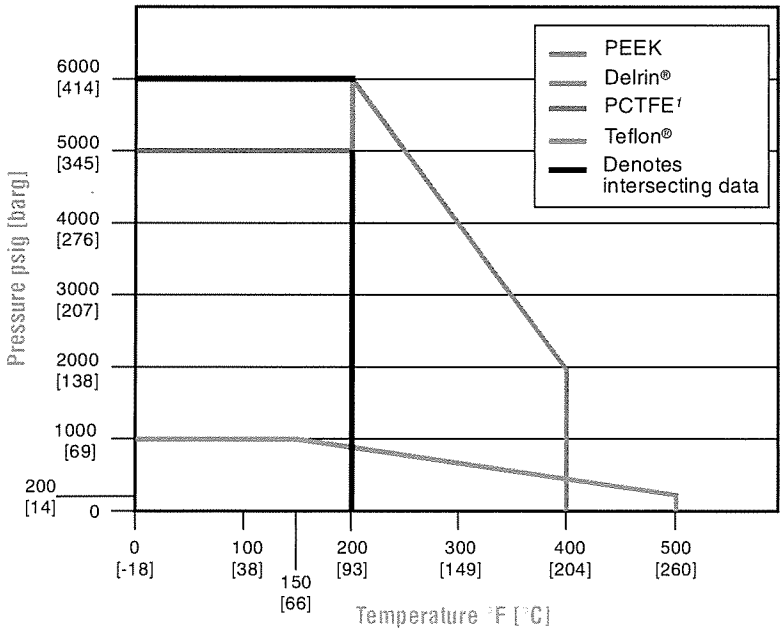
Standard Materials

Valve	Body and Bonnet	Stem	Packing	Seat[2]
CS[1]	A108[1]	A581-303	Teflon® or BUNA-N O-ring with Teflon® backup ring	Delrin®
SS	A479-316	A276-316	Teflon® or Viton® O-ring with Teflon® backup ring	Delrin®
SG[3]	A479-316	Monel® R405	Teflon® or Viton® O-ring with Teflon® backup ring	Delrin®
SG3[5]	Hastelloy® C-276	Hastelloy® C-276	Teflon® or Viton® O-ring with Teflon® backup ring	Delrin®

Notes

1. CS is zinc cobalt plated to prevent corrosion.
2. PCTFE, PEEK, and Teflon® are available.
3. SG (Sour Gas) meets requirements of NACE MR0175-2002.
4. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.
5. SG3 (Sour Gas) meets the requirements of NACE MR0175-2003.

Pressure vs. Temperature



Pressure and Temperature Ratings

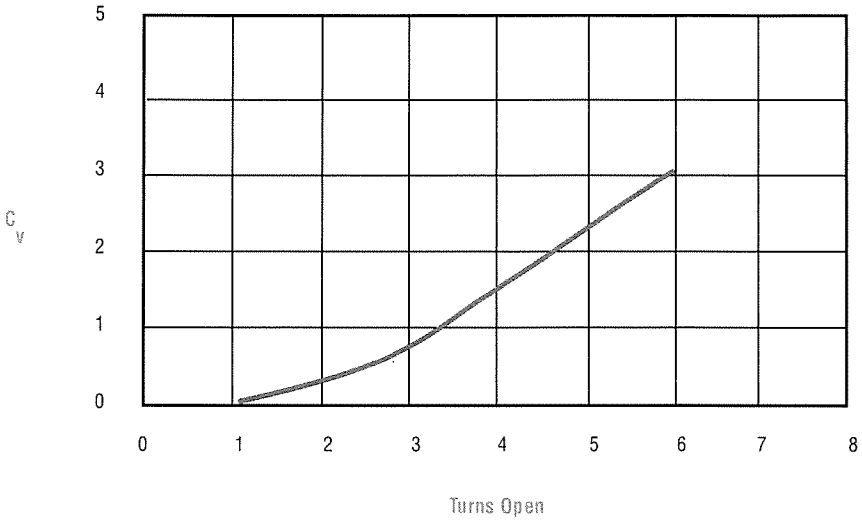
Seat	
Delrin®	6000 psig @ 200°F [414 barg @ 93°C]
PCTFE[4]	5000 psig @ 200°F [345 barg @ 93°C]
PEEK	6000 psig @ 200°F [414 barg @ 93°C] 2000 psig @ 400°F [138 barg @ 204°C]
Teflon®	1000 psig @ 150°F [69 barg @ 66°C] 200 psig @ 500°F [14 barg @ 260°C]

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H1 Specifications

3/8-inch [9.5 mm] Orifice

Flow Characteristics



3/8-inch [9.5 mm] orifice, C_V 3.0 maximum

Formulas

Liquids

$$Q_L = C_V \sqrt{\frac{(P_1 - P_2)(62.4)}{\rho}}$$

Gases (Where $P_2 > .5P_1$)

$$Q_V = (23.18)\, C_V \sqrt{\frac{(P_1 - P_2)\, P_2}{(S.G.)\, T}}$$

Gases (Where $P_2 < .5P_1$)

$$Q_V = \frac{(11.59)\, P_1 C_V}{\sqrt{S.G.\,(T)}}$$

Where:

Q_L = Flow (gpm)

Q_V = Flow (scfm)

ρ = Density of Liquid (lb/ft³)

P_1 = Upstream Pressure (psia)

P_2 = Downstream Pressure (psia)

T = Flowing Temperature (°R) (°R = °F + 460)

ρ (Water) = 62.4 lb/ft³ @ 60°F [16°C]

S.G. = Specific Gravity of Gas (M.W. of Air/28.96)

S.G. Air = 1.000

S.G. Nitrogen = 0.967

S.G. Oxygen = 1.105

S.G. Helium = 0.138

S.G. Hydrogen= 0.0696

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H1 Specifications

3/8-inch [9.5 mm] Orifice

Ordering Information

H1	V	D	S	– 4	– SG

Packing

V – Teflon®
R – Viton® O-ring with Teflon® backup ring

Seat

D – Delrin® (standard)
K – PCTFE[1]
E – PEEK
V – Teflon®

Material

C – CS
S – 316 SS
J – Hastelloy®

Connections (Bidirectional)

4 – 1/2-inch F x 1/2-inch F
48 – 1/2-inch F x 1-inch M
6Q – 3/4-inch F x 3/4-inch F
66Q – 3/4-inch F x 3/4-inch M
8Q – 1-inch F x 1-inch F
88Q – 1-inch F x 1-inch M

Options

SG – Sour Gas meets the requirements of NACE MR0175-2002 (316 SS only; Teflon® packed only)
SP – Special Requirements - please specify
SG3 – Sour Gas meets the requirements of NACE MR0175-2003

Note

1. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.

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Block and Bleed Gauge Valve – M9



Product Overview

The M9 (block and bleed) gauge valve is specifically designed to facilitate safe, compact, and economical gauge installation.

Block valve seating is interchangeable between 'hard' or 'soft' without changing the bonnet assembly. This feature enhances the value of the M9 by extending the useful life of the valve.

The M9's Bleed Plug is integral and employs metal-to-metal seating. It enables pressure to be safely vented without breaking threaded connections.

Applications

Static pressure gauge and instrument installation for isolation and venting.

Features and Benefits

- **Packing below threads (O-ring bonnet)** prevents lubricant washout, thread corrosion, and keeps solids from entering thread area, which can cause galling. It also prevents process contamination.
- **Adjustable packing** – Teflon® and GRAFOIL® packed bonnets adjust easily, decreasing packing replacement downtime and increasing valve life.
- **Safety back seating** prevents stem blowout or accidental removal while in operation and provides a metal-to-metal secondary stem seal while in the full open position.
- **Chrome plating of 316 SS stem** prevents galling or freezing of stem threads when similar metals mate. CS valves use a 303 SS stem.
- **Rolled threads** provide additional thread strength. The stem, bonnet, and male NPT threads are rolled, not cut.
- **Mirror stem finish** burnished to a 16 RMS finish in the packing area enabling smooth stem operation and extending packing life.
- **One-piece handle design** prevents loss of the valve handle due to vibration or during maintenance.
- **Soft or metal seat for bubble-tight shutoff** is field replaceable for easy maintenance. The V-tipped stem provides accurate flow control.
- **Extended valve life,** if soft seat becomes damaged it can be removed, leaving a metal seated valve.

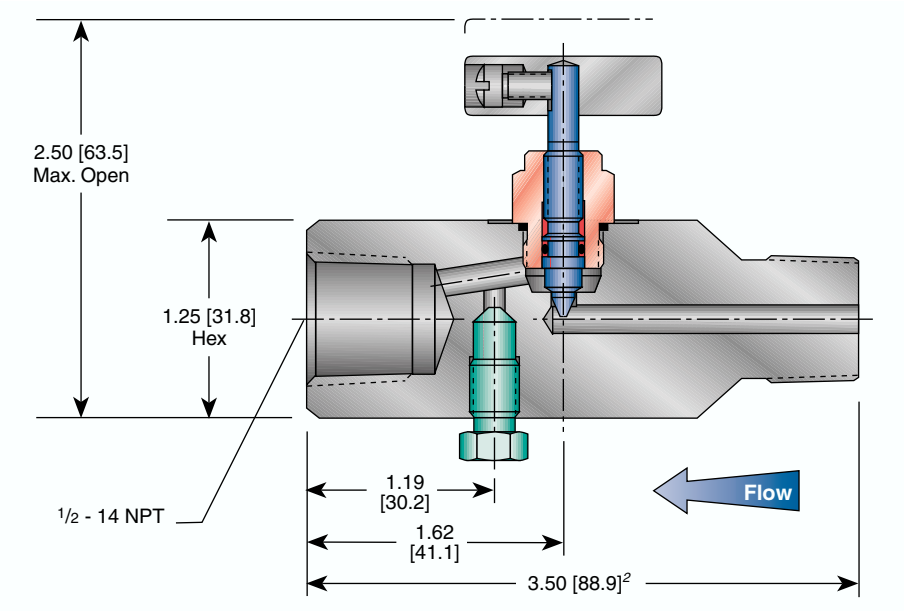
Note

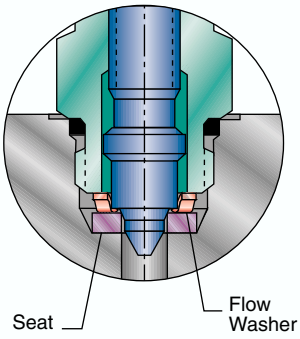
1. Teflon® is a registered trademark of the E.I. duPont de Nemours Company.

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Block and Bleed Gauge Valve – M9 Specifications

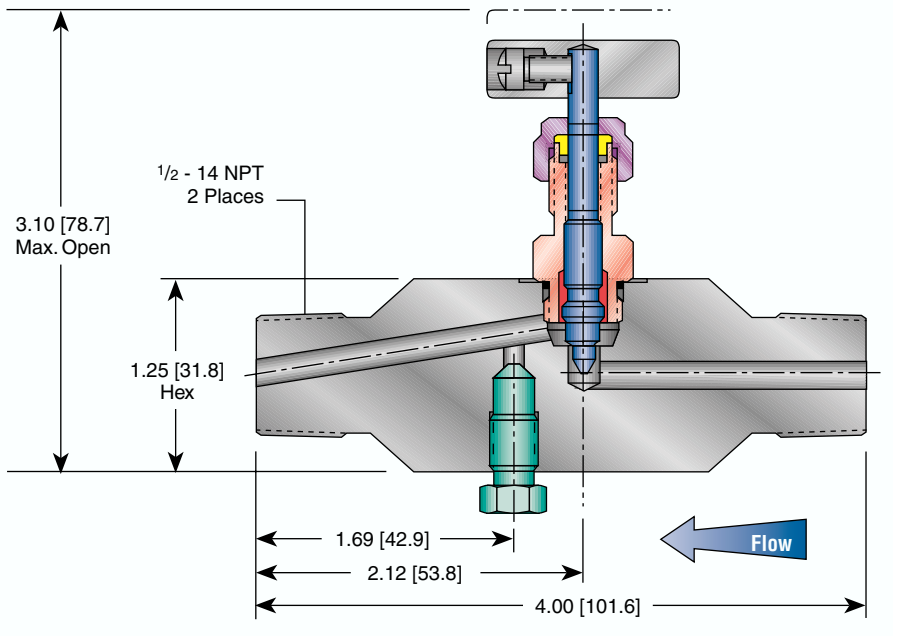
M9RIS – 44 Dimensions with O-ring Bonnet[1], inches [mm]

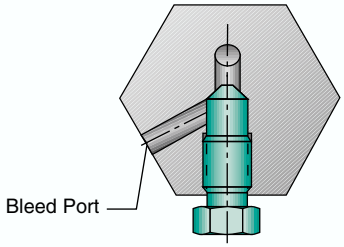




Optional Soft Seat

M9VIS – 4M Dimensions with Teflon® Bonnet[1], inches [mm]





Section Through Bleed Plug

Notes

1. Bonnets interchangeable between all body configurations.
2. 4.00-inch [101.6 mm] for -44C, -46C.

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Block and Bleed Gauge Valve – M9 Specifications

Standard Materials

Metal Seat

Valve[1]	Body	Bonnet	Stem	Packing	Bleed Plug	Seat
CS[2]	A108 CS	A108 CS	A581-303 SS	Teflon® or BUNA-N O-ring	A108 CS	Integral
SS	A479-316 SS	A479-316 SS	A276-316 SS	Teflon® or BUNA-N O-ring	A276-316 SS	Integral
SG[3]	A479-316 SS	A479-316 SS	Monel® 400	Teflon®	A279-316 SS	Integral
Monel®	Monel® R405	Monel® R405	Monel® R405	Teflon®	Monel® R405	Integral

Soft Seat

Valve[1]	Body	Bonnet	Stem	Packing	Flow Washer	Bleed Plug	Seat[4]
CS[2]	A108 CS	A108 CS	A581-303 SS	Teflon® or BUNA-N O-ring	316 SS	A108 CS	Delrin®
SS	A479-316 SS	A479-316 SS	A276-316 SS	Teflon® or Viton® O-ring	316 SS	A276-316 SS	PCTFE[5]
SG[3]	A479-316 SS	A479-316 SS	Monel® 400	Teflon®	316 SS	A276-316 SS	PCTFE[5]

Notes

1. Approximate valve weight 1.2 lb [.54 kg]. Orifice size .136-inch [3.5 mm] diameter. Valve C_v Hard Seat .25 maximum. Valve C_v Soft Seat .24 maximum.
2. CS is zinc-cobalt plated to prevent corrosion (except male plain end is black oxide coated).
3. SG (Sour Gas) meets the requirements of NACE MR0175-latest revision.
4. PEEK available.
5. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.
6. Viton® and Delrin® are registered trademarks of the E.I. duPont de Nemours Company.
7. Monel® is a registered trademark of the International Nickel Company.

Pressure and Temperature Ratings

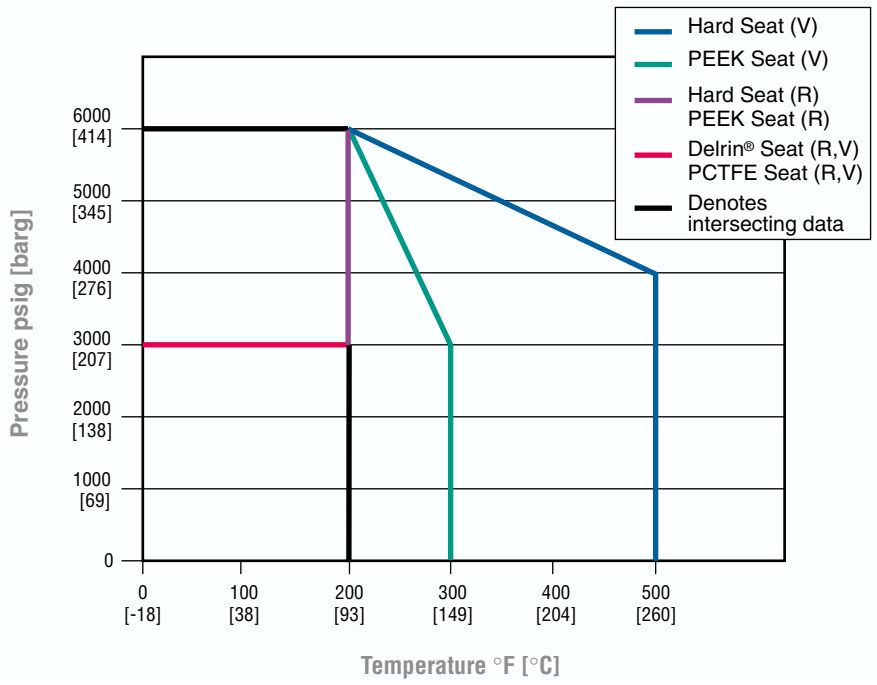
Ratings with Teflon® Bonnet

Hard Seat	6000 psig @ 200°F [414 barg @ 93°C] 4000 psig @ 500°F [276 barg @ 260°C]
Delrin® and PCTFE[5]	3000 psig @ 200°F [207 barg @ 93°C]
PEEK Seat	6000 psig @ 200°F [414 barg @ 93°C] 3000 psig @ 300°F [207 barg @ 149°C]

Ratings with O-ring Bonnet

Hard Seat	6000 psig @ 200°F [414 barg @ 93°C]
Delrin® and PCTFE[5]	3000 psig @ 200°F [207 barg @ 93°C]
PEEK Seat	6000 psig @ 200°F [414 barg @ 93°C]

Pressure vs. Temperature



(V) = with Teflon® Bonnet Assembly
(R) = with O-ring Bonnet Assembly

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Block and Bleed Gauge Valve – M9 Specifications

Ordering Information

M9 V I S – 44C – SG

Packing

V – Teflon® Bonnet (standard for 316 SS)
R – O-ring Bonnet

Seat

I – Integral
D – Delrin® (standard)
E – PEEK
K – PCTFE[1]

Body Materials

C – CS
S – SS
M – Monel®

Connections (Inlet/Outlet)

44 – 1/2-inch MNPT x 1/2-inch FNPT
46 – 3/4-inch MNPT x 1/2-inch FNPT
4M – 1/2-inch MNPT x 1/2-inch MNPT

C – Male plain end (CS is black oxide coated)

Options

AL – Arctic Lubricant (Low Temperature Service) Not available for CS valves.
CLC – Chlorine Cleaning
HD – Hydrostatic Testing (100%) (MSS-SP-61)
MS – Monel® Stem
OC – Oxygen Cleaning
PHB – Phenolic Black Handle
PHG – Phenolic Green Handle
PHR – Phenolic Red Handle
PM – Panel Mount (Teflon® packed only)
SG – Sour Gas meets the requirements of NACE MR0175-latest revision (SS only)
SP – Special Requirements - please specify

Note

1. PCTFE (Polychlorotrifluoroethylene) is the exact equivalent of Kel-F®.

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Integral Manifolds





Product Overview

Integral manifolds are those uniquely connected to the transmitter of a specific manufacturer's model and cannot be used on a different transmitter brand. This section is presently characterized by manifolds designed specifically for Rosemount® Transmitter Models 3051, 2024 and 3095.

The manifold/transmitter assembly has the advantage of small size, lightweight and may be either 2-inch pipestand or wall mounted. Plugged or valved vent/test ports are standard for field calibration checks.

This section has two parts:

1. Integral manifolds for industrial plants.
2. Integral manifolds for ASME B31.1 fossil fuel power plants.

Coplanar™ Compatible

All the Anderson Greenwood Integral Manifolds are designed and thoroughly tested to be compatible with the Rosemount® coplanar™ pressure transmitters including the Model 3051C, Model 3051P, Model 2024 and the Model 3095 Multivariable transmitters.

Coplanar™ Style Transmitters

Rosemount®'s unique coplanar™ design (sense diaphragms are on the same plane) has allowed Anderson Greenwood to develop a new series of process instrument manifolds specifically designed to 'integrate' the manifold to the transmitter. This innovative package is fully assembled, calibrated and leak tested at Rosemount®'s factories, worldwide.

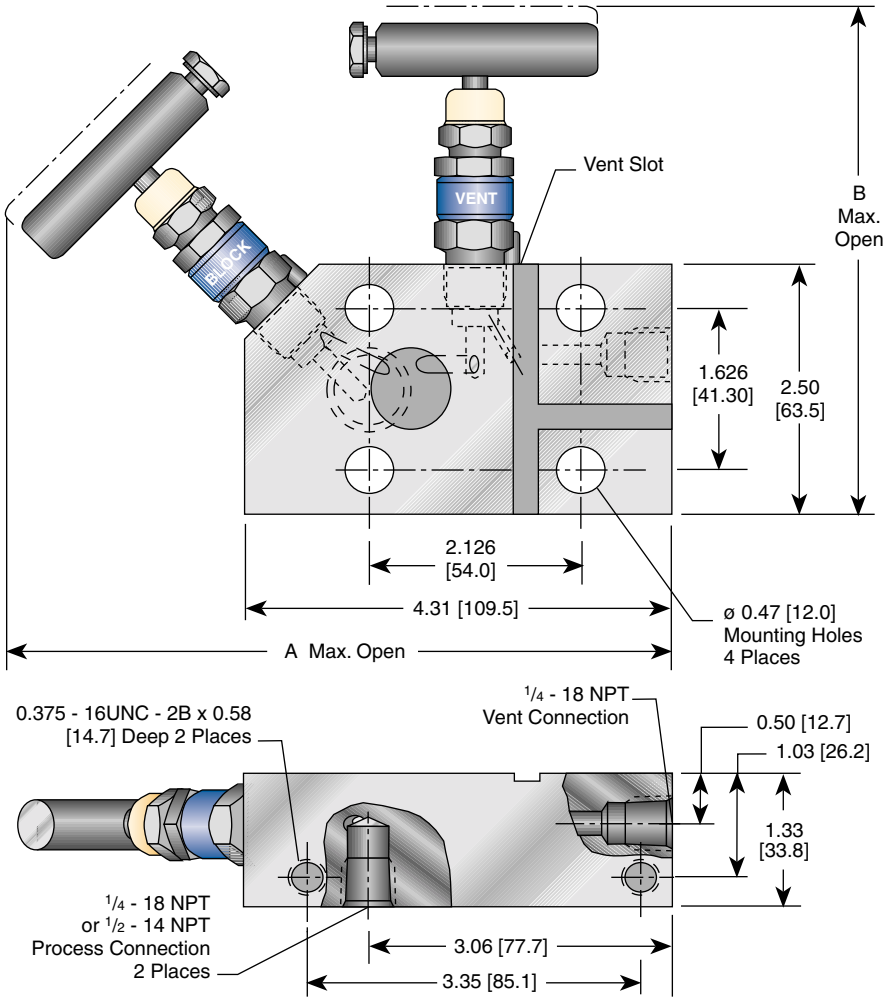
Bonnet Assembly Feature

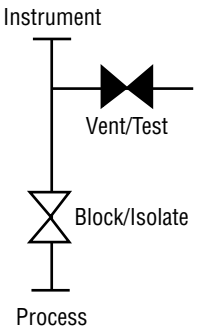
- **Ball End Stem** eliminates seat galling, provides bubble-tight shutoff and long life. The hardened, non-rotating ball ensures perfect alignment closure after closure.
- **Packing Below** threads prevents lubricant washout, thread corrosion, and keeps solids from entering the thread area which can cause galling. Also prevents process contamination.
- **Adjustable Packing** adjusts easily; loosen jam nut, tighten bushing slightly, then retighten jam nut. Decreases packing replacement downtime and increases valve life.
- **Dust Cover** prevents lubricant washout and keeps contaminants (dirt, rain, etc.) out of bonnet assembly.
- **Safety Back Seating** prevents stem blowout or accidental removal while in operation. Also provides a metal-to-metal secondary stem seal while in the full open position.
- **Chrome Plating of 316 SS Stem** prevents galling or freezing of thread when similar metals mate.Rolled Threads provides additional thread strength. The stem, bonnet, and male NPT threads are rolled, not cut.
- **Mirror Stem Finish** burnished to a 16 RMS finish in the packing area. Enables smooth stem operation and extends packing life.
- **Body-Bonnet Seal** is in constant compression, below the bonnet threads. This prevents thread corrosion, eliminates possible tensile breakage of bonnet and gives a reliable seal point.
- **Bonnet Lock Pin** is another safety feature, which prevents the accidental separation of the bonnet from the body. However, normal valve maintenance and repair are still easily accomplished.

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Integral Manifolds – MC2 Two-Valve Manifold for Static Pressure

Dimensions, inches [mm]





Dimensions, inches [mm]

Valve[1]	A	B
Teflon® Packed	6.85 [174.0]	5.10 [129.5]
GRAFOIL® and Low Emissions Graphite Packed	7.49 [190.2]	5.75 [146.1]

Notes

1. Approximate valve weight: 4.1 lb [1.9 kg]. 0.156-inch [4.0 mm] diameter orifice. Valve C_v 0.36 maximum.
2. See page 114 for ordering information.
3. Body face is slotted to assure atmospheric vent when a differential transmitter is used.
4. SG (Sour Gas) meets the requirements of NACE MR0175-latest revision.

Pressure and Temperature Ratings

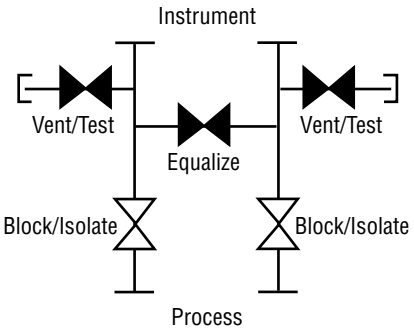
Valve	Packing	Ratings	
SS	Teflon®	6000 psig @ 200°F 4000 psig @ 500°F	[414 barg @ 93°C] [276 barg @ 260°C]
SS	GRAFOIL®/ Low Emissions Graphite	6000 psig @ 200°F 1500 psig @ 1000°F	[414 barg @ 93°C] [103 barg @ 538°C]
SG[4]	Teflon®	6000 psig @ 200°F 4000 psig @ 500°F	[414 barg @ 93°C] [276 barg @ 260°C]
SG[4]	GRAFOIL®/ Low Emissions Graphite	6000 psig @ 200°F 1500 psig @ 1000°F	[414 barg @ 93°C] [103 barg @ 538°C]

Standard Materials

Valve	Body and Bonnet	Stem and Ball
SS	A479-316 316	A276-316 316
SG[4]	A479-316 316	Monel® 400 Monel® K500

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Integral Manifolds – MC3 Three-Valve Manifold with Optional Externally Valved Test Ports



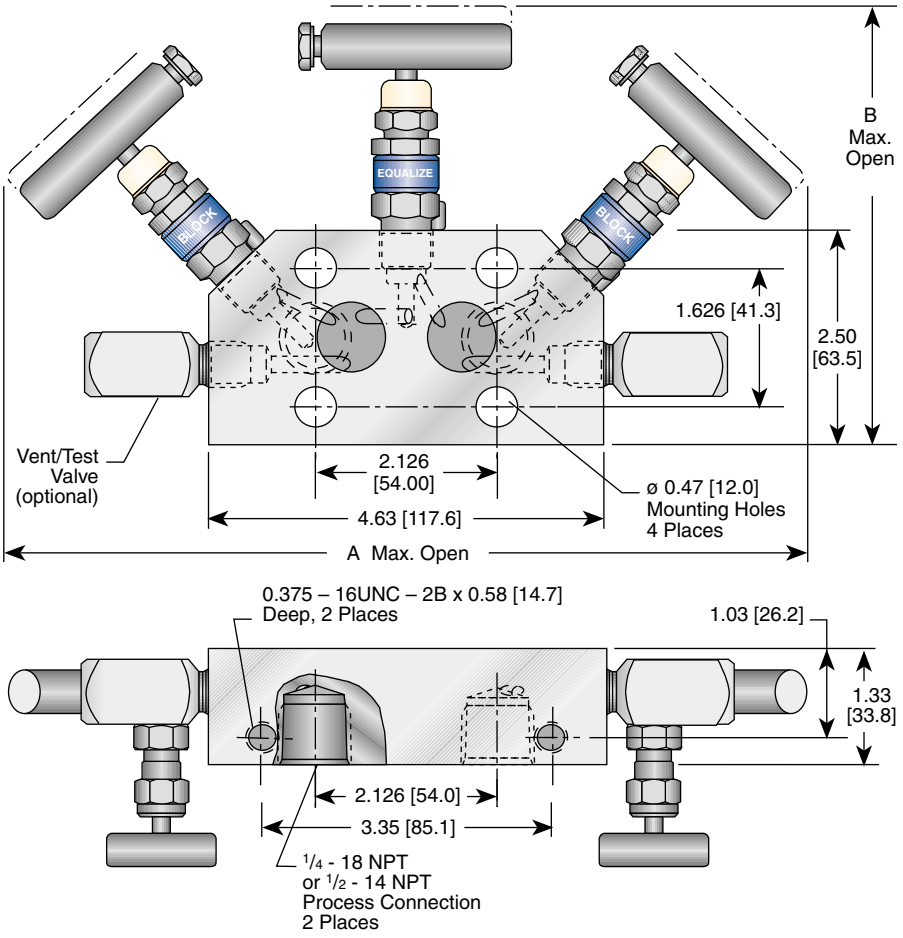
Dimensions, inches [mm]

Valve[1]	A	B
Teflon® Packed	9.60 [243.8]	5.10 [129.5]
GRAFOIL® and Low Emissions Graphite Packed	10.98 [278.9]	5.75 [146.1]

Notes

1. Approximate valve weight:
   5.0 lb [2.3 kg] for MC3VI [ ]-2-H5,
   4.4 lb [2.0 kg] for MC3VI [ ]-2
   0.156-inch [4.0 mm] diameter orifice.
   Valve C_v 0.36 maximum.
2. See page 114 for ordering information.
3. Optional test port valves are H5VDS-22, convertible soft-to-metal seat.
4. SG (Sour Gas) meets the requirements of NACE MR0175-latest revision.

Dimensions, inches [mm]



Standard Materials

Valve[3]	Body and Bonnet	Stem and Ball
SS	A479-316 316	A276-316 316
SG[4]	A479-316 316	Monel® 400 Monel® K500

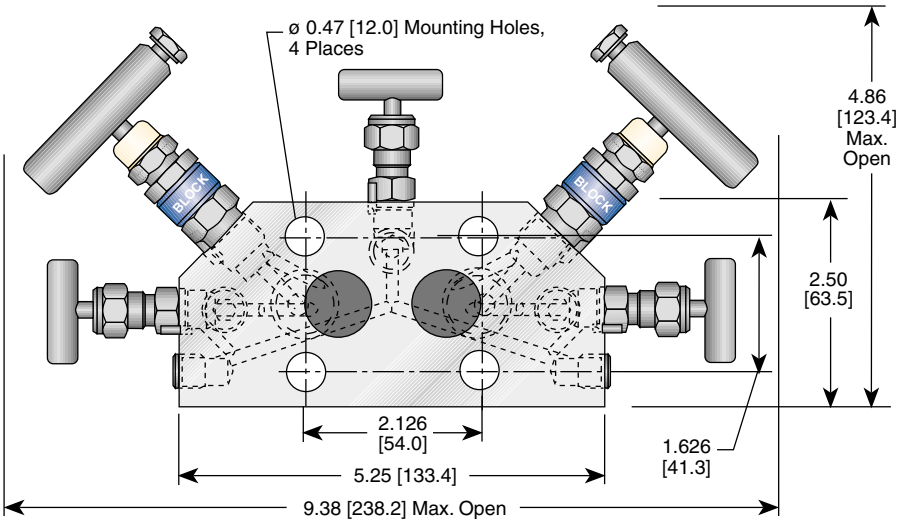
Pressure and Temperature Ratings

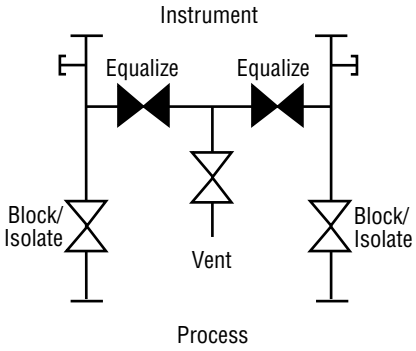
Valve	Packing	Ratings
SS	Teflon®	6000 psig @ 200°F [414 barg @ 93°C] 4000 psig @ 500°F [276 barg @ 260°C]
SS	GRAFOIL® Low Emissions Graphite	6000 psig @ 200°F [414 barg @ 93°C] 1500 psig @ 1000°F [103 barg @ 538°C]
SG[4]	Teflon®	6000 psig @ 200°F [414 barg @ 93°C] 4000 psig @ 500°F [276 barg @ 260°C]
SG[4]	GRAFOIL® Low Emissions Graphite	6000 psig @ 200°F [414 barg @ 93°C] 1500 psig @ 1000°F [103 barg @ 538°C]

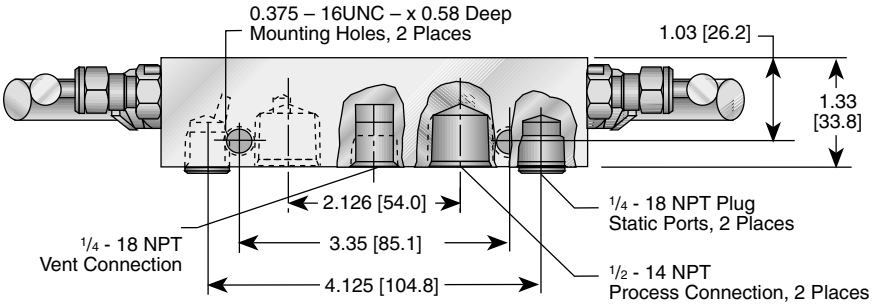
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Integral Manifolds – MC5G Five-Valve Manifold for Gas Service (Patent Protected)

Dimensions, inches [mm]







Standard Materials

Valve[1]	Body and Bonnet	Stem and Ball	Packing
SS	A479-316 316	A276-316 316	Teflon®
SG[3]	A479-316 316/Monel®	Monel® 400 Monel® K500	Teflon®

Pressure and Temperature Ratings

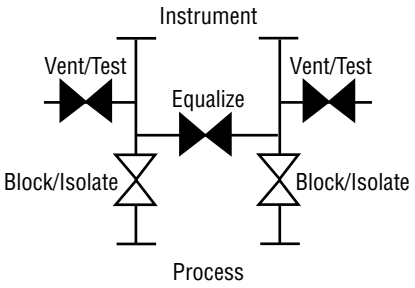
Valve	Ratings	
SS, SG[3]	6000 psig @ 200°F 4000 psig @ 500°F	[414 barg @ 93°C] [276 barg @ 260°C]

Notes

1. Approximate valve weight: 4.8 lb [2.2 kg]. 0.136-inch [3.5 mm] diameter orifice. Valve C_v 0.24 maximum.
2. See page 114 for ordering information.
3. SG (Sour Gas) meets the requirements of NACE MR0175-latest revision.

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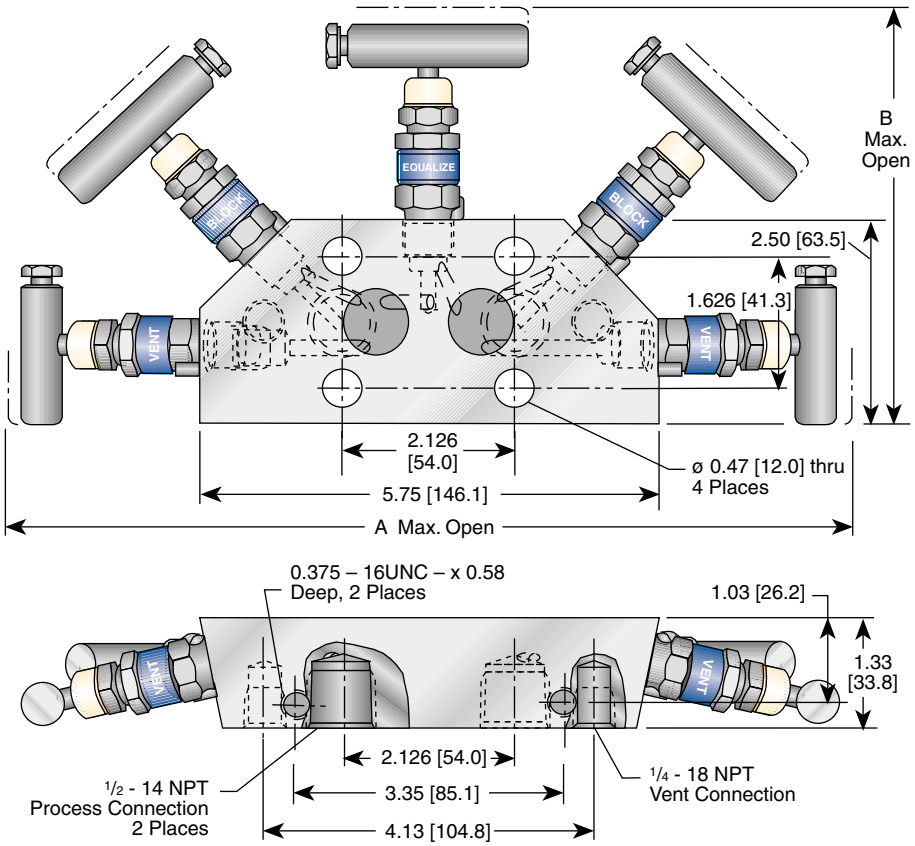
Integral Manifolds – MC5P Five-Valve Manifold with Two Integral Test Valves (Patent Protected)



Dimensions, inches [mm]

Valve[1]	A	B
Teflon® Packed	10.95 [278.1]	5.10 [129.5]
GRAFOIL® or Low Emissions Graphite Packed	12.40 [315.0]	5.75 [146.1]

Dimensions, inches [mm]



Notes

1. Approximate valve weight: 5.3 lb [2.4 kg]. 0.156-inch [4.0 mm] diameter orifice. Valve C_v 0.36 maximum.
2. See page 114 for ordering information.
3. SG (Sour Gas) meets the requirements of NACE MR0175-latest revision.

Standard Materials

Valve	Body and Bonnet	Stem and Ball	Packing
SS	A479-316 316	A276-316 316	Teflon®
SG[3]	A479-316 316/Monel®	Monel® 400 Monel® K500	Teflon®

Pressure and Temperature Ratings

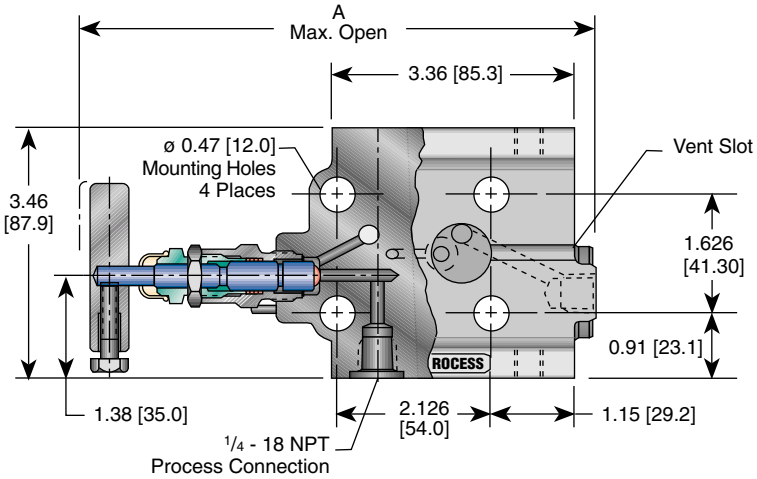
Valve	Ratings	
SS, SG[3]	6000 psig @ 200°F 4000 psig @ 500°F	[414 barg @ 93°C] [276 barg @ 260°C]

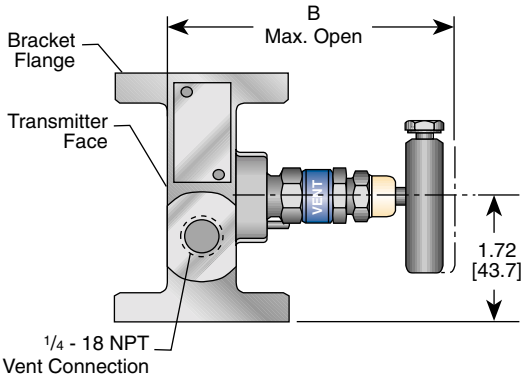
See Page 110 or 111 for additional ratings.

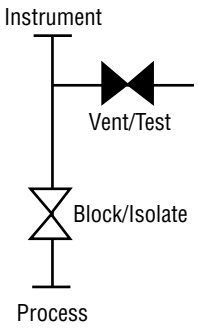
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Integral Manifolds – MT2 Two-Valve Manifold for Static Pressure

Dimensions, inches [mm]







Dimensions, inches [mm]

Valve[1]	A	B
Teflon® Packed	6.79 [172.5]	4.04 [102.6]
GRAFOIL® and Low Emissions Graphite Packed	7.44 [188.9]	4.69 [119.1]

Notes

1. Approximate valve weight: 4.6 lb [2.09 kg]. 0.156-inch [4.0 mm] diameter orifice. Valve C_v 0.36 maximum.
2. See page 115 for ordering information.
3. Body face is slotted to assure atmospheric vent when a differential transmitter is used.
4. SG (Sour Gas) meets the requirements of NACE MR0175-latest revision.

Pressure and Temperature Ratings

Valve	Packing	Ratings
SS	Teflon®	6000 psig @ 200°F [414 barg @ 93°C] 4000 psig @ 500°F [276 barg @ 260°C]
SS	GRAFOIL®/ Low Emissions Graphite	6000 psig @ 200°F [414 barg @ 93°C] 1500 psig @ 1000°F [103 barg @ 538°C]
SG[4]	Teflon®	6000 psig @ 200°F [414 barg @ 93°C] 4000 psig @ 500°F [276 barg @ 260°C]
SG[4]	GRAFOIL®/ Low Emissions Graphite	6000 psig @ 200°F [414 barg @ 93°C] 1500 psig @ 1000°F [103 barg @ 538°C]

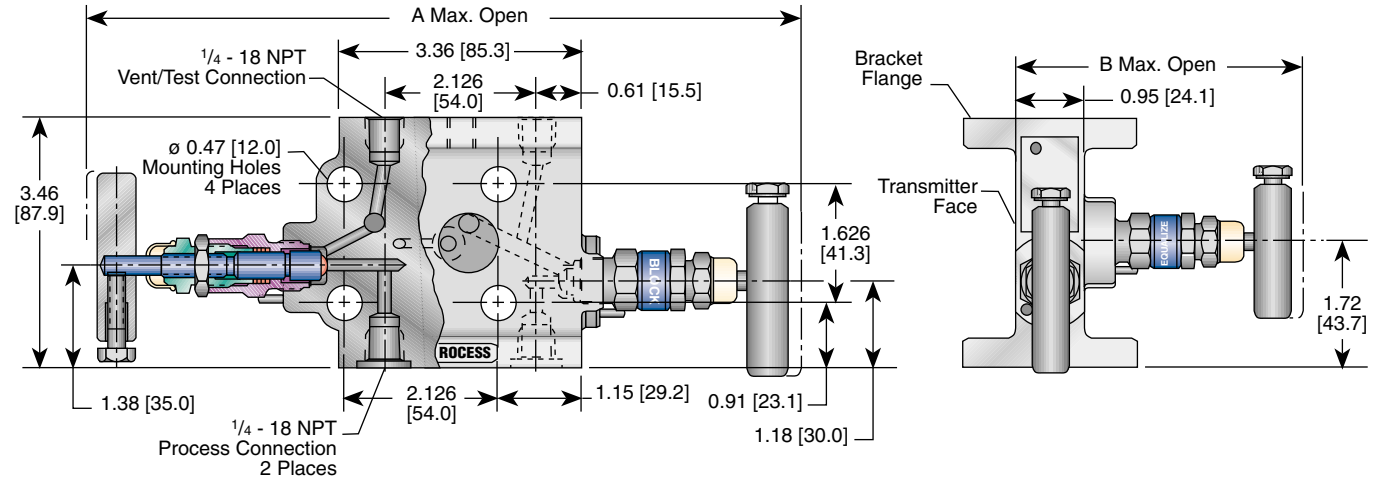
Standard Materials

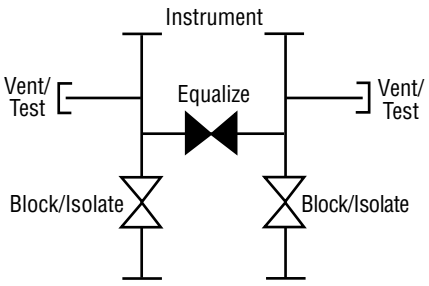
Valve	Body and Bonnet	Stem and Ball
SS	A351-CF8M SS 316	A276-316 316
SG[4]	A351-CF8M SS 316	Monel® 400 Monel® K500

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Integral Manifolds – MT3 Three-Valve Manifold With Test Ports

Dimensions, inches [mm]





Dimensions, inches [mm]

Valve[1]	A	B
Teflon® Packed	9.72 [246.9]	4.04 [102.6]
GRAFOIL® and Low Emissions Graphite Packed	11.02 [279.9]	4.69 [119.1]

Notes

1. Approximate valve weight: 4.9 lb [2.22 kg]. 0.156-inch [4.0 mm] diameter orifice. Valve C_v 0.36 maximum.
2. See page 115 for ordering information.
3. Monel® and Hastelloy® are also available.
4. SG (Sour Gas) meets the requirements of NACE MR0175-latest revision.

Standard Materials[3]

Valve	Body and Bonnet	Stem and Ball
SS	A351-CF8M SS 316	A276-316 316
SG[4]	A351-CF8M SS 316	Monel® 400 Monel® K500

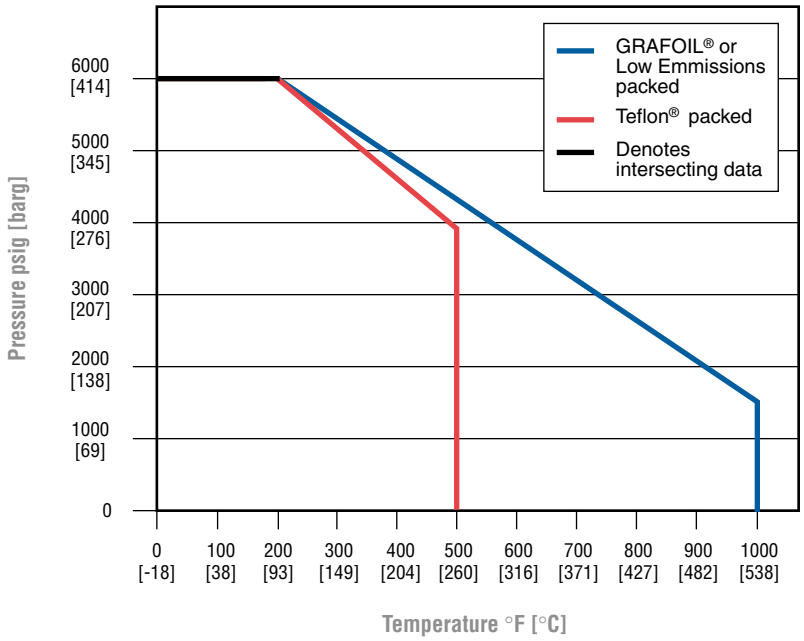
Pressure and Temperature Ratings

Valve	Body and Bonnet	Ratings
SS	Teflon®	6000 psig @ 200°F [414 barg @ 93°C] 4000 psig @ 500°F [276 barg @ 260°C]
SS	GRAFOIL® Low Emissions Graphite	6000 psig @ 200°F [414 barg @ 93°C] 1500 psig @ 1000°F [103 barg @ 538°C]
SG[4]	Teflon®	6000 psig @ 200°F [414 barg @ 93°C] 4000 psig @ 500°F [276 barg @ 260°C]
SG[4]	GRAFOIL® Low Emissions Graphite	6000 psig @ 200°F [414 barg @ 93°C] 1500 psig @ 1000°F [103 barg @ 538°C]

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Integral Manifolds

Pressure vs. Temperature



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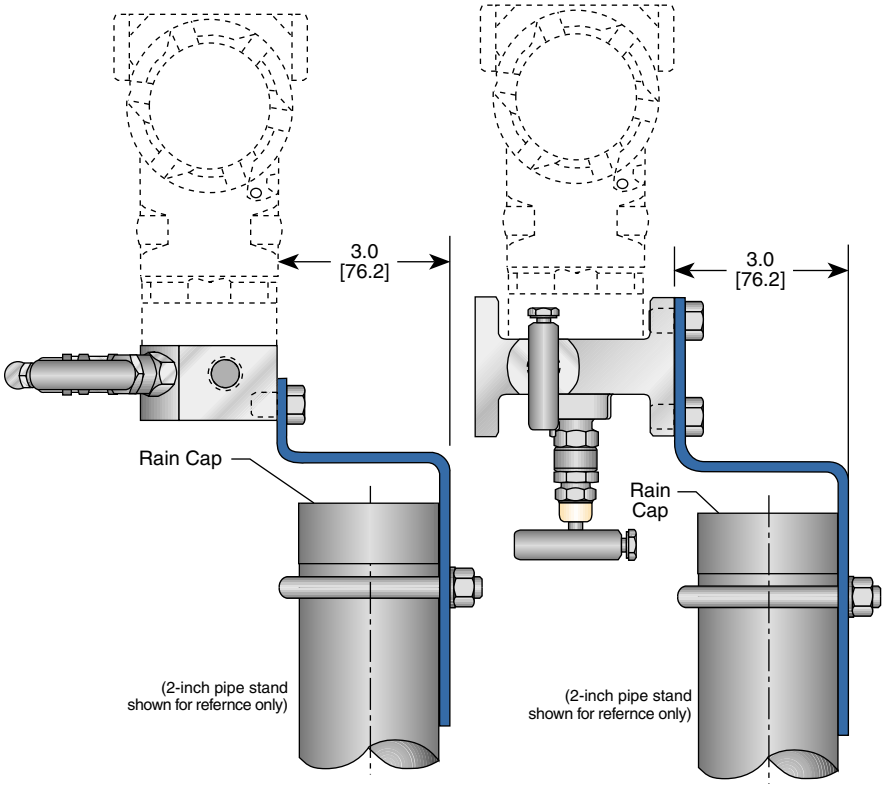
Integral Manifolds

MC/MT AGCO Mount Kits

Manifold Style	Kit Part No.	Material
MT	02.1639.971	CS[1]
MT	02.1639.972	SS
MC	06.1662.502	CS[1]
MC	06.1662.501	SS

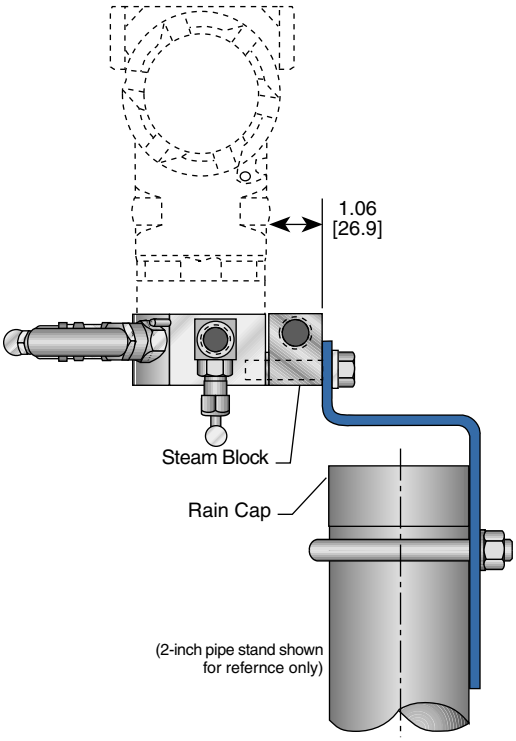
Note

1. Zinc cobalt plated.



MC Steam Block Option Kit

Manifold Style	Part No.	Material
MC	02.1639.901	SS



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Integral Manifolds – MC (Rosemount® Coplanar™ only) Specifications

Ordering Information

MC 3 V I S –4 –SG

Style

MC – Coplanar™

Type

2 – Two Valve (static pressure)
3 – Three Valve (ΔP)
5G – Five Valve (gas) (ΔP)
5P – Five Valve (power) (ΔP)

Packing

V – Teflon® (patent protected)
H – GRAFOIL® (not available for MC5G)
E – Low Emissions Graphite (not available for MC5G)

Seat

I – Integral (body material)

Material

S – 316 SS

End Connection

2 – 1/4-inch FNPT (use if futbol mounting to inlet)
4 – 1/2-inch FNPT

Options

–AL Arctic Lubricant (low temperature service). Not available for CS valves.
–AM AGCO Mount Kit for 2-inch Pipestand Mounting. (page 113)
–BL Bonnet Lock Device (patent protected) (standard on power plant manifolds)
–CB Ceramic Ball Ended Stem
–CL Cleaned for Chlorine Service.
–OC Cleaned for Oxygen Service.
–HD Hydrostatic Testing
–SG Sour Gas meets the requirements of NACE MR0175-latest revision.
–ST Stellite Ball Ended Stem
–SP Special Requirements - please consult factory
–SB Steam Block (MC only)
–H5 H5VDS-22 Vent Valve (2) (MC3 only)
–1H5 H5VDS-22 Vent Valve (1) (MC2, MC3 only)
–PS For M5G Static Test Ports only

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Integral Manifolds – MT (Rosemount® Coplanar™ only) Specifications

Ordering Information

MT 3 V I S –4 –SG

Style

MT – Traditional (double flanged)

Type

2 – Two Valve (static pressure)
3 – Three Valve (ΔP)

Packing

V – Teflon® (patent protected)
H – GRAFOIL®
E – Low Emissions Graphite

Seat

I – Integral (body material)

Material

S – 316 SS

End Connection

2 – 1/4-inch FNPT (use if futbol mounting to inlet)

Options

–AL	Arctic Lubricant (low temperature service). Not available for CS valves.
–AM	AGCO Mount Kit for 2-inch Pipestand Mounting. (page 113)
–BL	Bonnet Lock Device (patent protected) (standard on power plant manifolds)
–CB	Ceramic Ball Ended Stem
–CL	Cleaned for Chlorine Service.
–OC	Cleaned for Oxygen Service.
–HD	Hydrostatic Testing
–SG	Sour Gas meets the requirements of NACE MR0175-latest revision.
–ST	Stellite Ball Ended Stem
–SP	Special Requirements - please consult factory

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Integral Manifolds – MC and MT ASME B31.1 Specifications

MC ASME B31.1 Ordering Information – Power Industry Applications[1]

MC 3HP S –4 –XP –SP

Style
MC – Coplanar™

Type
2HP – Two Valve (static pressure)
3HP – Three Valve (ΔP)
5HP – Five Valve (power) (ΔP)

Material
S – 316 SS

End Connection
2 – 1/4-inch FNPT (use if futbol mounting to inlet)
4 – 1/2-inch FNPT

Options
–AM AGCO Mount Kit for 2-inch Pipestand Mounting. (page 113)
–SP Special Requirements - please consult factory

MT ASME B31.1 Ordering Information – Power Industry Applications[1]

MT 3HP S –4 –XP –SP

Style
MT – Traditional (double flanged)

Type
2HP – Two Valve (static pressure)
3HP – Three Valve (ΔP)

Material
S – 316 SS

End Connection
2 – 1/4-inch FNPT (use if futbol mounting to inlet)

Options
–AM AGCO Mount Kit for 2-inch Pipestand Mounting. (page 113)
–SP Special Requirements - please consult factory

Notes

1. All Manifolds come standard with GRAFOIL® packing, integral seats, bonnet locks, and are subjected to hydrostatic testing.
2. Manifold ratings:
   6000 psig @ 100°F
   2915 psig @ 1000°F
   [414 barg @ 38°C]
   [201 barg @ 538°C]
3. See page 148 for Code Requirements.

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Allen-Bradley

1756 ControlLogix Chassis and Power Supplies

ATTENTION:
- Before installing, configuring, operating or maintaining this product, read this document and the documents listed in the Additional Resources section for installing, configuring, or operating equipment. Users should familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.
- Installation, adjustments, putting into service, use, assembly, disassembly, and maintenance shall be carried out by suitably trained personnel in accordance with applicable code of practice. In case of malfunction or damage, no attempts at repair should be made. The module should be returned to the manufacturer for repair. Do not dismantle the module.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
- Equipment designated as 'XT' is certified for use only within surrounding air temperature range of -25...70 °C (-13...158 °F). Equipment designated as 'LXT' is certified for use only within a surrounding air temperature range of -25...60 °C (-13...140 °F) even when used with other 'XT' equipment. Non-XT equipment is certified for use only within surrounding air temperature range of 0...60 °C (32...140 °F). The equipment must not be used outside its range.
- Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls, publication SGI-1.1, available from your local Rockwell Automation® sales office or online at http://www.rockwellautomation.com/literature describes some important differences between solid state equipment and hard-wired electromechanical devices.

IMPORTANT Any illustrations, charts, sample programs, and layout examples shown in this publication are intended solely for the purposes of example. Since there are many variables and requirements associated with any particular installation, Rockwell Automation does not assume responsibility or liability for actual use based upon the examples shown in this publication.

ATTENTION: Do not install this product until you read the documentation in your local language. Go to http://www.rockwellautomation.com/literature or contact your local sales office or Rockwell Automation representative.

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Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA or be approved for the application if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:
- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements
- NEMA 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations:
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local authority having jurisdiction at the time of installation.

WARNING: EXPLOSION HAZARD
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Substitution of components may impair suitability for Class I, Division 2.
- If this product contains batteries, they must be changed only in an area known to be nonhazardous.

Informations sur l'utilisation de cet équipement en environnements dangereux:
Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation

AVERTISSEMENT: RISQUE D'EXPLOSION
- Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement.
- Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit.
- La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2.
- S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

The following applies to products marked Ex II 3 G: Such modules:
- Are Equipment Group II, Equipment Category 3, and comply with the Essential Health and Safety Requirements relating to the design and construction of such equipment given in Annex II to Directive 94/9/EC. See the EC Declaration of Conformity at http://www.rockwellautomation.com/products/certification for details. The type of protection used is "Ex nA IIC T- or Ex nC IIC T-" according to EN 60079-15. The specific temperature code is marked on the product.
- Are intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air or dust mixtures are unlikely to occur, or are likely to occur only infrequently and for short periods. Such locations correspond to Zone 2 classification according to ATEX directive 1999/92/EC.

WARNING: Special Conditions for Safe Use:
- This equipment must be installed in an enclosure providing at least IP54 protection when applied in Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Rockwell Automation.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Zone 2 environments.
- This equipment must be used only with ATEX certified Rockwell Automation backplanes.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

Wires, Cables and Torque Ratings

Cat. Nos.	Description	Wire Size/Cable	Torque
1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17, 1756-A4LXT, 1756-A5XT, 1756-A7LXT, 1756-A7XT	Protective Earth Ground (terminal stud)	2.1 mm^2 (14 AWG) solid or stranded copper wire rated at 90 °C (194 °F) or greater	16.27 N•m (12 lb•in)
	Functional Earth Ground (mounting tab)	8.3 mm^2 (8 AWG) solid or stranded copper wire rated at 90 °C (194 °F) or greater	N/A
1756-PA72, 1756-PA75, 1756-PB72, 1756-PB75, 1756-PC75, 1756-PH75, 1756-PAXT, 1756-PBXT	Protective Earth Ground	2.1 mm^2 (14 AWG) solid or stranded copper wire rated at 90 °C (194 °F) or greater	0.8 N•m (7 lb•in)
	Power	2.5 mm^2 (14 AWG) solid or stranded copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max	
1756-PA75R, 1756-PB75R	Protective Earth Ground	2.1 mm^2 (14 AWG) solid or stranded copper wire rated at 90 °C (194 °F) or greater	
	Power	2.5 mm^2 (14 AWG) solid or stranded copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max	
	Annunciator Cable	0.25... 2.5 mm^2 (22...14 AWG) solid or stranded copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max	

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
ControlLogix Selection Guide, publication 1756-SG001	Provides overview of the ControlLogix® system and its products.
ControlLogix Chassis Specifications Technical Data, publication 1756-TD006	Provides technical specifications for ControlLogix chassis.
ControlLogix Power Supplies Specifications Technical Data, publication 1756-TD005	Provides technical specifications for ControlLogix power supplies.
ControlLogix Chassis and Power Supplies Installation Instructions, publication 1756-IN005	Provides planning and installation information for the ControlLogix chassis and power supplies.
ControlLogix System User Manual, publication 1756-UM001	Provides information on how to install, configure, program, and use ControlLogix controllers.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http://www.rockwellautomation.com/literature/.
To order paper copies of technical documentation, contact your local Allen-Bradley® distributor or Rockwell Automation sales representative.

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Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Publication 1756-PC007A-EN-P - December 2011

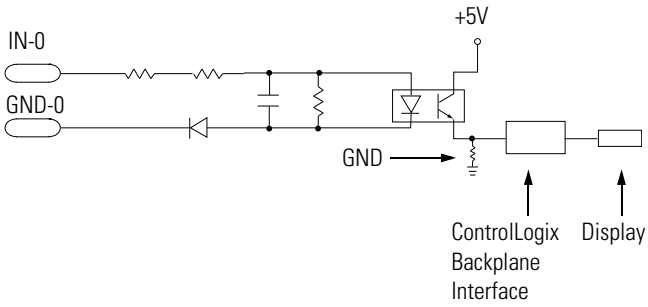
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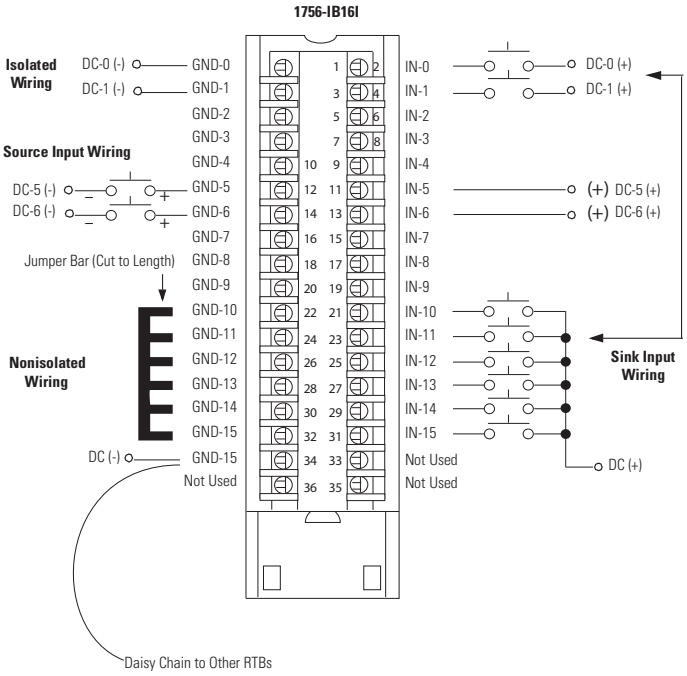
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1756-IB16I

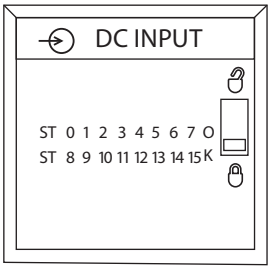
ControlLogix DC (10...30V) isolated input module

Simplified Schematic





Additional jumper bars are available as cat. no. 1756-JMPR.



Attribute	1756-IB16I
Inputs	16 individually isolated
Voltage category	12/24V DC sink/source
Operating voltage range	10...30V DC
Input voltage, nom	24V DC
Input delay time OFF to ON ON to OFF	 Hardware delay: 1 ms max + filter time User-selectable filter time: 0, 1, or 2 ms Hardware delay: 4 ms max + filter time User-selectable filter time: 0, 1, 2, 9, or 18 ms
Current draw @ 5.1V	100 mA
Current draw @ 24V	3 mA
Power dissipation, max	5 W @ 60 °C (140 °F)
Thermal dissipation	17.05 BTU/hr
Off-state voltage, max	5V
Off-state current, max	1.5 mA
On-state current, min	2 mA @ 10 V DC
On-state current, max	10 mA @ 30V DC
Inrush current, max	250 mA peak (decaying to < 37% in 22 ms, without activation)

Attribute	1756-IB16I
Input impedance, max	3 kΩ @ 30V DC
Cyclic update time	200 µs...750 ms
Isolation voltage	250V (continuous), basic insulation type, inputs-to-backplane, and input-to-input Routine tested @ 1350V AC for 2 s
Removable terminal block housing	1756-TBCH 1756-TBS6H
Slot width	1
Wire size	0.33... 2.1 mm^2 (22...14 AWG) solid or stranded copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max(1)
Wire category	1(2)
North American temperature code	T4
IEC temperature code	T4
Enclosure type	None (open-style)

(1) Maximum wire size requires extended housing, catalog number 1756-TBE.

(2) Use this conductor category information for planning conductor routing as described in the system-level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Attribute	1756-IB16I
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)
Temperature, surrounding air	60 °C (140 °F)
Temperature, storage IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Nonoperating Damp Heat)	5…95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g
Emissions	CISPR 11: Group 1, Class A
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80... 2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000...2700 MHz
EFT/B immunity IEC 61000-4-4	±4 kV at 5 kHz on signal ports

Attribute	1756-IB16I
Surge transient immunity IEC 61000-4-5	±1 kV line-line (DM) and ±2 kV line-earth (CM) on signal ports
Conducted RF immunity IEC 61000-4-6	10Vrms with 1 kHz sine-wave 80% AM from 150 kHz...80 MHz
Oscillatory surge withstand IEEE C37.90.1	3 kV

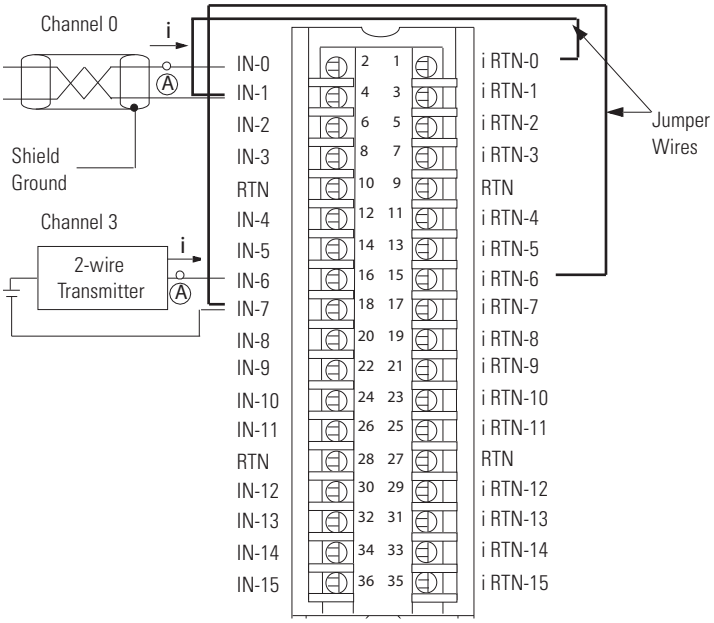
Certification[1]	1756-IB16I
UL	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584.
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.
CE	European Union 2004/108/IEC EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2006/95/EC LVD, compliant with: • EN 61131-2; Programmable Controllers (Clause 11)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
Ex	European Union 94/9/EC ATEX Directive, compliant with: • EN 60079-15; Potentially Explosive Atmospheres, Protection "n" • EN 60079-0; General Requirements II 3 G Ex nA IIC T4 X
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations
TÜV	TÜV Certified for Functional Safety: Capable of SIL 2

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

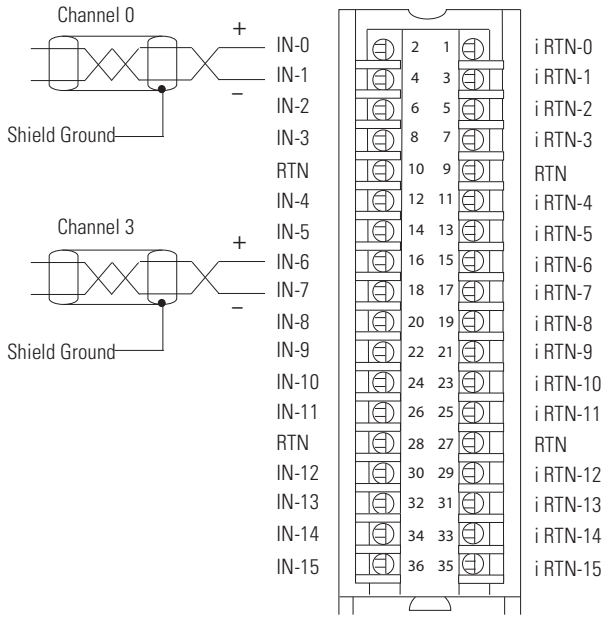
1756-IF16

ControlLogix voltage/current analog input module

1756-IF16 Differential Current



1756-IF16 Differential Voltage



- Use this table when wiring your module in Differential mode.

This channel	Uses these terminals
Channel 0	IN-0 (+), IN-1 (-), i RTN-0
Channel 1	IN-2 (+), IN-3 (-), i RTN-2
Channel 2	IN-4 (+), IN-5 (-), i RTN-4
Channel 3	IN-6 (+), IN-7 (-), i RTN-6
Channel 4	IN-8 (+), IN-9 (-), i RTN-8
Channel 5	IN-10 (+), IN-11 (-), i RTN-10
Channel 6	IN-12 (+), IN-13 (-), i RTN-12
Channel 7	IN-14 (+), IN-15 (-), i RTN-14

- All terminals marked RTN are connected internally.
- A 249 Ω current loop resistor is located between IN-*x* and i RTN-*x* terminals.
- If multiple (+) or multiple (-) terminals are tied together, connect that tie point to a RTN terminal to maintain the module's accuracy.
- Place additional loop devices (such as strip chart recorders) at the A location in the current loop.
- Do not connect more than two wires to any single terminal.

IMPORTANT: When operating in 4 channel, High Speed mode, only use channels 0, 2, 4, and 6.

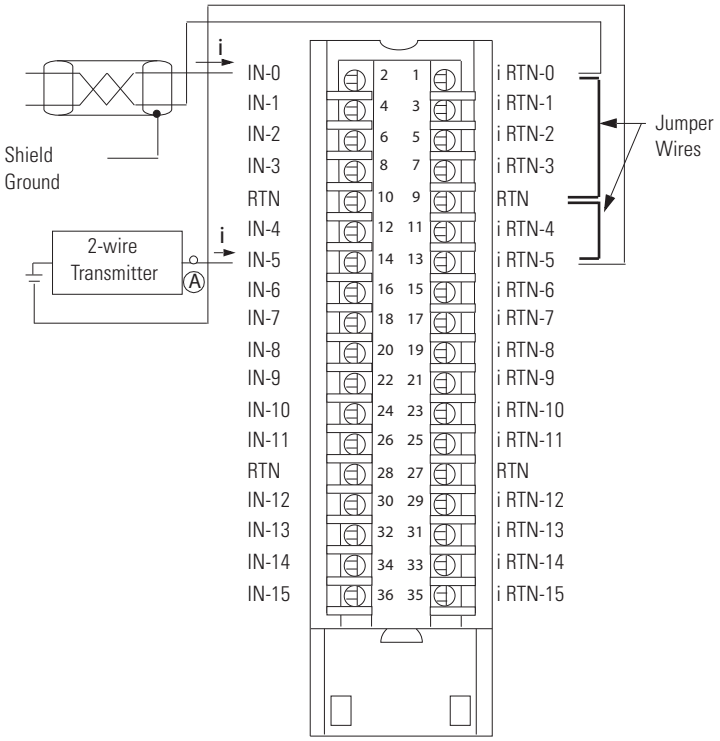
- Use this table when wiring your module in Differential mode.

This channel	Uses these terminals
Channel 0	IN-0 (+), IN-1 (-)
Channel 1	IN-2 (+), IN-3 (-)
Channel 2	IN-4 (+), IN-5 (-)
Channel 3	IN-6 (+), IN-7 (-)
Channel 4	IN-8 (+), IN-9 (-)
Channel 5	IN-10 (+), IN-11 (-)
Channel 6	IN-12 (+), IN-13 (-)
Channel 7	IN-14 (+), IN-15 (-)

- All terminals marked RTN are connected internally.
- If multiple (+) or multiple (-) terminals are tied together, connect that tie point to a RTN terminal to maintain the module's accuracy.
- Terminals marked RTN or i RTN are not used for differential voltage wiring.
- Do not connect more than two wires to any single terminal.

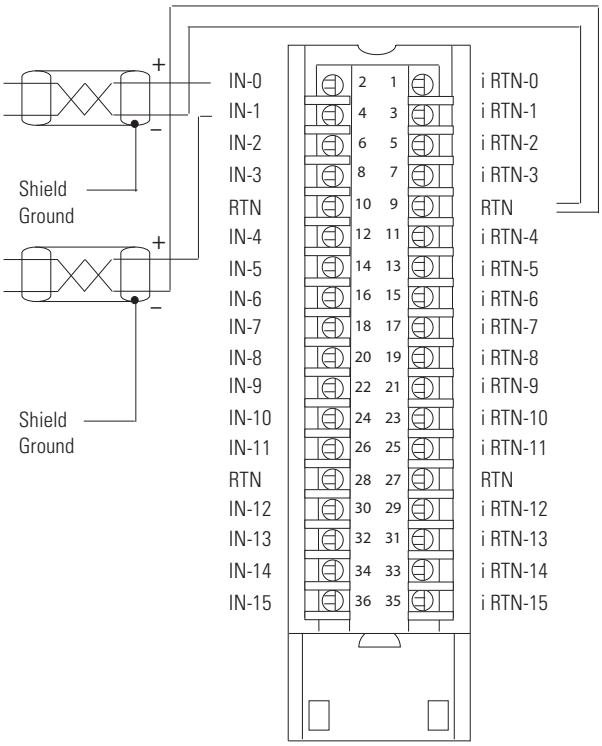
IMPORTANT: When operating in 4 channel, High Speed mode, only use channels 0, 2, 4, and 6.

1756-IF16 Single-ended Current

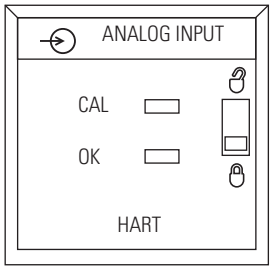


- All terminals marked RTN are connected internally.
- For current applications, all terminals marked i RTN must be wired to terminals marked RTN.
- A 249 Ω current loop resistor is located between IN-*x* and iRTN-*x* terminals.
- Place additional loop devices (such as strip chart recorders) at the A location in the current loop.
- Do not connect more than two wires to any single terminal.

1756-IF16 Single-ended Voltage



- All terminals marked RTN are connected internally.
- Terminals marked i RTN are not used for single-ended voltage wiring.
- Do not connect more than two wires to any single terminal.



Attribute	1756-IF16
Inputs	16 single ended, 8 differential or 4 differential (high speed)
Input range	±10.25V 0…10.25V 0…5.125V 0…20.5 mA
Resolution	±10.25V (15 bits + sign bipolar) 0…10.25V (16 bits) 0…5.125V (16 bits) 0…20.5 mA (16 bits)
Current draw @ 5.1V	150 mA
Current draw @ 24V	65 mA
Power dissipation, max	Voltage: 2.3 W Current: 3.9 W

Attribute	1756-IF16
Thermal dissipation	Voltage: 7.84 BTU/hr Current: 13.3 BTU/hr
Input impedance	Voltage: >10 MΩ Current: 249 Ω
Open circuit detection time	Differential voltage - Positive full scale reading within 5 s Single-ended/differential current - Negative full scale reading within 5 s Single-ended voltage - Even numbered channels go to positive full scale reading within 5 s, odd numbered channels go to negative full scale reading within 5 s
Overvoltage protection, max	Voltage: 30V DC Current: 8V DC
Normal mode noise rejection	>80 dB @ 60 Hz(1)
Common mode noise rejection	100 dB @ 50/60 Hz
Channel bandwidth	15 Hz (-3 dB)(1)
Settling time	<80 ms to 5% of full scale(1)
Calibrated accuracy 25 °C (77 °F)	Voltage: Better than 0.05% of range Current: Better than 0.15% of range
Offset drift	45 μV/°C
Gain drift with temperature	Voltage: 15 ppm Current: 20 ppm
Module error	Voltage: 0.1% of range Current: 0.3% of range
Module input scan time, min	16 pt single-ended: 16...488 ms 8 pt differential: 8...244 ms 4 pt differential: 5...122 ms(1)
Isolation voltage	250V (continuous), reinforced insulation type, inputs-to-backplane No isolation between individual inputs Routine tested at 1350V AC for 2 s
Removable terminal block	1756-TBCH 1756-TBS6H
Slot width	1
Wire size	0.33... 2.1 mm^2 (22...14 AWG) solid or stranded copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max(2)
Wire category	2(3)
North American temperature code	T4A
IEC temperature code	T4
Enclosure type	None (open-style)

(1) Notch filter dependent.

(2) Maximum wire size requires extended housing, catalog number 1756-TBE.

(3) Use this conductor category information for planning conductor routing as described in the system-level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Attribute	1756-IF16
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)
Temperature, surrounding air	60 °C (140 °F)
Temperature, storage IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Nonoperating Damp Heat)	5…95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g
Emissions	CISPR 11: Group 1, Class A
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80... 2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000...2700 MHz
EFT/B immunity IEC 61000-4-4	±2 kV at 5 kHz on shielded signal ports
Surge transient immunity IEC 61000-4-5	±2 kV line-earth (CM) on shielded signal ports
Conducted RF immunity IEC 61000-4-6	10Vrms with 1 kHz sine-wave 80% AM from 150 kHz...80 MHz on shielded signal ports

Certification(1)	1756-IF16
UL	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584.
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.
CE	European Union 2004/108/IEC EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2006/95/EC LVD, compliant with: • EN 61131-2; Programmable Controllers (Clause 11)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
Ex	European Union 94/9/EC ATEX Directive, compliant with: • EN 60079-15; Potentially Explosive Atmospheres, Protection "n" • EN 60079-0; General Requirements II 3 G Ex nA IIC T4 X
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations
TÜV	TÜV Certified for Functional Safety: Capable of SIL 2

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Allen-Bradley

1756 ControlLogix Power Supplies Specifications

Standard Power Supplies Catalog Numbers 1756-PA72, 1756-PA75, 1756-PB72, 1756-PB75, 1756-PC75, 1756-PH75
ControlLogix-XT Power Supplies Catalog Numbers 1756-PAXT, 1756-PBXT
Redundant Power Supplies Catalog Numbers 1756-PA75R, 1756-PB75R
Chassis Adapter Module Catalog Number 1756-PSCA2

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Redundant Power Supplies	10

ControlLogix® power supplies are used with the 1756 chassis to provide 1.2V, 3.3V, 5V, and 24V DC power directly to the chassis backplane. Standard, ControlLogix-XT™, and redundant power supplies are available.

Standard AC Power Supplies

Table 1 - Technical Specifications - ControlLogix Standard AC Power Supplies

Attribute	1756-PA72/C	1756-PA75/B
Input voltage range	85…265V AC	
Input voltage, nom	120V/240V AC	
Input frequency range	47…63 Hz	
Input power, max	100VA/100 W	
Output power, max	75 W @ 0…60 °C (32…140 °F)(2)	
Power consumption	25 W @ 0…60 °C (32…140 °F)	
Power dissipation	85.3 BTU/hr	
Hold up time(1)	5 cycles @ 85V AC, 50/60 Hz 6 cycles @ 120V AC, 50/60 Hz 6 cycles @ 200V AC, 50/60 Hz 6 cycles @ 240V AC, 50/60 Hz	
Inrush current, max	20 A	
Current capacity at 1.2V DC	1.5 A	
Current capacity at 3.3V DC	4 A	
Current capacity at 5.1V DC	10 A	13 A
Current capacity at 24V DC	2.8 A	
Overcurrent protection, max	User-supplied 15 A(3)	
Fusing	Non-replaceable fuse is soldered in place(4)	
Transformer load, max	100VA	
Isolation voltage	250V (continuous), reinforced insulation type Type tested @ 3500V DC for 60 s, power input-to-backplane	
Weight, approx.	0.95 kg (2.10 lb)	
Dimensions	140 x 112 x 145 mm (5.51 x 4.41 x 5.71 in.)	
Module location	Left side of 1756 chassis	Left side of 1756 chassis (series B only)
Chassis	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17	
Chassis compatibility	Series A Series B	Series B
Wire size	2.5 mm^2 (14 AWG) solid or stranded copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max	
Wire category	1 - on power ports(5)	
Conductor screw torque	0.8 N•m (7 lb•in)	
North American temperature code	T4	
Enclosure type rating	None (open-style)	

(1) The hold up time is the time between input voltage removal and DC power failure.
(2) The combination of all output power (5.1V backplane, 24V backplane, 3.3V backplane, and 1.2V backplane) cannot exceed 75 W.
(3) Use time-delay type overcurrent protection in all ungrounded conductors.
(4) This fuse is intended to guard against fire hazard due to short circuit conditions.
(5) Use this conductor category information for planning conductor routing as described in the system level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Table 2 - Environmental Specifications - ControlLogix Standard AC Power Supplies

Attribute	1756-PA72/C, 1756-PA75/B
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)
Temperature, surrounding air, max	60 °C (140 °F)
Temperature, non-operating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5…95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g
Emissions	CISPR 11: Group 1, Class A
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80... 2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1kHz sine-wave 80% AM from 2000...2700 MHz
EFT/B immunity IEC 61000-4-4	±4 kV at 5 kHz on power ports
Surge transient immunity IEC 61000-4-5	±1 kV line-line (DM) and ±2 kV line-earth (CM) on power ports
Conducted RF immunity IEC 61000-4-6	10 Vrms with 1 kHz sine-wave 80% AM from 150 kHz...80 MHz
Oscillatory surge withstand IEEE C37.90.1	3 kV
Voltage variation IEC 61000-4-11	30% dips for 1 period at 0° and 80° on AC supply ports 60% dips for 5 and 50 periods on AC supply ports ±10% fluctuations for 15 min on AC supply ports >95% interruptions for 250 periods on AC supply ports

Table 3 - Certifications - ControlLogix Standard AC Power Supplies

Certification(1)	1756-PA72/C, 1756-PA75/B
UL	UL Listed Industrial Control Equipment. See UL File E65584.
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations
CE	European Union 2004/108/EC EMC Directive, compliant with: EN 61326-1; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2006/95/EC LVD, compliant with: EN 61131-2; Programmable Controllers (Clause 11)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Standard DC Power Supplies

Table 4 - Technical Specifications - ControlLogix Standard DC Power Supplies

Attribute	1756-PB72/C	1756-PB75/B	1756-PC75/B	1756-PH75/B
Input voltage range	18…32V DC		30…60V DC	90…143V DC
Input voltage, nom	24V DC		48V DC	125V DC
Input power, max	95 W			
Output power, max	75 W @ 0…60 °C (32…140 °F)(2)			
Power consumption	20 W @ 0…60 °C (32…140 °F)			
Power dissipation	68.2 BTU/hr			
Hold up time(1)	35 ms @ 18V DC 40 ms @ 24V DC 40 ms @ 32V DC		50 ms @ 30…60V DC nom	50 ms @ 90…143V DC nom
Inrush current, max	30 A		20 A	
Current capacity at 1.2V	1.5 A			
Current capacity at 3.3V	4 A			
Current capacity at 5.1V	10 A	13 A		
Current capacity at 24V	2.8 A			
Overcurrent protection, max	User-supplied 15 A(3)			
Fusing	Non-replaceable fuse is soldered in place(4)			
Isolation voltage	250V (continuous), reinforced insulation type, power input-to-backplane Type tested @ 3500V DC for 60 s			
Weight, approx.	0.95 kg (2.10 lb)			
Dimensions	140 x 112 x 145 mm (5.51 x 4.41 x 5.71 in.)			
Module location	Left side of 1756 chassis			
Chassis	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17			
Chassis compatibility	Series A Series B	Series B		
Wire size	2.5 mm^2 (14 AWG) solid or stranded copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max			
Wire category	1 - on power ports(5)			
Conductor screw torque	0.8 N•m (7 lb•in)			
North American temperature code	T4			
IEC temperature code	T4		N/A	
Enclosure type rating	None (open-style)			

(1) The hold up time is the time between input voltage removal and DC power failure.
(2) The combination of all output power (5.1V backplane, 24V backplane, 3.3V backplane, and 1.2V backplane) cannot exceed 75 W.
(3) Use time-delay type overcurrent protection in all ungrounded conductors.
(4) This fuse is intended to guard against fire hazard due to short circuit conditions.
(5) Use this conductor category information for planning conductor routing as described in the system level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Table 5 - Environmental Specifications - ControlLogix Standard DC Power Supplies

Attribute	1756-PB72/C, 1756-PB75/B	1756-PC75/B, 1756-PH75/B
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)	
Temperature, surrounding air, max	60 °C (140 °F)	
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)	
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5…95% noncondensing	
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz	
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g	
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g	
Emissions	CISPR 11: Group 1, Class A	
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges	
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80... 2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000...2700 MHz	
EFT/B immunity IEC 61000-4-4	±4 kV at 5 kHz on power ports	
Surge transient immunity IEC 61000-4-5	±1 kV line-line (DM) and ±2 kV line-earth (CM) on power ports	
Conducted RF immunity IEC 61000-4-6	10 Vrms with 1 kHz sine-wave 80% AM from 150 kHz...80 MHz	
Oscillatory surge withstand IEEE C37.90.1	N/A	3 kV
Voltage variation IEC 61000-4-11 IEC 61000-4-29	 60% dips for 100 ms on DC supply ports 100% dips for 50 ms on DC supply ports ±20% fluctuations for 15 min on DC supply ports 5 s interruptions on DC supply ports 10 ms interruption on DC supply ports	

Table 6 - Certifications - ControlLogix Standard DC Power Supplies

Certification[1]	1756-PB72/C, 1756-PB75/B	1756-PC75/B, 1756-PH75/B
UL	N/A	UL Listed Industrial Control Equipment. See UL File E65584.
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for US and Canada. See UL File E194810.	N/A
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.	
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations	N/A
CE	European Union 2004/108/EC EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2006/95/EC LVD, compliant with: • EN 61131-2; Programmable Controllers (Clause 11)	
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions	
Ex	European Union 94/9/EC ATEX Directive, compliant with: • EN 60079-15; Potentially Explosive Atmospheres, Protection "n" • EN 60079-0; General Requirements II 3 G Ex nA IIC T4 X	N/A
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3	

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756 ControlLogix-XT Power Supplies

The ControlLogix-XT products include control and communication system components that, when used with FLEX I/O-XT™ products, provide a complete control system solution that can be used in environments where temperatures range from -20...70 °C (-4...158 °F).

When used independently, the ControlLogix-XT system can withstand environments where the temperature ranges from -25...70 °C (-13...158 °F).

Table 7 - Technical Specifications - ControlLogix-XT Power Supplies

Attribute	1756-PAXT	1756-PBXT
Input voltage range	85...265V AC	18…32V DC
Input voltage, nom	120/240V AC	24V DC
Input frequency range	47…63 Hz	N/A
Input power, max	82VA 64 W	54 W
Output power, max	42 W @ -25…70 °C (-13…158 °F)	
Power consumption	22 W	12 W
Power dissipation	75.1 BTU/hr	40.9 BTU/hr
Hold up time(1)	6 cycles @ 85V AV, 50/60 Hz 6 cycles @ 120V AV, 50/60 Hz 6 cycles @ 200V AV, 50/60 Hz 6 cycles @ 240V AV, 50/60 Hz	35 ms @ 18V DC 40 ms @ 24V DC 40 ms @ 32V DC
Inrush current, max	20 A	30 A
Current capacity at 1.2V	1.5 A	
Current capacity at 3.3V	4 A	
Current capacity at 5.1V	8 A	
Current capacity at 24V	1.75 A	
Overcurrent protection, max	User-supplied 15 A(2)	
Fusing	Non-replaceable fuse is soldered in place(3)	
Isolation voltage	250V (continuous), reinforced insulation type, power input-to-backplane Type tested @ 3260V DC for 60 s	
Weight, approx.	0.95 kg (2.10 lb)	
Dimensions	140 x 112 x 145 mm (5.51 x 4.41 x 5.71 in.)	
Module location	Left side of 1756 chassis	
Chassis	1756-A4XT, 1756-A5XT, 1756-A7XLT	
Wire size	2.5 mm^2 (14 AWG) solid or stranded copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max	
Wire category	1 - on power ports(4)	
Conductor screw torque	0.8 N•m (7 lb•in)	
North American temperature code	T4	T4A
IEC temperature code	T4	
Enclosure type rating	None (open-style)	

(1) The hold up time is the time between input voltage removal and DC power failure.
(2) Use time-delay type overcurrent protection in all ungrounded conductors.
(3) This fuse is intended to guard against fire hazard due to short circuit conditions.
(4) Use this conductor category information for planning conductor routing as described in the system level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Table 8 - Environmental Specifications - ControlLogix-XT Power Supplies

Attribute	1756-PAXT	1756-PBXT
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	-25…70 °C (-13…158 °F)	
Temperature, surrounding air, max	70 °C 158 °F)	
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)	
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5…95% noncondensing	
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz	
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g	
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g	
Emissions	CISPR 11: Group 1, Class A	
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges	
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz	
EFT/B immunity IEC 61000-4-4	±4 kV at 5 kHz on power ports	
Surge transient immunity IEC 61000-4-5	±1 kV line-line (DM) and ±2 kV line-earth (CM) on power ports	
Conducted RF immunity IEC 61000-4-6	10 Vrms with 1 kHz sine-wave 80% AM from 150 kHz...80 MHz	
Oscillatory surge withstand IEEE C37.90.1	3 kV	N/A
Voltage variation IEC 61000-4-11 IEC 61000-4-29	30% dips for 1 period at 0° and 180° on AC supply ports 60% dips for 5 and 50 periods on AC supply ports ±10% fluctuations for 15 min on AC supply ports >95% interruptions for 250 periods on AC supply ports N/A	60% dips for 100 ms on DC supply ports 100% dips for 50 ms on DC supply ports ±20% fluctuations for 15 min on DC supply ports 5 s interruptions on DC supply ports 10 ms interruption on DC supply ports

Table 9 - Certifications - ControlLogix-XT Power Supplies

Certification[1]	1756-PAXT, 1756-PBXT
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for US and Canada. See UL File E194810.
CE	European Union 2004/108/EC EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2006/95/EC LVD, compliant with: • EN 61131-2; Programmable Controllers (Clause 11)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
Ex	European Union 94/9/EC ATEX Directive, compliant with: • EN 60079-15; Potentially Explosive Atmospheres, Protection "n" • EN 60079-0; General Requirements II 3 G Ex nA IIC T4 X
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Redundant Power Supplies

To build a redundant power supply system, you need the following.

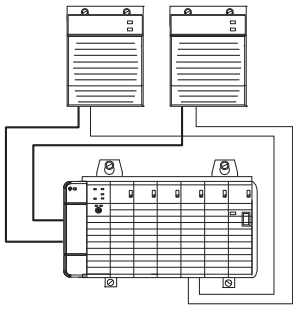
Cat. No.	Description	Amount
1756-PA75R/A or 1756-PB75R/A	Redundant power supply	2
1756-CPR2	Redundant power supply cable (Length = 0.9 1m [3 ft])	2
1756-PSCA2	Redundant power supply chassis adapter module(1)	1
User-supplied	Annunciator wiring(2) (Max. length = 10 m [32.8 ft])	2

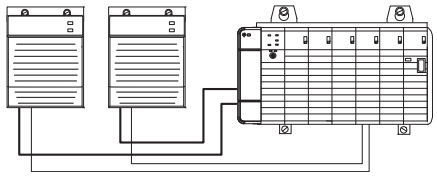
(1) The 1756-PSCA2 chassis adapter module is a passive device that funnels power from the redundant power supplies to the single power connector on the ControlLogix series B chassis backplane.
(2) Optional user-provided annunciator wiring can be connected to the solid state relay for status and troubleshooting purposes.

System Configuration Recommendations

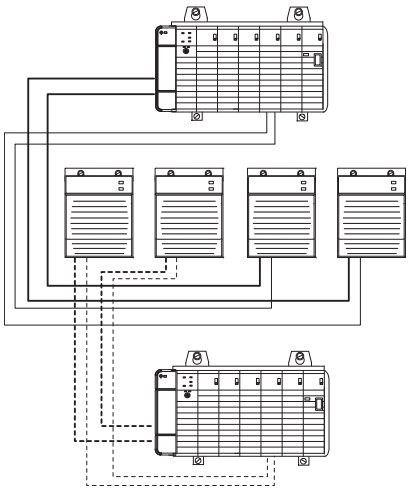
We recommend you use one of these methods to configure your redundant power supply system.

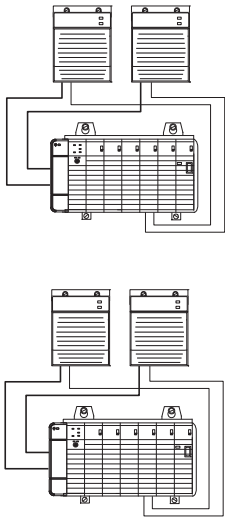
Recommended Configurations for a System Using One Chassis



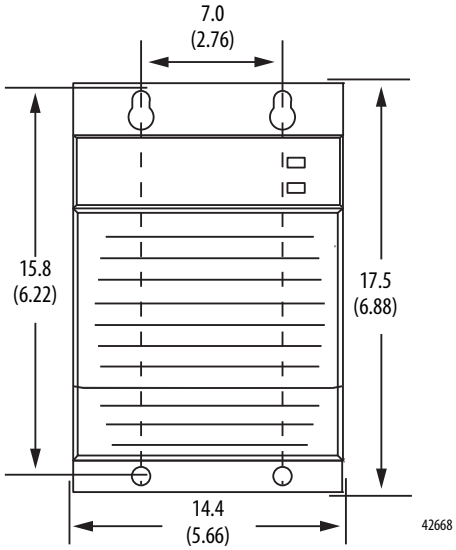


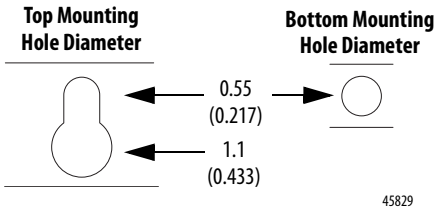
Recommended Configurations for a System Using Two Chassis





1756-PA75R and 1756-PB75R Mounting Dimensions





Dimensions are in cm (in.).

Redundant Power Supply Features

The redundant power supplies offer the same features as the standard power supplies, in addition to the following:

- Automatic chassis load sharing between the redundant power supplies
- Status indicators for visual operating status of the pair
- Solid state relay for system recognition of supply status when wired to an input module

Table 10 - Technical Specifications - ControlLogix Redundant Power Supplies

Attribute	1756-PA75R	1756-PB75R
Input voltage range	85…265V AC	19.2…32V DC
Input voltage	120V/220V AC	24V DC
Input frequency range	47…63 Hz	DC
Input power, max	120VA 115 W	110 W
Output power, max	75 W @ 0…60 °C (32…140 °F)	
Hold up time[1]	2 cycles @ 60 Hz 2 cycles @ 50 Hz	20 ms
Inrush current, max	20 A	30 A
Current capacity at 1.2V	1.5 A	
Current capacity at 3.3V	4 A	
Current capacity at 5.1V	13 A	
Current capacity at 24V	2.8 A	
Annunciator power	240V AC/DC, 50 mA, Resistive only	
Overcurrent protection, max	User-supplied 15 A[2]	
Fusing	Non-replaceable fuse is soldered in place[3]	
Isolation voltage	250V (continuous), Reinforced Insulation Type, Power Input to Backplane, Power Input to Annunciator, Annunciator to Backplane Type tested at 2500V DC for 60 s	

Table 10 - Technical Specifications - ControlLogix Redundant Power Supplies

Attribute	1756-PA75R	1756-PB75R
Dimensions (HxWxD), approx.	175 x 145 x 137 mm (6.9 x 5.7 x 5.4 in.)	
Weight, approx.	1.45 kg (3.2 lb)	
Chassis	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17	
Wire Size	Power - 2.5 mm^2 (14 AWG) solid or stranded copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max Annunciator - 0.25…2.5 mm^2 (22…14 AWG) solid or stranded copper wire rated at 90 °C (194 °F), or greater, 1.2 mm (3/64 in.) insulation max	
Wire category (4)	1 - on power ports 3 - on annunciator ports 3 - on 1756-CPR2 connections	
Pilot duty rating	Annunciator - not rated	
Conductor screw torque	0.79 N•m (7 lb•in)	
Solid state relay contact	240V AC/DC(5)	
North American temperature code	T3C	T4
IEC temperature code	N/A	T4
Enclosure type rating	None (open-style)	

(1) The hold up time is the time between input voltage removal and DC power failure.
(2) Use time-delay type overcurrent protection in all ungrounded conductors.
(3) This fuse is intended to guard against fire hazard due to short circuit conditions.
(4) Use this conductor category information for planning conductor routing as described in the system level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.
(5) Do not exceed 50 mA; resistive only.

Table 11 - Environmental Specifications - ControlLogix Redundant Power Supplies

Attribute	1756-PA75R	1756-PB75R
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)	
Temperature, surrounding air, max	60 °C 140 °F)	
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)	
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5…95% noncondensing	
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz	
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g	
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g	
Emissions	CISPR 11: Group 1, Class A	
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges	
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 30... 1000 MHz 10V/m with 200 Hz 50% Pulse 100% AM @ 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz	
EFT/B immunity IEC 61000-4-4	±4 kV at 5 kHz on power ports ±4 kV at 5 kHz on annunciator ports	

Table 11 - Environmental Specifications - ControlLogix Redundant Power Supplies

Attribute	1756-PA75R	1756-PB75R
Surge transient immunity IEC 61000-4-5	±1 kV line-line (DM) and ±2 kV line-earth (CM) on power ports	
Conducted RF immunity IEC 61000-4-6	10 Vrms with 1 kHz sine-wave 80% AM from 150 kHz...80 MHz	
Voltage variation IEC 61000-4-1 IEC 61000-4-29:	 30% dips for 1 period at 0° and 180° on AC supply ports 60% dips for 5 and 50 periods on AC supply ports ±10% fluctuations for 15 min on AC supply ports >95% interruptions for 250 periods on AC supply ports N/A	 60% dips for 100 ms on DC supply ports 100% dips for 50 ms on DC supply ports\ ±20% fluctuations for 15 min on DC supply ports 5 s interruptions on DC supply ports 10ms interruption on DC supply ports

Table 12 - Certifications - ControlLogix Redundant Power Supplies

Certification[1]	1756-PA75R	1756-PB75R
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.	
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.	
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations	
CE	European Union 2004/108/EC EMC Directive, compliant with: EN 61326-1; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) European Union 2006/95/EC LVD, compliant with: EN 61131-2; Programmable Controllers (Clause 11)	
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions	
Ex	N/A	European Union 94/9/EC ATEX Directive, compliant with: EN 60079-15; Potentially Explosive Atmospheres, Protection "n" EN 60079-0; General Requirements II 3 G Ex nA IIC T4 X
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3	

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

ControlLogix Redundant Power Supply Chassis Adapter Module

Table 13 - Technical Specifications - ControlLogix Redundant Power Supplies Chassis Adapter Module

Attribute	1756-PSCA2
Current capacity at 1.2V DC	1.5 A
Current capacity at 3.3V DC	4 A
Current capacity at 5.1V DC	15 A
Current capacity at 24V DC	2.8 A
Wire category [1]	3 - on 1756-CPR2 connections
North American temperature code	T5
IEC temperature code	T5
Enclosure type rating	None (open-style)

(1) Use this conductor category information for planning conductor routing as described in the system level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Table 14 - Environmental Specifications - ControlLogix Redundant Power Supplies Chassis Adapter Module

Attribute	1756-PSCA2
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)
Temperature, surrounding air, max	60 °C 140 °F)
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5…95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g
Emissions	CISPR 11: Group 1, Class A
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz

Table 15 - Certifications - ControlLogix Redundant Power Supplies Chassis Adapter Module

Certification(1)	1756-PSCA2
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations
CE	European Union 2004/108/EC EMC Directive, compliant with: EN 61326-1; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
Ex	European Union 94/9/EC ATEX Directive, compliant with: EN 60079-15; Potentially Explosive Atmospheres, Protection "n" EN 60079-0; General Requirements II 3 G Ex nA IIC T5 X
KC	Korean Registration of Broadcasting and Communications Equipment, compliant with: Article 58-2 of Radio Waves Act, Clause 3

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Power Load and Transformer Sizing

The following graphs show the input power requirements for the power supplies, given the power they are providing to the modules in the chassis.

Follow these steps to determine the power requirements for you chassis.

1. Calculate the Backplane Power Load by adding the power draw (in Watts) for all of the planned modules.

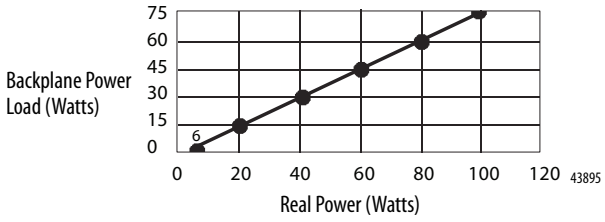
   For module power draws, refer to the module specification tables in the ControlLogix Selection Guide, publication 1756-SG001.

2. Locate the Backplane Power Load on the graph's vertical (y) axis and determine the corresponding Real Power (input-power) rating on the horizontal (x) axis.

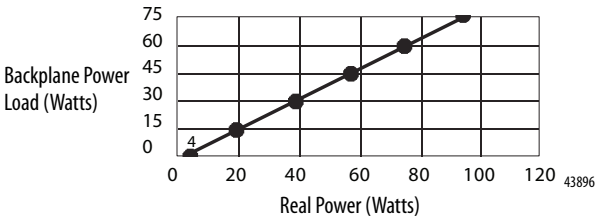
   The Real Power value is the amount of power consumed by the power supply.

Power Supply Power Requirements

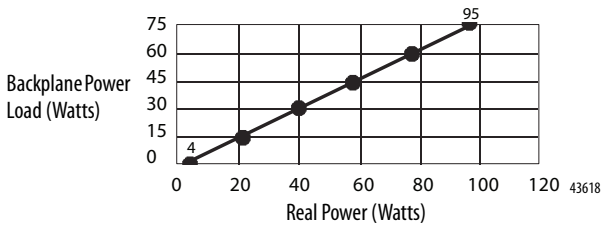
1756-PA72/C, 1756-PA75/B (AC)



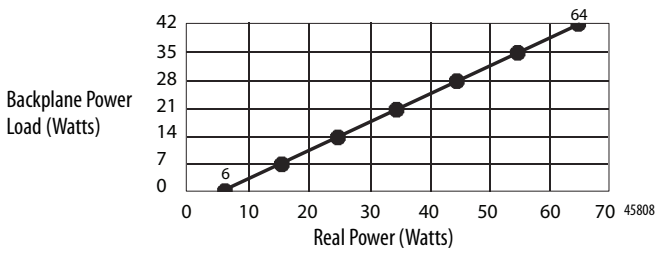
1756-PB72/C, 1756-PB75/B (DC)



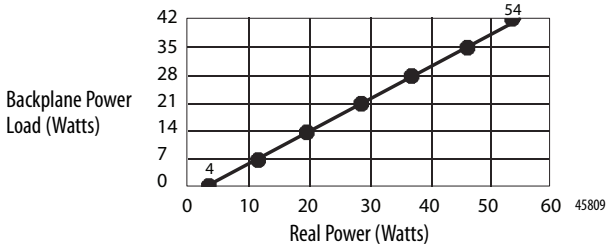
1756-PH75/B, 1756-PC75/B (DC)



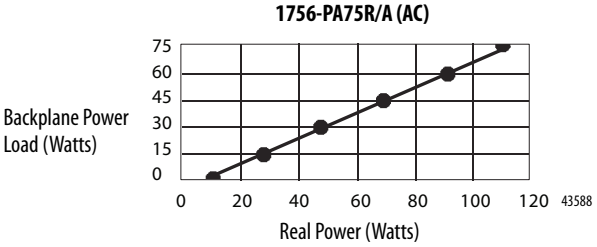
1756-PAXT (AC)



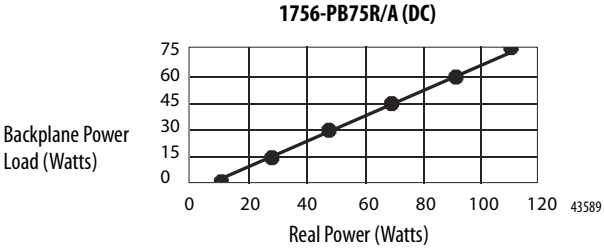
1756-PBXT (DC)



1756-PA75R/A (AC)



1756-PB75R/A (DC)



Apparent Power (Watts) = Transformer Load (VA) = Real Power (Watts)

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
ControlLogix Selection Guide, publication 1756-SG001	Provides overview of the ControlLogix system and its products.
ControlLogix Chassis Specifications Technical Data, publication 1756-TD006	Provides technical specifications for ControlLogix chassis.
ControlLogix Chassis and Power Supplies Installation Instructions, publication 1756-IN005	Provides planning and installation information for the ControlLogix chassis and power supplies.
ControlLogix System User Manual, publication 1756-UM001	Provides information on how to install, configure, program, and use ControlLogix systems.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation® industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http://www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley® distributor or Rockwell Automation sales representative.

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

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Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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Accessories - I/O Modules

1756 Removable Terminal Blocks



Removable terminal blocks (RTBs) provide a flexible interconnection between your plant wiring and 1756 I/O modules. The RTB plugs into the front of the I/O module. The type of module determines which RTB you need. You can choose screw-clamp or spring-clamp RTBs.

RTBs are not shipped with I/O modules. You must order them separately. The standard housing on the front of the wiring arm is not deep enough for 2.5 mm^2 (14 AWG) wiring. If you plan to use 2.5 mm^2 (14 AWG) wiring, also order the extended housing.

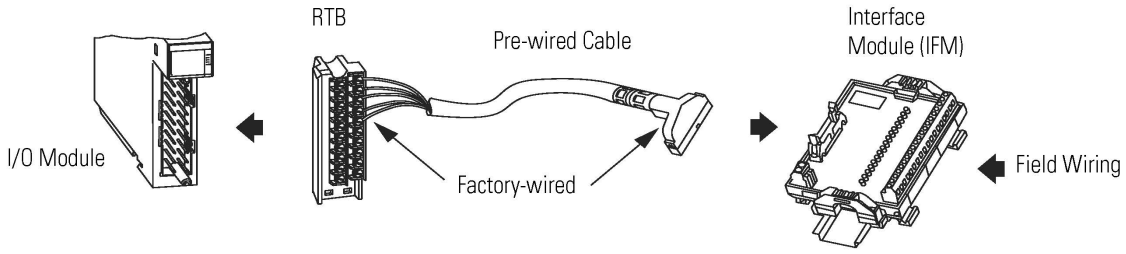
Attribute	1756-TBNH	1756-TBSH	1756-TBCH	1756-TBS6H	1756-TBE
Description	20-position NEMA screw-clamp removable block	20-pin spring-clamp removable terminal block with standard housing	36-pin cage-clamp removable terminal block with standard housing	36-pin spring-clamp removable terminal block with standard housing	Extended depth terminal block housing
Screw torque	0.8…1 N•m 7…9 lb•in		0.4 N•m 4.4 lb•in		—
Screwdriver width	8 mm (5/16 in.) max				

Wiring Systems



As an alternative to buying RTBs and connecting the wires yourself, you can buy a wiring system of:

- interface modules (IFMs) that provide the output terminal blocks for digital I/O modules. Use the pre-wired cables that match the I/O module to the IFM.
- analog interface modules (AIFMs) that provide the output terminal blocks for analog I/O modules. Use the pre-wired cables that match the I/O module to the AIFM.
- I/O module-ready cables. One end of the cable assembly is an RTB that plugs into the front of the I/O module. The other end has individually color-coded conductors that connect to a standard terminal block.





PanelConnect Modules

A PanelConnect module and its sensor connection system connect sensors directly to I/O modules by using convenient pre-built cables and connectors.

The PanelConnect module mounts on the enclosure and creates the correct seal for the entry of the sensor connections. You do not need to seal the opening where the sensor cables enter the enclosure, create custom connectors, or wire to those custom connectors.

Passive Speed Sensors

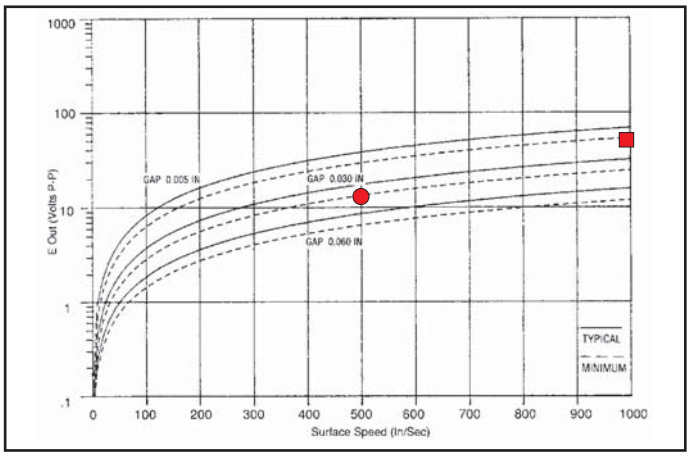
LISTED PRODUCT

UL/CSA Sensors

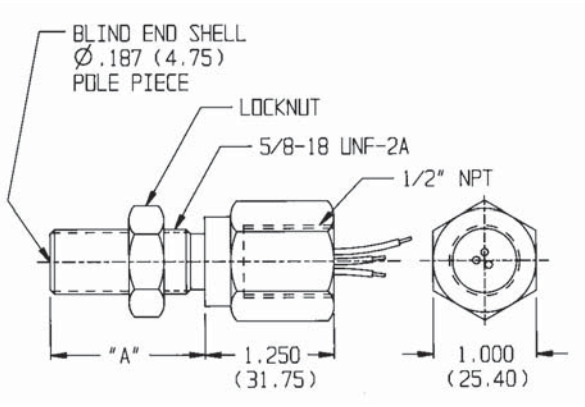
Ordering Part #	Thread Length (A)	
70085-1010-081	1.500	(38.10)
70085-1010-411	1.875	(47.63)
70085-1010-329	2.750	(69.85)
70085-1010-330	4.000	(101.60)
70085-1010-412	6.000	(152.40)

Rating: UL and CSA listed for hazardous locations. Class I, Div 1, Groups A, B, C & D; Class II, Div 1, Groups E, F ,G. Temp Code T3C. Consult factory for ATEX listing.

Performance Curves



Based on 8 D.P. Gear



Specifications:

- ■ Output Voltage (Standard): 54 V (P-P)
- ● Output Voltage (Guarantee Point):13.4 V (P-P)

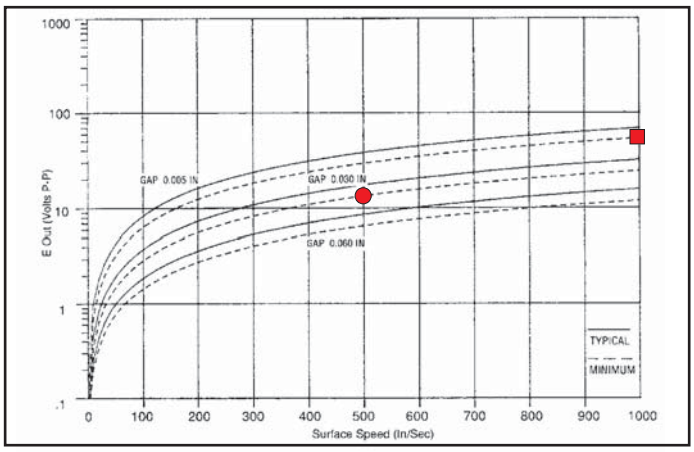
DC Resistance: 240 ohms max.
Typical Inductance: 30 mH ref.
Output Polarity: White lead positive
Operating Temperature: -65 to 100°C
Lead Length: 10 ft (3.05 m)
Housing Ground: Green/Yellow Tracer
Net Weight: 14 oz. max.

UL/CSA Sensors

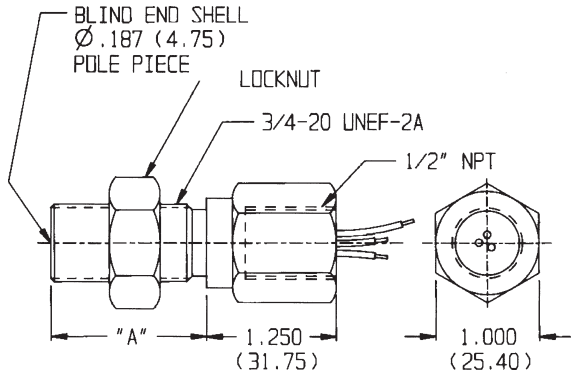
Ordering Part #	Thread Length (A)	
70085-1010-413	1.500	(38.10)
70085-1010-005	1.875	(47.63)
70085-1010-327	2.750	(69.85)
70085-1010-328	4.000	(101.60)
70085-1010-414	6.000	(152.40)

Rating: UL and CSA listed for hazardous locations. Class I, Div 1, Groups A, B, C & D; Class II, Div 1, Groups E, F ,G. Temp Code T3C. Consult factory for ATEX listing.

Performance Curves



Based on 8 D.P. Gear



Specifications:

- ■ Output Voltage (Standard): 54 V (P-P)
- ● Output Voltage (Guarantee Point):13.4 V (P-P)

DC Resistance: 240 ohms max.
Typical Inductance: 30 mH ref.
Output Polarity: White lead positive
Operating Temperature: -65 to +100°C
Lead Length: 10 ft (3.05 m)
Housing Ground: Green/Yellow Tracer
Net Weight: 14 oz. max.

Dimensions in inches and (mm).

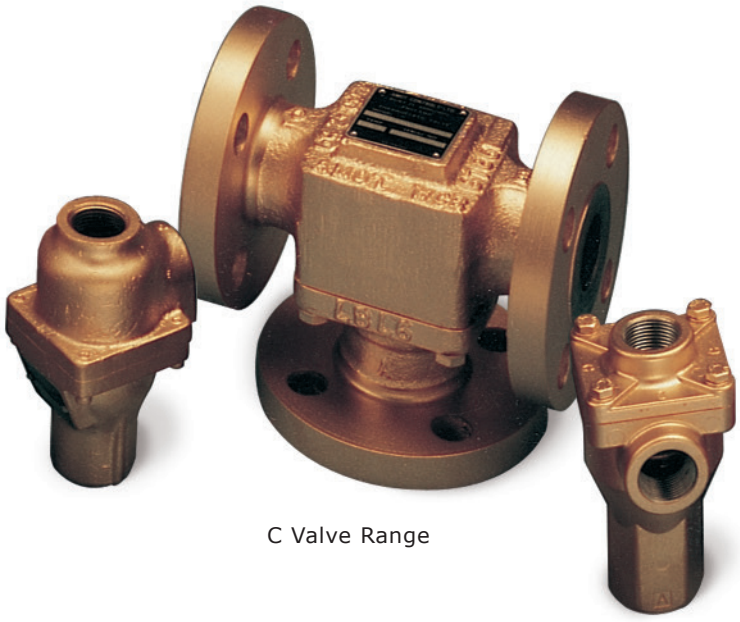
AI-Tek Instruments, Cheshire, CT USA

Thermostatic Control Valves

Model C

Typical applications

- Lubricating oil temperature control
- Jacket temperature (HT)
- Secondary water low temperature (LT)
- Heat recovery
- Water saving applications
- Boiler inlet temperature control
- Co-generation, cooling towers
- Temperature mixing or diverting
- Engine and compressor cooling system



C Valve Range

Key benefits

- No external power source required - simple, low cost installation
- No user setting needed - 'fit and forget' solution
- Small number of parts - simple maintenance and low cost of ownership
- Robust design capable of high vibration and shock applications
- Easy installation, operates in any mounting position
- Automatic self-sensing control with positive proportional valve action

Key features

- Flow rates of 1.4 - 12m^3/hr (6 - 54 US gpm)
- Combinations available:
  Housings in cast iron, aluminum, bronze, carbon steel, stainless steel
- DN15 - D40 ($^1/_2$" to 1 $^1/_2$") pipe sizes
- Threaded and flanged connections
- Tamper-proof temperature settings from 18°C to 113°C (65°F to 235°F)
- Pressure ratings up to 72 bar (1050 psi)

Accreditations available

- PED Suitable for Group 1 & 2 liquids (Ensure materials are compatible)
- ATEX Ex 11 2 G X
- CE Complies with all relevant EU directives

Contents

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Applications 4
Valve Characteristics 4
Pressure drop 4
Flow coefficient 5
Temperature & element characteristics 7
Element type and seal material 7
How to order 6
Service kits 8
Specification 10
Weights 10
Dimensions 11

Thermostatic Control Valves - Model C

Overview

AMOT model C thermostatic valves are available in a wide selection of sizes and settings to fill a multitude of fluid temperature control requirements. These valves may be mounted in any position and use the proven expanding wax principle to actuate the 3-way temperature element assemblies. The model C valves may be used for diverting or mixing service. They make very economical temperature limiting valves to prevent scalding in home, motel or hotel hot water supply systems. Radiant heating systems can use these valves in limiting water temperature to prevent surface cracking and over-heating of plastic piping. Other applications include electronic and battery cooling circuits, pump temperature relief valves etc.

Available housing materials

- Cast iron
- Aluminum
- Bronze
- Steel
- Stainless steel

Seal materials

- Buna-N/Nitrile
- Viton
- Neoprene

Element materials

- Bronze, brass and stainless steel
- Nickel plated/Stainless steel
- Stainless steel

Leak holes

In some applications, it is necessary to have leak holes drilled in the element to ensure a small flow between ports A and C. Leak holes are available in sizes ranging from 0.8mm to 6.3mm ($^{1}/_{32}$" to $^{1}/_{4}$"). Please contact AMOT to determine the hole size required for specific applications.

Temperature settings

A wide selection of element materials, seals and temperatures are available. Follow the equipment manufacturers' guidelines for heating/cooling systems.

Temperature settings are available from 18°C to 113°C (65°F to 235°F). Refer to the Temperature & Element Characteristics table on page 6 for specific temperature settings. In general the temperature quoted is the nominal operating temperature in diverting mode on water systems.

For long life, AMOT valves should not be operated continuously at temperatures in excess of 14°C (25°F) of their maximum continuous rating. If this condition is anticipated then consult AMOT for suitable alternatives.

For mixing and oil circuits the temperature may be one to two degrees higher due to flow, viscosity and other system parameters.

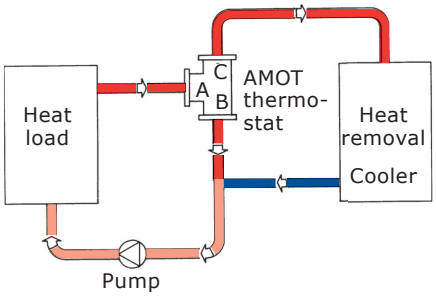
Elements and seals are available in a variety of materials. These materials are suitable for most applications. Please contact AMOT for material compatibility information.

Thermostatic Control Valves - Model C

Applications

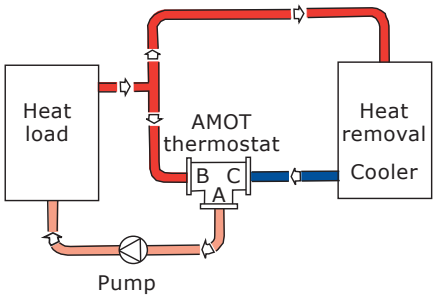
Diverting Applications

When valves are used for diverting service, the inlet is Port A (temperature sensing port), with Port C being connected to the cooler, and Port B connected to the cooler by-pass line.



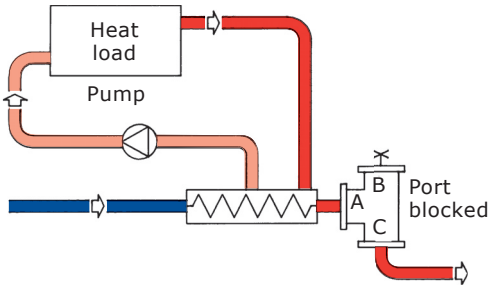
Mixing Applications

When valves are used for mixing service, Port C is the cold fluid inlet port from the cooler, Port B is the hot by-pass fluid inlet, and Port A the common outlet. Port A is the temperature sensing port and will mix the hot and cold fluids in the correct proportion so as to produce the desired outlet temperature leaving Port A.



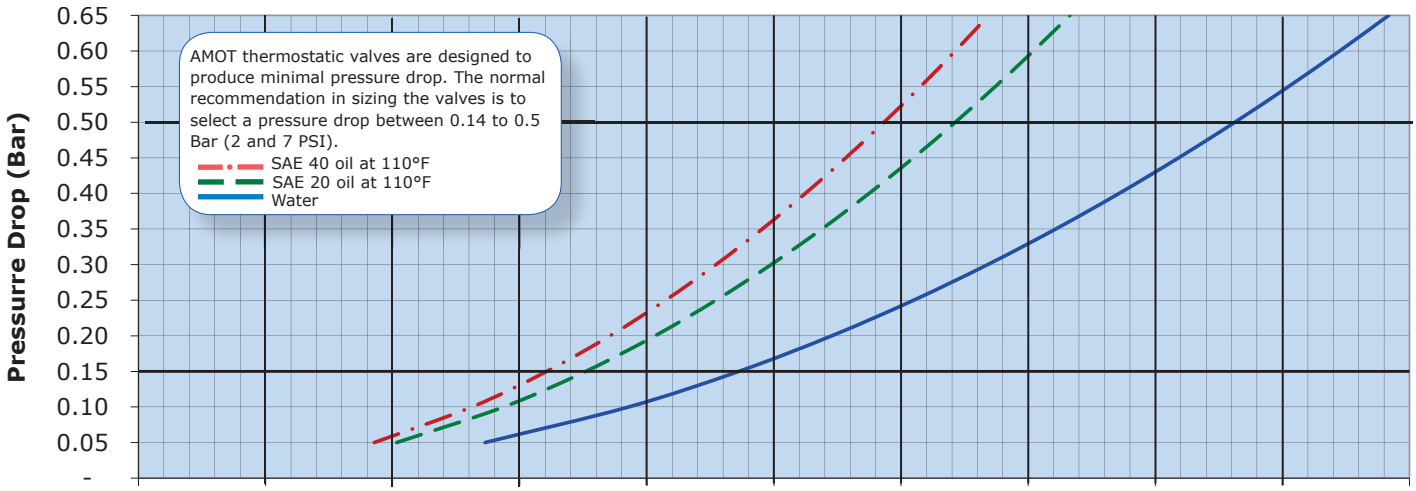
2-way Water Saving Applications

Valve as shown maintains minimum flow through cooler to conserve water. Requires internal leak hole to permit small flow for sensing.



Valve characteristics

Pressure drop (Metric units)

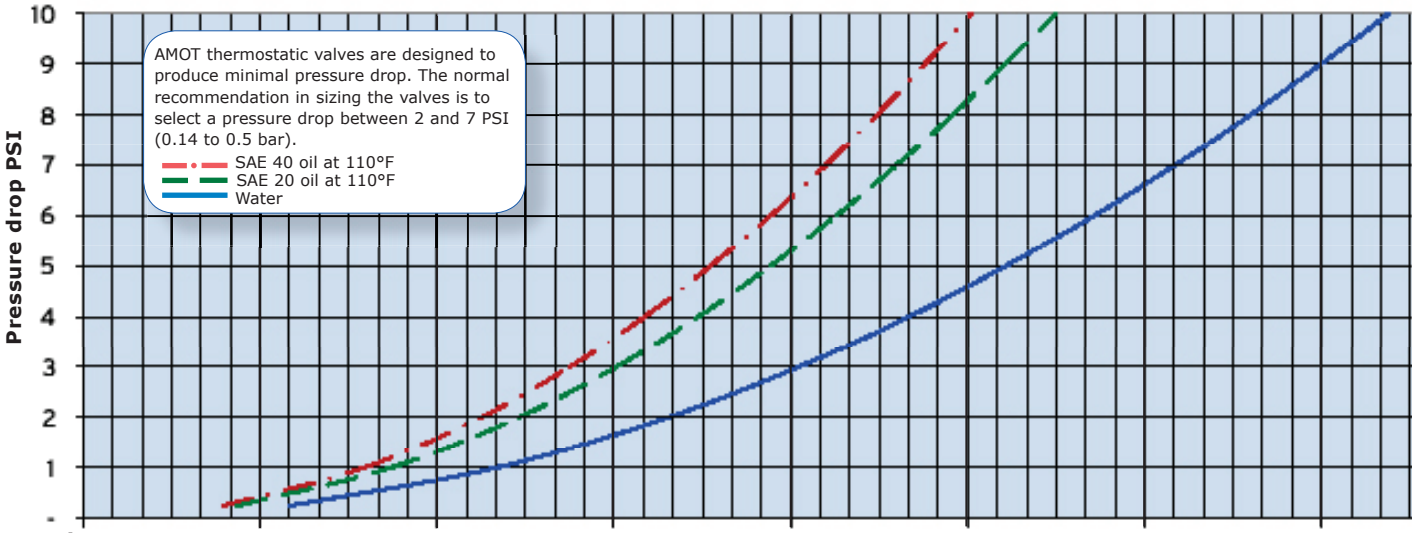


Size	♦	♦	♦	♦	♦	♦	♦	♦	♦
1/2 CL	0.3	0.6	0.9	1.1	1.4	1.7	2.0	2.3	2.6
3/4 CL	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9
1 CL	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9
1 1/2 CL	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2
1/2 CM	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
3/4 CM	0.7	1.3	2.0	2.7	3.4	4.0	4.7	5.4	6.0
1 CM	0.7	1.5	2.2	3.0	3.7	4.4	5.2	5.9	6.6
1 1/4 CM	0.8	1.6	2.5	3.1	3.9	4.7	5.5	6.2	7.0
1 1/2 CM/CF	0.8	1.6	2.5	3.1	3.9	4.7	5.5	6.2	7.0
1 1/4 CCM	1.5	2.9	4.4	5.8	7.3	8.7	10.2	11.6	13.1

Flowrate m³/hr

Valve characteristics

Pressure drop (English units)



Size							
1/2 CL	1.7	3.4	5.1	6.9	8.6	10.3	12.0
3/4 CL	1.9	3.9	5.8	7.7	9.6	11.6	13.5
1 CL	1.9	3.9	5.8	7.7	9.6	11.6	13.5
1 1/2 CL	2.1	4.3	6.4	8.6	10.7	12.9	15.0
1/2 CM	3.0	6.0	9.0	12.0	15.0	18.0	21.0
3/4 CM	4.1	8.1	12.2	16.3	20.4	24.4	28.5
1 CM	4.5	8.9	13.4	17.8	22.3	26.7	31.2
1 1/4 CM	4.7	9.4	14.1	18.9	23.6	28.3	33.0
1 1/2 CM/CF	4.7	9.4	14.1	18.9	23.6	28.3	33.0
1 1/4 CCM	8.8	17.6	26.4	35.1	43.9	52.7	61.5

Flowrate US gpm

Flow coefficient

Flow coefficients (calculated)		
Size	**Kv**	**Cv**
1/2 CL	3.5	4.0
3/4 CL	3.9	4.5
1 1/2 CL	4.3	5.0
1/2 CM	6.1	7.0
3/4 CM	8.2	9.5
1 CM	9.0	10.4
1 1/4 CM	9.5	11
1 1/2 CM/CF	9.5	11
1 1/4 CCM	17.7	20.5

Kv is the flow coefficient in metric units. It is defined as the flow rate in cubic meters per hour (m^3/h) of water at a temperature of 16° Celsius with a pressure drop across the valve of 1 bar. The basic formula to find a valve's Kv is shown below:

$$DP = \left(\frac{Q}{Kv}\right)^2 SG \qquad Q = Kv\sqrt{\frac{DP}{SG}}$$

Q = Flow in m^3/hr
DP = Pressure drop (Bar)
SG = Specific gravity of fluid (Water = 1.0)
Kv = Valve flow coefficient

Cv is the flow coefficient in English units. It is defined as the flow rate in US Gallons per minute (gpm) of water at a temperature of 60° Fahrenheit with a pressure drop across the valve of 1 psi. The basic formula to find a valve's Cv is shown below:

$$DP = \left(\frac{Q}{Cv}\right)^2 SG \qquad Q = Cv\sqrt{\frac{DP}{SG}}$$

Q = Flow in US gallons
DP = Pressure drop (Psi)
SG = Specific gravity of fluid (Water = 1.0)
Cv = Valve flow coefficient

Valve characteristics continued

Available versions

Cast iron	Bronze	Aluminum	Steel	Stainless Steel
Threaded	Threaded	Threaded	Threaded	Threaded
1/2 CM/CL	1/2 CM/CL	3/4 CM/CL	3/4 CM/CL	3/4 CM/CL
3/4 CM/CL	3/4 CM/CL	1 CM/CL	1 CM/CL	1 CM/CL
1 CM/CL	1 CM/CL	Flanged	Flanged	Flanged
1 1/4 CCM	1 1/2CM/CL	None	1 1/2 CF	1 1/2 CF
1 1/4 CM	Flanged		Welded	Welded
1 1/2 CM/CL	None		3/4” & 1” CM	3/4” & 1” CM
Flanged				
1 1/2CF				

How to Order Valve

Use the tables below to select the unique specification of your G valve.

Example: **A B C D E F - G H - J**

Model **1 1/4 CCM C U 120 01 - F 1 - AA**

A	Valve Size
	Nominal Bore Size
1/2	1/2 inch (DN15)
3/4	3/4 inch (DN20)
1	1 inch (DN25)
1 1/4	1 1/4 inch (DN32)
1 1/2	1 1/2 inch (DN40)

B	Valve Model	
	Connections	No. of Elements
CM	Threaded valve	1
CCM	High flow valve (1 1/4” valve only)	2
CL	Low flow valve	1
CF	Flanged connection (1 1/2” valve only)	1

C	Body Material
B	Bronze (CM and CL)
C	Cast iron (CM, CCM, CF and CL)
A	Aluminum (CM, 3/4” and 1 “ only)
S	Steel (3/4” and 1” CM, 1 1/2” CF only
R	Stainless steel (3/4” and 1” CM, 1 1/2” CF only)

D	Port Connection
C	Flanged EN 1092, PN10, PN16
F	Flanged ANSI 125 lb
H	Flanged ANSI 300 lb (steel and stainless steel only
J	Flanged 150 lb (steel and stainless steel only)
K	Flanged ANSI 600 lb (steel and stainless steel only)
M	Socket weld (3/4” & 1” steel & stainless steel CM valves
T	Threaded NPT to USAS B2.1
U	Threaded BSP (PL) to BS 21
V	Threaded BSP (TR) Japanese (JIS)
W	Threaded to SAE J5 14H (straight thread, o-ring seal)
R	Threaded BSP (PL), boss faced, DIN 3852 Form X (Bronze, cast iron and ductile iron only)

How to Order Valve - continued

E	Control Temperature							
	Control temp.		Rated range				Max temp cont.	
	°C	°F	Crack open		Full open		°C	°F
			°C	°F	°C	°F		
065	18	65	15	59	25	77	47	116
075	23	75	20	68	29	85	60	140
085	30	85	24	75	34	93	63	145
095	35	95	30	86	40	104	73	163
100	38	100	33	91	42	108	61	143
110	43	110	38	100	47	117	82	180
120	49	120	43	110	55	131	86	187
130	54	130	49	120	60	140	95	203
140	60	140	54	130	65	150	95	203
150	65	150	60	140	71	160	100	212
160	71	160	65	150	76	170	100	212
170	76	170	72	163	82	180	100	212
175	80	175	76	170	85	185	105	221
180	82	180	79	175	88	190	110	230
190	87	190	85	185	93	200	110	230
200	93	200	90	194	100	212	110	230
205	96	205	93	200	103	218	110	230
215	101	215	96	205	107	225	115	239
225	107	225	101	214	114	237	120	248
235	113	235	107	225	133	253	124	257

F	Element Type and Seal Material			
	Valve model	Element type	Element construction	Seals
01	CM/CCM/CF	1125X	Standard element	BunaN/ Nitrile
	CL	10765X		
06	CM/CCM/CF	1125X	Standard element	Viton
	CL	10765X		
99	CM/CCM/CF	3362U	Standard Element	Neoprene
	CL	10765U		
09	CM/CCM/CF	1125P	Nickel plated	BunaN/ Nitrile
	CL	10765P		
02	CM/CCM/CF	1125P	Nickel plated	Viton
	CL	10765P		
82	CM/CCM/CF	9778C	Nickel plated	Neoprene
	CL	10765K		
86	CM/CCM/CF	44844X	Salt water - SS	Viton

G	Leakhole Sizes inches (mm)
B	1/32” (0.8)
C	1/16” (1.6)
D	3/32” (2.4)
F	1/8” (3.2)
G	1/4” (6.3)
H	3/16” (5)
0	None

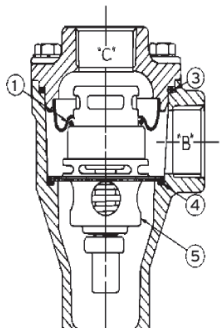
H*	Leakhole Quantity (Number of elements w/leak hole, max. one per element
0	None (Specified on CCM only)
1	1 (Specified on CCM only)
2	2 (Specified on CCM only)

*Note: Leakhole quantity (this field is not used for CM, CL, CF valves. CCM only).

J	Customer Special Code Assigned
-AA	Standard products
-***	Customer special code assigned

Service kits

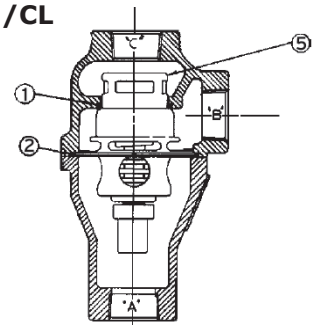
Service Kit for Models CM/CL
Aluminum, steel or stainless steel housing



Replacement parts include:

⑤ Element
① Element O-ring seal
③ Housing O-ring seal
④ O-ring seal

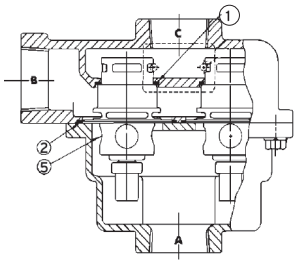
Service Kit for Models CM/CL
Cast iron or bronze housing



Replacement parts include:

⑤ Element
① Element O-ring seal
② Housing O-ring seal

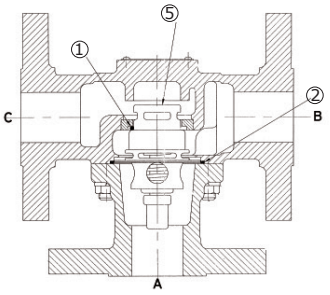
Service Kit for Models CCM
Cast iron housing
Requires two sets of parts



Replacement parts include:

⑤ 2 x Elements
① 2 x Element O-ring seals
② 2 x Housing O-ring seals

Service Kit for Models CF
Cast iron, steel or stainless steel housing



Replacement parts include:

⑤ Element
① Element O-ring seal
② Housing O-ring seal

When properly applied and installed, AMOT thermostatic valves should operate for years with minimal maintenance. An inspection at two or three year intervals is adequate to detect and make provision for normal wear. The frequency of element replacement will depend on the operating conditions and the type of fluid being controlled. Because of the diaphragm and plug construction of the wax actuated element, calibration will be maintained over thousands of cycles.

Whenever elements are replaced, the O-ring seals should also be replaced. For convenience, elements and O-ring seals may be ordered together in the service kits listed here.

Service kits continued

Service kits are available with elements and seals required to service the valve. Order kits by part number and nominal temperature setting. If these are not known, refer to the model number structure that is printed on the valve nameplate and on page 7. The element part number and temperature are also stamped onto the element flange.

Service kit model number structure

Sample codes

1/2 CM A KIT 160 01 - 0 - AA

1 1/4 CCM C KIT 180 06 - B2- AA

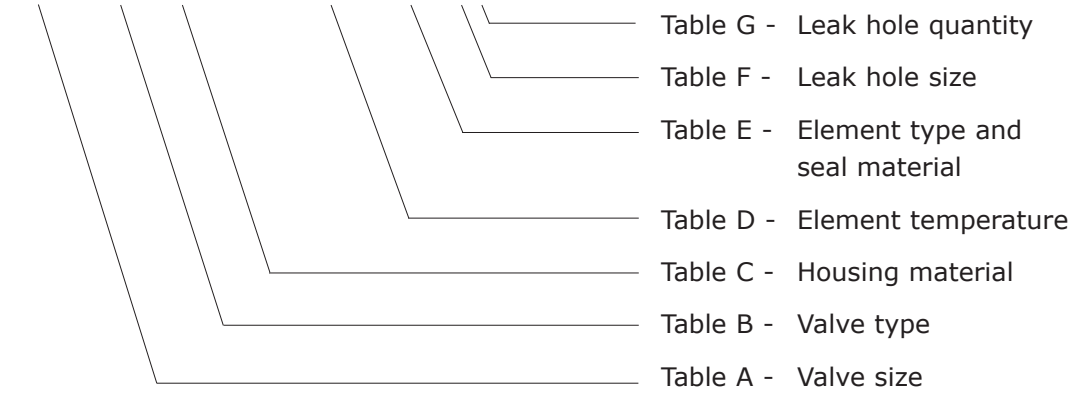


Table A	Table B	Table C	Table D	Table E			Table F		Table G (for CCM only)
Valve Size	**Valve Type**	**Housing Material Code**	**Element Temp. Code**	**Code no.**	**Element Type**	**Seal Material**	**Leak Hole Code**	**Leak Hole Size**	**No. of elements with leak hole**
1/2”	CM	A - aluminum	000*	01	Standard	Buna N	0	None	0
3/4”	CCM	B - bronze	065	06	Standard	Viton	B	1/32”	1
1”	CL	C - cast iron	075	99	Standard	Neoprene	C	1/16”	2
1 1/4”	CF	S - steel	085	09	Plated	Buna N	D	3/32”	
1 1/2”		R - stainless steel	095	02	Plated	Viton	F	1/8”	
			100	82	Plated	Neoprene	G	1/4”	
			110	86	Salt water	Viton	H	3/16”	
			120						
			130						
			140						
			150						
			160						
			170						
			180						
			190						
			200						
			215						
			225						
			235						

Note

*Kit provides seals only.
No element is included.

Specification

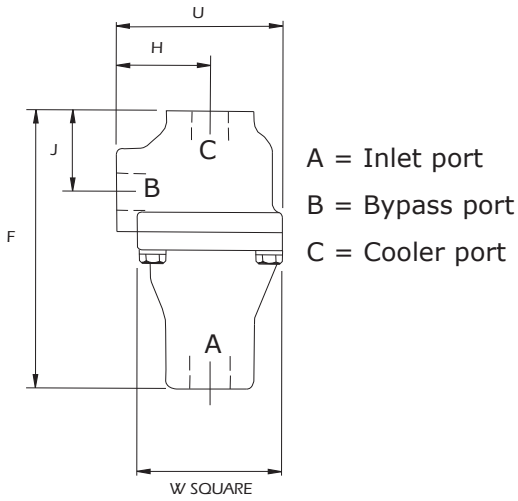
Flow rate		1.4 - 12m³/hr	(6 - 54 gpm)
Body materials & pressure ratings	Cast iron	10 bar	(150 psi)
	Bronze `	10 bar	(150 psi)
	Aluminum	24 bar	(350 psi)
	CS / SS Threaded	48 bar	(700 psi)
	CS / SS 150# Flanged	16 bar	(230 psi)
	CS / SS 300# Flanged	45 bar	(655 psi)
	CS / SS 600# Flanged	72 bar	(1050 psi)
Seal materials	Nitrile/Buna N, Viton, Neoprene		
Mounting position	Any orientation		
Ports	Below nominal temperature	Ports A and B connected	
	Above nominal temperature	Ports A and C connected	
Port connections	Threaded	15, 20, 25, 32 & 40 mm	(1/2", 3/4", 1", 1 1/4" & 1 1/2")
	Flanged	40 mm	(1 1/2")
Valve sizes (nominal bore)		15, 20, 25, 32 & 40 mm	(1/2", 3/4", 1", 1 1/4" & 1 1/2")
Recommended pressure drop		0.14 to 0.5 bar	(2 to 7 psi)
Control temperatures		18°C - 113°C	(65°F to 235°F)

Weight Weights in kg (lbs)

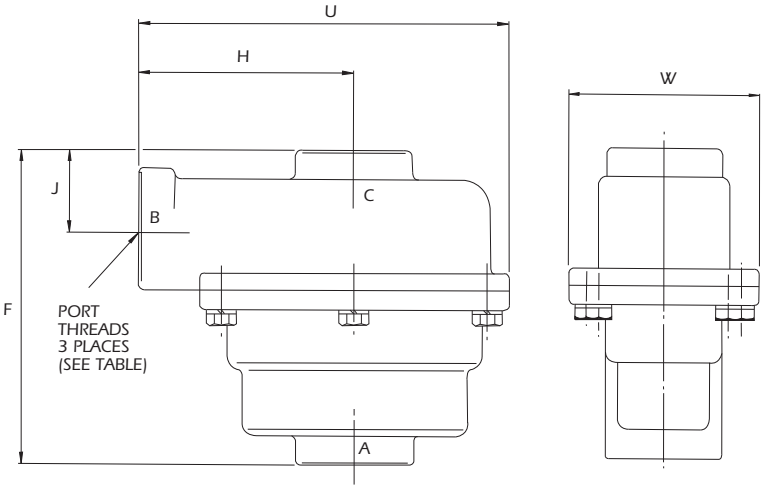
Material	1/2CM, CL 3/4CM, CL, 1CM, CL	3/4CMA, CL 1CMA, CL	3/4CMS, CL 1CMS, CL	1 1/4 CM 1 1/2 CM, 1 1/2 CL	1 1/4 CCM	1 1/2 CFCF	1 1/2 CFSJ 1 1/2 CFRJ	1 1/2 CFSH 1 1/2 CFRH	1 1/2 CFSK 1 1/2 CFSRK
Bronze	2 (4)	–	–	3 (6.6)	–	-	–	–	–
Cast iron	2 (4)	–	–	3 (6.6)	4.3 (9.5)	11 (24)	–	–	–
Stainless steel	–	–	3.6 (8)	–	–	–	9 (20)	13.5 (30)	16.3 (36)
Steel	–	–	3.6 (8)	–	–	–	9 (20)	13.5 (30)	16.3 (36)
Aluminum	–	1.2 (3)	–	–	–	–	–	–	

Valve Dimensions

Model CM

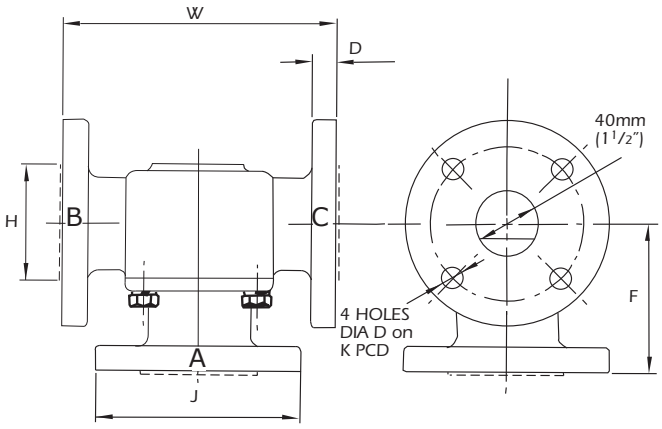


Model 1¹/₄ CCM



Valve Size and Type					
Threaded					
Dimension mm (inches)	**¹/₂CMB, CMC, CLB, CLC ³/₄CMB, CMC, CLB, CLC 1CMB, CMC, CLB, CLC**	**³/₄CMA, CLA 1CMA, CLA**	**³/₄CMR, CMS, CLR, CLS 1CMR, CMS, CLR, CLS**	**1¹/₄ CM 1¹/₂ CM, CL**	**1¹/₄ CCM**
H	50.8 (2)	54 (2.1)	54 (2.1)	73 (2.9)	111 (4.4)
J	44.5 (1.78)	54 (2.1)	54 (2.1)	38.1 (1.5)	39.7 (1.6)
F	152.4 (6.10)	160.3 (6.4)	160.3 (6.4)	158.8 (6.3)	155.6 (6.2)
U	90.5 (3.62)	95.3 (3.8)	95.3 (3.8)	115.9 (4.6)	190.5 (7.6)
W	79.4 (3.18)	82.6 (3.3)	85.7 (3.4)	85.7 (3.4)	98.4 (3.9)

Model 1¹/₂ CF



Flange Sizing mm (inches)		
Flange	**D**	**K**
ANSI 125 lb	16 (1/2)	98.43 (4)
ANSI 150 lb	16 (1/2)	98.43 (4)
ANSI 300 lb	22 (3/4)	114.3 (4 1/2)
ANSI 600 lb	22.2 (7/8)	114.3 (4 1/2)

Valve Size and Type (Flanged)				
Dimension mm (inches)	**1¹/₂ CFCF**	**1¹/₂ CFSJ 1¹/₂ CFRJ**	**1¹/₂ CFSH 1¹/₂ CFRH**	**1¹/₂ CFSK 1¹/₂ CFSRK**
H	-	73 (2.9)	73 (2.9)	73 (2.9)
J	150 (6)	127 (5)	156 (6.2)	156 (6.2)
F	100.8 (4)	100.8 (4)	120.6 (4.8)	130 (5.1)
W	178 (7)	178 (7)	203.2 (8)	223 (8.75)

Americas

AMOT USA
8824 Fallbrook Dr
Houston, TX 77064
USA

Tel +1 (281) 940 1800
Fax +1 (713) 559 9419
Email general: sales@amotusa.com
orders: orders@amotusa.com
customer service: cs@amotusa.com

Asia Pacific

AMOT Shanghai
Bd. 7A, No. 568, Longpan Rd.,
Malu Jiading
Shanghai 201801 China

Tel +86 (0) 21 5910 4052
Fax +86 (0) 21 5237 8560
Email shanghai@amot.com

Europe, Middle East and Africa

AMOT
Western Way
Bury St Edmunds
Suffolk, IP33 3SZ
United Kingdom

Tel +44 (0) 1284 762222
Fax +44 (0) 1284 760256
Email info@amot.com

AMOT Controls GmbH
Rondenbarg 25
22525 Hamburg
Germany

Tel +49 (0) 40 8537 1298
Fax +49 (0) 40 8537 1331
Email germany@amot.com

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76-100 SERIES

Stainless Steel Ball Valve with Mounting Pad 1/4" - 1"

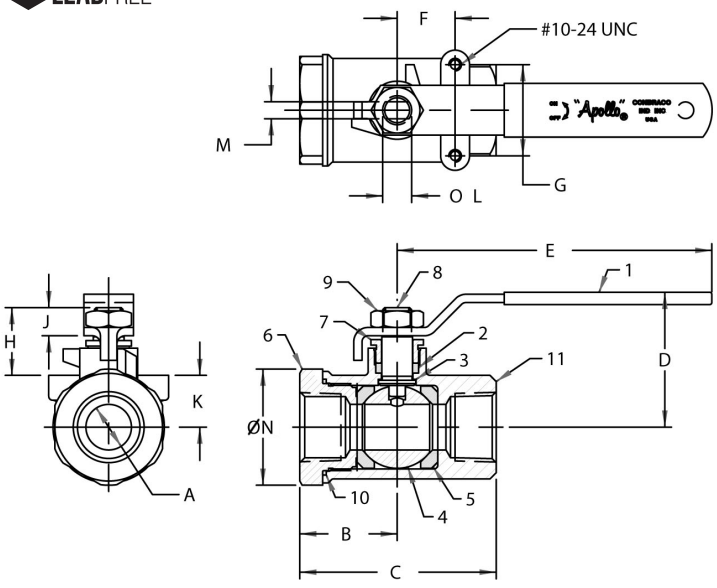
Female NPT Thread, 2000 CWP (psig). Cold Non-Shock. (See referenced P/T chart)
150 psig Saturated Steam.
Vacuum Service to 29 inches Hg.
MSS SP-110 compliant.

5 YEAR WARRANTY ON ALL DOMESTIC MADE PRODUCT

FEATURES

- Investment cast components
- Reinforced seats
- Mounting pad for easy actuator mounting
- Blow-out-proof stem design
- Adjustable packing gland
- Stainless Steel lever and nut
- Fire safe to API 607 (requires -24 suffix)
- Meets NACE MR0175 (2000) & MR0103 (2012)
- CSA CGA 3.16-M88 (Requires "GS" suffix)
- NSF/ANSI 61 Section 8, Annex G
- NSF-372, Drinking Water System Components - Lead Content

CERTIFIED LEADFREE



STANDARD MATERIAL LIST

	PART	MATERIAL
1	Lever and grip	304 SS w/vinyl
2	Stem packing	MPTFE
3	Stem bearing	RPTFE
4	Ball	A276-316 Stainless Steel
5	Seat (2)	RPTFE
6	Retainer	A351-CF8M SS or A276-316 SS
7	Gland nut	A276-316 Stainless Steel
8	Stem	A276-316 Stainless Steel
9	Lever nut	18-8 Stainless Steel
10	Body seal	PTFE
11	Body	A351-CF8M Stainless Steel

OPTIONS AVAILABLE: (More information in Section J)

- Minimum quantities apply
- To specify an option, replace the "01" standard suffix with the suffix of the option.
- To specify multiple options, replace the "01" suffix with the desired suffixes in the numerical order shown below. NOTE: Not all suffixes can be combined together.

(SUFFIX)	OPTION	SIZES
-01	Standard Configuration	All
-P -01-	BSPP (Parallel) Thread Connection	1/4" to 3"
-T -01-	BSPT (Tapered) Thread Connection	1/4" to 3"
-02-	Stem Grounded	1/4" to 3"
-04-	2.25" Stem Extension (Carbon Steel, Zinc Plated)	1/4" to 3"
-07-	Steel Tee Handle	1/4" to 2"
-08-	90º Reversed Stem	1/4" to 3"
-14-	Side Vented Ball (Uni-Directional)	1/4" to 2"
-15-	Wheel Handle, Steel	1/4" to 2"
-16-	Chain Lever - Vertical	3/4" to 2"
-19-	Lock Plate	1/4" to 2"
-21-	UHMWPE Trim (Non-PTFE)	1/4" to 3"
-24-	Graphite packing, PTFE body seal, RPTFE bearing (Fire Safe API 607, 6th edition, ISO 10497:2010)	1/4" to 3"
-27-	SS Latch-Lock Lever & Nut	1/4" to 3"
-30-	Cam-Lock and Grounded	1/4" to 2"
-32-	SS Tee Handle & Nut	1/4" to 2"
-35-	PTFE Trim	1/4" to 3"
-39-	SS Hi-Rise Locking Wheel Handle, SS Nut	1/4" to 2"
-40-	Cyl-Loc and Grounded	1/4" to 2"
-44-	Seal Welded	1/4" to 2"
-45-	Less Lever & Nut	1/4" to 3"
-46-	Latch Lock Lever - Lock in Closed Position Only	1/4" to 3"
-47-	SS Latch Lock Oval Handle	1/4" to 2"
-48-	SS Oval Handle (No Latch) & Nut	1/4" to 2"
-49-	No Lubrication. Assembled Dry.	1/4" to 3"
-50-	2.25" CS Locking Stem Extension	1/4" to 3"
-57-	Oxygen Cleaned	1/4" to 3"
-58-	Chain Lever - Horizontal	3/4" to 2"
-60-	Static Grounded Ball & Stem	1/4" to 3"
-64-	250# Steam Trim (MPTFE Seats & Packing)	1/4" to 3"
-GS	CSA CGA 3.16	All

PRODUCT NUMBER	SIZE	A	B	C	D	E	F	G	H	J	K	L	M	N	WT.
76-101-01A	1/4"	0.37	1.02	2.05	1.71	3.85	0.50	1.12	0.88	0.34	0.53	0.375	0.234	1.16	0.58
76-102-01A	3/8"	0.37	1.02	2.05	1.71	3.85	0.50	1.12	0.88	0.34	0.53	0.375	0.234	1.16	0.55
76-103-01A	1/2"	0.50	1.12	2.23	1.79	3.85	0.50	1.12	0.90	0.34	0.59	0.375	0.234	1.38	0.63
76-104-01A	3/4"	0.68	1.47	2.96	2.03	4.75	0.87	1.37	1.02	0.42	0.78	0.437	0.256	1.75	1.30
76-105-01A	1"	0.87	1.67	3.34	2.16	4.75	0.87	1.37	1.02	0.42	0.91	0.437	0.256	1.94	1.60

** LEAD FREE: The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with Federal Public Law 111-380. ANSI 3rd party approved and listed.*

FOR PRESSURE/TEMPERATURE RATINGS, REFER TO PAGE M-14, GRAPH NO. 14

76-100 SERIES

Stainless Steel Ball Valve with Mounting Pad 1.25" - 2"

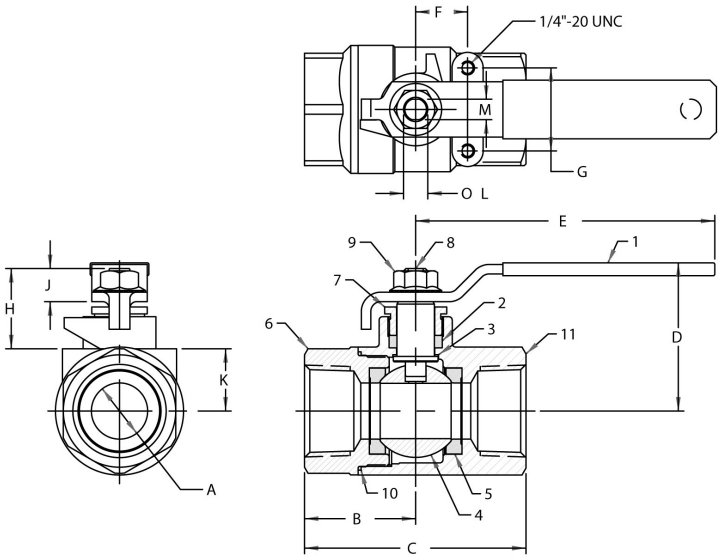
Female NPT Thread, 1500 CWP (psig). Cold Non-Shock. (See referenced P/T chart)
150 psig Saturated Steam.
Vacuum Service to 29 inches Hg.
MSS SP-110 compliant.

5 YEAR WARRANTY

FEATURES

- Investment cast components
- Reinforced seats
- Mounting pad for easy actuator mounting
- Blow-out-proof stem design
- Adjustable packing gland
- Stainless Steel lever and nut
- Fire safe to API 607 (requires -24 suffix)
- Meets NACE MR0175 (2000) & MR0103 (2012)
- CSA CGA 3.16-M88 (Requires "GS" suffix)
- NSF/ANSI 61 Section 8, Annex G
- NSF-372, Drinking Water System Components - Lead Content

CERTIFIED LEADFREE



STANDARD MATERIAL LIST

	PART	MATERIAL
1	Lever and grip	304 SS w/vinyl
2	Stem packing	MPTFE
3	Stem bearing	RPTFE
4	Ball	A276-316 Stainless Steel
5	Seat (2)	RPTFE
6	Retainer	A351-CF8M Stainless Steel
7	Gland nut	A276-316 Stainless Steel
8	Stem	A276-316 Stainless Steel
9	Lever nut	18-8 Stainless Steel
10	Body seal	PTFE
11	Body	A351-CF8M Stainless Steel

OPTIONS AVAILABLE: (More information in Section J)

- Minimum quantities apply
- To specify an option, replace the "01" standard suffix with the suffix of the option.
- To specify multiple options, replace the "01" suffix with the desired suffixes in the numerical order shown below. NOTE: Not all suffixes can be combined together.

(SUFFIX)	OPTION	SIZES
-01	Standard Configuration	All
-P -01-	BSPP (Parallel) Thread Connection	1/4" to 3"
-T -01-	BSPT (Tapered) Thread Connection	1/4" to 3"
-02-	Stem Grounded	1/4" to 3"
-04-	2.25" Stem Extension (Carbon Steel, Zinc Plated)	1/4" to 3"
-07-	Steel Tee Handle	1/4" to 2"
-08-	90º Reversed Stem	1/4" to 3"
-14-	Side Vented Ball (Uni-Directional)	1/4" to 2"
-15-	Wheel Handle, Steel	1/4" to 2"
-16-	Chain Lever - Vertical	3/4" to 2"
-19-	Lock Plate	1/4" to 2"
-21-	UHMWPE Trim (Non-PTFE)	1/4" to 3"
-24-	Graphite packing, PTFE body seal, RPTFE bearing (Fire Safe API 607, 6th edition, ISO 10497:2010)	1/4" to 3"
-27-	SS Latch-Lock Lever & Nut	1/4" to 3"
-30-	Cam-Lock and Grounded	1/4" to 2"
-32-	SS Tee Handle & Nut	1/4" to 2"
-35-	PTFE Trim	1/4" to 3"
-39-	SS Hi-Rise Locking Wheel Handle, SS Nut	1/4" to 2"
-40-	Cyl-Loc and Grounded	1/4" to 2"
-44-	Seal Welded	1/4" to 2"
-45-	Less Lever & Nut	1/4" to 3"
-46-	Latch Lock Lever - Lock in Closed Position Only	1/4" to 3"
-47-	SS Latch Lock Oval Handle	1/4" to 2"
-48-	SS Oval Handle (No Latch) & Nut	1/4" to 2"
-49-	No Lubrication. Assembled Dry.	1/4" to 3"
-50-	2.25" CS Locking Stem Extension	1/4" to 3"
-57-	Oxygen Cleaned	1/4" to 3"
-58-	Chain Lever - Horizontal	3/4" to 2"
-60-	Static Grounded Ball & Stem	1/4" to 3"
-64-	250# Steam Trim (MPTFE Seats & Packing)	1/4" to 3"
-GS	CSA CGA 3.16	All

PRODUCT NUMBER	SIZE	A	B	C	D	E	F	G	H	J	K	L	M	WT.
76-106-01	1.25"	1.00	2.00	4.00	2.68	5.40	0.94	1.50	1.50	0.60	1.12	0.625	0.377	3.10
76-107-01	1.5"	1.25	2.17	4.34	3.25	7.75	0.94	1.50	1.50	0.60	1.28	0.625	0.377	4.20
76-108-01	2"	1.50	2.69	5.43	3.24	7.75	0.94	1.50	1.46	0.60	1.50	0.625	0.377	6.10

** LEAD FREE: The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with Federal Public Law 111-380. ANSI 3rd party approved and listed.*

FOR PRESSURE/TEMPERATURE RATINGS, REFER TO PAGE M-13, GRAPH NO. 12

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76-100 SERIES

Stainless Steel Ball Valve 2.5" - 3"

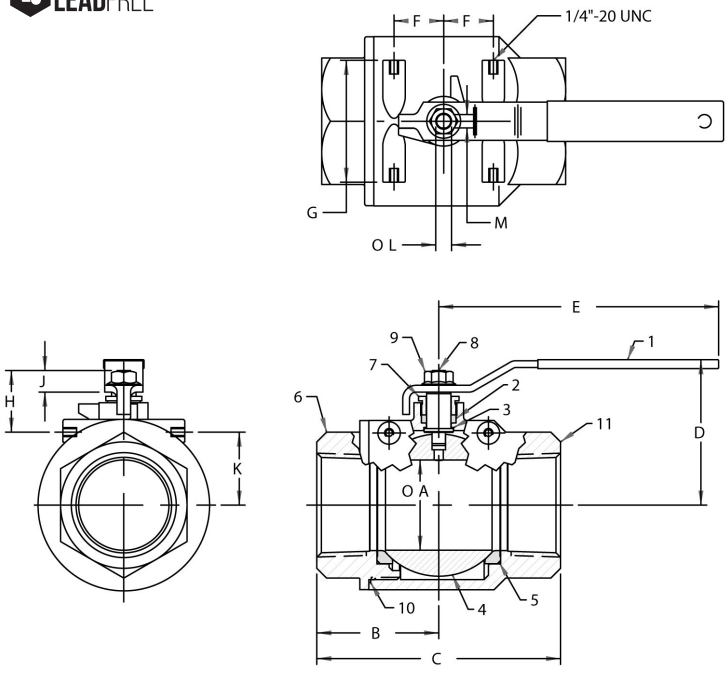
Female NPT Thread, 1000 CWP (psig). Cold Non-Shock. (See referenced P/T chart)
150 psig Saturated Steam.
Vacuum Service to 29 inches Hg.
MSS SP-110 compliant.

5 YEAR WARRANTY ON ALL DOMESTIC MADE PRODUCT

FEATURES

- Investment cast components
- Reinforced seats
- Mounting pad for easy actuator mounting
- Blow-out-proof stem design
- Adjustable packing gland
- Stainless Steel lever and nut
- Fire safe to API 607 (requires -24 suffix)
- Meets NACE MR0175 (2000) & MR0103 (2012)
- CSA CGA 3.16-M88 (Requires "GS" suffix)
- NSF/ANSI 61 Section 8, Annex G
- NSF-372, Drinking Water System Components - Lead Content

CERTIFIED LEADFREE



STANDARD MATERIAL LIST

	PART	MATERIAL
1	Lever and grip	304 SS w/vinyl
2	Stem packing	MPTFE
3	Stem bearing	RPTFE
4	Ball	A276-316 Stainless Steel
5	Seat (2)	RPTFE
6	Retainer	A351-CF8M Stainless Steel
7	Gland nut	A276-316 Stainless Steel
8	Stem	A276-316 Stainless Steel
9	Lever nut	18-8 Stainless Steel
10	Body seal	PTFE
11	Body	A351-CF8M Stainless Steel

OPTIONS AVAILABLE: (More information in Section J)

- Minimum quantities apply
- To specify an option, replace the "01" standard suffix with the suffix of the option.
- To specify multiple options, replace the "01" suffix with the desired suffixes in the numerical order shown below. NOTE: Not all suffixes can be combined together.

(SUFFIX)	OPTION	SIZES
-01	Standard Configuration	All
-02-	Stem Grounded	1/4" to 3"
-04-	2.25" Stem Extension (Carbon Steel, Zinc Plated)	1/4" to 3"
-07-	Steel Tee Handle	1/4" to 2"
-08-	90º Reversed Stem	1/4" to 3"
-14-	Side Vented Ball (Uni-Directional)	1/4" to 2"
-15-	Wheel Handle, Steel	1/4" to 2"
-16-	Chain Lever - Vertical	3/4" to 2"
-19-	Lock Plate	1/4" to 2"
-21-	UHMWPE Trim (Non-PTFE)	1/4" to 3"
-24-	Graphite packing, PTFE body seal, RPTFE bearing (Fire Safe API 607, 6th edition, ISO 10497:2010)	1/4" to 3"
-27-	SS Latch-Lock Lever & Nut	1/4" to 3"
-30-	Cam-Lock and Grounded	1/4" to 2"
-32-	SS Tee Handle & Nut	1/4" to 2"
-35-	PTFE Trim	1/4" to 3"
-39-	SS Hi-Rise Locking Wheel Handle, SS Nut	1/4" to 2"
-40-	Cyl-Loc and Grounded	1/4" to 2"
-44-	Seal Welded	1/4" to 3"
-45-	Less Lever & Nut	1/4" to 3"
-46-	Latch Lock Lever - Lock in Closed Position Only	1/4" to 3"
-47-	SS Latch Lock Oval Handle	1/4" to 2"
-48-	SS Oval Handle (No Latch) & Nut	1/4" to 2"
-49-	No Lubrication. Assembled Dry.	1/4" to 3"
-50-	2.25" CS Locking Stem Extension	1/4" to 3"
-57-	Oxygen Cleaned	1/4" to 3"
-58-	Chain Lever - Horizontal	3/4" to 2"
-60-	Static Grounded Ball & Stem	1/4" to 3"
-64-	250# Steam Trim (MPTFE Seats & Packing)	1/4" to 3"
-GS	CSA CGA 3.16	All

** LEAD FREE: The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with Federal Public Law 111-380. ANSI 3rd party approved and listed.*

FOR PRESSURE/TEMPERATURE RATINGS, REFER TO PAGE M-12, GRAPH NO. 8

PRODUCT NUMBER	SIZE	A	B	C	D	E	F	G	H	J	K	L	M	WT.
76-109-01	2.5"	2.50	3.38	6.75	4.03	7.75	1.38	3.37	1.71	0.60	2.00	0.625	0.377	15.60
76-100-01	3"	2.50	3.38	6.75	4.03	7.75	1.38	3.37	1.71	0.60	2.00	0.625	0.377	16.50

FLOW DATA

For Apollo® Ball Valves

The listed Cv "factors" are derived from actual flow testing, in the Apollo® Ball Valve Division, Conbraco Industries, Inc., Pageland, South Carolina. These tests were completed using standard "off the shelf" valves with no special preparation and utilizing standard schedule 40 pipe. It should be understood that these factors are for the valve only and also include the connection configuration. The flow testing is done utilizing water as a fluid media and is a direct statement of the gallons of water flowed per minute with a 1 psig pressure differential across the valve/connection unit. Line pressure is not a factor. Because the Cv is a factor, the formula can be used to estimate flow of most media for valve sizing.

FLOW OF LIQUID

$$Q = C_V \sqrt{\frac{\Delta P}{SpGr}}$$

$$\text{or } \Delta P = \frac{(Q)^2 (SpGr)}{(Cv)^2}$$

Where:

Q = flow in US gpm
ΔP = pressure drop (psig)
SpGr = specific gravity at flowing temperature
Cv = valve constant

FLOW OF GAS

$$Q = 1360\, C_V \sqrt{\frac{(\Delta P)(P_2)}{(SpGr)(T)}}$$

$$\text{or } \Delta P = \frac{5.4 \times 10^{-7} (SpGr)(T)(Q)^2}{(Cv)^2 (P_2)}$$

Where:

Q = flow in SCFH
ΔP = pressure drop (psig)
SpGr = specific gravity (based on air = 1.0)
P_2 = outlet pressure–psia (psig + 14.7)
T = (temp. °F + 460)
Cv = valve constant

CAUTION: The gas equation shown, is valid at very low pressure drop ratios. The gas equation is NOT valid when the ratio of pressure drop (ΔP) to inlet pressure (P1) exceeds 0.02.

NOTE: Only use the gas equation shown if (P1-P2)/P1 is less than 0.02.

Cv FACTORS FOR APOLLO VALVES

VALVE	SIZE (IN.)														
	1/4	3/8	1/2	3/4	1	1.25	1.5	2	2.5	3	4	6	8	10	12
70B-140 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
70-100/200 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	---
70-300/400 Series	--	--	15	30	43	48	84	108	--	--	--	--	--	--	--
70-600 Series	2.3	4.5	5.4	12	14	21	34	47	--	--	--	--	--	--	--
70-800 Series	8.4	7.2	15	30	43	48	84	--	--	--	--	--	--	--	--
71-AR Series	--	--	--	30	43	48	84	108	190	370	--	--	--	--	--
71-100/200 Series	--	--	--	30	43	48	84	108	190	370	--	--	--	--	--
72-100/900 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
73A-100 Series	8.4	7.2	15	30	43	48	84	108	--	--	--	--	--	--	--
73-300/400 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
74-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
75-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
76-AR Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
76F-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76FJ-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76FK-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76-300/400 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
76-600 Series	2.3	4.5	5.4	12	14	21	34	47	--	--	--	--	--	--	--
76J-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76J-AR Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
76K-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76K-AR Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
7K-100 Series	--	--	15	51	68	125	177	389	503	--	--	--	--	--	--
77-AR Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
77C-100/200 Series	4.5	7.2	16	36	68	125	177	389	503	--	--	--	--	--	--
77D-140 Series	4.5	7.2	16	36	68	125	177	389	--	--	--	--	--	--	--

continued on next page

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FLOW DATA

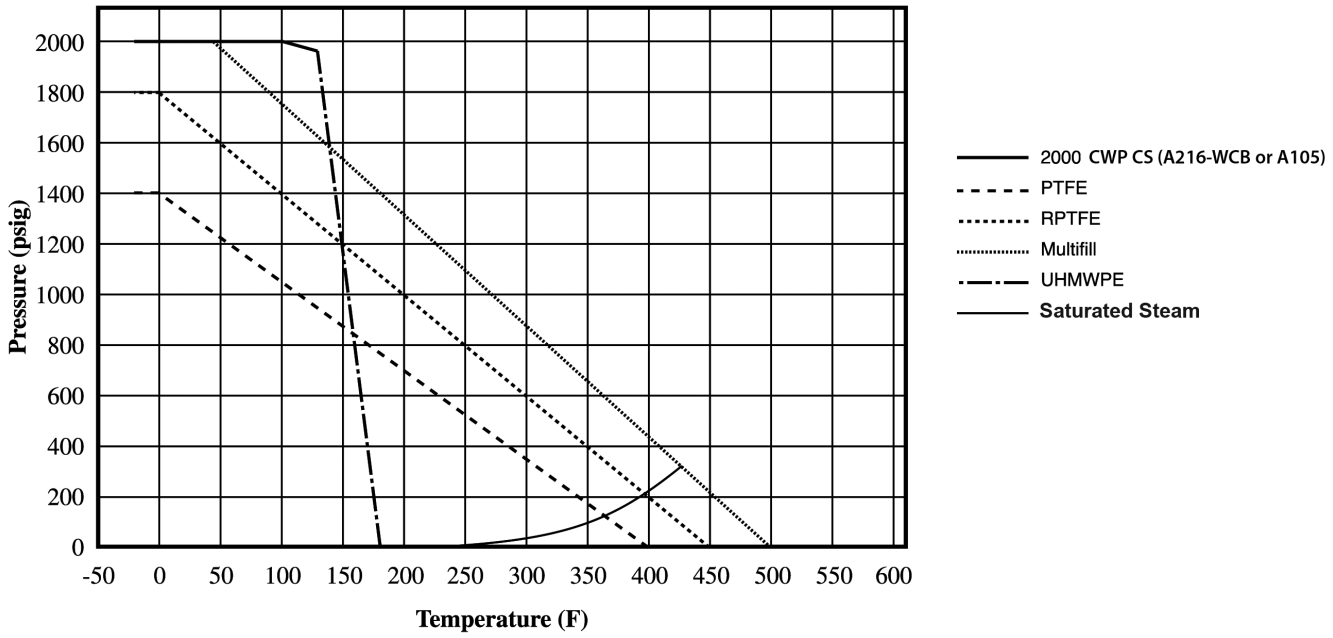
For Apollo® Ball Valves

Cv FACTORS FOR APOLLO VALVES (*continued from M-3)*

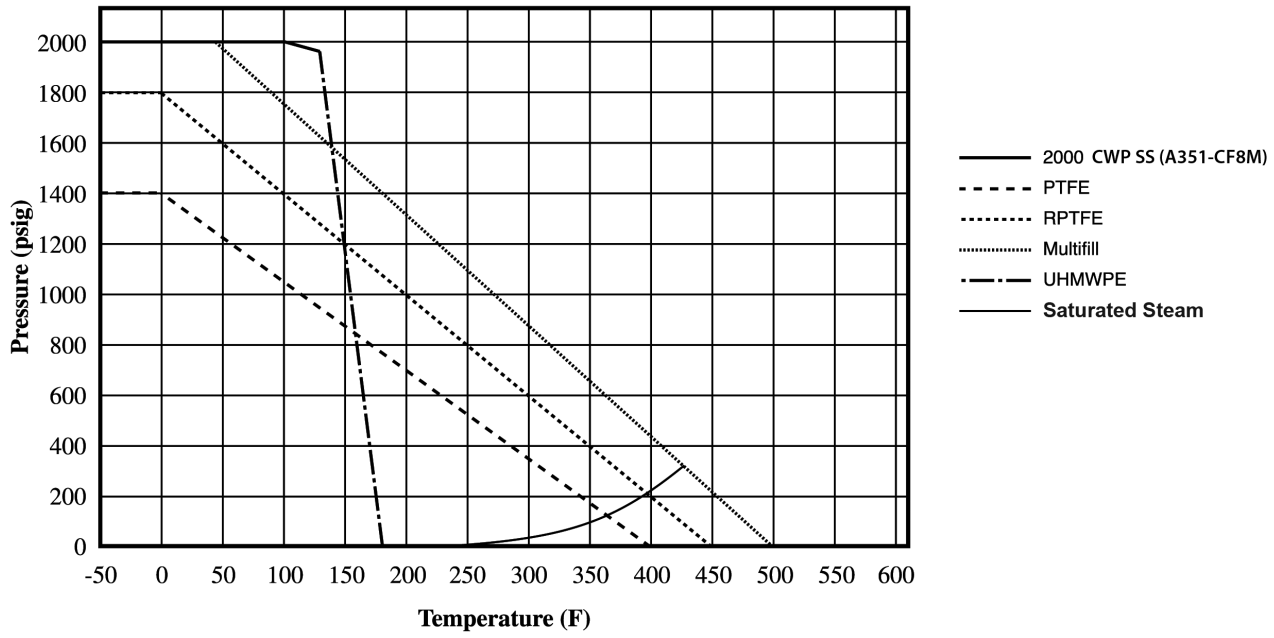
VALVE	SIZE (IN.)														
	1/4	3/8	1/2	3/4	1	1.25	1.5	2	2.5	3	4	6	8	10	12
77D-640 Series	--	--	--	11	24	35	--	--	--	--	--	--	--	--	--
77G-UL Series	4.5	7.2	16	36	68	125	177	389	503	--	--	--	--	--	--
77W Series	--	--	16	36	68	125	177	389	--	--	--	--	--	--	--
77-100/200 Series	8.1	15	15	51	68	125	177	389	503	--	--	--	--	--	--
79 Series	8.5	8.5	9.8	32	44	66	148	218	440	390	--	--	--	--	--
80 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
82-100/200 Series	8.1	14	26	51	68	120	170	376	510	996	1893	--	--	--	--
83A/83B Series	8.1	14	26	51	68	120	170	376	--	--	--	--	--	--	--
83R-100/200 Series	--	--	--	--	--	--	170	376	--	996	1893	--	--	--	--
86A/86B Series	8.1	14	26	51	68	120	170	376	--	--	--	--	--	--	--
86R-100/200 Series	--	--	--	--	--	--	170	376	--	996	1893	--	--	--	--
87A-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87A-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87A-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87A-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87A-F00 Series	--	--	--	--	75	--	195	410	545	1021	2016	4837	--	--	--
87B-100 Series	--	--	--	--	--	--	--	--	--	375	673	1099	1902	3890	--
87J-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87J-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87J-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87J-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87K-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87K-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87K-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87K-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
88A-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-700 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
88A-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-F00 Series	--	--	--	--	75	--	195	410	545	1021	2016	4837	--	--	--
88B-100 Series	--	--	--	--	--	--	--	--	--	375	673	1099	1902	3890	--
89-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
9A-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
90-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
92-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
93-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
94A-100/200 Series	6	7	19	34	50	104	268	309	629	1018	1622	--	--	--	--
96-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
399-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
489-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--

PRESSURE TEMPERATURE RATINGS

2000 CWP (CS) ASTM A216-WCB or A105 (GRAPH 13)

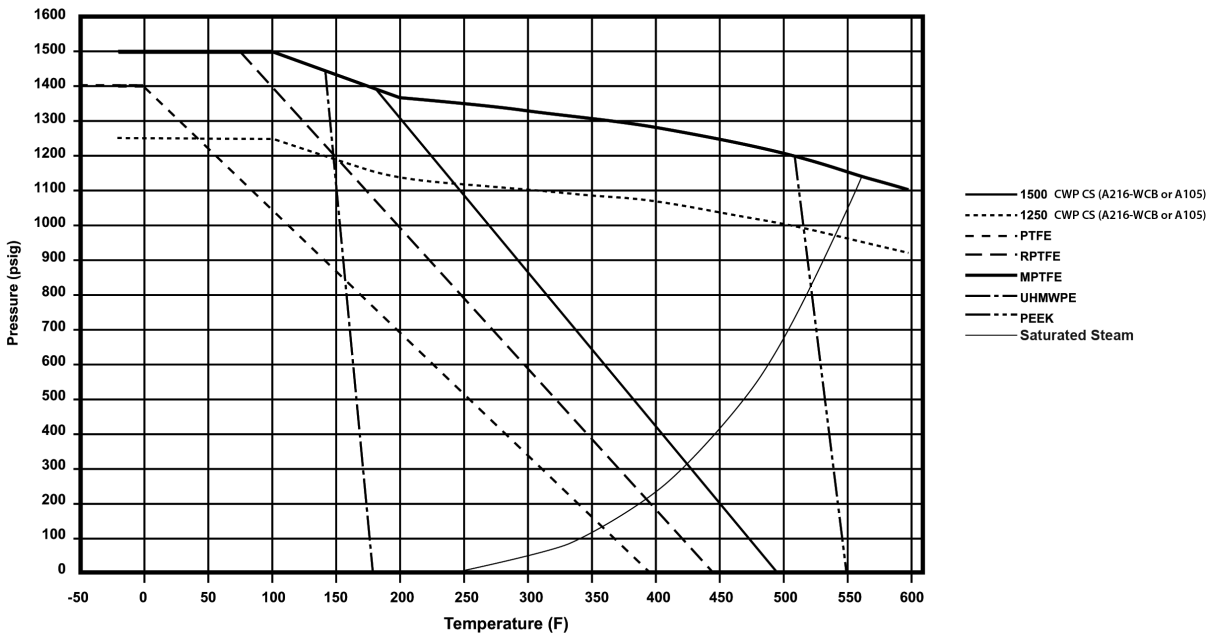


2000 CWP (SS) ASTM A351-CF8M (GRAPH 14)

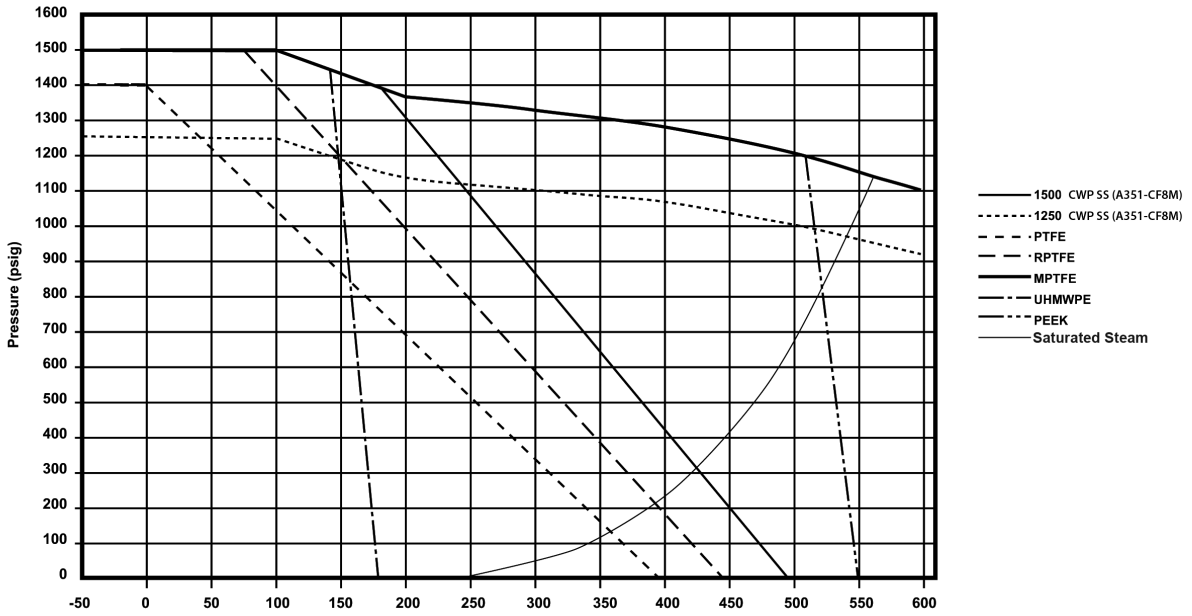


PRESSURE TEMPERATURE RATINGS

1500 CWP (CS) ASTM A216-WCB or ASTM A105 (GRAPH 11)



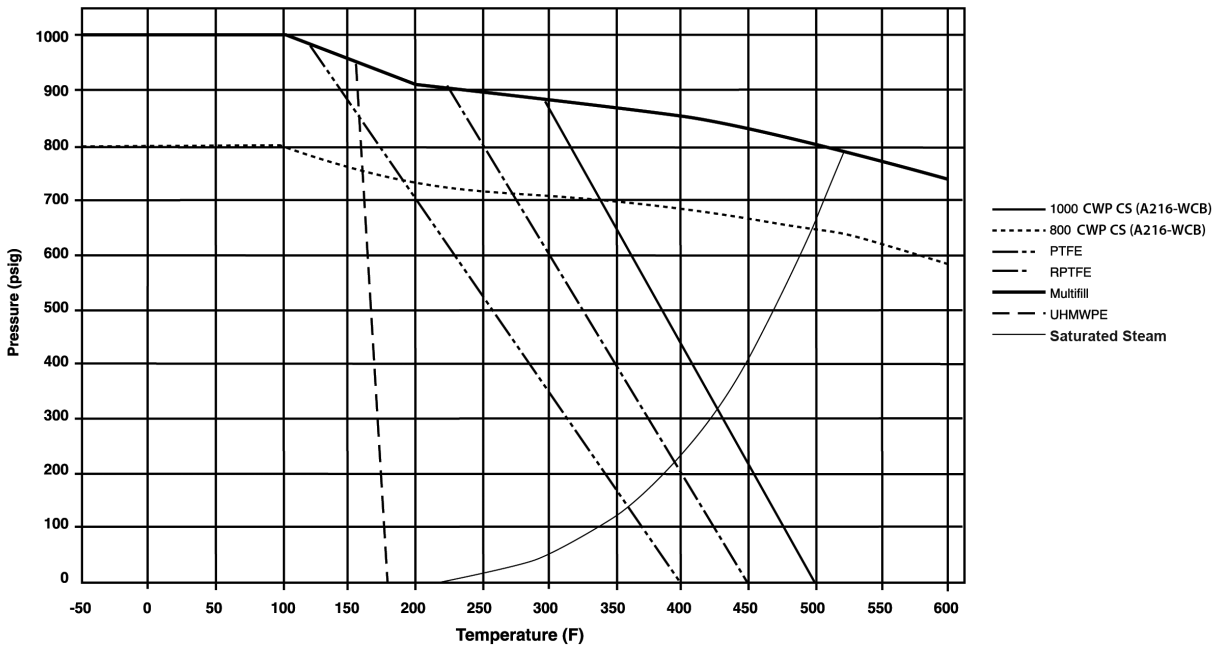
1500 CWP (SS) ASTM A351-CF8M (GRAPH 12)



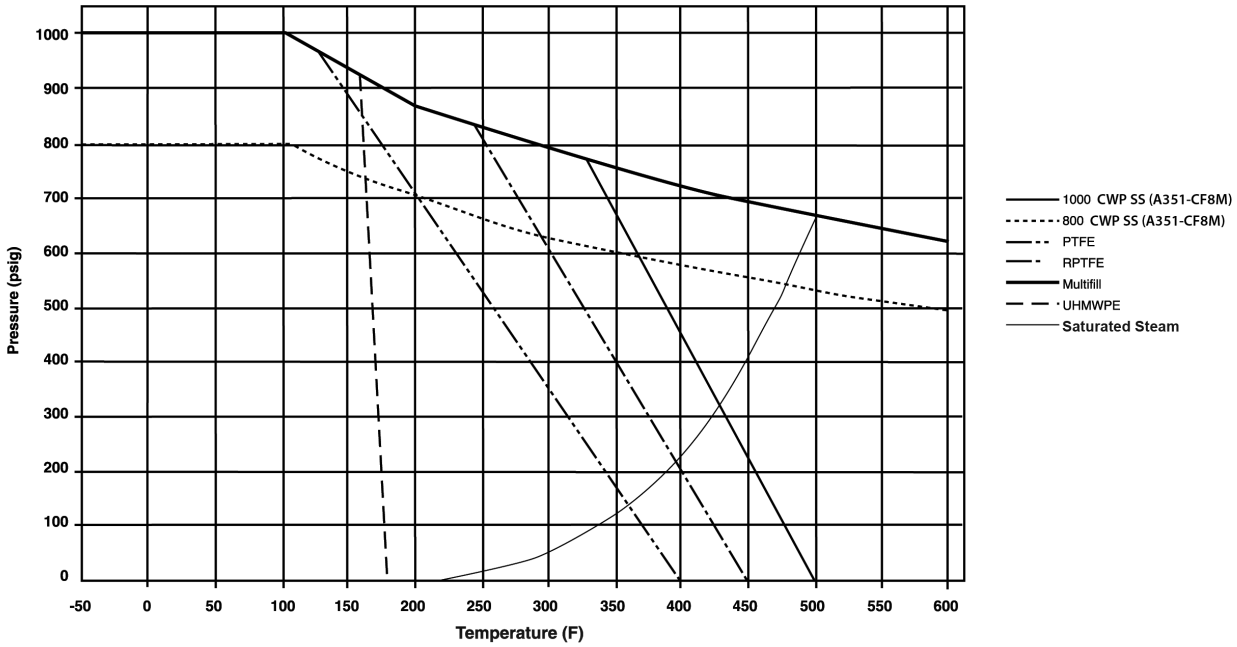
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PRESSURE TEMPERATURE RATINGS

1000 CWP (CS) ASTM A216-WCB (GRAPH 7)



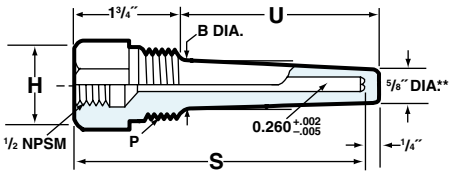
1000 CWP (SS) ASTM A351-CF8M (GRAPH 8)



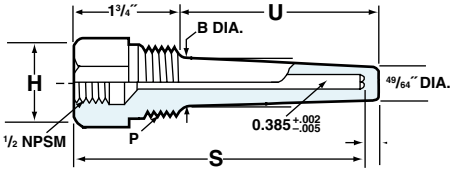
Thermowells
Threaded Configuration

Tapered Shank

Tapered Shank
1/4″ Nominal Bore



Tapered Shank
3/8″ Nominal Bore



Legend: U = Shank length under threads
B = Shank base diameter
P = Process connection NPT
H = Hex size across flats
S = Bore depth = instrument element length including threads

P	H	B*
½″	1.125″	.62″
¾″	1.125″	.87″
1″	1.375″	1.06″

*Stepped shank only, RT

Dimensions (inches)			Part Number	
S	**U**	**P****	**¼″ Bore (.260)**	**⅜″ Bore (.385)**
4	2½	½	50W0250HT260	N.A.*
		¾	75W0250HT260	75W0250HT385
		1	10W0250HT260	10W0250HT385
6	4½	½	50W0450HT260	N.A.*
		¾	75W0450HT260	75W0450HT385
		1	10W0450HT260	10W0450HT385
9	7½	½	50W0750HT260	N.A.*
		¾	75W0750HT260	75W0750HT385
		1	10W0750HT260	10W0750HT385
12	10½	½	50W1050HT260	N.A.*
		¾	75W1050HT260	75W1050HT385
		1	10W1050HT260	10W1050HT385
15	13½	½	50W1350HT260	N.A.*
		¾	75W1350HT260	75W1350HT385
		1	10W1350HT260	10W1350HT385
18	16½	½	50W1650HT260	N.A.*
		¾	75W1650HT260	75W1650HT385
		1	10W1650HT260	10W1650HT385
24	22½	½	50W2250HT260	N.A.*
		¾	75W2250HT260	75W2250HT385
		1	10W2250HT260	10W2250HT385

*Not available
**For ½″ process, tip diameter is ½″

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Type 1132 – 2½˝, 3½˝, 4˝, 4½˝, & 6˝ Differential Gauge



- *Small convoluted diaphragm actuator*
- *Stainless steel case*
- *Ranges from 1 psid-60 psid*
- *Static pressures up to 3000 psi*
- *Aluminum(3), brass or stainless steel bodies(1)*
- *Buna-N O-rings (others available)*
- *Superior magnets for smoother power motion*
- *Standard or explosion-proof reed switches available*
- *5-year warranty*

The Type 1132 uses a convoluted-diaphragm design with no migration of the process media. It is recommended for lower differential and high static pressures, up to 1500 psi. Body materials are available in Aluminum, Brass and Stainless Steel, with Buna, Viton or EPDM seals.(2)

NOTES:

(1) Not for use with incompatible media.

(2) Other wetted parts include stainless steel spring, Teflon piston and ceramic magnet.

(3) Aluminum bodies not to be used with water or corrosive applications.

PRODUCT SPECIFICATIONS

Model Number:	1132
Accuracy (Ascending):	±2%
Migration:	Zero
Ranges:	0-1 psid to 60 psid
Maximum Static Pressure:	1500 psi (all)
Actuator:	Convoluted diaphragm
Temp. Limit	–20/170°F
Case Material:	Stainless steel
Dial Size:	2½˝ (25), 3½˝ (35), 4˝ (40), 4½˝ (45), 6˝ (60)
Maximum Process Temp.:	175°F/80°C
Body Materials:	Aluminum (F), brass (A), stainless steel (S)
O-Rings/Diaphragm:	Buna-N
Connection Size (Female):	¼ NPT (25)
Connection Location:	In-Line (S), Lower (L), Back (B)
Window:	Glass

PRODUCT OPTIONS

Switches(1):		Available
⅛ NPTF adaptor:	XGE	Available
Front Flange:	XFF	Available
Viton O-Rings:	XVD	Available
EPDM O-Rings:	XEM	Available
Fill:		
Glycerin	L	Standard
Silicone	XGV	Available
Window		
Plastic:	XPD	Available
Explosion Proof:	XEK	Available(2)
Pipe Mounting Bracket:	XTM	In-line (only)

(1) Applicable to switches:
XV1 – 1 SPST with DIN plug
XV2 – 1 SPST with terminal strip
XV3 – 2 SPST with DIN plug
XV4 – 2 SPST with terminal strip
XV5 – 1 SPDT with DIN plug
XV6 – 1 SPDT with terminal strip
XV7 – 2 SPDT with DIN plug
XV8 – 2 SPDT with terminal strip
Adjustable from 30-100% of range
Terminal or DIN connected switches are not available with back connection

(2) Specify lower or back connection for gauge (not available in-line) and switch type V2, V4, V6, V8

HOW TO ORDER:

25	1132	FD	25S	XXX	30#

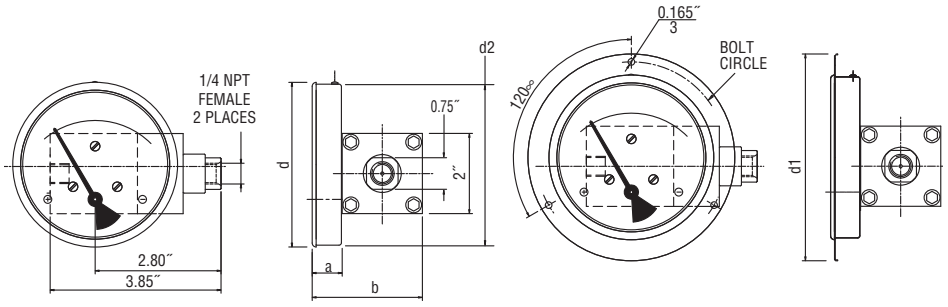
Dial Size: 2½˝, 3½˝, 4˝, 4½˝, & 6˝
Case Type Number: 1132
Body Material
Connection Size: ¼ NPTF
Connection Location: In-line (S), Lower (L), Back (B)
Optional Features: see above
Standard Pressure Range

ISO 9001
REGISTERED FIRM
BULLETIN DP-1132

All specifications are subject to change without notice.
All sales subject to standard terms and conditions.
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Type 1132 – 2½˝, 3½˝, 4˝, 4½˝, & 6˝ Differential Gauge



Type 1132 Dimension Drawing

Dial Size	a	b	d	d^1	d^2	Bolt Circle
2.5˝	0.75˝	2.74˝	2.59˝	3.66˝	2.55˝	3.26˝
3.5˝	0.75˝	2.74˝	3.26˝	4.29˝	3.22˝	3.89˝
4˝	0.75˝	2.74˝	4.10˝	5.15˝	4.01˝	4.76˝
4.5˝	0.75˝	2.74˝	4.71˝	5.74˝	4.60˝	5.35˝
6˝	0.75˝	2.74˝	6.07˝	7.12˝	6.00˝	6.73˝

Type 1132 – Standard Ranges

psi	0-1		0-5	0-8		0-15	0-20	0-25	0-30		0-40	0-50	0-60
in.H_2O	0-25	0-100		0-200		0-400	0-500						
kPa		0-25		0-50	0-75	0-100		0-160	0-200	0-250	0-300		0-400
kg/cm²-bar	0-0.075	0-0.25		0-0.5	0-0.75	0-1		0-1.6	0-2	0-2.5	0-3		0-4
mbar	0-75	0-250											

Ratings for Both Standard & Explosion Proof Switches:

SPST SWITCH
Specifications:
Contact Rating
10 VA ac (rms) or dc (max)
Switching Current
0.5 Amp ac (rms) or dc (max)
Switch Voltage
100 Vac/Vdc (max)

SPDT SWITCH
Specifications:
Contact Rating
3 VA ac (rms) or dc (max)
Switching Current
0.3 Amp ac (rms) or dc (max)
Switch Voltage
30 Vac/Vdc (max)

Explosion Proof Switches Information:

Switches and electrical connections are mounted in an explosion-proof enclosure with UL, CSA, Cenelec and FM approval. The enclosure meets Class 1, Groups B, C, D, Class 2 Groups E, F, G, Class 3, NEMA 7 & 9 and IP 66. Two ¾˝ electrical conduit connections.

All specifications are subject to change without notice.
All sales subject to standard terms and conditions.
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ASHCROFT®

Duragauge® Pressure Gauge Type 1279, Grade 2A (±0.5%)

- ***Exclusive Teflon coated 400 series stainless steel rotary movement for longer life***
- ***Patented Duratube™ with "Welded-Tube" construction controls stress for longer life***
- ***Exclusive "Round Cap Tip" construction lowers stresses for longer life***
- ***Easily adjustable, self-locking micrometer pointer***
- ***New PLUS!™ Performance Option:***
  - ***Liquid-filled performance in a dry gauge***
  - ***Fights vibration and pulsations without liquid-filled headaches***
  - ***See page 174 for details***
  - ***Order as option XLL***

Type 1279 Duragauge® pressure gauge is offered in 4½″ phenolic case for superior chemical and heat resistance. Solid-front case design with blow-out back for safety. Dry, liquid-filled, hermetically sealed or ***PLUS!*** options available. Field convertible to liquid-fill with conversion kit (detailed on page 170). All case styles provide full temperature compensation.



BOURDON SYSTEM SELECTION

Ordering Code	Bourdon Tube & Tip Material[1] (all joints TIG welded except "A")	Socket Material	Tube Type	Range Selection Limits (psi)	NPT Conn.[2]
A	Grade A Phosphor Bronze Tube-Brass Tip, Silver Brazed	Brass	C-Tube	12/1000	¼, ½
B	4130 alloy steel	1019 steel	C-Tube	15/1500	¼,½
			Helical	2000/5000	¼,½
R	316L stainless steel	1019 steel	C-Tube	12/1500	¼,½
			Helical	2000/20,000	¼,½
S	316L stainless steel	316 stainless steel	C-Tube	12/1500	¼,½
			Helical	2000/20,000	¼,½
P[3]	K Monel	Monel 400	C-Tube	15/1500	¼,½
			Helical	2000/30,000	¼,½[4]

(1) For selection of the correct bourdon system material, see the media application table on page 178.
(2) Other connections available on application.
(3) Use for applications where NACE standard MR-01-75 is specified.
(4) 30,000 psi range supplied with ¼ high pressure connection, ½ NPT optional.

STANDARD RANGES

Pressure psi	Compound psi
0/15	30″Hg/15 psi
0/30	30″Hg/30 psi
0/60	30″Hg/60 psi
0/100	30″Hg/100 psi
0/160	30″Hg/150 psi
0/200	30″Hg/300 psi
0/300	
0/400	**Vacuum**
0/600	30/0 in.Hg
0/800	34/0 ftH₂O
0/1000	
0/1500	
0/2000	
0/3000	
0/5000	**NOTE:**
0/10,000	**Equivalent standard kg/cm², and kPa metric ranges are available.**
0/20,000	
0/30,000	

TO ORDER THIS 1279 DURAGAUGE:

Select: **45** **1279** **RS*** **04L** **XXX** **0/2000 psi**

1. Dial size–4½″
2. Case type–1279
   Ring–threaded reinforced polypropylene
3. Bourdon system selection ordering code
4. Connection–¼ NPT (02), ½ NPT (04), Lower (L), Back (B)
5. Optional features–see page 108
6. Standard pressure range
7. Accessories–see pages 165-171

(*) "S" denotes solid front case design

Reference Bulletin DU-1

MADE IN U.S.A.

DRESSER Measurement

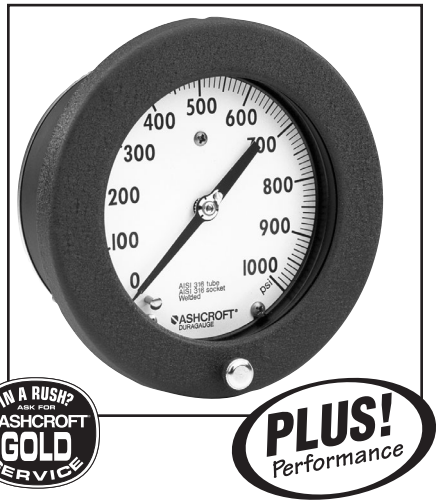
ASHCROFT®

Duragauge® Pressure Gauge Type 1377, Grade 2A (±0.5%)

- ***Exclusive Teflon coated 400 series stainless steel rotary movement for longer life***
- ***Patented Duratube™ with "Welded-Tube" construction controls stress for longer life***
- ***Exclusive "Round Cap Tip" construction lowers stresses for longer life***
- ***Easily adjustable, self-locking micrometer pointer***
- ***New PLUS!™ Performance Option:***
  - ***Liquid-filled performance in a dry gauge***
  - ***Fights vibration and pulsations without liquid-filled headaches***
  - ***See page 174 for details***
  - ***Order as option XLL***

Type 1377 Duragauge® pressure gauge is offered in 4½″, 6″ and 8½″ dial sizes.

Designed for flush mounting, this solid-front gauge is ideal for panel board applications. Its black epoxy coating and its tough aluminum weatherproof case easily allow application in a variety of climatic conditions.



BOURDON SYSTEM SELECTION

Ordering Code	Bourdon Tube & Tip Material[1] (all joints TIG welded except "A")	Socket Material	Tube Type	Range Selection Limits (psi)	NPT Conn.[2]
A	Grade A Phosphor Bronze Tube-Brass Tip, Silver Brazed	Brass	C-Tube	12/1000	¼, ½
B	4130 alloy steel	1019 steel	C-Tube	15/1500	¼, ½
			Helical	2000/5000	¼, ½
R[4]	316L stainless steel	1019 steel	C-Tube	12/1500	¼, ½
			Helical	2000/20,000	¼, ½
S	316L stainless steel	316 stainless steel	C-Tube	12/1500	¼, ½
			Helical	2000/20,000	¼, ½
P[3]	K Monel	Monel 400	C-Tube	15/1500	¼, ½
			Helical	2000/30,000	¼, ½[5]

(1) For selection of the correct bourdon system material, see the media application table on page 178.
(2) Other connections available on application.
(3) Use for applications where NACE standard MR-01-75 is specified.
(4) "R" bourdon system not available in 8½″ dial size.
(5) 30,000 psi range supplied with ¼ high pressure connection, ½ NPT optional.

STANDARD RANGES

Pressure psi	Compound psi
0/15	30″ Hg/15 psi
0/30	30″ Hg/30 psi
0/60	30″ Hg/60 psi
0/100	30″ Hg/100 psi
0/160	30″ Hg/150 psi
0/200	30″ Hg/300 psi
0/300	
0/400	**Vacuum**
0/600	30/0 in.Hg
0/800	34/0 ftH₂O
0/1000	
0/1500	
0/2000	
0/3000	
0/5000	**NOTE:**
0/10,000	**Equivalent standard kg/cm², and kPa metric ranges are available.**
0/20,000	
0/30,000	

TO ORDER THIS 1377 DURAGAUGE:

Select:	45	1377	AS*	04B	XXX	0/2000 psi
1. Dial size–4½″						
2. Case type–1377 Ring–steel, black enamel finish						
3. Bourdon system selection ordering code						
4. Connection–¼ NPT (02), ½ NPT (04), Lower (L), Back (B)						
5. Optional features–see page 108						
6. Standard pressure range						
7. Accessories–see pages 166-173						

(*) "S" denotes solid front case design

Reference Bulletin DU-1

MADE IN U.S.A.

DRESSER Measurement

ASHCROFT®

Duragauge® Pressure Gauge Type 1379, Grade 2A (±0.5%)

- ***Exclusive Teflon coated 400 series stainless steel rotary movement for longer life***
- ***Patented Duratube™ with "Welded-Tube" construction controls stress for longer life***
- ***Exclusive "Round Cap Tip" construction lowers stresses for longer life***
- ***Easily adjustable, self-locking micrometer pointer***
- ***New PLUS!™ Performance Option:***
  - ***Liquid-filled performance in a dry gauge***
  - ***Fights vibration and pulsations without liquid-filled headaches***
  - ***See page 174 for details***
  - ***Order as option XLL***

Type 1379 Duragauge® pressure gauge is offered in 4½˝, 6˝ and 8½˝ dials sizes.

This rugged, solid-front aluminum case gauge is tops in its field. It is available as a weatherproof hermetically sealed or liquid-filled version in 4½˝ and 6˝ sizes in pressures to 30,000 psi. Like the 1279, it can be easily field converted from the weatherproof version to either the sealed or liquid-filled version using an optional kit. Ranges 50,000, 80,000 and 100,000 psi are available in 6˝ hermetically sealed and liquid-filled cases. All size cases are coated with black epoxy which will withstand most environmental conditions.



BOURDON SYSTEM SELECTION

Ordering Code	Bourdon Tube & Tip Material[1] (all joints TIG welded except "A")	Socket Material	Tube Type	Range Selection Limits (psi)	NPT Conn.[2]
A	Grade A Phosphor Bronze Tube-Brass Tip, Silver Brazed	Brass	C-Tube	12/1000	¼, ½
B	4130 alloy steel	1019 steel	C-Tube	15/1500	¼, ½
			Helical	2000/5000	¼, ½
R	316L stainless steel	1019 steel	C-Tube	12/1500	¼, ½
			Helical	2000/20,000	¼, ½
S	316L stainless steel	316 stainless steel	C-Tube	12/1500	¼, ½
			Helical	2000/20,000	¼, ½
P[4]	K Monel	Monel 400	C-Tube	15/1500	¼, ½
			Helical	2000/30,000	¼, ½[5]
WW	Inconel 718	316 stainless steel	Helical	50/80/100,000[3][6]	¼ high press.

(1) For selection of the correct bourdon system material, see the media application table on page 178.
(2) Other connections available on application.
(3) 50,000-100,000 psi available in 6˝ 1379 lower and back connection only.
(4) Use for applications where NACE standard MR-01-75 is specified.
(5) 30,000 psi offered with ¼ high pressure connection, ½ NPT optional.
(6) Offered hermetically sealed as standard. Liquid fillable optional.

STANDARD RANGES

Pressure psi	Compound psi
0/15	30˝ Hg/15 psi
0/30	30˝ Hg/30 psi
0/60	30˝ Hg/60 psi
0/100	30˝ Hg/100 psi
0/160	30˝ Hg/150 psi
0/200	30˝ Hg/300 psi
0/300	
0/400	**Vacuum**
0/600	30/0 in.Hg
0/800	34/0 ftH$_2$O
0/1000	
0/1500	
0/2000	
0/3000	
0/5000	
0/10,000	
0/20,000	
0/30,000	
0/50,000	**NOTE:**
0/80,000	**Equivalent standard kg/cm², and kPa metric ranges are available.**
0/100,000	

TO ORDER THIS 1379 DURAGAUGE:

Select: **45** **1379** **SS*** **04L** **XXX** **0/100 psi**

1. Dial size–4½˝, 6˝, or 8½˝
2. Case type–1379
   Ring–threaded reinforced polypropylene
3. Bourdon system selection ordering code
4. Connection–¼ NPT (02), ½ NPT (04), Lower (L), Back (B)
5. Optional features–see page 108
6. Standard pressure range
7. Accessories–see pages 166-173

(*) "S" denotes solid front case design

Reference Bulletin DU-1

MADE IN U.S.A.

DRESSER Measurement

ASHCROFT®

Duragauge® Pressure Gauge Type 2462, Grade 2A (±0.5%)

- ***Exclusive Teflon coated 400 series stainless steel rotary movement for longer life***
- ***Patented Duratube™ with "Welded-Tube" construction controls stress for longer life***
- ***Exclusive "Round Cap Tip" construction lowers stresses for longer life***
- ***Easily adjustable, self-locking micrometer pointer***
- ***New PLUS!™ Performance Option:***
  - ***Liquid-filled performance in a dry gauge***
  - ***Fights vibration and pulsations without liquid-filled headaches***
  - ***See page 174 for details***
  - ***Order as option XLL***

This solid-front gauge is designed for greater readability by using a large 6″ dial and a durable 4½″ system. Viewed from the front, it appears to be a 6″ gauge. Its glass-filled polypropylene case is highly impact resistant and holds up well in most environments. This general-purpose gauge offers truly functional styling and economy. The result is a gauge that will fit most applications at a price that represents outstanding value.



BOURDON SYSTEM SELECTION

Ordering Code	Bourdon Tube & Tip Material[1] (all joints TIG welded except "A")	Socket Material	Tube Type	Range Selection Limits (psi)	NPT Conn.[2]
A	Grade A Phosphor Bronze Tube-Brass Tip, Silver Brazed	Brass	C-Tube	12/1000	¼, ½
B	4130 alloy steel	1019 steel	C-Tube	15/1500	¼, ½
			Helical	2000/5000	¼, ½
R	316L stainless steel	1019 steel	C-Tube	12/1500	¼, ½
			Helical	2000/20,000	¼, ½
S	316L stainless steel	316 stainless steel	C-Tube	12/1500	¼, ½
			Helical	2000/20,000	¼, ½
P[3]	K Monel	Monel 400	C-Tube	15/1500	¼, ½
			Helical	2000/30,000	¼, ½[4]

(1) For selection of the correct bourdon system material, see the media application table on page 178.
(2) Other connections available on application.
(3) Use for applications where NACE standard MR-01-75 is specified.
(4) 30,000 psi range supplied with ¼ high pressure connection, ½ NPT optional.

STANDARD RANGES

Pressure psi	Compound psi
0/15	30″Hg/15 psi
0/30	30″Hg/30 psi
0/60	30″Hg/60 psi
0/100	30″Hg/100 psi
0/160	30″Hg/150 psi
0/200	30″Hg/300 psi
0/300	
0/400	**Vacuum**
0/600	30/0 in.Hg
0/800	34/0 ftH₂O
0/1000	
0/1500	
0/2000	
0/3000	
0/5000	**NOTE:**
0/10,000	**Equivalent standard kg/cm², and kPa metric ranges are available.**
0/20,000	
0/30,000	

TO ORDER THIS 2462 DURAGAUGE:

Select:	45	2462	RS*	04L	XXX	0/1000 psi

1. Dial size–4½″
2. Case type–2462
   Ring–threaded reinforced polypropylene
3. Bourdon system selection ordering code
4. Connection–¼ NPT (02), ½ NPT (04), Lower (L), Back (B)
5. Optional features–see page 108
6. Standard pressure range
7. Accessories–see pages 165-173

(★) "S" denotes solid front case design

Reference Bulletin DU-1

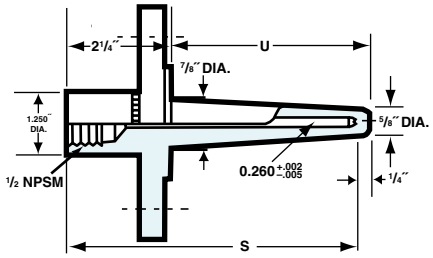
MADE IN U.S.A.

TRANSCAT®
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DRESSER Measurement

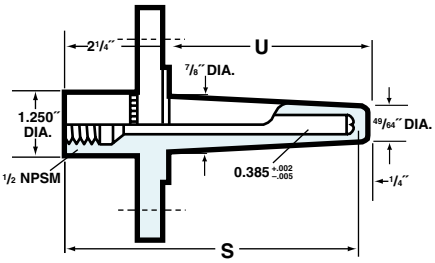
Thermowells
Flanged Configuration

Raised Face (1.5″ Pipe)

1/4″ Nominal Bore



3/8″ Nominal Bore



Legend: U = Shank length under threads
S = Bore depth = instrument element length including threads

Dimensions (inches)			Part Number	
S	**U**	**Flange Rating**	**1/4″ Bore (.260)**	**3/8″ Bore (.385)**
4	2	150#	15W0200HF260–R150	15W0200HF385–R150
		300#	15W0200HF260–R300	15W0200HF385–R300
		600#	15W0200HF260–R600	15W0200HF385–R600
6	4	150#	15W0400HF260–R150	15W0400HF385–R150
		300#	15W0400HF260–R300	15W0400HF385–R300
		600#	15W0400HF260–R600	15W0400HF385–R600
9	7	150#	15W0700HF260–R150	15W0700HF385–R150
		300#	15W0700HF260–R300	15W0700HF385–R300
		600#	15W0700HF260–R600	15W0700HF385–R600
12	10	150#	15W1000HF260–R150	15W1000HF385–R150
		300#	15W1000HF260–R300	15W1000HF385–R300
		600#	15W1000HF260–R600	15W1000HF385–R600
15	13	150#	15W1300HF260–R150	15W1300HF385–R150
		300#	15W1300HF260–R300	15W1300HF385–R300
		600#	15W1300HF260–R600	15W1300HF385–R600
18	16	150#	15W1600HF260–R150	15W1600HF385–R150
		300#	15W1600HF260–R300	15W1600HF385–R300
		600#	15W1600HF260–R600	15W1600HF385–R600
24	22	150#	15W2200HF260–R150	15W2200HF385–R150
		300#	15W2200HF260–R300	15W2200HF385–R300
		600#	15W2200HF260–R600	15W2200HF385–R600

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AXH air-coolers

MAIN MENU – TABLE OF CONTENTS

Customer: L.A. Turbine Corp	AXH Job: 165400A-B
Ref: 23582/23713	Model: 42ZF
Tag:	End User:

- Installation and Operation Manual

Drawings
- G/A Certified Drawing
- Shaft Drawing

- Parts List

- Cooler Specification (Data) Sheet

Q.A. Documentation
- U-1A Data Reports
- Nameplate Scans
- Inspection Checklists
- Dye Penetrate/Magnetic Particle Test Reports
- Hydrostatic Test Certification Reports
- Run Tests
- Flushing Reports

Standard Component Information
- Fans
- Electric Motor with Data Sheets
- Vibration Switches

- Soft Bug Screen Installation Instructions

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  - *LUBRICATION GUIDE* 4
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- *PROCESS START UP* 5
- *HEADER ACCESS PLUGS* 5

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- *FIN CLEANING* 6
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AXH air-coolers

401 East Lowry Road, Claremore, Oklahoma 74017

(918) 283-9200 Fax (918) 283-9229

www.axh.com

INTRODUCTION

This manual has been prepared for the purpose of providing general information and recommendations for the operation and maintenance of your air-cooled heat exchanger in order to insure that it will continue to provide you maximum performance in future years under a variety of operating conditions.

Normal maintenance items and light repairs as outlined can be achieved with basic mechanics tools. These include adjusting v-belt tension, checking and adjusting fan blade pitch angle, lubrication of bearings, setting of vibration switches and the periodic cleaning of fin tubes, both externally and internally. For more specific and detailed information please refer to the individual manufacturer's maintenance instructions for the specific item or component in question (i.e. motors, fans, bearings, and controls). The Table of Contents indicates the appropriate section where this information is contained.

Naturally, prudent judgment should always be exercised when repairing, replacing or particularly modifying any original parts to make certain that they are equivalent to the original design. ***AXH air-coolers*** stocks **most** standard parts and components and are available within a 24 hour emergency basis if necessary.

RECEIPT OF EQUIPMENT & SITING

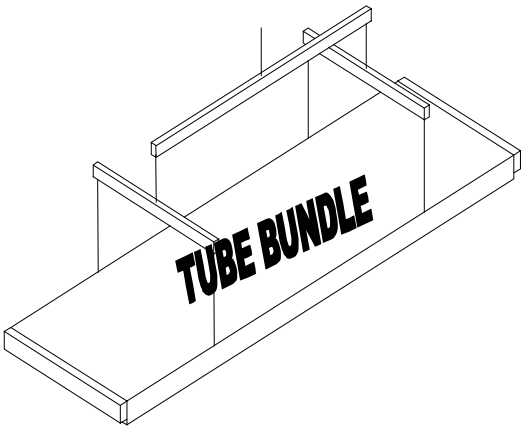
Upon arrival at site, the cooler should be inspected thoroughly by receiving personnel. Damage in transit could be the result of dropping or being struck by heavy objects or equipment. Observe the sub-skid, flanges, plenum side panels and coil sections for any apparent physical damage. Dents, bent flanges, crushed fins, damaged controls are among other items that should be described on the bill of lading document and presented by the carrier. Prompt reporting will expedite filing of claims and will expedite resolution and compensation from the responsible party.

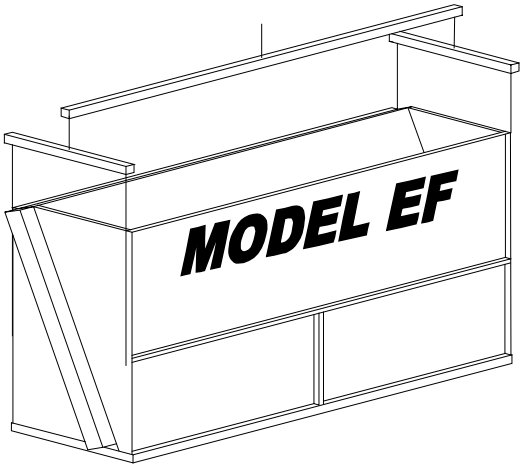
Installation of the cooler(s) is the responsibility of the purchaser or contractor who must insure that the cooler intake areas are free from obstructions and provide adequate airflow. Spacing of air coolers should be adequate to avoid hot air re-circulation (and the affects of other coolers). The impact of grouping coolers closely together may be compensated for by either elevating and/or separating them.

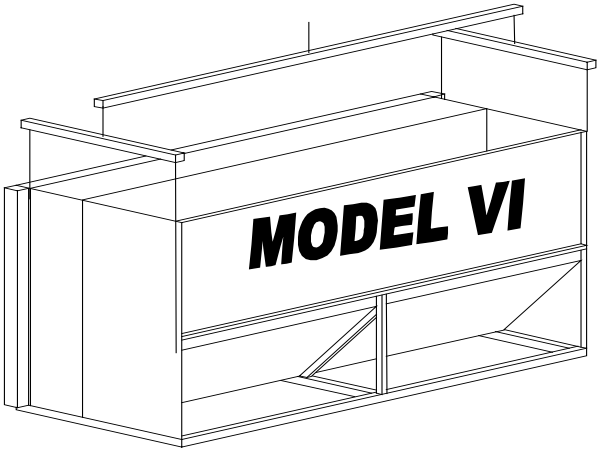
The cooler is normally completely shop assembled and no field assembly at the job-site is required. However, occasionally optional or special accessories may require disassembly to meet transportation height or width limitations. In the event some assembly of the unit is required, the appropriate assembly instructions will accompany the shipment. The packing list should be checked carefully to see that all parts shipped with the cooler are on hand. These parts may be shipped separately, secured to the skid base (if so designed) or inside the plenum area.

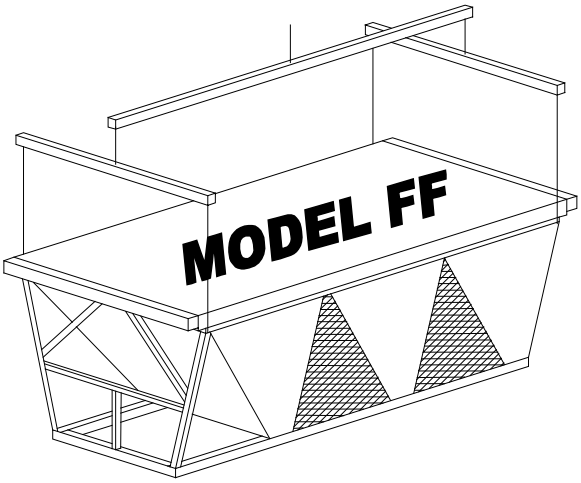
UNLOADING & HANDLING COOLERS

Spreader bars should be used for lifting when the cooler width is over eight (8) feet. The cooler is normally supplied with multiple lifting points to be used for off loading from carrier. Lifting by any other point may cause damage to the cooler. Following are some recommended ways of lifting. Please refer to the illustration below that resembles the type of ***AXH air-coolers*** cooler to be handled and use it as a guide on how to unload and handle the cooler properly. (See unit name plate for unit type i.e. EF, VI, FF, ZF, etc.)









PRIOR TO RUN-IN & START UP

HYDROSTATIC TEST

AXH air-coolers tube bundles (sections) are hydrostatically tested to 1.3 times the design pressure as required by ASME before being released for shipment. To ensure that no damage has been done during shipment and/or installation, it is good practice to hydro test the entire system, including piping, heat exchangers, pumps, etc., prior to start up.

BEARINGS

Check bearings for lubrication. **Caution: DO NOT OVER GREASE**. The manufacturer has greased the bearings and no additional grease is necessary at start up. Remote lubrication lines, when provided, should be loosened at the bearing end, and checked to be sure they are filled with grease from the fitting end. This will ensure that the lube lines are full of grease and free of air and any debris. During high-speed operation too much grease will cause over-heating. When dust and water are present bearings should contain as much grease as the operating speed will permit since a full bearing with very slight leakage is the best protection against the entrance of foreign material. Under normal conditions refer to the following table as a general guideline, although certain conditions may require a change of lubrication periods other than those described. Bearing mounting bolts and set screws should be checked for tightness. See bearing manufacturer recommended lubrication chart for recommended maintenance schedule and type of grease.

FANS

Check fan blade bolts and hub bushing set screws for tightness. Rotate fan by hand to insure that shaft, speed reducer, and driver turn freely. The fan blades should be checked for adequate tip clearance and blade pitch angle. To measure this, first move all blades past a fixed point on the inside of the fan ring and observe which blade has the least amount of clearance at that point. Then move the blade selected 360 degrees to the point of minimum clearance. Refer to the section on fans. If the fan is found not to be centered in the fan ring, slight adjustment of the tip clearance can be made by loosening the fan shaft bearing bolts and moving the complete fan and fan shaft assembly until it is centered in the fan ring. To check the fan blade angle, use a level bubble protractor (this can be obtained from ***AXH air-coolers***). Loosen the nuts on the bolts and place the protractor on the angle setting mark or the clevis. Refer to fan manufactures information for proper location and ***AXH air-coolers*** parts list for design angle. Using a mallet, tap on the shank end of the blade to adjust the angle. Tighten fan blade bolts to the proper torque (refer to manufactures maintenance instructions) making sure to tighten evenly. Recheck blade angle. Occasionally coolers may be equipped with an auto-variable type fan. These fans have blade angles controlled by varying the air supply pressure. Air pressure should be applied to the fan before starting to check for proper operation. **Before starting, any electric motor should be "bumped" to check for proper direction of fan rotation and air flow. This will also insure that the motor is in proper working order.**

LOUVERS/SHUTTERS

Check all mounting brackets and bolts for tightness. To insure that the linkage is adjusted properly on manually operated louvers, operate blades from a fully open to a fully closed position. On automatic louvers with air motors (optional) air should be applied to actuator to check for proper linkage adjustment, free operation, and sufficient air supply. For further information on air motors see attached manufacture maintenance instructions.

CAUTION: DO NOT WALK ON LOUVERS OR USE THEM AS A LADDER

V-BELT DRIVES

Check V-Belt tension in accordance with V-Belt tensioning section of this manual.

GEAR BOX

When supplied, check gearbox for oil. Gears are shipped without oil and must be filled and serviced in accordance with the instructions contained later in this operating manual.

VIBRATION SWITCH (OPTIONAL)

For Murphy switches, after the switch has been installed, adjust it by turning the adjustment screw in a clockwise direction until the starting torque does not trip the vibration switch. For other brands see the specific manufacture's information.

PROCESS START-UP

The process start-up should be conducted in a manner that will minimize thermal shock of the tube bundles. Over cooling of fluids during periods of low ambient temperature and/or low heat load duty should also be avoided, especially during start up.

HEADER ACCESS PLUGS

Header plugs opposite each tube are installed at room temperature. To correct any minor leaking, it may be necessary to tighten the plugs when the bundle is at operating temperature. WARNING: DO NOT tighten plugs while bundle is under pressure. If any plugs are removed, the soft iron gasket (shoulder plugs only) should always be replaced. Replacement gaskets are in stock and may be ordered from ***AXH air-coolers***. When installing the plugs, a thread lubricant and/or anti-galling compound should be used.

LONG TERM MAINTENANCE

FIN CLEANING

Fins should be kept free of dirt and lint. Bug and lint screens are an available option that will greatly assist in keeping tube bundles clean. Fin tubes can be cleaned by directing compressed air perpendicular to the tubes in a direction OPPOSITE to the normal airflow. Caution should be when using steam or chemicals to clean fins. DO NOT clean or spray water when the section/bundle is hot.

TUBE CLEANING

The internal cleaning of tubes can be done in several different ways:

1. **Mechanical Cleaning -** This consists of using a drill, (or wire brushes), on long rods, and rotating them with air or electric motors. This is normally followed by a treated water or chemical wash or air purge.

2. **Chemical Cleaning** - This consists of circulating chemical solutions through the tubes. The solution should contain inhibitors to avoid corrosion of the tube walls.

3. **High Pressure Water Sprays** - This consists of placing a high-pressure water jet head at the end of hollow rods and pushing through the individual tubes.

NOTE: The last two processes will not work on tubes that have been “plugged” with sealing pins.

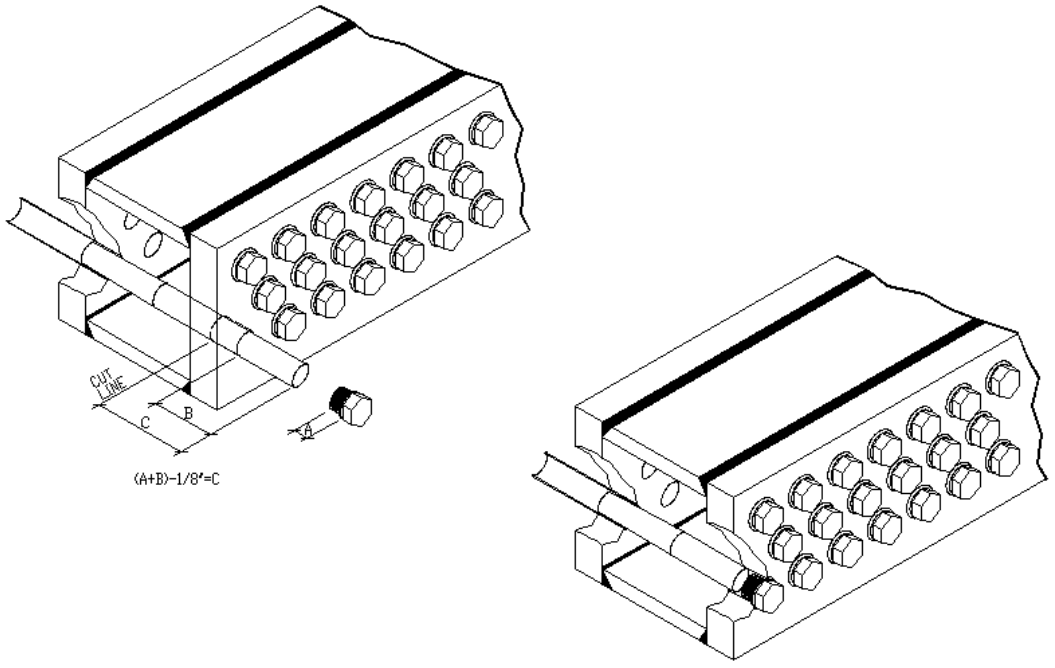
LEAKING TUBES

Tube leaks are generally of two types: 1) leaks through the tube wall itself, and more commonly 2) leaks in the tube end attachment in the header (tube sheet). In the first case it is desirable to plug both ends of the tube. Only a limited number of tubes can be sealed off in this manner before performance is adversely affected and will vary with each specific application. When cooling performance falls below acceptable limits, the tube bundle may be re-tubed. If leaks develop in the tube end attachment at the tube sheet, re-rolling of the tube may be necessary. Care must be taken in selecting the proper tube expander for the tube size (diameter) and gauge of tube to be rolled. When rolling a tube, excess or “over-rolling” must be avoided. Consult the factory for further information on taper sealing pins to plug the tubes and tube roller sizes.

INSTRUCTIONS FOR USING TAPER PINS FOR SEALING TUBES

1.) Remove header access plug from one end of leaking tube (do not switch plugs in holes) and replace with new gaskets whenever possible.
2.) Insert taper sealing pin through plug hole into tube and tap lightly with hammer until seated firmly, but not too tight to be removed.
3.) Measure plug to determine the depth it was originally screwed into header plug sheet. (Dimension A)
4.) Measure the distance that the taper pin protrudes from the header plug sheet in “seated” position. (Dimension B)
3.) Add the distance measured in Steps 3 and 4 and subtract 1/8". This will be the length which should be cut off the large end of the taper sealing pin. (A+B-1/8” = Dimension C)
4.) Remove the taper pin from the end of the tube.
5.) Cut the end off the large end of the taper pin to the length calculated in Step 5. CAUTION: Do not cut the pin too short.
6.) Re-insert the taper sealing pin in the tube and drive securely into place.
7.) Lubricate the access plug and replace it in plug sheet and run in tightly. The plug should now seat tightly and hold taper pin in place.
8.) Repeat operation on other end of tube.
9.) Hydro-test section to insure proper pressure seal without leaks.

NOTE: If the access plug that was removed does not seal properly, replace it along with the gasket if it is a shoulder type plug.



INSPECTION

TUBES

Tubes should be inspected for internal and external corrosion and/or erosion periodically. This depends on the severity and type of service and atmosphere that the tubes are operating in. Inspection of the tubes should be performed every six months to one year intervals. Tube wall thickness can be checked externally using an ultrasonic technique.

FANS

Fans should be inspected for wear or loose bolts (cracks, pitting and corrosion) on all surfaces. These inspections should be performed every six months. In addition to surface inspections, all bolts and nuts must be checked for proper torque. (See the fan section of the manual).

BEARINGS

In addition to checking bearings as recommended by the manufacture, the mounting bolts should be checked for proper torque and alignment. These checks should be done at least every six months.

STRUCTURE

A general inspection of the structure should be performed every six months to a year. This inspection should include checks for corrosion, damaged members, sheeting guards and for loose bolts.

HEADERS

Headers should be inspected for corrosion periodically. This corrosion should not be allowed to proceed past the stated corrosion allowance as stated on the individual job specification data sheet.

RECOMMENDED SPARE PARTS

We suggest that one each of the parts that are identified as recommended spare parts on the Table of Contents page, be kept in stock or be readily available. The down time caused by waiting for delivery of a replacement part may cost far more in lost production or service than the cost of the item itself.

Spare parts orders should be specified in accordance with the parts list description and always include the corresponding *AXH air-coolers'* model and job number.

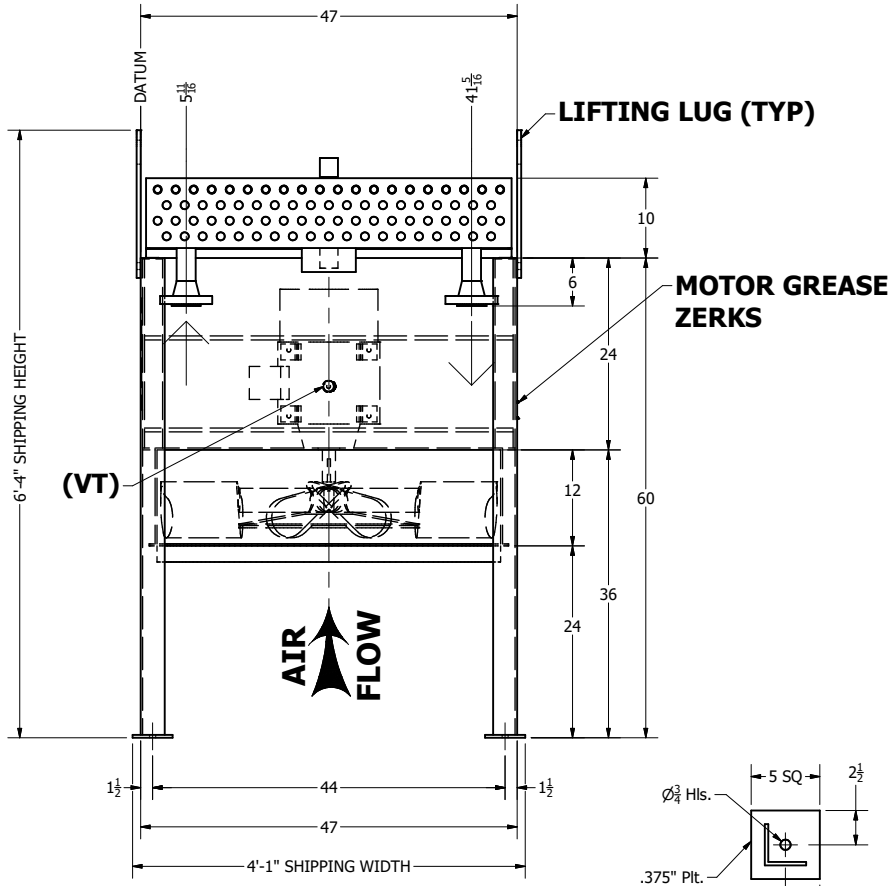
WARRANTY

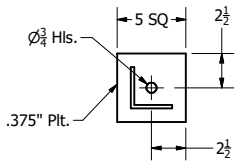
AXH air-coolers warrants that the equipment it *manufactures* is free of defects in material and workmanship, when operated in accordance with conditions stated, for a period of one (1) year after start-up not to exceed fifteen (15) months from shipment. Such warranty shall not apply to any equipment that has been altered or repaired by other than the Company's personnel. The Company's obligation under this warranty is limited, however, to repairing or, if in the Company's judgment it seems more appropriate, to furnishing without charge, F.O.B. the Company's factory, a similar part to replace any part which after examination shall, to its own satisfaction be determined to have been defective at the time it was shipped. This warranty applies only if the Company received an immediate written notice upon discovery of such defect. The Company makes no warranties covering deterioration or failure due to corrosion, erosion or fouling or due to improper installation or operation. EXCEPT AS SPECIFICALLY STATED ABOVE, AXH AIR-COOLERS HEREBY DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE.

LIMITATION OF LIABILITY

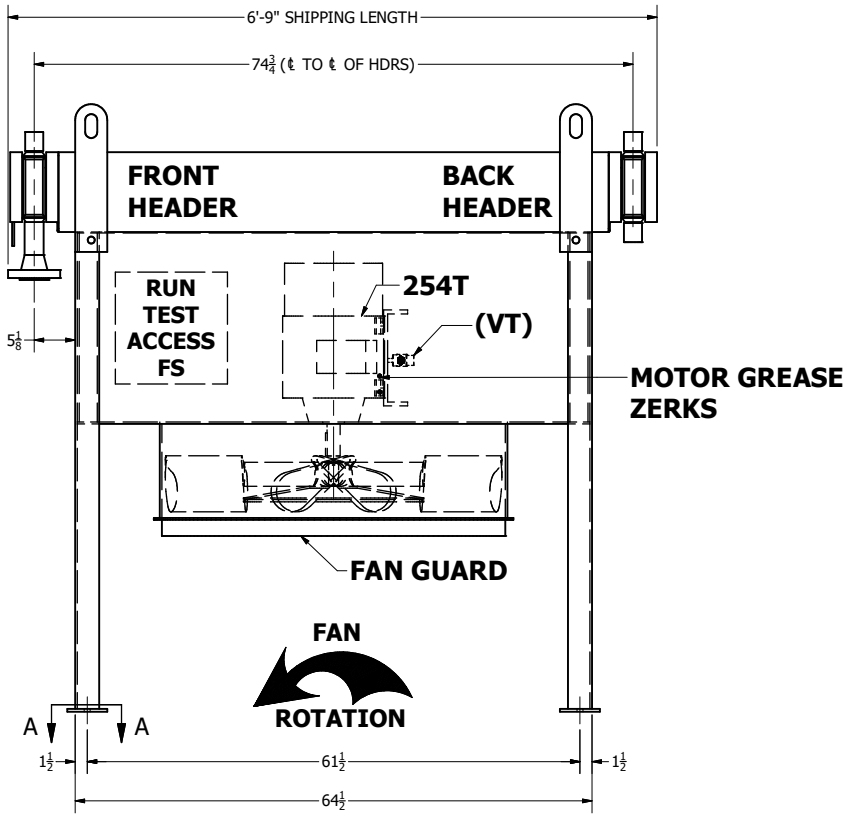
The remedies set forth herein are exclusive. AXH air-coolers shall not be liable, in excess of the purchase price of the equipment, for any damages, whether in contract, in tort or on any other basis, sustained by the customer or any other person arising from or related to the delivery, use or failure of the equipment or for any delay, special, incidental, consequential, indirect or commercial damages whether due to lost profits or otherwise resulting from the delivery, use or failure of the equipment. If it is ever necessary to contact our plant for service or replacement parts, it is essential that our job number and other identifying data be obtained from the metal nameplate attached to the cooler, or the nameplate attached to the tube bundle header box, which also contains the design pressure, temperature, and serial number.

ITEM	SERVICE	MAWP	CODE	INLET	OUTLET	V/D/TEMP	DIM B	DIM C	LOUVERS	BUG SCREEN	DRIVE	FAN	FINISH
1	S1 3.07 CU.FT.	850 PSI @ 200/-20° F	ASME	2"-600 RFWN	2"-600 RFWN	(3) 1"-6000#	-	-	NONE	NONE	ELECTRIC MOTOR DRIVE GUARDS BY AXH 5HP, 900RPM, 460/60/3 TEFC VFD COMP. MOTOR (CSA) (VT) METRIX VIBRATION TRANSMITTER ST5484-121-020	42" Ø (1) MOORE-1K-10 4- BLADE 31.8° PA. LH ROTATION 875 RPM @ 2.75 HP REQ'D Ø1.625" BORE WITH .375 x .1875 KWY.	HEADERS SIDEFRAMES STD PRIMER W/ WARM GRAY ENAMEL TOP COAT STRUCTURE FAN GUARD GALVANIZED





SECTION A-A
SCALE 1/7



RELEASED

FABRICATION OF THIS ORDER HAS BEGUN

NOTE Please be aware that if any changes are made they may result in additional manufacturing and engineering costs and may also adversely impact the current scheduled shipping date. *NOTE*

REV	DESCRIPTION	BY	CK	DATE
3	REVISED FAN RING DEPTH	DC	JS	12/8/2016
2	CHANGED QTY. TO 2, REVISED VIB. SWITCH AND ADDED PO NUMBER	JB	JS	10/25/2016
1	ADDED GREASE FITTINGS FOR ELECTRIC MOTOR, FLOW ARROWS & RELEASED	DC	JS	10/13/2016

FOR: L.A. TURBINE CORPORATION
P.O. #: 23582 & 23713
CUST. TAG #:
USER: UNKNOWN
JOBSITE: UNKNOWN
JOB #: 165400
DR: D Caldwell DATE: 9/28/2016
CK: J Shepherd DATE: 10/3/2016

ESTIMATED DRY WEIGHT 3,700 #

AXH air-coolers

CERTIFIED DRAWING FOR:
MODEL 42ZF QUANTITY: 2

SIZE | DWG NO 165400-CRT | REV 3
SCALE FULL | DATE 9/28/2016 | SHEET 1 OF 1

AXH air-coolers
401 E. Lowry Road, Claremore, Oklahoma 74017
(918) 283-9200 Fax (918) 283- 9229
www.axh.com

Job number: 165400A
Customer: L.A. TURBINE CORPORATION
Quantity: 1.00
Model: 42-Z

Parts List

Note: Quantity Shown is for One Unit Only

Revision	Engineer	Date	Description
0	JB	09/29/2016	Initiated parts list
1	JB	10/25/2016	Changed qty to 2
2	JB	11/01/2016	Added blind flanges

	QUANTITY		DESCRIPTION OF PARTS	
**	1.00	FAN	EA	FAN

Make: Moore
Blade Tips: N/A
Class: 1,000 HD
Series: 10
Diameter: 42"
No. Blades: 4
Rotation: Left Hand
Angle: 31.8
Bore: 1-5/8"
Keyway: 3/8"

Fan to have extended hub

**	1.00	Electric-Motor	EA	Item for Attatched Notes

Make: TECO Westinghouse
Catalog #: HB0058 w/ mods (M2), (M13) & (M21A)
Horsepower: 5
RPM: 900
V/P/HZ: 460/3/60
Frame: 254T
Enclosure: TEFC
Shaft: Vertical
Mounting: W-6

Special Notes:
CSA
IEEE841
120V Space heater
Stainless Steel breather Drains (Shaft Down)
Cast Iron Drip Cover
Per TECO Quote #: 160907DWH03 Rev. 0

	1.00	VS-METRIX-CLASS1	EA	Vib. Switch Metrix ST5484E-121-020-00, CSA, Cl.1, Div.1, 4-20mA
	1.00	Blind Flange	EA	

2 ea - 2"-600# Blind Flange

1.00	Blind Flange hardware	EA	

8 ea - 5/8" dia X 4 1/4" lg with nuts

** = RECOMMENDED SPARE PART

AXH air-coolers
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Job number: 165400A
Customer: L.A. TURBINE CORPORATION
Quantity: 1.00
Model: 42-Z

Parts List

Note: Quantity Shown is for One Unit Only

Revision	Engineer	Date	Description
0	JB	09/29/2016	Initiated parts list
1	JB	10/25/2016	Changed qty to 2
2	JB	11/01/2016	Added blind flanges

QUANTITY	DESCRIPTION OF PARTS	
1.00	Blind Flange Gasket	EA

1 ea 2"-600# blind flange gasket

** = RECOMMENDED SPARE PART

AXH air-coolers
WESTLAND ENGINEERING SOLUTIONS EST. 1955

401 E. Lowry Road
Claremore, OK 74017
info@axh.com

Phone (918) 283-9200
Fax (918) 283-9229
www.axh.com

Proposal / Job No.	165400
Date	9/6/2016
Page	1 OF 1

Purchaser	LAT				*Ultimate User*			
Inquiry / PO#					*Destination*			
# Units	1	*Model*	42ZF		*Reference*	LAT573		
Assembly	PACKAGED	*Draft*	FORCED		*Overall Size , Ft*	~4'Wx7'L	*Est Wt*	2620 LBS

THERMAL & MECHANICAL DESIGN

Service	S1
Flow	21GPM
Fluid	ISO VG 32
Temp. In / Out, °F	152.4 / 120.0
Pressure, PSI	285 / 370PSIG
Pressure Drop, PSI	12.3
Heat Load, BTU/HR	140000
True LMTD	17.1
Overall Rate, U	72.4
Fouling Factor	.0010
Surface, Tube / Total, Sq Ft	117 / 2513
Sections, #	(1)
Design Temp, °F Max / Min	200 / -20
MWP / Test Press, PSIG	850 / 1275
Pass Arrangement	CROSSFLOW
# Tube Rows	4
# Tube Passes	6
Tubes, OD x BWG	1X16
Material	SA179 STEEL
# Per Section / Length, Ft	78 / 6
Turbulators	WIRE CORE
Accelerators	
Fins, Type	HI-EFF
Material	AL
Nozzles, Rating / Type	600RF
Material	SA105
#-Inlets / Size In	(1) 2
#-Oulets / Size In	(1) 2
Headers, Type	BOX
Material	SA516-70
Corrosion Allow, In	
Grooved Tubesheet	DBL
Plugs, Type	SHOULDER
Plugs Material	A105 STEEL
PWHT	
ASME Code & Nat'l Board	YES
CRN	
Add'l Specs & Options	
API	
Louvers / Hail Screen	/
Inspection / NDT	

FX= *100% X-Ray of all header seam, attachment & nozzle butt welds.* ***SX=*** *Spot X-Ray of 1 long seam & 1 end closure, per header*
BX= *100% X-Ray of all nozzle butt welds.* ***UT =*** *100% UT of all header seam, attachment & nozzle butt welds.* ***H*** *= Hardness testing.*

AIR-SIDE PERFORMANCE		FAN DATA		DRIVER DATA	STRUCTURAL	
Ambient Air Temp, In °F	110	*Fan(s)*	(1) MOORE-1K-10	*Type*	*Guards*	FAN/DRIVE
Elevation, Ft	2900	*Blade Material*	ALUMINUM	DIRECT DRIVE BY (1) 5HP,		
Air Flow, SCFM	11,124	*HP / Fan*	2.75	900RPM, 460/60/3, TEFC,		
Outlet Air Temp, °F	121.1	*Dia, In / # Blades*	42 / 4	MOTOR (CSA)		
Min Air Temp, °F	-20	*RPM*	875			
		Tipspeed, FPM	9621			
		Pitch, Deg	31.8			

Additional Info.

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS

(ALTERNATIVE FORM FOR SINGLE CHAMBER, COMPLETELY SHOP OR FIELD FABRICATED VESSELS ONLY)

AS REQUIRED BY THE PROVISIONS OF THE ASME BOILER AND PRESSURE VESSEL CODE RULES, SECTION VIII, DIVISION 1

1. Manufactured and certified by : AXH air-coolers, LLC - 401 EAST LOWRY ROAD - CLAREMORE, OKLAHOMA 74017
(Name and address of manufacturer)

2. Manufactured for: L.A. TURBINE CORPORATION, 28557 INDUSTRY DRIVE, VALENCIA, CA 91355

3. Location of installation: UNKNOWN
(Name and address)

4. Type: HORZ. H. EXCHANGER (Horizontal. or vertical, tank) | 165400A-B.1 (Manufacturer's serial no.) | NONE (CRN) | 165400-HDR-S1 R1 (Drawing number) | 36255-36256 (National Board number) | 2016 (Year built)

5. ASME CODE, SECTION VIII, DIVISION 1 | 2015 EDITION / NONE [Edition and Addenda, if applicable (date)] | - (Code Case numbers) | - [Special service per UG-120(D)]

6. Shell | TUBE/PLUG: SA-516-70 (Material spec. number, grade) | FR & BK 1 1/2" (Nominal thickness) | NONE (Corr. Allow.) | FR & BK 0' 8 3/4" (Inner diameter) | 3' 9 5/8" [Length (overall)]

Body Flanges on Shells

No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Bolting: Num & Size	Bolting: Bolting Material	Bolting: Washer (OD, ID, thk)	Bolting: Washer Material
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

7. Seams | CORNER JOINT [Long. (welded, dbl., sngl., lap, butt)] | NONE R.T. (spot or Full) | 1.0 (Eff., %) | NONE (H.T. temp.°F) | NONE (Time, hr) | - [Girth (welded, dbl., sngl., lap, butt)] | - [R.T. (spot or full)] | - (Eff., %) | *2 (No. of courses)

8. Heads (a) Material: WRAPPERS: SA-516-70 (Spec. no., grade) (b) Material: ENDS: SA-516-70 (Spec. no., grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	WRAPPERS	1/2"	NONE	-	-	-	-	-	**	FLAT
(b)	ENDS	1/2"	NONE	-	-	-	-	-	***	FLAT

Body Flanges on Heads

	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Bolting: Num & Size	Bolting: Bolting Material	Bolting: Washer (OD, ID, thk)	Bolting: Washer Material
(a)	-	-	-	-	-	-	-	-	-	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-

9. MAWP: 850 psi (Internal) | N/A (External) | at max. temp 200 °F (Internal) | N/A (External)

Min. design metal temp. -20 °F at 850 psi. Hydro., ~~pneu. or comb.~~ test pressure 1275 psi.

Proof test NONE

10. Nozzles, inspection, and safety valve openings:

Purpose (Inlet,Outlet,Drain)	No.	Diameter or size	Type	Material: Nozzle	Material: Flange	Nozzle Thickness: Nom.	Nozzle Thickness: Corr.	Reinforcement Material	Attachment Details: Nozzle	Attachment Details: Flange	Location (Insp. Open.)
INLET/OUTLET	2	2"-600#	PIPE/RFWN	SA106B	SA105	S/80	NONE	NONE	UW-16(a)	UW-12(1)	HEADER
INSTRUMENT	3	1"	CPLG	SA105	-	6000#	NONE	NONE	UW-16(a)	-	HEADER
PLUGS	156	1 1/8"-12	UNF	SA105	-	-	-	-	-	-	HEADER

11. Supports: Skirt NO (Yes or no) Lugs N/A (Number) Legs N/A (Number) Other STRUCTURE (Describe) Attached BOLTED (Where and How)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report:
(Name of part, item number, Manufacturer's name and identifying stamp)

*2 HEADERS, ONE AT EACH END. **WRAPPERS FLAT DIA. 3" X 3' 9 5/8". ***ENDS FLAT DIA. 3" X 7 3/4".

78 TUBES SA-179 1" O.D. X .065 MW 6' 0" LG.

IMPACTS EXEMPT PER UG-20(f). PRESSURE RELIEF DEVICE BY OTHERS PER UG-125. CONSTRUCTED IN ACCORDANCE WITH APPENDIX 28.

FORM U-1A (Back)

CERTIFICATE OF SHOP / FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 34,950 expires 02/07/2017

Date 12-6-16 Co. name AXH air-coolers, LLC. (Manufacturer) Signed [signature] (Representative)

CERTIFICATE OF SHOP / FIELD INSPECTION

Vessel constructed by AXH air-coolers, LLC. at 401 E. LOWRY ROAD - CLAREMORE, OKLAHOMA 74017

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by ONECIS INSURANCE COMPANY OF LYNN, MA

have inspected the component described in this Manufacturer's Data Report on 12-1-16, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 12-6-16 Signed [signature] (Authorized Inspector) Commissions NB12461A [National Board (incl. endorsements)]

NB 36255

CERTIFIED BY **AXH air-coolers, LLC**

CLAREMORE, OKLAHOMA

U

W

S1

MAX. ALLOWABLE WORKING PRESSURE 850 **PSI** @ 200 °F

MIN. DESIGN METAL TEMP. -20 °F @ 850 **PSI**

SER. NO. 165400A.1 **CRN.** -

YEAR 2016 **HYDRO.** 1275 **PSIG SERVICE**

NB 36256

CERTIFIED BY **AXH air-coolers, LLC**

CLAREMORE, OKLAHOMA

U

W

S1

MAX. ALLOWABLE WORKING PRESSURE 850 **PSI** @ 200 °F

MIN. DESIGN METAL TEMP. -20 °F @ 850 **PSI**

SER. NO. 165400B.1 **CRN.** -

YEAR 2016 **HYDRO.** 1275 **PSIG SERVICE**

11-29-16

FINAL IN PROCESS
INSPECTION CHECKLIST

AXH air-coolers

CUSTOMER:	L.A. TURBINE
JOB / MODEL NUMBER:	165400 / 42ZF
UNIT:	A

	PROD.	LEAD	Q.C.	CUST.	
NOZZLE ARRANGEMENT AND FLANGE FACING	JN. RC 12-5-16 X	F.O. X	YZA 12-8 X		
RUST PREVENTION OF NOZZLE FACES	X				
RUST PREVENTION OF SHAFTS	JN 12-8-16 X				
DIMENSIONAL INSPECTION OF COLUMNS	JN. F.O 12-8-16 X	F.O X	YZA 12-8 X		
DIMENSIONAL INSPECTION OF BASE HOLES	JN 12-8-16	F.O			
TORQUING OF FAN HUB & BLADES	JN 12-8-16 X	F.O X			
CHECK FAN BLADE CLEARANCE AND PITCH 31.8 º	JN 12-8-16 X	F.O X	YZA 12-8 X		
PARAFLEX CPLG, FAN BUSHING, AND BEARINGS SECURED	JN 12-8-16 X	F.O X	YZA 12-8 X		
BEARINGS GREASED	X		X		
IDLER ALIGNMENT					
ELECTRIC MOTOR / SHEAVE ALIGNMENT	JN 12-8-16 X	F.O X	YZA 12-8 X		
MANUAL AND/OR AIR MOTORS					
SHUTTERS OPERATE CORRECTLY, PICTURES TAKEN					
SIDE FLAP INSTALLATION (FRONT HEADER END) (BACK HEADER END)					
FINAL FINISH AVG. MIL. **(HEADERS & SIDEFRAMES)** 4	EP 12-6-16 X	MM 12-7-16 X	YZA 12-8 X		
CLEANING OF GALVANIZED PARTS AS REQUIRED	JN/F.O 12-8-16 X				
HAIL GUARD, FAN GUARD, AND/OR BUGSCREENS	JN. F.O 12-8-16 X				
UNIT / MISC NAMEPLATE INSPECTION & ATTACHMENT	JN 12-8-16 X	F.O X	YZA 12-8 X		
TEST FIT OF LADDERS / PLATFORMS, PICTURES TAKEN					
PARTS SHIPPING LOOSE					
VIBRATION SWITCH	JN 12-5-16 X		YZA 12-8 X		
ELECTRIC MOTOR VERIFICATION	JN 11-30-16 X	F.O X	KD 11-30-16 X		
RUN TEST AND VIBRATION CHECK		TUK X	YZA 12-8 X		
VERIFY WEIGHT	JN 12-8-16 X				

Q.C. RELEASE FOR SHIPMENT: YZA #2945 12-8-16

COMMENTS: **OIL FLUSH PER JOB INSTRUCTIONS.**

FINAL IN PROCESS
INSPECTION CHECKLIST

AXH air-coolers

CUSTOMER:	L.A. TURBINE
JOB / MODEL NUMBER:	165400 / 42ZF
UNIT:	B

	PROD.	LEAD	Q.C.	CUST.	
NOZZLE ARRANGEMENT AND FLANGE FACING	JN 12-5-16 X	FO X	ZZA 12-8 X		
RUST PREVENTION OF NOZZLE FACES	X				
RUST PREVENTION OF SHAFTS	JN 12-8-16 X				
DIMENSIONAL INSPECTION OF COLUMNS	JN FO 12-8-16 X	FO X	ZZA 12-8 X		
DIMENSIONAL INSPECTION OF BASE HOLES					
TORQUING OF FAN HUB & BLADES	JN 12-8-16 X	FO X			
CHECK FAN BLADE CLEARANCE AND PITCH 31.8 °	JN 12-8-16 X	FO X	ZZA 12-8 X		
PARAFLEX CPLG, FAN BUSHING, AND BEARINGS SECURED	JN 12-8-16 X	FO X	ZZA 12-8 X		
BEARINGS GREASED	X		X		
IDLER ALIGNMENT					
ELECTRIC MOTOR / SHEAVE ALIGNMENT	JN 12-8-16 X	FO X	ZZA 12-8 X		
MANUAL AND/OR AIR MOTORS					
SHUTTERS OPERATE CORRECTLY, PICTURES TAKEN					
SIDE FLAP INSTALLATION (FRONT HEADER END) (BACK HEADER END)					
FINAL FINISH AVG. MIL. **(HEADERS & SIDEFRAMES)** 4	EP 12-6-16 X	mm 12-7-16 X	ZZA 12-8 X		
CLEANING OF GALVANIZED PARTS AS REQUIRED	JN-FO 12-8-16 X				
HAIL GUARD, FAN GUARD, AND/OR BUGSCREENS	JN-FO 12-8-16 X				
UNIT / MISC NAMEPLATE INSPECTION & ATTACHMENT	JN 12-8-16 X	FO X	ZZA 12-8 X		
TEST FIT OF LADDERS / PLATFORMS, PICTURES TAKEN					
PARTS SHIPPING LOOSE					
VIBRATION SWITCH	JN 12-5-16 X		ZZA 12-8 X		
ELECTRIC MOTOR VERIFICATION	JN 11-30-16 X	FO X	KP 11-30-16 X		
RUN TEST AND VIBRATION CHECK		TMK X	ZZA 12-8 X		
VERIFY WEIGHT #2,945	JN 12-8-16 X				

Q.C. RELEASE FOR SHIPMENT: ZZA 12-8-16

COMMENTS: OIL FLUSH PER JOB INSTRUCTIONS.

AXH air-coolers

REPORT OF NONDESTRUCTIVE TESTING
MAGNETIC PARTICLE EXAMINATION RECORD

REFERENCE STANDARD: ASME SECT.V, ASME SECT. VIII DIV.1, APPENDIX 6
AXH AIR-COOLERS STANDARD MS-20.0 REVISION: 0

EXAMINATION EQUIPMENT & METHOD

MAGNETIZING EQUIPMENT: Parker Research Contour Probe SERIAL #: 3563

CURRENT TYPE: [X] AC [ ] DC

MT TYPE: [ ] WET [X] DRY [ ] FLOURESCENT [X] VISIBLE

LIGHTING EQUIPMENT:
[X] FLOURESCENT LIGHT
[X] WHITE LIGHT USING PARKER RESEARCH Y300 OR Y400 PROBE LIGHTING
[ ] FLASHLIGHT [ ] # OF BATTERIES TYPE: ____ CELL ____
MAXIMUM DISTANCE FROM OBJECT: ____ FEET
[ ] OTHER ____

MINIMUM LIGHT INTENSITY ON SURFACE TO BE EXAMINED: 100 FOOT CANDLES

EXAMINATION RESULTS

IDENTIFICATION:

CUSTOMER: L.A. Turbine DATE: 11-28-16

JOB #: 165402 A, B ITEM #: .1 (EXAMPLE: .1, .2, .3)

MATERIAL TYPE: SA516 70 MATERIAL THICKNESS: ____

EXAMINATION PERFORMED:

[✓] PLATE EDGES PER ASME SECTION VIII, DIV. 1, UG-93: BEFORE WELDING - WELD JOINT PREPARATION (OR AREA TO BE WELDED) OF ALL TUBE AND PLUG SHEETS, AND AFTER WELDING - PERIPHERAL EDGE OF TUBE AND PLUG SHEETS
BEFORE 11-15-16 AFTER 11-28-16

[ ] ALL WELDED SEAMS WHERE ACCESSIBLE
[ ] ALL FINAL WELD SEAMS, NOZZLES, & COUPLINGS WHERE ACCESSIBLE
[ ] ALL NOZZLE & COUPLING ROOT PASSES WHERE ACCESSIBLE
[ ] OTHER ____

EXAMINATION RESULTS:

[✓] ACCEPT [ ] REJECT

DESCRIPTION AND/OR MAP OF INDICATIONS FOUND

T.E. Teff — EXAMINER

II — QUALIFICATION LEVEL

AXH air-coolers

HYDROSTATIC TEST REPORT

MANUFACTURED FOR **L.A. TURBINE**

AXH JOB NUMBER **165400**

VESSEL TESTED **165400A-B.1 S1**

TEST PRESSURE **1275** PSI

HYDRO TEST HELD FOR **1** HR.

THIS REPORT IS TO CERTIFY THAT THE AFOREMENTIONED VESSEL (OR) VESSELS WERE HYDROSTATIC TESTED IN ACCORDANCE WITH ASME SECTION VIII DIV 1.

CUSTOMER WITNESS _____

ACCEPTED BY R. Bergeron DATE 12-1-16

QUALITY CONTROL REPRESENTATIVE

AXH air-coolers

SECTION FLUSHING REPORT
REFERENCE: AXH AIR-COOLERS STANDARD MS-32.0

CUSTOMER: L.A. Turbine PO #: _____

AXH JOB #: 165400, 1A-B SECTION: S1

FLUSHING OIL USED: Industrial Oils Unlimited, Premium Flushing Oil No. 7

FLOW RATE REQ'D: 100 GPM TEMPERATURE: 155 +/- °F

RECORDED FLOW RATE: 400 GPM TEMPERATURE: 155 °F

MINIMUM REQUIRED FLUSHING TIME: 8 HOURS

MAXIMUM NUMBER OF PARTICLES ALLOWED: _____

NUMBER OF PARTICLES FOUND: 150 pcs.
(GREATEST DIMENSION OF ANY PARTICLE FOUND SHALL NOT EXCEED 0.010 INCHES)

On Pre-Flush (if required) Date: 12/2/16 Time: 6:00 AM.

Off Pre-Flush (if required) Date: 12/2/16 Time: 10:00 AM.

On Flush Date: 12/2/16 Time: 11:00 AM.

Off Flush Date: 12/2/16 Time: 3:00 PM -

TOTAL SECTION FLUSHING TIME: 8 HOURS

FLUSHING OIL ADDED (COVERING BOTTOM TUBE ROW) BY: [signature]

SIGN OFF:

MANUFACTURING: [signature] DATE: 12-2-16

QUALITY CONTROL: [signature] DATE: 12-5-16

CUSTOMER INSPECTOR: _____ DATE: _____

OIL FLUSH LOG

JOB #: 165400 A-B

DATE: 12/2/16

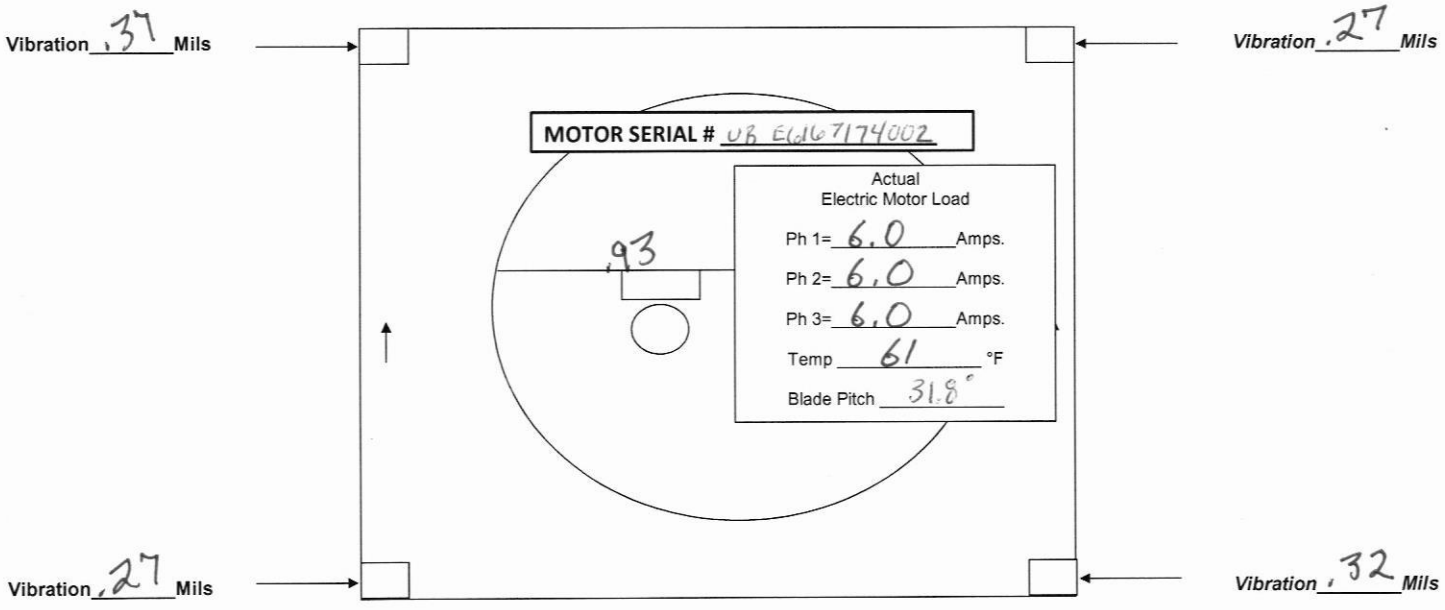
	BASKET CHECK	PARTICLES	FLOW RATE	TEMP	DIRECTION	INITIALS	NOTES
	12-1-16	Started	Pre	flush	3:00 Pm		
6:00 am	12-2-16	1000	400	155	Reverse	KP	
	12-2-16	wire	inserts	installed	flush		started 11:00 am
3:00 Pm	12-2-16	150		155	forward		Blow down

AXH air-coolers
401 East Lowery Rd. - Claremore, Ok. 74017
918-283-9200 - fax: 918-283-9229
www.axh.com

JOB NUMBER(S): 165400A
CUSTOMER: L.A. TURBINE
QUANTITY: 1-MOTOR
MODEL: 42ZF

RUN-IN TESTING

BACK HEADER END



FRONT HEADER END

TESTING PERFORMED

1. Vibration Displacement in Mils. Peak to peak
2. Vibration Meter: Balmac Model 205

AXH air-coolers

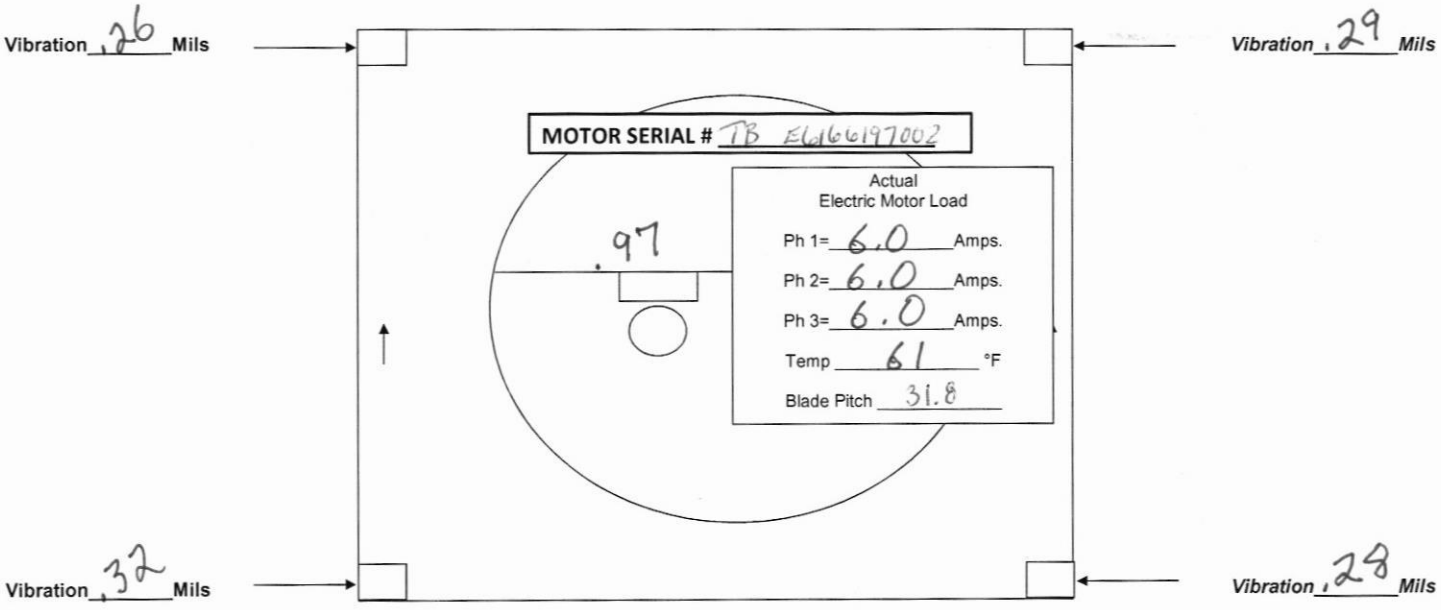
Tested By: [signature]
Date Tested: 12-8-16
Time Tested: 3:35 am (pm)

AXH air-coolers
401 East Lowery Rd. - Claremore, Ok. 74017
918-283-9200 - fax: 918-283-9229
www.axh.com

JOB NUMBER(S):	165400B
CUSTOMER:	L.A. TURBINE
QUANTITY:	1-MOTOR
MODEL:	42ZF

RUN-IN TESTING

BACK HEADER END



FRONT HEADER END

TESTING PERFORMED

1. Vibration Displacement in Mils. Peak to peak
2. Vibration Meter: Balmac Model 205

AXH air-coolers

Tested By: FLS

Date Tested: 12-8-16

Time Tested: 3:15 am (pm)

MOORE FANS LLC

CLASS 1000 FANS
INSTALLATION INSTRUCTIONS

The clevises on the hubs are set at approximately the required angle for the specified fan performance. Install hubs without loosening the clevises. The bushing has been installed and lubricated at the factory. No further lubrication is required. Place the hub/bushing on the shaft with the key in place (preferably bolts will be towards free end of shaft). Then tighten the allen set screw holding the key in place using a 5/32" Allen wrench. Using a 10 mm Allen wrench, sequentially tighten the bolts to firmly engage the bushing in the hub and seat the bushing on the shaft. Once the bushing/ hub is firmly seated on the shaft, continue tightening the bolts sequentially until the specified torque of 50 ft-lb (6.9 kg-m) is reached. Do not over tighten the bolts as this could cause damage to the hub.

The bolts holding the clevis to the hub should be torqued to 50 ft-lb (6.9 kg-m). Install blades so they extend straight out from the hub and torque the clevis bolt/nut to 50 ft-lb (6.9 kg-m). The threads on the clevis bolt are supplied from the factory with a lubricant coating. Be sure the lubricant is still present before tightening.

To install the air seal, screw the end of the stud with the shorter threads into the center hub of the fan and then place the air seal on the studs. Use the stainless steel locknuts to secure the air seal in place.

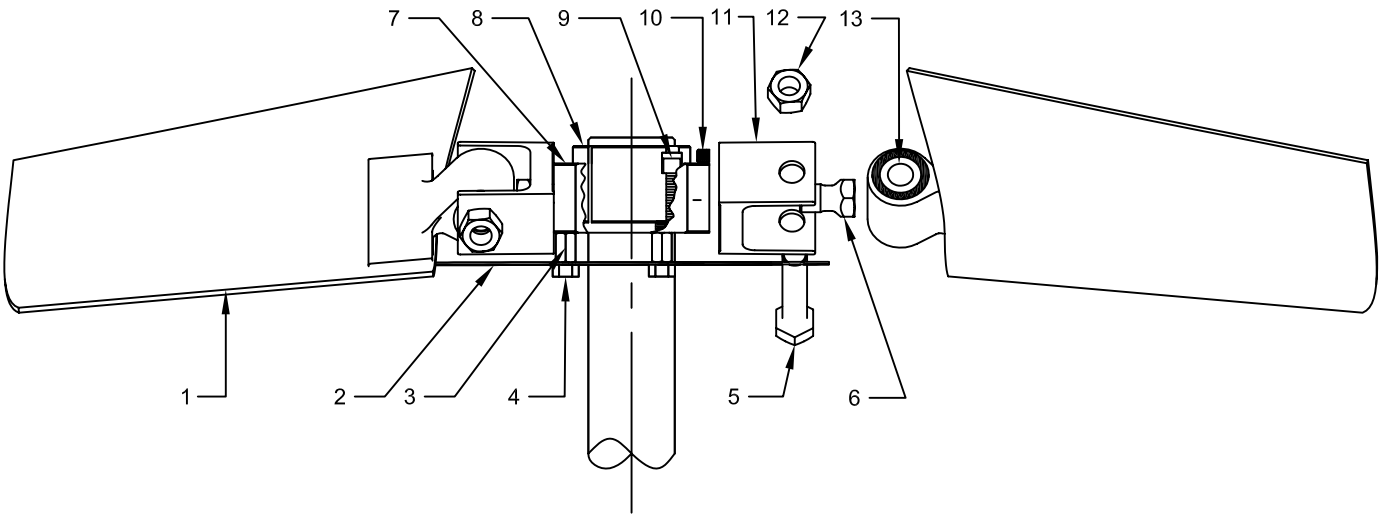
Before starting the fan, manually check all bolts and nuts to see if they are tightened. Take care not exceed torque limits. Manually rotate the fan while checking each blade for proper clearance. Start the fan and watch it in operation. All blades should move to the same operating position, indicating that the blade angles are properly set and that all blades are equally loaded. After the fan has been operating for several minutes, stop the fan and observe the blades as the fan comes to rest. All of the blades should return to their original position at the same rate. Inspect the inner surface of the fan ring and the blade tips for any indication of scoring. The horsepower given on the fan specifications is the calculated horsepower that is required for the specified performance. Consult the factory before increasing the blade angle.

Blade Pitch Adjustment

To reset the blade pitch angle on a vertically installed fan remove the blades and loosen the clevis center bolt that attaches the clevis to the hub. Manually rotate the fan so that the clevis to be adjusted is in the horizontal position. If the clevis is not in the horizontal position the blade angle will not be correctly measured during adjustment. Place a protractor level on the front or back flat of the clevis and rotate the clevis to the desired angle. While holding the clevis angle, tighten the clevis center bolt to a torque of 50 ft. lbs. After adjusting all clevises, reinstall the fan blades following the procedure in the installation section. Resetting the blade pitch angle on a horizontal fan is done the same way, except that the surface of the clevis on which the angle will be measured is on the top or bottom flat.



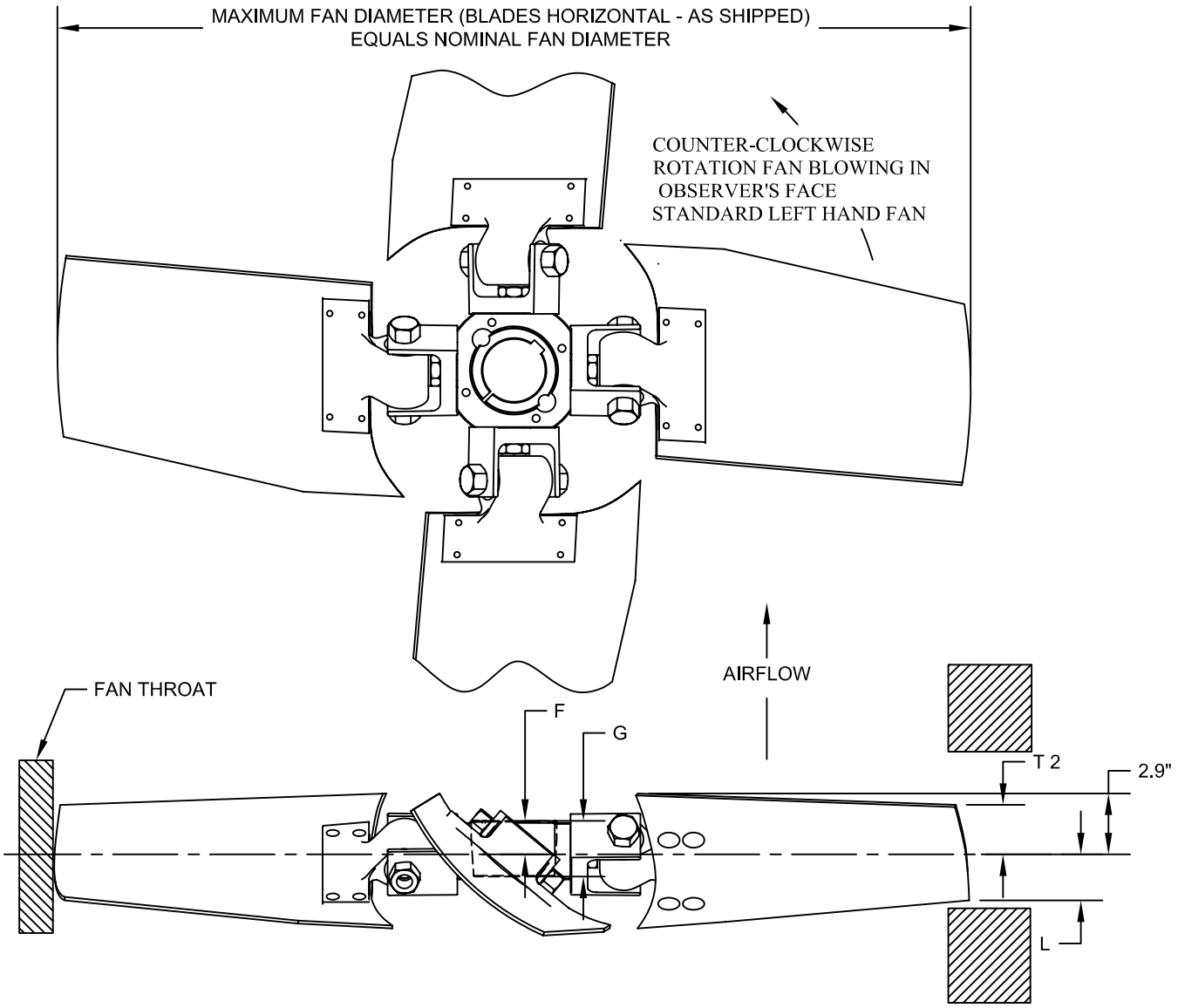
For a complete illustration of the Class 1000 fans please see Class 1000 Series 10 Parts List (TMC 750) and Class 1000 Series 16 Parts List (TMC 751).



DWG NO.	SHOP PART NO.	DESCRIPTION	DWG NO.	SHOP PART NO.	DESCRIPTION
1.		BLADE	9.	4698	BUSHING BOLT
2.		AIRSEAL	10.	4596	SET SCREW
3.	4840	AIRSEAL STUD	11.	4264	CLEVIS
4.	5122	AIRSEAL STUD NUT	12.	169	CLEVIS BOLT NUT
5.	4261	BLADE BOLT	13.	958	RESILIENT MOUNT
6.	4262	CLEVIS CENTER BOLT			
7.		HUB			
8.		"T" BUSHING			

CLASS1000 SERIES 10

SERIES 10 FAN PARTS LIST



NOTE : ALL MEASUREMENTS ASSUME HIGHEST BLADE LOADING AND ANGLE (50°)

FAN SHOWN WITHOUT AIRSEAL FOR CLARITY

T 2 = FAN CENTER LINE TO TRAILING EDGE @ TIP
L = FAN CENTER LINE TO LEADING EDGE AT TIP
F = CENTERLINE OF FAN TO BASE OF BUSHING (STANDARD HUB)
G = OVER ALL BUSHING LENGTH
# = WITH S.A.E. STANDARD SQUARE KEYWAY
* = WITH SHALLOW KEYWAY IN BUSHING

WITH FAN OPERATING AT 12000 FT : MINUTE BLADE TIP SPEED

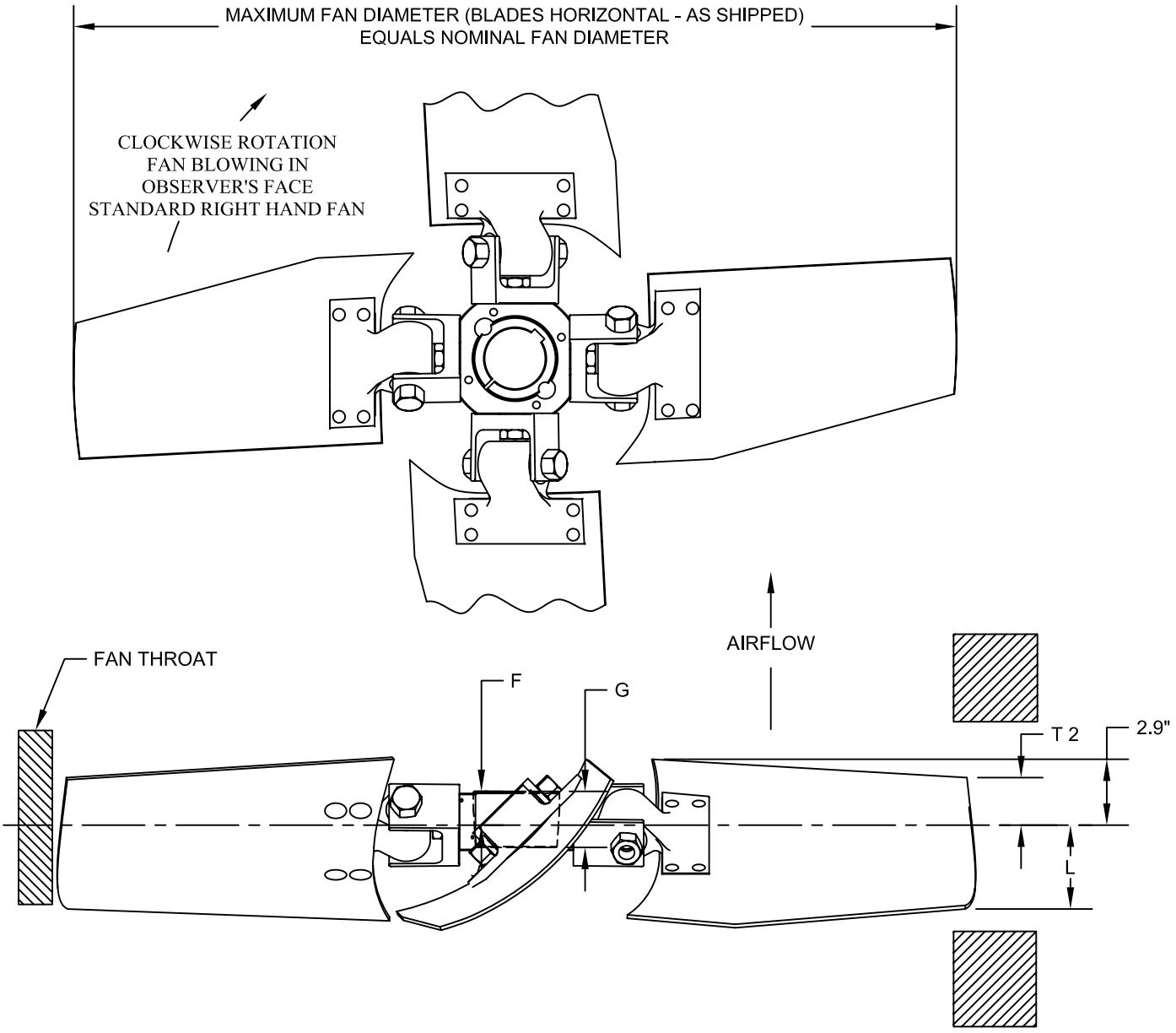
PERCENT BLADE LOADING

	100%	
DIA	T 2	L
24"	2.6"	3.0"
30"	1.9"	3.2"
32"	1.7"	3.2"
36"	1.4"	3.3"
42"	0.9"	3.4"
48"	0.1"	3.8"

MAX	BUSHING	MAX #	MAX *		
BLADES	TYPE	BORE	BORE	F	G
4	T	2.000"	2.188"	1.3"	1.9"

SERIES 10 FAN
LEFT HAND ROTATION

CLASS1000 SERIES 10



NOTES : ALL MEASUREMENTS ASSUME HIGHEST BLADE LOADING AND ANGLE (50°)

FAN SHOWN WITHOUT AIRSEAL FOR CLARITY

T 2 = FAN CENTER LINE TO TRAILING EDGE @ TIP
L = FAN CENTER LINE TO LEADING EDGE AT TIP
F = CENTERLINE OF FAN TO BASE OF BUSHING (STANDARD HUB)
G = OVER ALL BUSHING LENGTH
# = WITH S.A.E. STANDARD SQUARE KEYWAY
* = WITH SHALLOW KEYWAY IN BUSHING

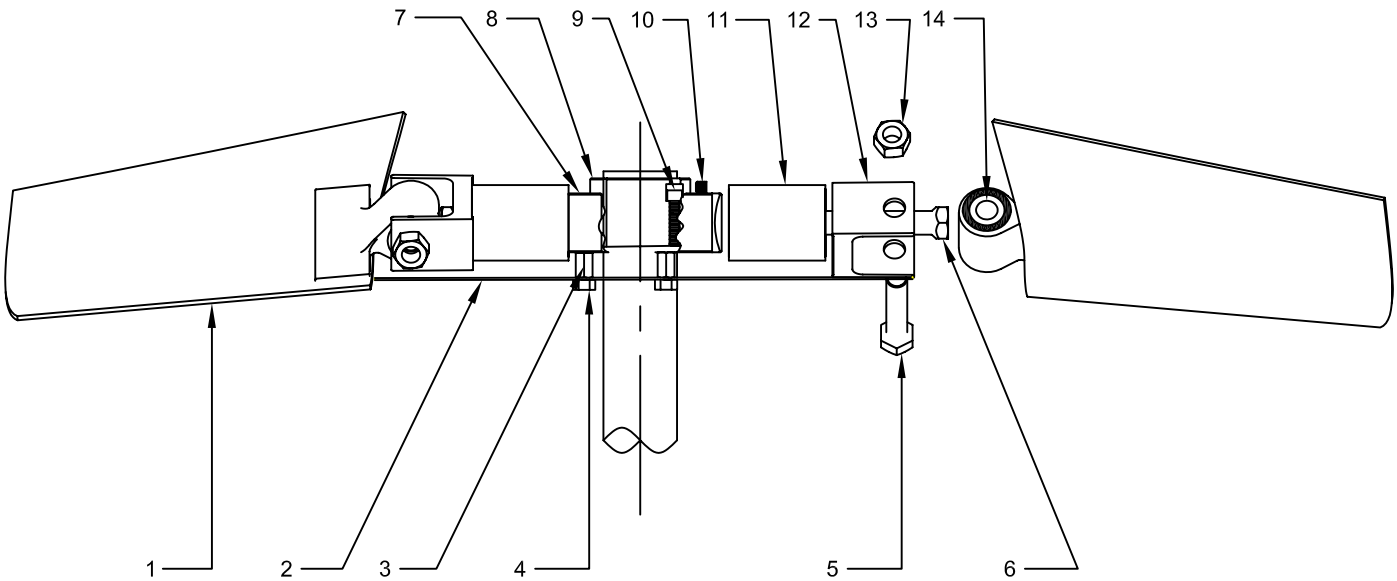
WITH FAN OPERATING AT 12000 FT : MINUTE BLADE TIP SPEED
PERCENT BLADE LOADING

	100%	
DIA	T 2	L
24"	2.6"	3.0"
30"	1.9"	3.2"
32"	1.7"	3.2"
36"	1.4"	3.3"
42"	0.9"	3.4"
48"	0.1"	3.8"

MAX BLADES	BUSHING TYPE	MAX # BORE	MAX * BORE	F	G
4	T	2.000"	2.188"	1.3"	1.9"

SERIES 10 FAN
RIGHT HAND ROTATION

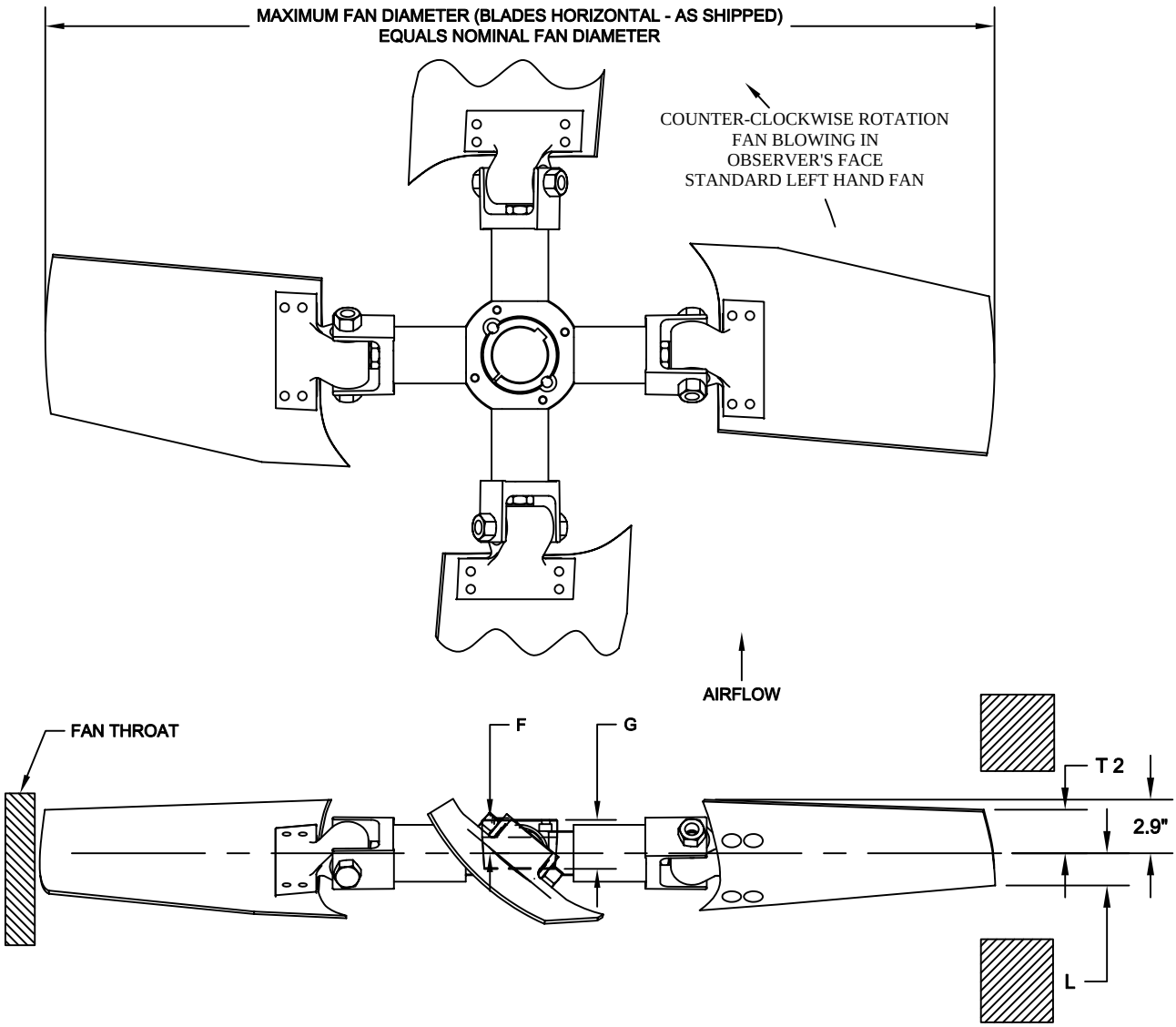
CLASS1000 SERIES 10



DWG NO.	SHOP PART NO.	DESCRIPTION	DWG NO.	SHOP PART NO.	DESCRIPTION
1.		BLADE	9.	4698	BUSHING BOLT
2.		AIRSEAL	10.	4596	SET SCREW
3.	4840	AIRSEAL STUD	11.		HUB TUBE
4.	5122	AIRSEAL STUD NUT	12.	4264	CLEVIS
5.	4261	BLADE BOLT	13.	169	CLEVIS BOLT NUT
6.		CLEVIS CENTER BOLT	14.	958	RESILIENT MOUNT
7.		HUB			
8.		"T" BUSHING			

SERIES 16 FAN
PARTS LIST

CLASS1000 SERIES 16



NOTE : ALL MEASUREMENTS ASSUME HIGHEST BLADE LOADING AND ANGLE (50°)

FAN SHOWN WITHOUT AIRSEAL FOR CLARITY

T 2 = FAN CENTER LINE TO TRAILING EDGE @ TIP
L = FAN CENTER LINE TO LEADING EDGE AT TIP
F = CENTERLINE OF FAN TO BASE OF BUSHING (STANDARD HUB)
G = OVER ALL BUSHING LENGTH
# = WITH S.A.E. STANDARD SQUARE KEYWAY
* = WITH SHALLOW KEYWAY IN BUSHING

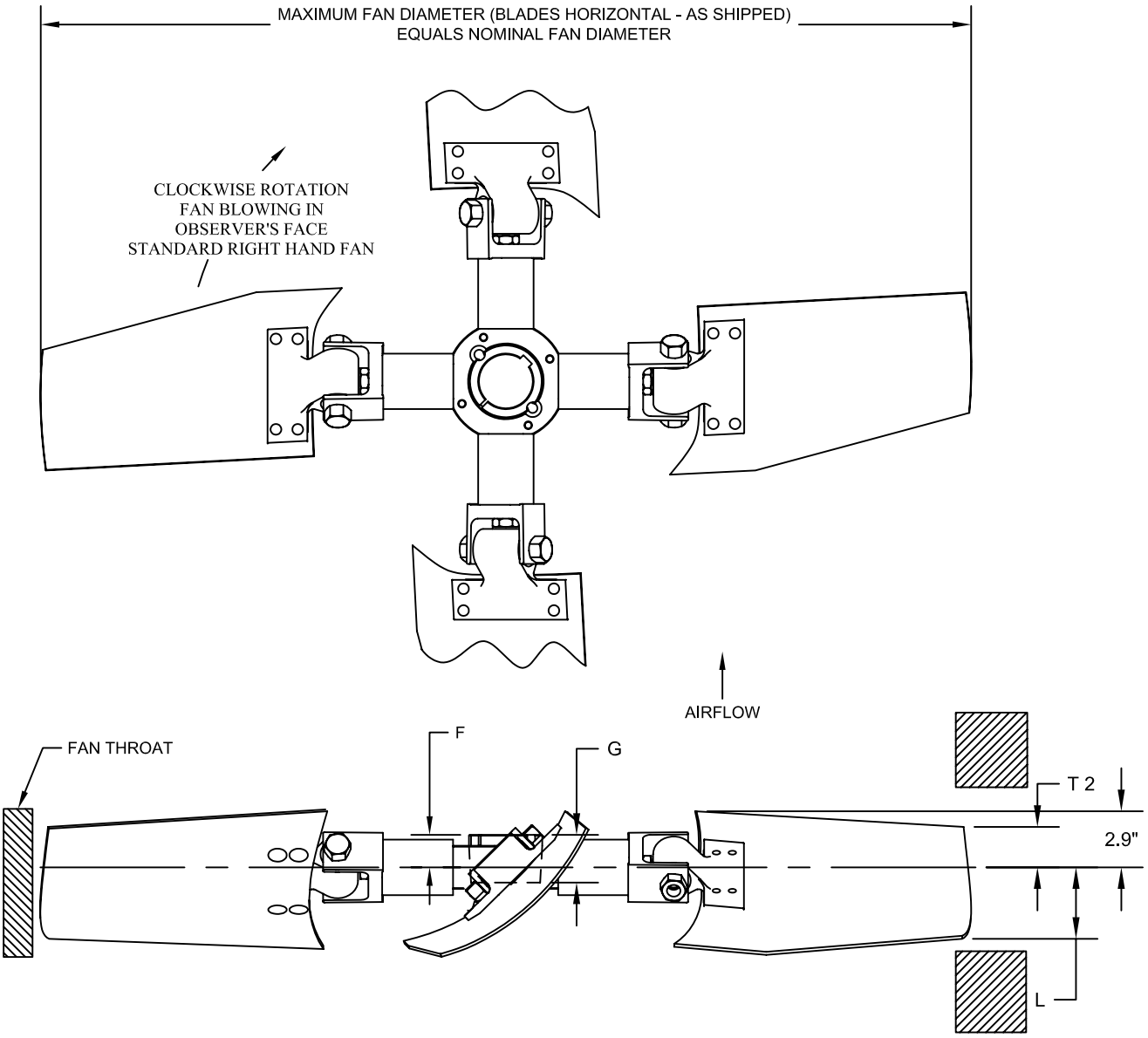
WITH FAN OPERATING AT 12000 FT : MINUTE BLADE TIP SPEED

PERCENT BLADE LOADING

	100%							
DIA	T 2	L						
36"	1.6"	3.6"						
42"	0.8"	3.9"	MAX	BUSHING	MAX #	MAX *		
48"	0.1"	4.2"	BLADES	TYPE	BORE	BORE	F	G
54"	-0.9"	4.8"	8	T	2.000"	2.188"	1.3"	1.9"
60"	-2.1"	5.5"	8	U	2.750"	2.938"	1.6"	2.7"

SERIES 16 FAN
LEFT HAND ROTATION

CLASS 10000 SERIES 16



NOTE : ALL MEASUREMENTS ASSUME HIGHEST BLADE LOADING AND ANGLE (50°)

FAN SHOWN WITHOUT AIRSEAL FOR CLARITY

WITH FAN OPERATING AT 12000 FT : MINUTE BLADE TIP SPEED

PERCENT BLADE LOADING

	100%	
DIA	T 2	L
36"	1.6"	3.6"
42"	0.8"	3.9"
48"	0.1"	4.2"
54"	-0.9"	4.8"
60"	-2.1"	5.5"

MAX BLADES	BUSHING TYPE	MAX # BORE	MAX * BORE	F	G
8	T	2.000"	2.188"	1.3"	1.9"
8	U	2.750"	2.938"	1.6"	2.7"

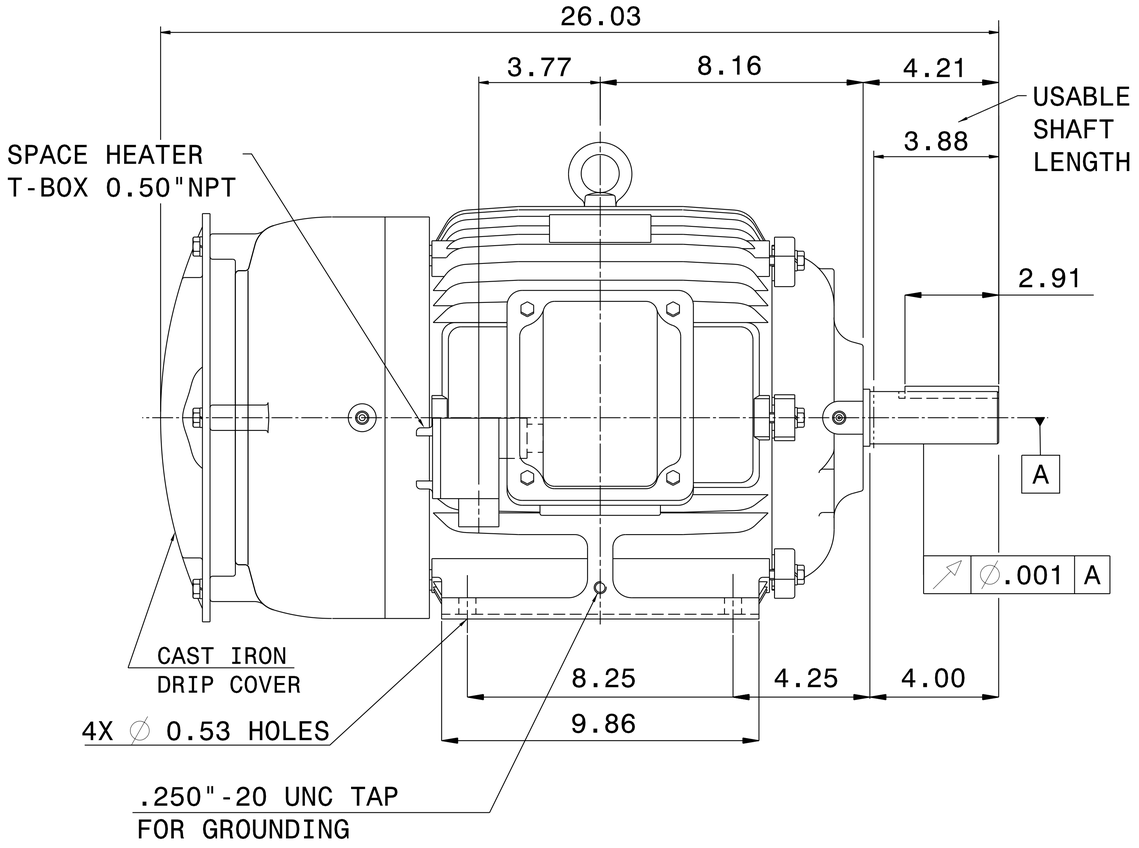
T 2 = FAN CENTER LINE TO TRAILING EDGE @ TIP
L = FAN CENTER LINE TO LEADING EDGE AT TIP
F = CENTERLINE OF FAN TO BASE OF BUSHING (STANDARD HUB)
G = OVER ALL BUSHING LENGTH
# = WITH S.A.E. STANDARD SQUARE KEYWAY
* = WITH SHALLOW KEYWAY IN BUSHING

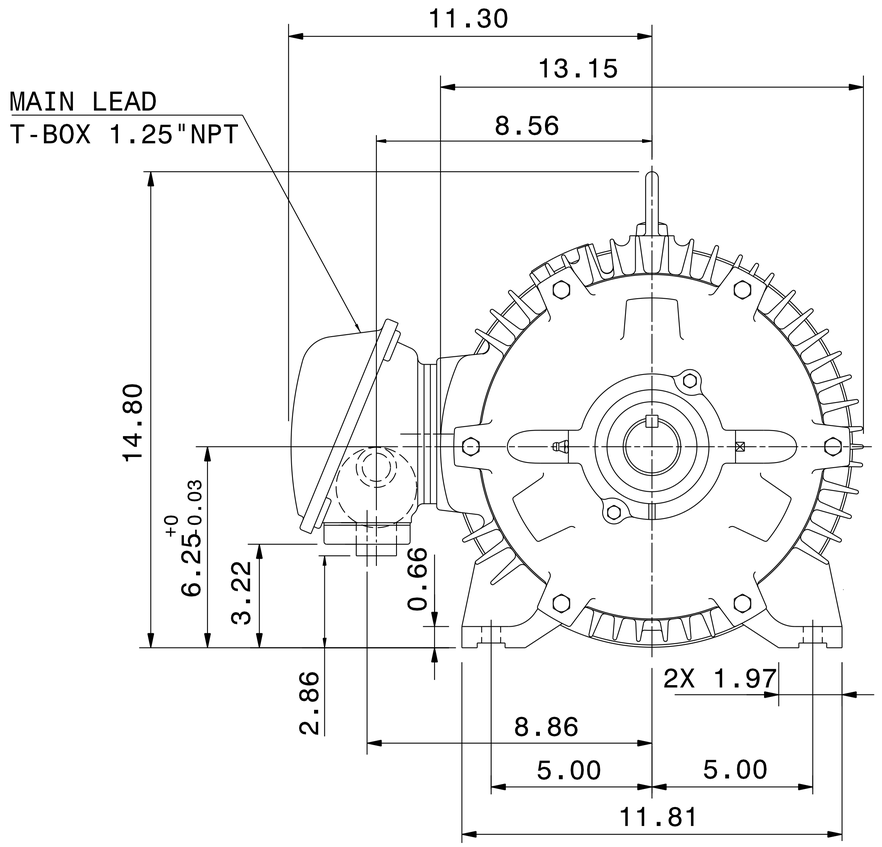
SERIES 16 FAN
RIGHT HAND ROTATION

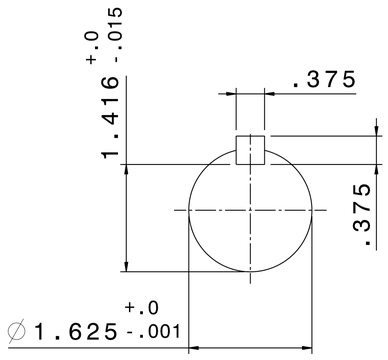
CLASS1000 SERIES 16

CATALOG #	TYPE	FRAME	OUTPUT		POLE	SYN. SPEED R.P.M.	VOLTAGE V.	Hz.	TIME RATING	INSULATION CLASS	SERVICE FACTOR	BEARINGS		WEIGHT LBS
			HP	kW								DE	NDE	
HB0058	AEHH8B	254T	5	3.73	8	900	460	60	CONT.	F	1.15	6309ZC3	6307ZC3	297

TOTALLY ENCLOSED FAN-COOLED TYPE. SQUIRREL CAGE MOTOR







NOTES:

1. DIMENSIONS IN INCH.
2. ENCLOSURE: IP55.
3. FOR DIRECT FLEXIBLE COUPLING.
4. AUTOMATIC STAINLESS STEEL BREATHER DRAINS.
5. NON-SPARKING FAN.
6. NOISE LEVEL NOT TO EXCEED 85 dB(A) AT 1 METER AT NO LOAD.
7. VIBRATION VERTICAL/HORIZONTAL BELOW 0.08 IN/SEC, AXIAL BELOW 0.06 IN/SEC.
8. INPRO SEALS ON BOTH ENDS.
9. SPACE HEATER RATED AT 120 VOLT, SINGLE PHASE, 60 WATTS.

REV. DATA

REF: 31049HB625060

TECO Westinghouse

REV NO 01

3-PHASE INDUCTION MOTOR OUTLINE DIMENSIONS

DWG NO. 1000030631

DWN	K. MILNER	122116	APPD	T. FELPS	122116

TECO-WESTINGHOUSE MOTOR COMPANY ROUND ROCK, TEXAS USA

APPR REV A

TECO Westinghouse

ISSUED	PERFORMANCE DATA	ENCLOSURE
March 23, 2012	3-PHASE INDUCTION MOTOR	TEFC
TYPE		CATALOG#
AEHH8B		HB0058

NAMEPLATE INFORMATION

OUTPUT HP	OUTPUT KW	POLE	FRAME SIZE	VOLTAGE	HZ	RATED AMBIENT	INS. CLASS	NEMA DESIGN	TIME RATING	SERVICE FACTOR
5	3.7	8	254T	460	60	40°C	F	B	CONT.	1.15

TYPICAL PERFORMANCE

FULL LOAD RPM	EFFICIENCY				POWER FACTOR			MAXIMUM POWER FACTOR CORRECTION
	FULL LOAD		3/4 LOAD	1/2 LOAD	F. L.	3/4 LOAD	1/2 LOAD	
	MIN. %	NOM. %	%	%	%	%	%	
870	84	86.5	86.5	85.5	72	64	51.5	4 KVAR

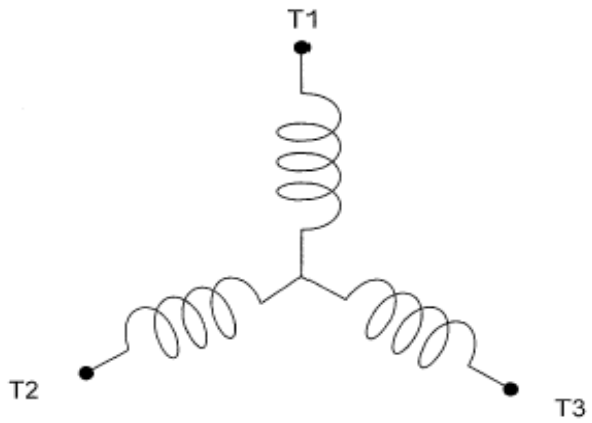
CURRENTS			NEMA KVA CODE LETTER
NO LOAD AT 460 VOLT	FULL LOAD AT 460 VOLT	LOCKED ROTOR AT 460 VOLT	
4.64	7.52	46.00	J

TORQUE				INERTIA			ACCEL TIME	
FULL LOAD lb-ft	LOCKED ROTOR %FLT	PULL UP %FLT	BREAK DOWN %FLT	ROTOR WR^2 $lb\text{-}ft^2$	NEMA LOAD WK^2 $lb\text{-}ft^2$	MAX ALLOWABLE WK^2 $lb\text{-}ft^2$	NEMA LOAD WK^2 Sec	MAX ALLOWABLE WK^2 Sec
30.17	190	185	240	1.66	142	353	6.73	16.60

SAFE STALL TIME IN SECONDS		ALLOWABLE STARTS PER HOUR		SOUND PRESSURE LEVEL @ 3 FT dB(A)
COLD	HOT	COLD	HOT	
47	33	2	1	54

APPROVED:	M. PRATER	DRAWING NO.	31057HB0058	REVISION 0

DATE: December 29, 2011	CONNECTION DIAGRAM	CATALOG NO.: HB0058



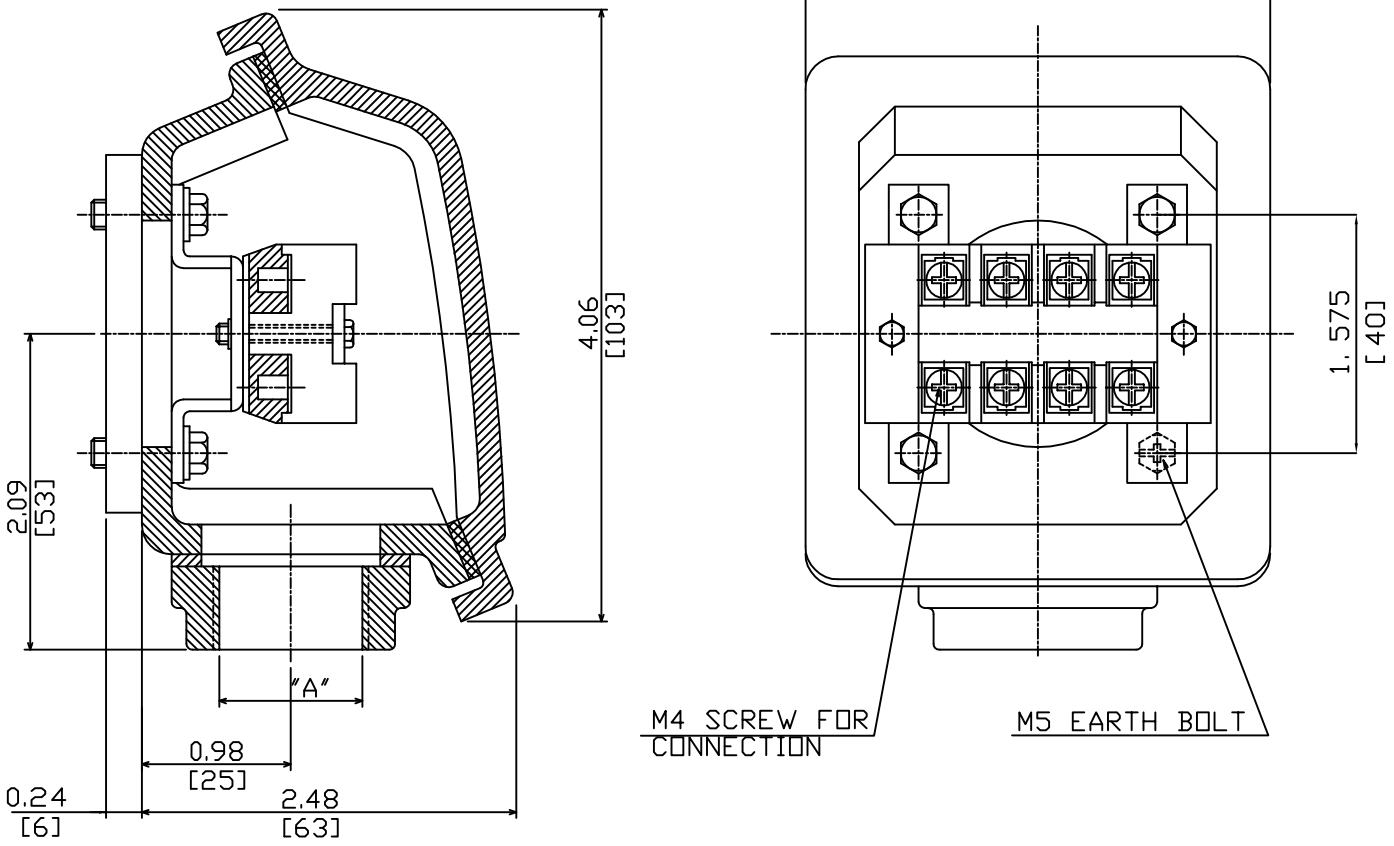
SCHEMATIC - Y CONNECTION

ACROSS THE LINE CONNECTION

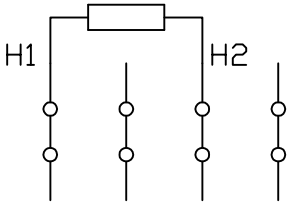


460 VOLT CONNECTION

TECO Westinghouse	DWG NO. DAC-1548-2



SPACE HEATER
CONNECTION



ITEM	A
01	NPT - 0.75"
02	
03	
04	
05	

NOTE:
1. DIMENSIONS IN INCHES [MM].
2. TW-06
3. SPACE HEATER T-BOX.
4. ENCLOSURE: IP55.
5. SINGLE PHASE POWER SOURCE, SHOULD BE DE-ENERGIZED WHEN MOTOR IS IN OPERATION.

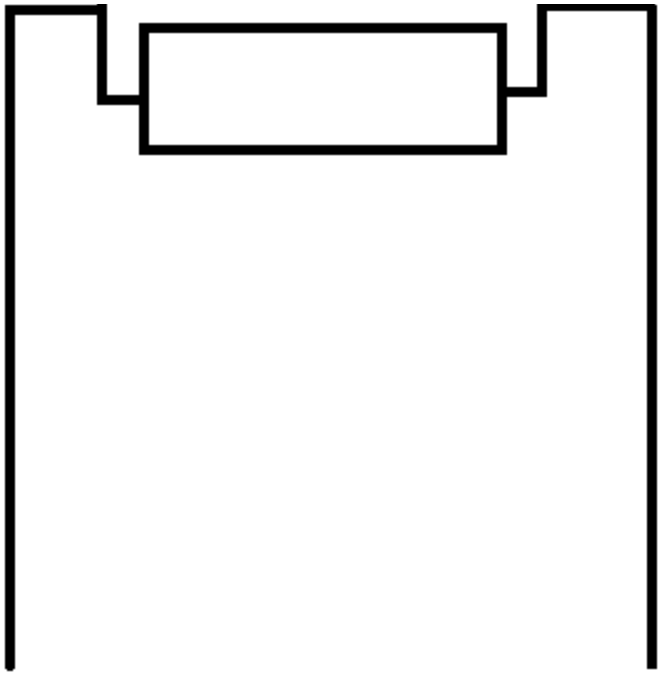
DWN.	H.HUANG	JUL·19·2003
CHKD.	H.HUANG	JUL·19·2003
APPD.	C.WANG	JUL·19·2003

DATE

SCHEMATIC DRAWING
TERMINAL BOX

TECO Westinghouse

DWG NO. 3A040U272 REV:03



120 VOLT SINGLE PHASE POWER SOURCE

SHOULD BE DE-ENERGIZED WHEN MOTOR IS IN OPERATION

Parallel

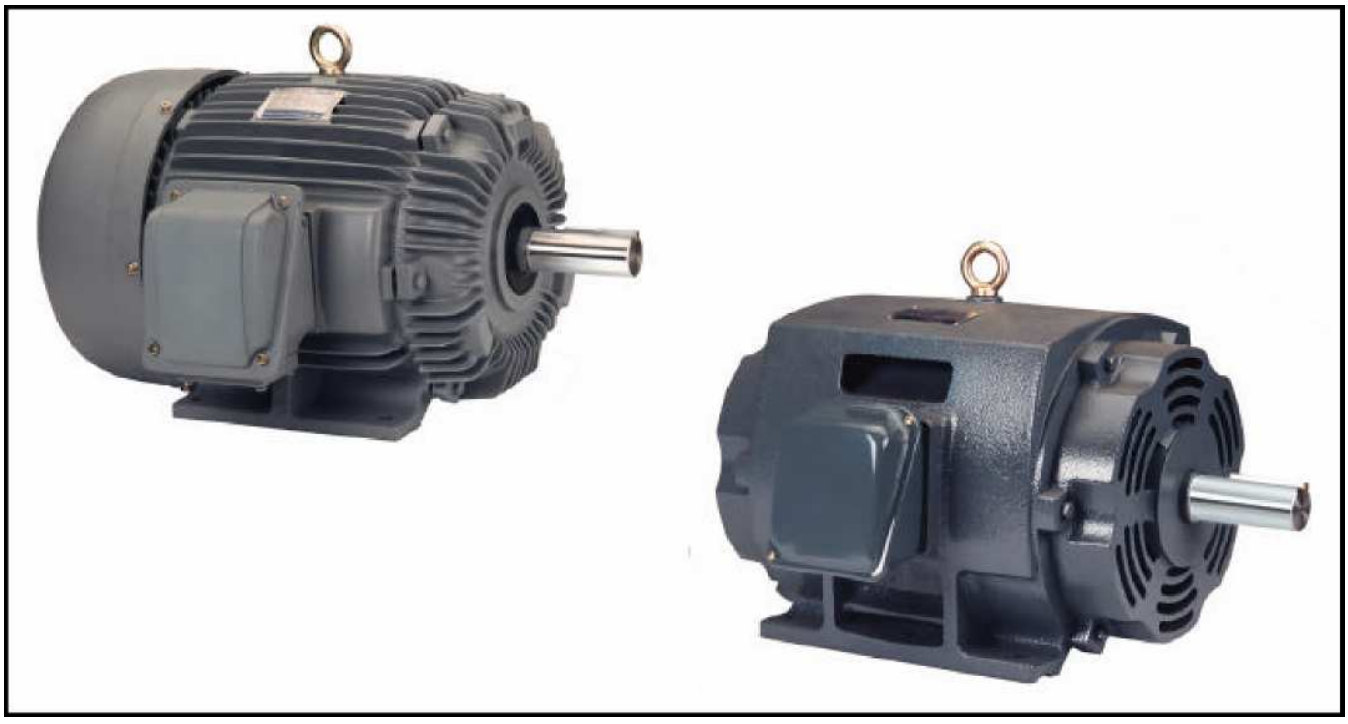
SPACE HEATER SCHEMATIC DIAGRAM

DWG NO. REV:00

3A040D099

INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR THREE PHASE INDUCTION MOTORS

Frames 143T - 449TZ



5100 North IH 35 Round Rock, Texas 78681

RECEIVING

1. Check nameplate data.
2. Check whether any damage has occurred during transportation.
3. After removal of shaft clamp, turn shaft by hand to check that it turns freely.
4. If motor is to be reshipped (alone or installed to another piece of equipment) the shaft must again be clamped to prevent axial movement.
   Note: Remove the bearing clamp before turning the shaft on 284T-449TZ frame motors.

WARNING
THE FOLLOWING SAFETY PRECAUTIONS MUST BE OBSERVED:

1. Electric rotating machinery and high voltage can cause serious or fatal injury if improperly installed, operated or maintained. Responsible personnel should be familiarized with NEMA MG-1; Safety Standards for Construction and Guide Selection. Installation and Use of Electric Motors and Generators; National Electric Code and all local safety requirements.
2. When servicing, all power sources to the motor and to the accessory devices should be de-energized and disconnected and all rotating parts should be at standstill.
3. Lifting means, when supplied, are intended for lifting the motor only. When two lifting devices are supplied with the motor a dual chain must be used.
4. Suitable protection must be used when working near machinery with high noise levels.
5. Safeguard or protective devices must not be by-passed or rendered inoperative.
6. The frame of this machine must be grounded in accordance with the National Electric Code and applicable local codes.
7. A suitable enclosure should be provided to prevent access to the motor by other than authorized personnel. Extra caution should be observed around motors that are automatically or have automatic re-setting relays as they may restart unexpectedly.
8. Shaft key must be fully captive or removed before motor is started.
9. Provide proper safeguards for personnel against possible failure of motor-mounted brake, particularly on applications involving overhauling loads.
10. Explosion proof motors are constructed to comply with the label service procedure manual, repair of these motors must be made by TECO-Westinghouse Motor Company or U/L listed service center in order to maintain U/L listing.

LOCATION

1. Drip-proof motors are intended for use where atmosphere is relatively clean, dry, well ventilated and non-corrosive.
2. Totally enclosed motors may be installed where dirt, moisture, or dust are present and in outdoor locations.
3. Explosion-proof motors are built for use in hazardous locations as indicated by Underwriters' label on the motor.
4. Chemical duty enclosed motors are designed for installation in high corrosion or excessive moisture locations.

   Note: in all cases, no surrounding structure should obstruct normal flow or ventilating air through or over the motor.

MOUNTING

1. Mount motor securely on a firm, flat base. All ball bearing normal thrust motors up to and including 256T frame size may be side-wall or ceiling mounted; all others check nearest TECO-Westinghouse office for mounting recommendations.
2. Align motor accurately, using a flexible coupling if possible. For drive recommendations, consult with drive or equipment manufacturer, or TECO-Westinghouse.
3. Mounting bolts must be carefully tightened to prevent changes in alignment and possible damage to the equipment. The recommended tightening torque's for medium carbon steel bolts, identified by three radial lines at 120 degrees on the head, are:

Bolt Size	Recommended Torque (Ft-lb.)	
	Minimum	Maximum
2/8	25	37
1/2	60	90
5/8	120	180
3/4	210	320

4. V-belts Sheave Pitch Diameters should not be less than those shown in Table 1 (NEMA recommended values)
5. Tighten belts only enough to prevent slippage. Belt speed should not exceed 5000 ft. per min.

TABLE 1. V-Belt Sheave Pitch Diameters (MG1-14.42)

Frame Number	Horsepower at Synchronous Speed, RPM				V-Belt Sheave			
					Conventional A, B, C, D AND E		Narrow 3V, 5V, AND 8V	
	3600	1800	1200	900	Minimum Pitch Diameter Inches	*Maximum Width Inches	Minimum Outside Diameter Inches	**Maximum Width Inches
143T	1.5	1	.75	.5	2.2	4.25	2.2	2.25
145T	2-3	1.5-2	1	.75	2.4	4.25	2.4	2.25
182T	3	3	1.5	1	2.4	5.25	2.4	2.75
182T	5	...	...	...	2.6	5.25	2.4	2.75
184T	...	...	2	1.5	2.4	5.25	2.4	2.75
184T	5	...	...	...	2.6	5.25	2.4	2.75
184T	7.5	5	...	...	3.0	5.25	3.0	2.75
213T	7.5-10	7.5	3	2	3.0	6.5	3.0	3.375
215T	10	...	5	3	3.0	6.5	3.0	3.375
215T	15	10	...	...	3.8	6.5	3.8	3.375
254T	15	...	7.5	5	3.8	7.75	3.8	4
254T	20	15	...	...	4.4	7.75	4.4	4
256T	20-25	...	10	7.5	4.4	7.75	4.4	4
256T	...	20	...	...	4.6	7.75	4.4	4
284T	...	...	15	10	4.6	9	4.4	4.625
284T	...	25	...	...	5.0	9	4.4	4.625
286T	...	30	20	15	5.4	9	5.2	4.625

TABLE 1. V-Belt Sheave Pitch Diameters (MG1-14.42)

Frame Number	Horsepower at Synchronous Speed, RPM				V-Belt Sheave			
					Conventional A, B, C, D AND E		Narrow 3V, 5V, AND 8V	
	3600	1800	1200	900	Minimum Pitch Diameter Inches	*Maximum Width Inches	Minimum Outside Diameter Inches	**Maximum Width Inches
324T	...	40	25	20	6.0	10.25	6.0	5.25
326T	...	50	30	25	6.8	10.25	6.8	5.25
364T	...	...	40	30	6.8	11.5	6.8	5
364T	...	60	...	...	7.4	11.5	7.4	5.785
365T	...	...	50	40	8.2	11.5	8.2	5.785
365T	...	75	...	...	9.0	11.5	8.6	5.785
404T	...	...	60	...	9.0	14.25	8.0	7.25
404T	...	...	...	50	9.0	14.25	8.4	7.25
404T	...	100	...	...	10.0	14.25	8.6	7.25
405T	...	...	75	60	10.0	14.25	10.0	7.25
405T	...	100	...	...	10.0	14.25	8.6	7.25
405T	...	125	...	...	11.5	14.25	10.5	7.25
444T	...	...	100	...	11.0	16.75	10.0	8.5
444T	...	...	...	75	10.5	16.75	9.5	8.5
444T	...	125	...	...	11.0	16.75	9.5	8.5
444T	...	150	...	...	...	16.75	10.5	8.5
445T	...	...	125	...	12.5	16.75	12.0	8.5
445T	...	...	...	100	12.5	16.75	12.0	8.5
445T	...	150	...	...	...	16.75	10.5	8.5

*****Max. Sheave width = 2(N-W) - .25

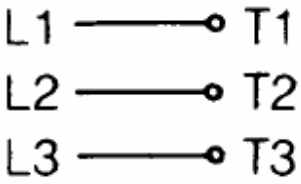
**Max Sheave width = N-W

***Sheave ratios grater than 5:1 and center-to-center distance less than the diameter of the large sheave should be referred to TECO-Westinghouse.

POWER SUPPLY & CONNECTIONS

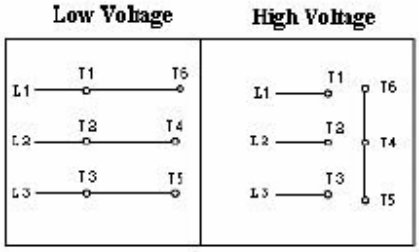
1. Wiring of motor and control, overload protection and grounding should be in accordance with National Electrical Code and all local safety requirements.
2. Nameplate voltage and frequency should agree with power supply. Motor will operate satisfactorily on line voltage within ±10% of nameplate voltage; or frequency with ±5% and with a combined variation not to exceed ±10%. 230-volt motors can be used on 208-volt network systems, but with slightly modified performance characteristics as shown on the nameplate.
3. Dual voltage and single voltage motors can be connected for the desired voltage by following connection diagram shown on the nameplate or inside of the conduit box.
4. All Explosion Proof motors have Temperature Limiting Devices in the motor enclosure to prevent excessive external surface temperature of the motor in accordance with U/L standards. Terminals of thermal protectors (P1 & P2) should be connected to the motor control equipment, according to the connection diagram inside of the conduit box.
5. Standard connection diagram for three phase, not thermally protected, dual rotation motors are shown in diagrams A through E. **(Note: To change rotation, Interchange any two line leads)**

A. 3 Lead, Single Voltage

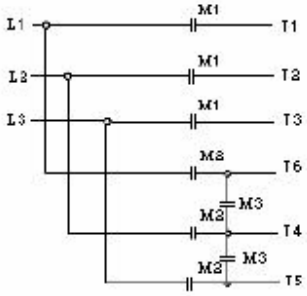


B. 6 Lead, Dual Voltage & Voltage Ration 1 to 3

B-1 Across the Line Start & Run



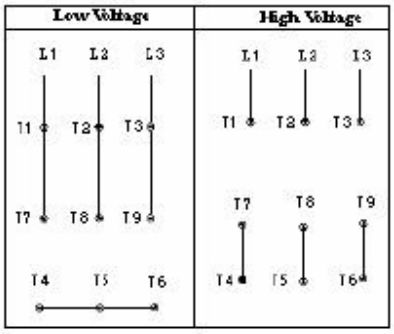
B-2 Wye Start & Delta Run
(Low Voltage only)



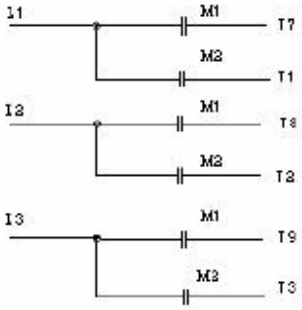
	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
M3	CLOSE	OPEN

C. 9 Leads; Dual Voltage & Voltage Ratio 1 to 2, Wye Connected

C-1 Across the Line Start & Run



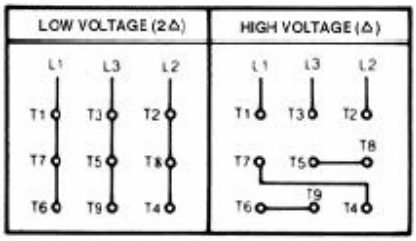
C-2 Part Winding Start
(Low Voltage only)



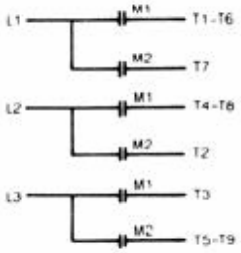
	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
Tie Together	(T4-T5-T6)	

D. 9 Leads; Dual Voltage & Voltage Ration 1 to 2, Delta Connected

D-1 Across the Line Start & Run



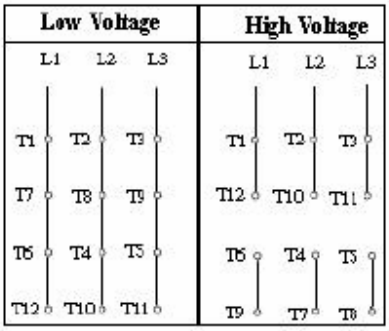
D-2 Part Winding Start
(Low Voltage only)



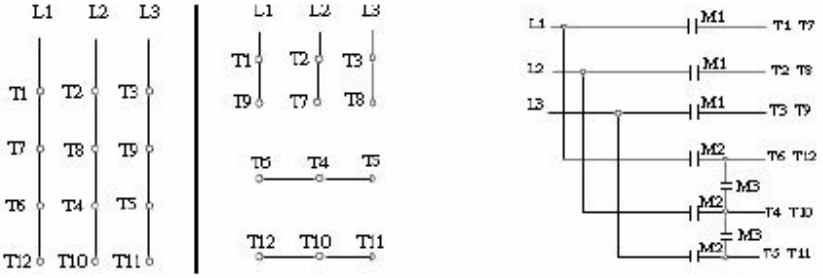
	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE

E. 12 Leads, Dual Voltage

E-1 Across the Line Start & Run

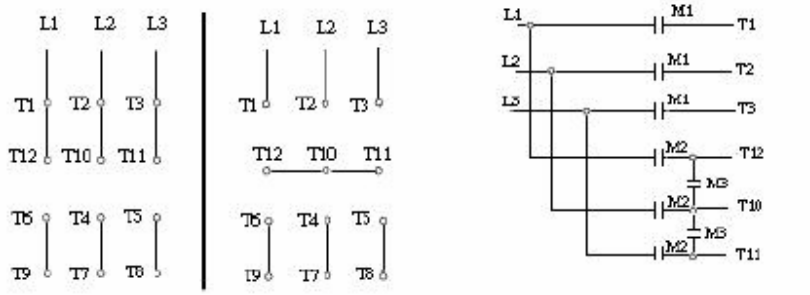


E-2-1 Wye Start & Delta Run (Low Voltage only)



	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
M3	CLOSE	OPEN

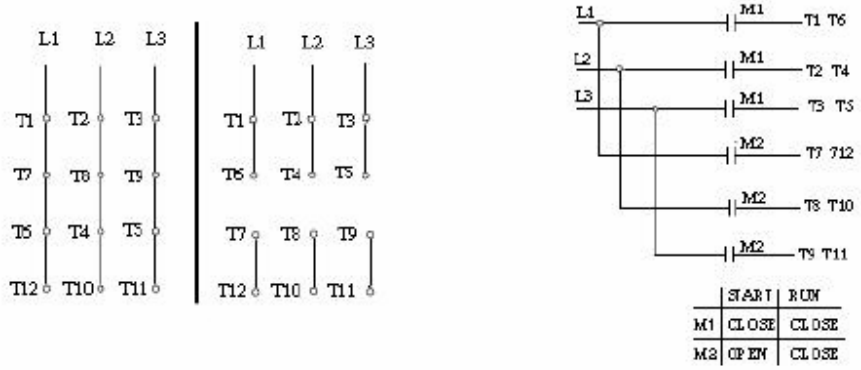
E-2-2 Wye Start & Delta Run (High Voltage only)



	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
M3	CLOSE	OPEN

Tie Together (T4-T7); (T5-T8); (T6-T9)

E-3 Part Winding Start (Low Voltage only)



*Important: For Part Winding Start, M2 contactor should be closed within two (2) seconds after M1 contactor is closed.
Only 4 pole and above (e.g., 6P, 8P...) motors are satisfactory for Part Winding Start at low voltage.

START UP

1. Disconnect load and start motor. Check direction of rotation. If rotation must be changed, ALLOW THE MOTOR TO STOP COMPLETLEY. Interchange any two leads of a three-phase motor.
2. Connect load. The motor should start quickly and run smoothly. If no, shut power off at once. Recheck the assembly including all connections before restarting.
3. If excessive vibration is noted, check for loose mounting bolts too flexible motor support structure or transmitted vibration from adjacent machinery. Periodic vibration checks should be made; foundations often settle.
4. Operate under load for short period of time and check operating current against nameplate.

TESTING

If the motor has been in storage for an extensive period or has been subjected to adverse moisture conditions, it is best to check the insulation resistance of the stator winding with a megometer. Depending on the length and conditions of storage it may be necessary to regrease or change rusted bearings.
If the resistance is lower than one megohm the windings should be dried in one of the following two ways:

1. Bake in oven at temperatures not exceeding 194°F until insulation resistance becomes constant.
2. With rotor locked, apply low voltage and gradually increase the current through windings until temperature measured with a thermometer reaches 194°F. Do not exceed this temperature.

MAINTENANCE

INSPECTION

Inspect motor at regular intervals. Keep motor clean and ventilation openings clear.

LUBRICATION

1. Frame 143T-256T: Double shielded and pre-lubricated ball-bearing motors without grease fittings and don't need re-lubrication, except on MAX-E1® and MAX-E2® products which have re-greasable features.
2. Frames 280TS, 320-449TZ(TS): Motors having grease fittings and grease discharge devices at brackets. Motors are shipped with grease for initial running. It is necessary to re-lubricate anti-friction bearing motors periodically, depending on size and type of service. See Table 2 to provide maximum bearing life. Excessive or too frequent lubrication may damage the motor.

TABLE 2

Horsepower	Standard Conditions	Severe Conditions	Extreme Conditions
1 Thru 30 Hp, 1800 rpm and below	7 years	3 years	180 days
40 Thru 75 Hp, 1800 rpm and below	210 days	70 days	30 days
100 Thru 150 Hp, 1800 rpm and below	90 days	30 days	15 days
1 Thru 20 Hp, 3600 rpm	5 years	2 years	90 days
25 Thru 75 Hp, 3600 rpm	180 days	60 days	30 days
100 Thru 150 Hp, 3600 rpm	90 days	30 days	15 days

Note:

A. Standard conditions: 8 hours operation per day, normal or light loading, clear and 40°C ambient conditions.
B. Severe conditions: 24-hour operation per day or light shock loading, vibration or in dirty or dusty conditions.
C. Extreme conditions: With heavy shock loading or vibration or dusty conditions.
D. For double shielded bearings, above data (lubrication frequency) means that the bearing must be replaced.

3. Be sure fittings are clean and free from dirt. Using a low-pressure grease gun, pump in the recommended grease until new grease appears at grease discharge hole.
4. Use the POLYUREA grease unless special grease is specified on the nameplate.
5. If re-lubrication is to be performed with the motor running, stay clear of rotating parts. After re-greasing, allow the motor to run for ten to thirty minutes.

RENEWAL PARTS

1. Use only genuine TECO-Westinghouse renewal parts or as recommended by TECO-Westinghouse Motor Company.
2. When you order renewal parts please specify complete information to TECO-Westinghouse office/agent such as type, frame no., poles, horsepower, voltage, series no., quantity, etc.

FOR FURTHER INFORMATION PLEASE CONTACT

TECO-WESTINGHOUSE MOTOR COMPANY

Round Rock, TX **800-873-8326**

ST5484E Seismic Velocity 4-20 mA Transmitter

Datasheet

OVERVIEW

The ST5484E is a self-contained seismic velocity transmitter that incorporates a piezoelectric accelerometer, signal integrator, RMS peak detector, and a 4-20 mA signal conditioner into a single package. It can be mounted directly on a machine case or bearing housing without intervening signal conditioning equipment. The amplitude of the integrated acceleration (velocity) signal is converted to a proportional 4-20 mA signal compatible with industrial process control instrumentation such as PLCs, DCSs, and SCADA systems that can provide trending and/or alarming capabilities for a simplified vibration monitoring strategy.

When the flying lead or terminal block connector options are chosen, the transmitter does not need a separate environmental housing and can directly accept conduit. To reduce installed cost, it can be used with barriers for intrinsically safe installations, or wired directly to explosion-proof conduit fittings for explosion- proof installations.



Flying Leads
(Option D=0, 1, 5, or 6) (2-wire shown; 4-wire also available)



4-Pin Terminal Block
(Option D=3)



2-Pin Terminal Block
(Option D=2)



2-Pin MIL Connector
(Option D=4)



Need A Local Display?

When continuous, local indication of vibration levels is required at the transmitter, the Metrix ST5491E provides these capabilities. Its sensing and transmitter elements are similar to the ST5484E, but it includes a convenient 2½ digit LCD display in an integral conduit elbow and is rated for use in temperatures from -10°C to +70°C. Refer to Metrix datasheet 1004598 for ordering information and detailed specifications.

APPLICATIONS

A vibration transmitter may be appropriate in applications where a stand-alone monitoring system may not be warranted.

The ST5484E handles general-purpose vibration measurements on a wide range of rotating and reciprocating machinery with rotative speeds between 120- and 6,000-rpm. Seismic measurements are suitable for machines with rolling-element bearings because shaft vibration in such machines is usually transmitted directly through the bearing to the bearing housing without substantial damping or attenuation. Seismic transducers can also measure vibration that does not originate at the shaft, such as bearing-related wear and defects, footing/foundation problems, piping resonances that are coupled to the machine, etc.

Why Measure Velocity?

Acceleration and displacement levels are heavily influenced by the frequencies at which the vibration is occurring, while velocity levels are much less influenced. Thus, although acceleration, velocity, and displacement measurements are inter-related mathematically, seismic velocity measurements tend to be more consistent over a wide range of frequencies than either displacement or acceleration. Consequently, broadband (sometimes called “overall” or “unfiltered”) velocity measurements are appropriate for monitoring many machines as a reliable indicator of damaging vibratory energy, with the notable exception of machines with fluid-film bearings, which are usually better addressed by shaft-observing proximity probes.

Casing displacement is not a practical measurement to make directly and is typically just an integrated seismic velocity measurement. As such, the primary decision when selecting a seismic sensor will usually be whether to measure casing velocity or casing acceleration. As noted above, casing velocity will often be more appropriate because it tends to be a more reliable indicator of damaging vibratory energy over a broad frequency spectrum for low- to medium-speed machinery.

NOTE: For machines with fluid-film bearings, shaft-observing proximity probes will provide more effective vibration measurements than seismic transducers due to the rotor dynamics of the machine and the attenuation of vibratory energy through a fluid-film boundary. Accordingly, Metrix recommends and provides proximity probes and associated 4-20 mA transmitters or monitoring systems for such applications.

For machines with rolling element bearings and running above 6,000 rpm, and/or where impulsive casing vibration occurs, acceleration may be a better measurement. In such situations, it is recommended that you consult with a Metrix sales professional who can review your application and assist with selection of the proper transducer type and associated transmitter or monitoring system.

FEATURES

- **RFI/EMI Immunity** – Enhanced circuit design and installation techniques aggressively filter out noise from common sources such as handheld radios
- **Excellent Moisture Resistance** – The 2-pin MIL connector version is hermetically sealed to provide an IP67-rated enclosure. Flying lead and terminal block versions are fully potted and rated to IP56 when installed with optional IEC conduit elbow
- **Hazardous Area Approvals** – North American (CSA), Brazilian (INMETRO), and European (ATEX & IEC) approvals available
- **Dynamic Signal Availability** – 2-wire versions provide a 4-20 mA velocity- proportional signal for easy connection to PLCs, DCSs, and other plant control systems. Optional 4-wire versions[1] also provide the raw acceleration signal (100 mV/g) for use with vibration data collectors and analyzers
- **Variety of Connection Options** – Flying leads, terminal block, and MIL-type connectors available
- **Conduit-Ready[2]** – Terminal block and flying lead options have conduit threads on top of sensor. No special housings are required for connection of conduit
- **Rugged, Industrial Design** – Robust construction offers outstanding durability; built-in base and housing strain protection helps ensure that over-torqueing sensor-to- machine and sensor-to-conduit connections won't damage internals or body
- **High- and Low-Pass Filter Options** – The ST5484E can be ordered with a wide variety of low- and high-pass filter options to precisely tailor the band over which vibration is measured
- **Polarity-Independent Wiring** – Metrix patented IPT® technology allows loop power to be connected without regard to voltage polarity, reducing field wiring errors and ensuring that the raw acceleration output[1] is not phase inverted
- **Multiple Mounting Options** – Integral and removable mounting stud options available in both metric and English thread sizes; flat base mounting adapters are also available
- **Loop-Powered** – Runs on nominal 24 V_{DC} power supplied by the 4-20 mA current loop
- **Wide Supply Voltage Range** – Accepts loop power voltages from 11 to 29.6 V_{DC} (intrinsically safe) or 30.0 V_{DC} (explosion proof & non-incendive)
- **RMS Amplitude Detection** – Measures Root Mean Square (RMS) vibration amplitude. Options available for True RMS or scaled RMS (RMS x √2) for "derived peak"
- **Numerous Full Scale Ranges** – The full scale ranges provided in option AAA reflect frequently-ordered ranges; however, many others (too numerous to list) are also available. Consult factory for applications requiring other full scale ranges

Notes:

1. Dynamic raw acceleration signal available with 4-wire versions only (ordering options D= 1 and D=3).
2. Metrix recommends flexible (rather than solid) conduit when possible. Solid conduit can introduce preload forces on the sensor and alter of the vibration response of the sensor.

SPECIFICATIONS

All specifications are at +25°C (+77°F) and +24 V_{DC} supply voltage unless otherwise noted.

Inputs	
Supply Voltage (see also note under max loop resistance)	11 – 29.6 V_{DC} (24 V_{DC} nominal) (intrinsically safe); 11 – 30 V_{DC} (24 V_{DC} nominal) (explosion proof and non-incendive); Metrix patented IPT® independent polarity diode bridge circuit allows voltage to be connected without regard to polarity
Circuit-to-Case Isolation	500 Vrms
Outputs	
4-20 mA	Proportional to velocity full scale range (4mA = 0 vibration, 20mA = full scale vibration)
Maximum 4-20 mA loop resistance	R_L = 50 x (Vs – 11) Ω where Vs = Supply Voltage at transmitter terminals. NOTE: For every 50 Ω of resistance in the 4-20 mA loop, 1 V_{DC} above the minimum supply voltage (11 V_{DC}) must be available at the transmitter terminals. For example, 12 V_{DC} at the transmitter terminals will allow a 50 Ω loop resistance; 30 V_{DC} at the transmitter terminals will allow a 950 Ω loop resistance. For intrinsically safe applications, the use of a passive zener barrier will incur a voltage drop of approximately 8.1 volts at the barrier, and the loop supply voltage is limited to 26 V_{DC}. Thus, with passive barriers and a 26 V_{DC} supply, the maximum available voltage at the transmitter will be 17.9 V_{DC} and the corresponding maximum loop resistance will be 345 Ω.
Dynamic Signal	100 mV/g (10.2 mV / m/s²) acceleration, filtered to same frequency band as proportional velocity (see ordering options E & F)

Dynamic Signal Output Impedance	10 kΩ **NOTES:** 1. The dynamic signal output is short-circuit protected by means of a 10 kΩ resistor, resulting in a relatively large output impedance. Many data collectors and analyzers have relatively low input impedances (100 kΩ or less) which will load this dynamic output and attenuate the signal by 10% or more. Refer to Table 1 for the dB and percentage attenuation for various load impedances. 2. Because the ST5484E is a loop-powered device with low operating power, the dynamic signal output requires a buffer amplifier for cable runs in excess of 16 feet (5 meters). Longer cable runs will also introduce distributed cable capacitance that acts as a low-pass filter, attenuating high- frequency signal content. In such situations, consult the factory for assistance selecting an appropriate low-capacitance cable.
Recommended Minimum Load Impedance (Zload) for Dynamic Signal Connection	500 kΩ (see also note 1 above)
Signal Processing	
Frequency Response (+/- 3dB passband)	2 Hz – 1500 Hz (standard) 2 Hz – 2000 Hz (optional)
Optional High-Pass Filter Corner	5, 10, 20, 50, 100, or 200 Hz (must be specified at time of ordering)
High-Pass Roll-Off	12 dB / octave
Optional Low-Pass Filter Corner	230, 250, 350, 450, 500, or 1000 Hz (must be specified at time of ordering)
Low-pass Roll-Off	12 dB / octave
Accuracy	± 2.5% (within passband) ± 4% (at corner frequencies)
Maximum Full Scale	5.0 in / sec (others by request)
Minimum Full Scale	0.5 in / sec (others by request)
Full Scale Range Units	• in / sec (standard) • mm / sec (available by request)
Amplitude Detection	True RMS detector; full scale may be ordered with True RMS units or scaled RMS (RMS x $\sqrt{2}$) for "derived peak" measurements See ordering option AAA.

Physical	
Operating Temperature	-40°C to +100°C (-40°F to +212°F)
Weight	0.9 lbs (0.36 kg)
Dimensions	Refer to Figures 1 and 2 on page 8
Sensitive Axis	Same as mounting stud axis
Axis Orientation	Any
Enclosure Material	• 303 stainless steel (standard) • 316L stainless steel (optional)
Enclosure Rating	**MIL-Style Connector (option D=4):** • IP67 and NEMA 4X
	Flying Leads and Terminal Block Connectors (option D≠4): • **IP56** when used with the following conduit elbows: 8200-001-IEC, 8200-002-IEC, 8200-003-IEC, 8200-008-IEC, 8200-009-IEC • **No Rating*** when used with the following conduit elbows: 8200-001, 8200-002, 8200-003, 8200-005, 8200-006, 8200-008, 8200-009, 8200-010, 8200-101, 8200-103, 8200-108 * **NOTE:** IP and NEMA ratings pending; refer to table on page 6.
Connector Types	• Flying Leads (2- and 4-wire) • MIL-C-5015 (2-wire only) • Terminal Block (2- and 4-wire)
Humidity	• 95%, non-condensing (flying lead and terminal block versions) • 100% condensing (MIL-style connector)
Approvals	
CE Mark	• Yes
Hazardous Areas	• CSA • ATEX • IECEx • INMETRO • GOST (consult factory) (refer to ordering option C)
Recommended IS Barriers	
Passive (Zener Type)	MTL 7787+ or equal
Active (Zener Type)	MTL 7706 or equal
Active (Galvanic Type)	MTL 5541 or equal
ST5484E Entity Parameters	• Vmax: 29.6 V_{DC} (intrinsically safe) • Vmax: 30 V_{DC} (explosion proof and non-incendive) • Imax: 100 mA

ORDERING INFORMATION

AAA-BCD-EF
ST5484E-□□□-□□□-□□

AAA				Full Scale Range[1]
	1	2	1	1.0 in/sec (25.4 mm/s) peak[2]
	1	2	2	0.5 in/sec (12.7 mm/s) peak[2]
	1	2	3	2.0 in/sec (50.8 mm/s) peak[2]
	1	2	4	5.0 in/sec (127 mm/s) peak[2]
	1	2	6	0.8 in/sec (20.3 mm/s) peak[2]
	1	3	2	3.0 in/sec (76.2 mm/s) peak[2]
	1	5	1	1.0 in/sec (25.4 mm/s) true RMS
	1	5	2	0.5 in/sec (12.7 mm/s) true RMS
	1	5	3	2.0 in/sec (50.8 mm/s) true RMS
	1	5	4	5.0 in/sec (127 mm/s) true RMS
	1	5	6	0.8 in/sec (20.3 mm/s) true RMS
	1	6	2	3.0 in/sec (76.2 mm/s) true RMS

B		Housing Material & Stud Size[1]
	0	303 SS housing, ¼" NPT stud
	1	303 SS housing, ½" NPT stud
	2	303 SS housing, ⅜ x 24 UNF – ½" stud
	3	303 SS housing, ½ x 20 UNF – ½" stud
	4	303 SS housing, M8 x 1.0 – 12 stud
	5	303 SS housing, M10 x 1.25 – 12 stud
	6	303 SS housing, ¼ x 20 UNC – ½" stud
	7	303 SS housing, ¼ x 28 UNF – ½" stud
	8	303 SS housing, M8 x 1.25 – 12 stud
	9	303 SS housing, ⅜ x 16 UNC – ½" stud
	10	316 SS housing, ¼" NPT stud
	11	316 SS housing, ½" NPT stud
	12	316 SS housing, ⅜ x 24 UNF – ½" stud
	13	316 SS housing, ½ x 20 UNF – ½" stud
	14	316 SS housing, M8 x 1.0 – 12 stud
	15	316 SS housing, M10 x 1.25 – 12 stud
	16	316 SS housing, ¼ x 20 UNC – ½" stud
	17	316 SS housing, ¼ x 28 UNF – ½" stud
	18	316 SS housing, M8 x 1.25 – 12 stud
	19	316 SS housing, ⅜ x 16 UNC – ½" stud
	20	303 SS housing, ½ x 13 UNC – ½" stud
	30	316 SS housing, ½ x 13 UNC – ½" stud

C		Hazardous Area Certification[3,4,5]
	0	No Hazardous Approval Area
	1	CSA US/C, Class I, Div 2, Grps A-D (non-incendive)
	2	CSA US/C, Class I, Div 1, Grps B-D and Class II, Div 1, Grps E-G (explosion proof)
	3	ATEX, EEx ia IIC T4 Ga (intrinsically safe)
	4	CSA US/C, Class I, Div 1, Grps A-D (intrinsically safe)
	5	INMETRO, Ex ia IIC T4 Ga (intrinsically safe)
	6	INMETRO, Ex d IIC T4 Gb (explosion proof)
	7	IECEx, Ex ia IIC T4 Ga (intrinsically safe)
	8	ATEX/IECEx, Ex d IIC T4 Gb (explosion proof)

D		Connection Type[3]
	0	24" Flying Leads, 2-wire; (4-20 mA output only)
	1	24" Flying Leads, 4-wire; (4-20 mA output and dynamic raw acceleration signal)
	2	Terminal Block, 2-wire[6]; (4-20 mA output only)
	3	Terminal Block, 4-wire[6]; (4-20 mA output and dynamic raw acceleration signal)
	4	2-Pin MIL-Style (MIL-C-5015); (4-20 mA output only)
	5	72" Flying Leads, 2-wire; (4-20 mA output only)
	6	72" Flying Leads, 4-wire; (4-20 mA output and dynamic raw acceleration signal)

E		High-Pass Filter
	0	2 Hz (standard)
	1	5 Hz
	2	10 Hz
	3	20 Hz
	4	50 Hz
	5	100 Hz
	6	200 Hz[7]
	X	Custom (consult factory)[7]

F		Low-Pass Filter
	0	1500 Hz (standard)
	1	500 Hz
	2	1000 Hz

	3	2000 Hz
	4	250 Hz[7]
	5	230 Hz[7]
	6	350 Hz[7]
	7	450 Hz
	X	Custom (consult factory)[7]

NOTES:

1. Smaller-diameter mounting studs are not able to withstand sustained ambient vibration levels above 2.0 in/sec. Consult Table 2 for allowable combinations of A and B options.
2. The ST5484E uses an RMS amplitude detection circuit. Full scale ranges in peak units use scaled RMS (i.e., RMS x √2). The "derived peak" measurements will equal true peak only under the special case of a pure sinusoid, not complex vibration signals.
3. Hazardous Area Certifications are not compatible with all connection types. Consult Table 3 for allowable combinations of C & D options.
4. Some approvals require intrinsic safety barriers, others require Explosion-Proof wiring practices. Refer to Table 4.
5. ATEX/IECEx/INMETRO Ex d (flameproof) approvals (ordering option C=8 or C=6) require conduit elbow 8200-AAA-IEC, sold separately.
6. It may be difficult to connect wires to terminal blocks with the optional 8200 conduit elbow attached. It is suggested that wires be routed through conduit elbow, then landed on terminals, and then conduit elbow secured. Use of union adapter 8201 may be required. Refer to the Accessories section of this document.
7. High- and Low-Pass filter corners for standard filters must be separated by at least one octave (low-pass frequency must be at least twice the high-pass frequency). All combinations are allowed except E = 6 and F = 4, 5, or 6. Custom filters with closer separation and/or different roll-offs may be available in some instances. Consult the factory if custom filters are required.

Table 1 – Attenuation of Dynamic Signal versus Load Impedance (Z_{load})

Data Collector / Analyzer Load Impedance (Z_{load})	Dynamic Signal Voltage Attenuation (dB)	Dynamic Signal Voltage Attenuation (%)
10 MΩ	0.01 dB	0.1%
5 MΩ	0.02 dB	0.2%
2 MΩ	0.04 dB	0.5%
1 MΩ	0.09 dB	1%
500 kΩ	0.18 dB	2%
200 kΩ	0.43 dB	5%
100 kΩ	0.84 dB	9%
50 kΩ	1.61 dB	17%
20 kΩ	3.57 dB	33%
10 kΩ	6.10 dB	50%

Table 2 – Allowable Combinations for A & B Options

Full Scale Range AAA =	Allowable B options (Mounting Stud Sizes)
121, 122, 123, 126, 151, 152, 153, 156	All (no restrictions)
124 and 154	0, 1, 3, 10, 11, 13
132 and 162	0, 1, 2, 3, 5, 9, 10, 11, 12, 13, 15, 19

Table 3 – Allowable Combinations for C & D Options

D \ C	0	1	2	3	4	5	6	7	8
0	Y	Y	Y	N	N	N	Y	N	Y
1	Y	Y	Y	N	N	N	Y	N	Y
2	Y	Y	N	Y	Y	Y	N	Y	N
3	Y	Y	N	Y	Y	Y	N	Y	N
4	Y	Y	N	Y	Y	Y	N	Y	N
5	Y	Y	Y	N	N	N	N	N	N
6	Y	Y	Y	N	N	N	N	N	N

Table 4 – Approvals and corresponding wiring requirements

C	Agency	Approved Areas	I.S. Barriers Required	Explosion-Proof Wiring Required	I.S Barriers or XP Wiring Not Required
1	CSA US/C	Class I, Div 2,Groups A-D (non-incendive)			•
2	CSA US/C	Class I, Div 1, Groups B-D; Class II, Div 1, Groups E-G (explosion proof)		•	
3	ATEX	Ex ia IIC T4 Ga (intrinsically safe)	•		
4	CSA	Class I, Div 1, Groups A-D (intrinsically safe)	•		
5	INMETRO	Ex ia IIC T4 Ga (intrinsically safe)	•		
6	INMETRO	Ex d IIC T4 Gb (explosion proof)		•	
7	IECEx	Ex ia IIC T4 Ga (intrinsically safe)	•		
8	ATEX / IECEx	Ex d IIC T4 Gb (explosion proof)		•	

ACCESSORIES - ELBOWS

Conduit elbows are used with flying lead and terminal block versions of the ST5484E transmitter. They are not compatible with MIL-connector versions of the transmitter. A variety of available configurations accommodate English and metric conduit thread sizes, hazardous area approvals, materials of construction, and IP ratings. Most may also be purchased with or without terminal blocks under the cap. Note that not all configurations are available with hazardous area approvals or IP ratings. Consult the ordering information below.



Stainless steel elbows
(models AAA=005 and 006 only)



Copper-free aluminum elbows
(all models except
AAA=005 and 006)

ELBOWS									
A	**A**	**A**	**B[2,5]**	**Conduit Fitting Size**	**Terminal Block**	**Coating**	**Approvals**	**IP Rating (Elbow)**	**Material**
0	0	1		¾" NPT	No	Powder	CSA/UL[1]	NEMA4	Copper-free aluminum
0	0	1	IEC	¾" NPT	No	Powder	ATEX/IECEx[3,4]	IP56	Copper-free aluminum
0	0	2		½" NPT	4-position	Powder	CSA/UL[1]	NEMA4	Copper-free aluminum
0	0	2	IEC	½" NPT	4-position	Powder	ATEX/IECEx[3,4]	IP56	Copper-free aluminum
0	0	3		½" NPT	No	Powder	CSA/UL[1]	NEMA4	Copper-free aluminum
0	0	3	IEC	½" NPT	No	Powder	ATEX/IECEx[3,4]	IP56	Copper-free aluminum
0	0	5		½" NPT	No	None	None	None	303 stainless steel
0	0	6		½" NPT	4-position	None	None	None	303 stainless steel
0	0	8		M20 x 1.5 metric	No	Powder	CSA/UL[1]	NEMA4	Copper-free aluminum
0	0	8	IEC	M20 x 1.5 metric	No	Powder	ATEX/IECEx[3,4]	IP56	Copper-free aluminum
0	0	9		M20 x 1.5 metric	4-position	Powder	CSA/UL[1]	NEMA4	Copper-free aluminum
0	0	9	IEC	M20 x 1.5 metric	4-position	Powder	ATEX/IECEx[3,4]	IP56	Copper-free aluminum
0	1	0		¾" NPT	4-position	Powder	CSA/UL[1]	NEMA4	Copper-free aluminum
1	0	1		¾" NPT	No	Powder + clear epoxy	CSA/UL[1]	NEMA4	Copper-free aluminum
1	0	3		½" NPT	No	Powder + clear epoxy	CSA/UL[1]	NEMA4	Copper-free aluminum
1	0	8		M20 x 1.5 metric	No	Powder + clear epoxy	CSA/UL[1]	NEMA4	Copper-free aluminum

NOTES:

1. CSA approved through manufacturer (not Metrix) for the following areas:
   Class I, Div. 1 (Grps C & D)
   Class II, Div. 1 (Grps E, F & G)
   Class III
2. B=IEC is only available for AAA=001, 002, 003, 008, and 009 at this time
3. ATEX approved through manufacturer (not Metrix), (B=IEC)
   ITS09ATEX16417U
   Ex II2G, Ex d IIC
4. IECEx approved through manufacturer (not Metrix)
   IECExITS09.0024U
   Ex d IIC
5. Elbow 8200-AAA-IEC is required for ST5484E installations meeting ATEX/IECEx/INMETRO Ex d (flameproof) hazardous area certifications

UL approved through manufacturer (not Metrix) for the following areas:
Class I; Div. 1 (Grps. B, C, D)
Class II; Div. 1 (Grps. E, F, G)

ACCESSORIES - CABLES

	Part Number	Description
 NOTE: Dielectric grease must be applied on the rubber boot connector to prevent moisture ingression.	**8978-111-XXXX**	**2-pin MIL Splash-Proof (IP66) Cable Assembly** Used with 2-pin MIL style connector. Cable-to-sensor connection made by means of tight friction fit between cable molded boot and sensor - does not use threads. Connector is fully potted to provide IP66 seal against moisture ingression. 6.4mm (0.25”) diameter polyurethane jacketed cable encapsulates a single twisted pair of conductors and shield. XXX.X = cable length in meters (example: 0035= 3.5 m) Min. cable length: 0.5m (XXXX=0005) Max. cable length: 999.5m (XXXX=9995) **Note:** Must be ordered in increments of 0.5m
	**8978-211-XXXX**	**2-pin MIL Cable Assembly** Similar to 8978-111 but without splash-proof boot and without IP66 rating; identical constraints on XXXX ordering options.
	**8978-200-0000**	**2-pin MIL Connector Assembly** Similar to 8978-211 but without cable (connector can be disassembled for field installation of cable)
	**8978-311-XXXX**	**2-pin MIL Submersible (IP67) Cable Assembly** Similar to 8978-111 but uses overmolded screw-type connector for IP67 rating. 4.9mm (0.19”) diameter polyurethane jacketed cable encapsulates a single twisted pair of 20 AWG conductors and shield. Gold plated contacts, Stainless steel 316L Nut. XXX.X = cable length in meters (example: 0050= 5.0 m) **NOTE:** only 5m, 10m, and 20m lengths available at this time. 5m length stock std; other length may incur longer lead times.
  NOTE: Dielectric grease must be applied on the rubber boot connector to prevent moisture ingression.	**9334-111-XXXX-YYYY** **9334-211-XXXX-YYYY**	**2-pin MIL Splash-Proof (IP66) Cable Assembly With Armor** Used with 2-pin MIL-style connector. Connector is fully potted and provided with integral molded boot to provide IP66 seal against moisture ingression. 7.1mm (0.28”) diameter 304 stainless steel armor encapsulates a single twisted pair of conductors and shield. **2-pin MIL Armored Cable Assembly** Similar to 9334-111 but without splash-proof boot and without IP66 rating; identical constraints on XXXX and YYYY ordering options. XXX.X = armor length in meters (example: 0035= 3.5 m) Min. armor length: 0.5m Max. armor length: 60m Must be ordered in 0.5m increments YYY.Y = cable length in meters Min. cable length: 1.0 Max: 999.5m Must be ordered in 0.5 m increments; **NOTE:** cable length must exceed armor length by at least 0.5 m.
	**8169-75-002-XXX**	**2-wire Cable Assembly** Designed for installations where conduit will not be used to protect field wiring. Fitting mates directly to all 8200 elbows with ¾” NPT reducers. Cable is 2-conductor (20 AWG) twisted, shielded pair in PVC jacket. Cable grip included for strain relief. Material: zinc-plated steel XXX= length in feet (example: 010=10 feet) Min. cable length: 1 foot (001) Max. cable length: 999 feet (999)

	**8201-001**	**Conduit Union** Fits between ST5484E and 8200 conduit elbow when there is not enough room to rotate the elbow. Suitable for Class I, Div 1 (Grps A,B,C,D) and Class II, Div 1 (Grps E,F,G) hazardous areas. Material: zinc-plated steel
	**7084-001**	**Flange Mount Adapter** Adapts ½" NPT mounting stud on ST5484E to 3-hole flat-base pattern. Hole pattern is three equally spaced 0.26" diameter holes on 1.5" diameter circle. Adapter is 2" diameter x 0.75" thick. Material: 303 stainless steel
	7084-002	**Flange Mount Adapter** Same as 7084-001 except center hole adapts ¼" NPT stud on the 5484E.
	7084-005	**Flange Mount Adapter** Same as 7084-001 except center hole adapts ⅜ x 24 UNF stud on the 5484E.
	**8253-002**	**½" NPT to ¼" NPT Reducer Bushing** Adapts ¼" NPT stud on ST5484E (B=0) to ½" NPT mounting hole. Material: 303 stainless steel
	**93818-004**	**Cable Grip Strain Relief Fitting** Used primarily with 8978 cable assemblies where cable enters junction box. ¾" NPT male thread to cable grip. Fits cable diameters from 0.156" to 0.25". Complete with sealing ring and locknut. Hot dip / mechanically galvanized finish. Suitable for NEMA 4 junction boxes.
	**93818-018**	**Cable Grip Strain Relief Fitting** Similar to 93818-004, but fits larger cable diameters from 0.4" to 0.5", such as customer-supplied cables used with terminal block versions of ST5484E (D = 2 or 3).

OUTLINE DIAGRAMS

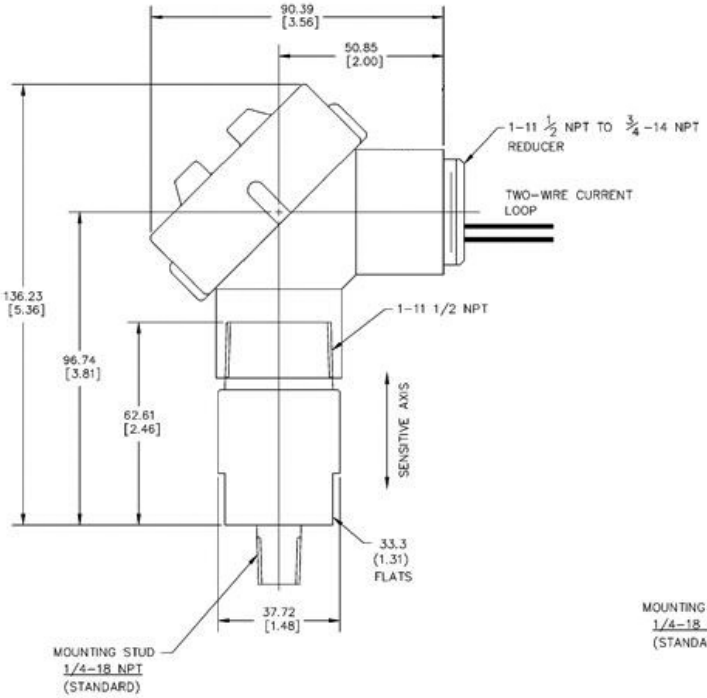
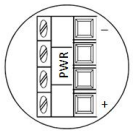


Figure 1: Outline dimensions of the ST5484E (all versions except MIL-Style Connector). Dimensions in mm [inches]. Optional* 8200-001 conduit elbow shown installed.

Figure 2: Outline dimensions of the ST5484E-XXX-XX4-XX (MIL-Style Connector). Dimensions in mm [inches].

* **NOTE:** 8200-AAA-IEC elbow is mandatory for ATEX/IECEx/INMETRO Ex d (flameproof) approved installations.

WIRING CONNECTIONS

Table 5 – Wiring Connection Legend		
Connector Type	**Dynamic Signal Connections**	**Power Connections**
MIL-C-5015	Not Available	24 V_{DC} power may be connected to all ST5484E models without regard to polarity. Sensor uses IPT® independent polarity diode bridge circuit that will always orient voltage correctly inside sensor, regardless of polarity externally. **NOTE:** Although the ST5484E allows polarity in either direction, installations using I.S. barriers will need to observe correct polarity at the barrier input side. However, the barrier output side (i.e., sensor connection) may be wired without regard to polarity.
2-wire flying leads	Not Available	
2-wire terminal block	Not Available	
4-wire flying leads	Red: Power + Blue: Power - White: Dynamic Signal - Black: Dynamic Signal +	
4-wire terminal block	 NOTE: ND – SYMBOLS ARE NOT ON LABEL	

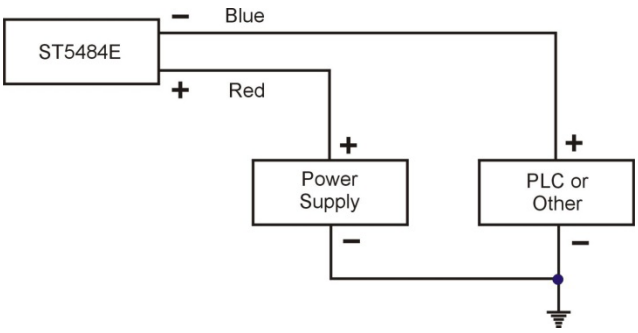


Figure 3: Typical installation for a single ST5484E seismic vibration transmitter.

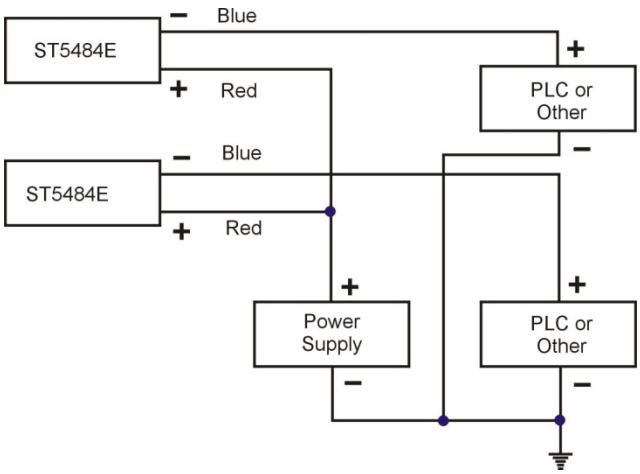


Figure 4: Typical installation for multiple ST5484E seismic vibration transmitters.

ADDITIONAL DOCUMENTATION

Description	Metrix Document Number
Manual	M9162
Installation Drawing – Hazardous Area with I.S. Barriers (CSA)	9426
Installation Drawing – Hazardous Area with I.S. Barriers (CENELEC)	9278
Installation Drawing – Div 2 / Zone 2	1086105

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INSTALLATION INSTRUCTIONS
POLYESTER VINYL BUG SCREEN PANELS

SERIES 1.2 – 0704

All “soft” bug screen panels are designed to provide ease of installation, quick removal, convenient storage, and optimum panel inter-changeability.

Panels are constructed of a woven, vinyl coated polyester 8 x 10 mesh, trimmed with polyester/vinyl binding, and attached using Velcro fastener material. They are designed for extended life and performance in all weather conditions for temperatures ranging from 120°F to minus 40°F.

CAUTION: READ ALL INSTRUCTIONS BEFORE PROCEEDING

1. To avoid damage in shipping, shop handling, subsequent paintings, etc., each panel has been **pre-fitted** with a matching Velcro “hook” tape that must first be removed and bonded to the structural frame. This is done by using the special, pressure-sensitive adhesive back on the Velcro “hook” tape.

2. The perimeter, or 1” edge of the bug screen framework, is to be used to apply the Velcro “hook” tape. The painted or galvanized structural frame surface should be **clean**, **dry**, and **free of oil**. The best adhesive bonding results will be obtained when installed at or above 60°F.

   CAUTION: A newly painted surface should have cured for at least 72 hours prior to application.

   NOTE: In field retrofit, applications to the surface should be thoroughly cleaned to remove any “dead” paint. To clean, use 50/50 isopropanol/water, MEK or similar solution prior to applying the permanent Velcro “hook” tape.

3. The back of the Velcro “hook” is prepared with a special, pressure-sensitive adhesive. Peel the clear protective backing from the “hook”, being careful not to touch the adhesive, and install the Velcro tape immediately to the 1” metal framework surface area around the perimeter of the panel opening. In joining the two surfaces, use finger pressure to firmly smooth the tape in place (especially important at corners and along edges). Note: A hard rubber roller can be used to ensure a smooth, firm fit.

4. For best results, round off or trim the outside corners to prevent "snagging"

5. Insert the 1" square "studs" at each corner in the ¼ hole in the framework. The stud should cover the ends of the "hook" tape in order to secure it and prevent the corners from coming loose in the future. These normally will need to be tapped or driven into place, and will provide a positive attachment point at each corner of each panel.

6. Allow adhesive to dry for 48 to 72 hours before cycling (attaching and removing panels). If necessary, drying time can be speeded up by applying heat to 200°F (example: hair dryer or heat gun).

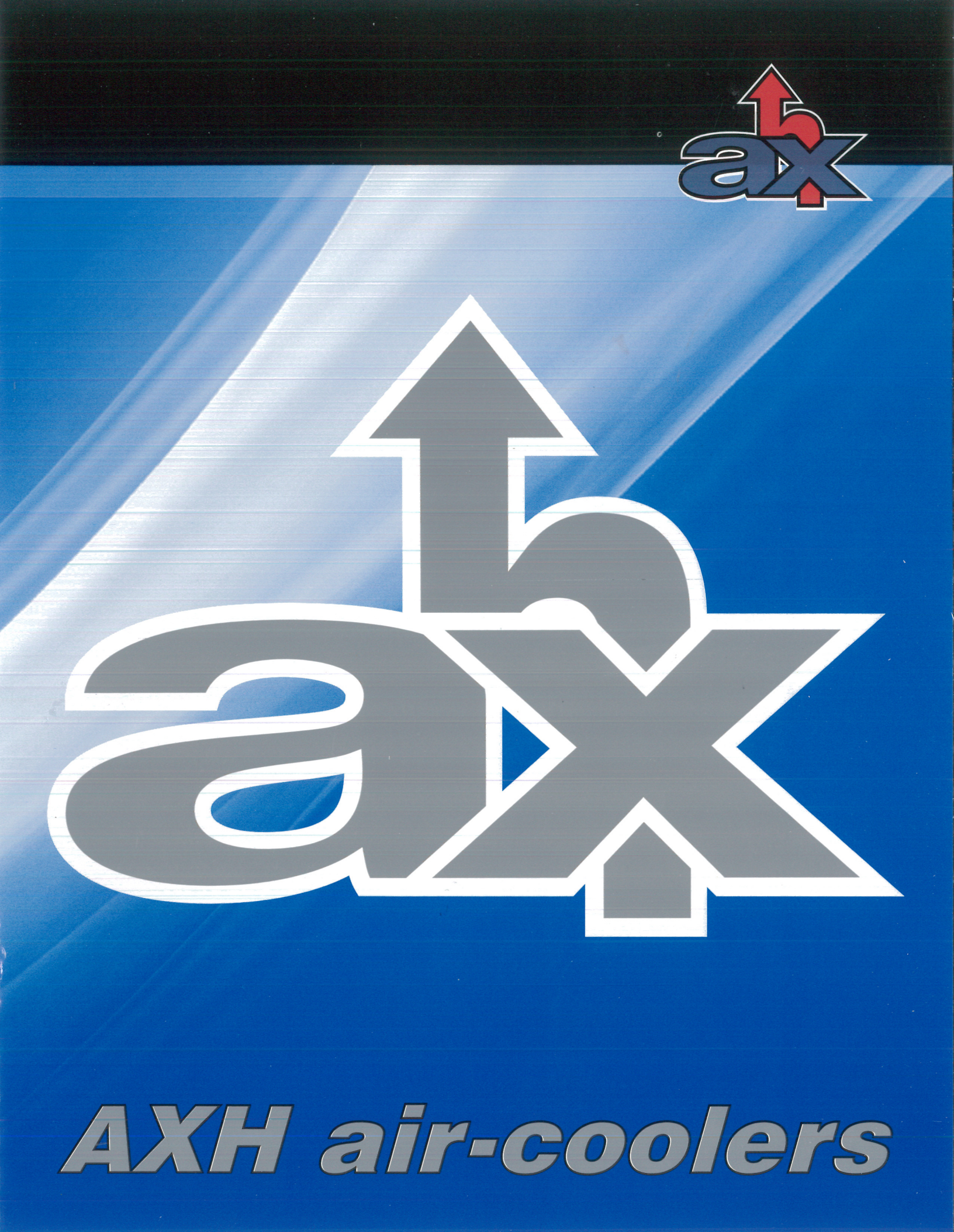
OPERATION: Individual panels should be kept clean to ensure adequate airflow and maximum cooling performance, especially in hot weather. As with any filtration medium, dirty or clogged screens or fin tubes will adversely affect the cooler operation.

GENERAL CHARACTERISTICS

- Highly resistant to water, oil, ultraviolet rays (sun light), and chemicals
- Vibration or pressure increases closure and holding strength
- Quick panel placement by simply pressing panel edges to permanent Velcro "hook" material on the framework
- Quick panel removal by simply "peeling" perimeter edges from permanent "hook" material on the framework.
- Exceptionally strong and treated to meet State of California Fire Code Bulletin 117-Class 1 (most stringent in the U.S.)
- Flexible and light weight for ease of installation, handling, and storage


B-2
AXH air-coolers
Claremore, Oklahoma
918-283-9200
www.axh.com
MODEL
JOB NO.
TAG NO.
REF NO.
NOTICE


DANGER
LOCK OUT EQUIPMENT
BEFORE ENTERING
IMPORTANT DOCUMENTS INSIDE
AXH air-coolers
Claremore, Oklahoma
918-283-9200
www.axh.com
INLET
OUTLET


AXH air-coolers

Experience, Reliability, Integrity....AXH air-coolers.

AXH air-coolers

represents more than 50 years of leadership experience in the air-cooled heat exchanger industry encompassing the entire spectrum of air-coolers from initial thermal application and mechanical engineering, through design drafting, project management and after market support. To meet the growing market demands and customer expectations, in early 2005 AXH air-coolers underwent the first of a continuing series of major expansions in both physical facilities and personnel.

Experience

AXH air-coolers' offers an unparalleled level of experience and technical expertise throughout the entire organization. AXH's complex consists of (6) plants, which total 553,500 sq. ft., are located on 67 acres outside of Tulsa adjacent to Route 66 in Claremore, Oklahoma, in which Plant 1 is the largest single manufacturing facility in the air-cooled industry.

Reliability

Having manufactured tens of thousands of air-coolers for the natural gas compression, process and power generation industries AXH has established an unmatched reputation for meeting "on time" delivery commitments backed by the highest level of quality assurance and customer support in the industry.

Integrity

AXH air-cooler's goal and commitment is to consistently provide customers with the highest quality air-cooler products with uncompromised support and reliability on a competitive basis resulting in exceptional long term value.

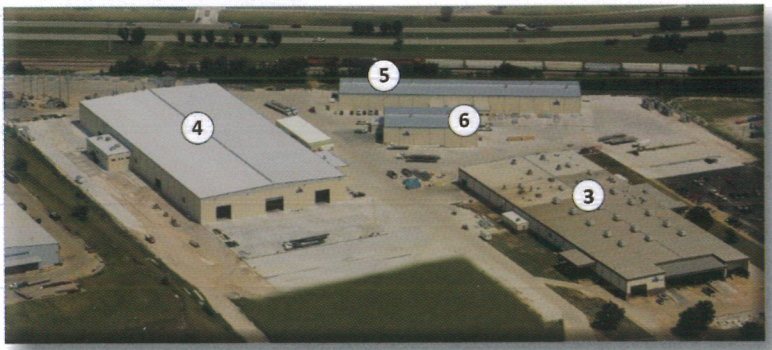




Corporate and Sales Office



Plant 1 is 204,000 Square Feet and located on 12 acres outside Tulsa and adjacent to Route 66 in Claremore, Oklahoma



2014-2015 Expansion Plants 3, 4, 5 and 6



AXH Complex - Plants 1, 3, 4, 5, 6 - (Plant 2 is located 6 miles South)



Plant #1 - Structure Assembly Bay, 40-Ton Lift Capacity



Plant #4 - Bay #1



Plant #6 - 15,000 SF Central Parts Warehouse



Plant #1 - Structure Dept, with 10 and 20-Ton Cranes

Facilities and Equipment



ASME Section VIII

Plant #1 - Industry's Largest Radiography Vault, 20'X70'



Plant #1 - (82) ASME Code Header Stations



Plant #1 - (7) Sub-Arc Stations

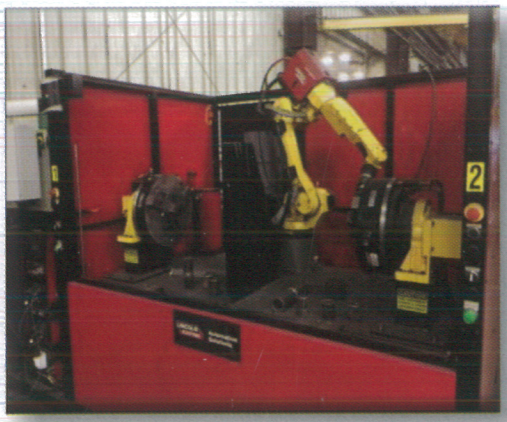


Plant #1 - 5-Axis CNC Pipe Beveler 20" ID Capacity



Plant #1 - 105' (3) Bridge, High Definition CNC Plasma Table





Plant #1 - Dual Robotic Flange To Pipe Welding Cells



Plant #1 - One of Five, CNC Horizontal Bridge Mills



Plant #1 - Plate & Structural Bead Blast.
12' Press Brake and Custom Plate Roll



Plant #4 - Assembly Bays 1 and 2 with 10, 20 and 30 Ton Cranes



Plant #4 - 30x75 and 34x75 Twin Paint Rooms



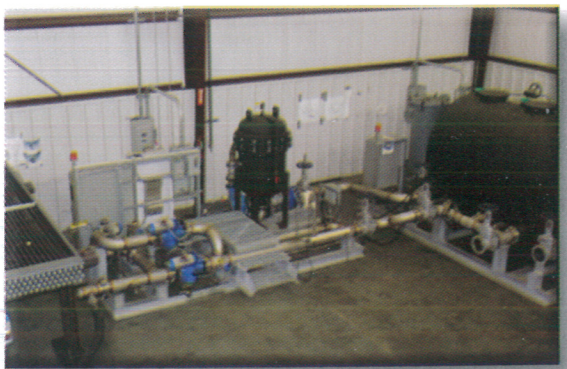
Plant #2 - Finning Operation



Plant #2 - (10) Finning Machines



Plant #2 - 72,000 SF on 13 Acres-Acoustical Test Site



Plant #5 - 1000 GPM Fully Automated Oil Flushing System

The Most Respected and Prevalent Engine Driven Cooler Design, Proven in Tens of Thousands of Natural Gas Compression Installations Worldwide

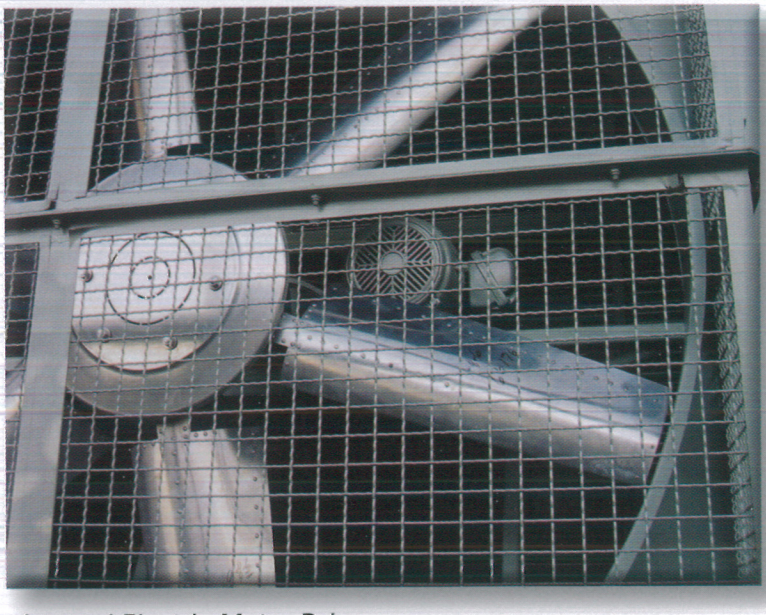


Advantages

- Inherently more efficient Forced draft design
- Ideally suited for multiple services including engine utility cooling along with oil and multi-stages of gas compression
- High vertical discharge air velocity results in the cooler being less affected by wind direction or adjacent equipment and minimizes hot air recirculation
- Sloped sections result in greater cooling capacity in a smaller footprint or skid area
- Elimination of "top-heaviness" with a true center of gravity means greater safety, stability, and ease of handling
- Improved safety with excellent visual inspection and access to critical moving parts



Model 168EF - Marcelus Area



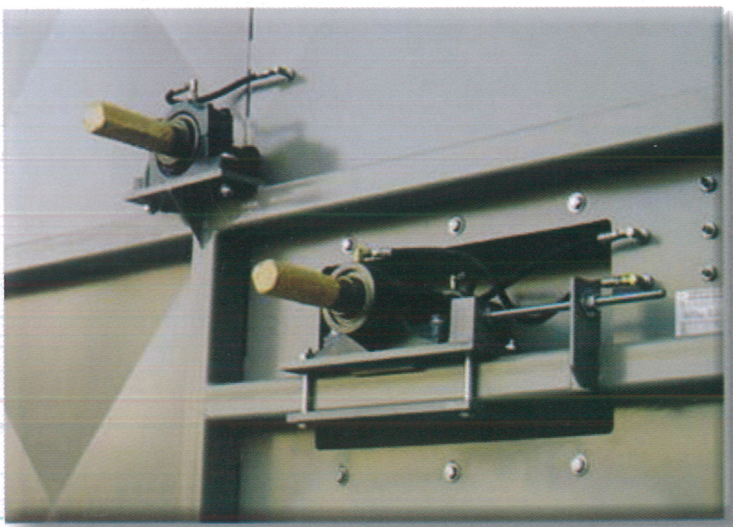
Internal Electric Motor Drive



Model 96EF with SS Sections and Warm Air Recirculation



Model 168 EF - MAG Fan



Enclosed Slide Idler with Dual Taper Roller Bearings

AXH Air-Coolers' Type FF is a Forced Draft, Multiple-Fan, Vertical Discharge Design With a Lower Profile that is Ideal for Large Horsepower Applications While Providing Similar Features at a Cost that is Comparable to Large Single Fan Vertical Discharge Cooler.

Advantages

- Combined engine, compressor, and multiple-stage gas cooling in a single multiple fan unit
- Forced draft design is inherently more efficient
- Narrow transportation width and lower profile
- Section design facilitates piping
- Single, fan-shaft drive
- Improved safety with excellent visual inspection and access to critical moving parts



Model 132FF2



Model 120FF5



Model 132FF4



Model 108FF2 Skid Mounted

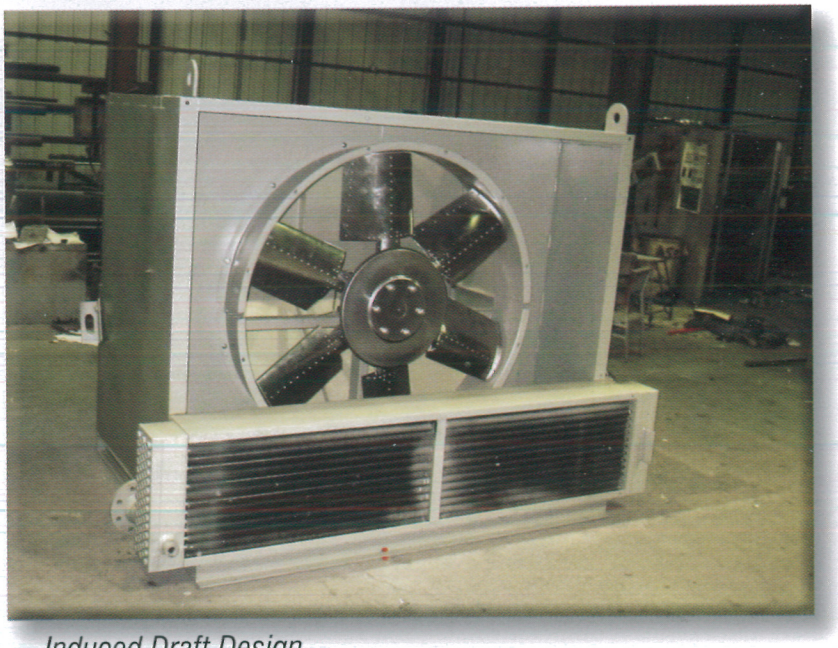


Model 132FF2

The Induced Draft Type VI Complements AXH Air-Coolers' Line of Vertical Discharge Coolers

Advantages

- Offers combined engine, compressor, and multiple-stage gas cooling in a single unit
- Vertical discharge hot air velocity results in the cooler being less affected by wind directions or adjacent equipment
- Excellent accessibility to sections
- Superior air-flow control offers improved process temperature control



Induced Draft Design



Model 144VI



Model 168VI including Pipe Spools Supplied



(3) Model 72VI's



(3) Model 60VI's with Full Warm Air Recirculation

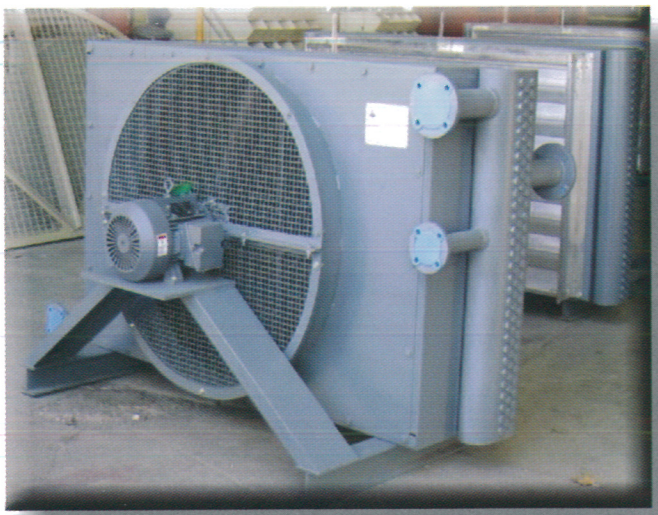
AXH Air-Coolers' Most Economical Cooler Design and a Superior Alternative to a "Radiator"

Advantages

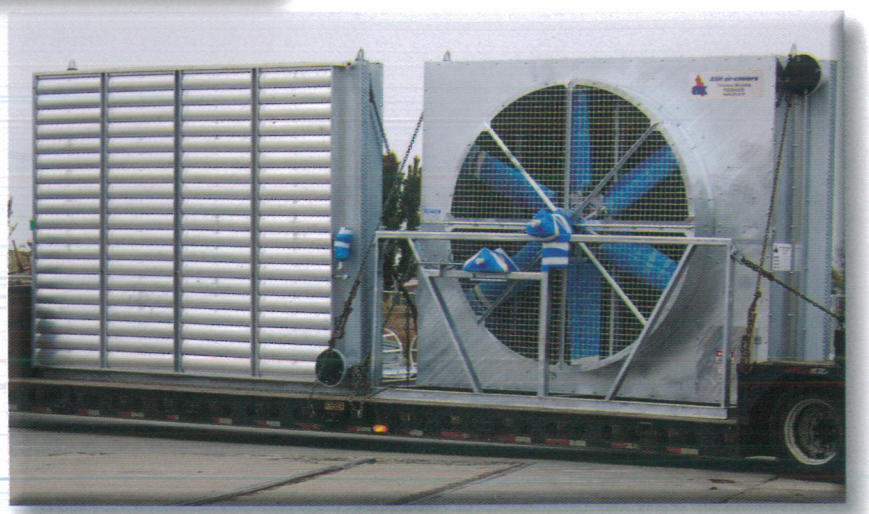
- Available as either a Forced or Induced draft design with horizontal air flow
- Can accommodate multiple cooling services in a single fan unit
- Round tube, box header construction with ASME code designs
- Small installation footprint
- Easy access to sections and drive
- Excellent for visual inspection and access to moving parts



Model 108VVF



Patented Obround Header



(2) Model 120VVF



(2) Model 144EF's with Warm Air Recirculation



(2) Model 42-2ZF with Evaporative Inlet Cooling



(2) Trailer Mounted Model 96EF's



Model 120ZI (Induced Draft)



Model 156-2ZI - Induced Draft/Internal MAG Fan and Internal Drives

Horizontal Designs Provide Flexibility in Remote Installation for Large HP Gas Compression, Process or Power Generation Cooling

Advantages

- The horizontal Type ZF coolers offer flexibility that can accommodate multiple cooling services in a common horizontal cooler
- Self-contained design eliminates field assembly and reduces transportation and field installation costs
- Forced or Induced draft configurations
- Available with single or multiple fans
- Accommodates various type drive options
- Excellent access for inspection and for component parts
- Optional temperature control includes VFD drive, louvers, winterization, warm air recirculation systems



Model 120ZF



Model 132ZF - SS Section - 850F Service



Model 132-2ZF



Model 204-2ZF (18'x62') - Weight 132,000 lbs



(9) Model 132FF3 and (9) Model 144-2ZF (Algeria Installation)



(4) Model 144-2ZF's



Model 60H



(2) Model 84ZF on Generator Sets



(5) Model 108ZF



Model 156-3ZF - Offshore Gulf of Mexico



(16) - Model 18VVS SS Section



(3) Model 132-2ZF, Two Fan with Winterization



Model 96-2ZF with Sub Structure



Slab Headers

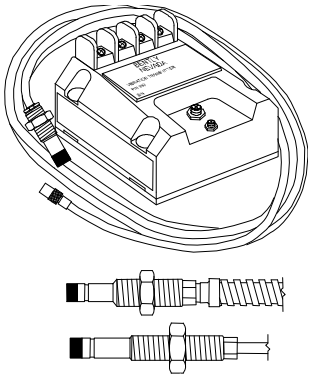


AXH air-coolers

401 Lowry Road, Claremore, Oklahoma 74017
(918) 283-9200 Fax (918) 283-9229
www.axh.com

990 Vibration Transmitter

Bently Nevada* Asset Condition Monitoring



Description

The 990 Vibration Transmitter is intended primarily for the original equipment manufacturers (OEMs) of centrifugal air compressors or small pumps, motors, or fans who prefer to provide a simple 4 to 20 mA proportional vibration signal as the input to their machinery control system. The transmitter is a 2-wire, loop-powered device that accepts input from our 3300 NSv* proximity probe and its matching extension cable (available in 5 m and 7 m system length options). The transmitter conditions the signal into appropriate peak-to-peak vibration amplitude engineering units, and provides this value as a proportional 4 to 20 mA industry-standard signal as the input to the control system where machinery protection alarming and logic occurs[1].

The 990 transmitter provides the following notable features:

- Integrated Proximitor* Sensor requires no external unit
- Non-isolated “PROX OUT" and "COM" terminals plus a coaxial connector to provide a dynamic vibration and gap voltage signal output for diagnostics[2].
- Non-interacting zero and span potentiometers under the Transmitter label supports loop adjustment.
- Test Input pin for quick verification of loop signal output, using a function generator as the input.
- A Power-up Inhibit circuit eliminates signal errors due to line voltage transients.
- A Not OK/Signal Defeat circuit prevents high outputs or false alarms due to a faulty proximity probe or loose connection.
- Choice of DIN-rail clips or bulkhead mounting screws as standard options simplifies mounting.
- Potted construction for high humidity (up to 100% condensing) environments.
- Compatibility with 3300 NSv proximity probe allows transducer installation in small areas with minimal clearance, typical of centrifugal air compressors.

Notes:

1. Vibration transmitters have many limitations when compared to a continuous vibration monitoring system. They are a practical solution in some applications for measuring general vibration levels and are a valuable tool for overall vibration trending. However, they provide limited capability for machinery diagnostics using the vibration signal and do not capture dynamic vibration signals (used for diagnostics) in the event of a vibration alarm. While the

transmitter is capable of peak vibration alarming and non-OK checking, the 4-20 mA signal cannot be used to determine the phase of vibration, and monitor functions such as gap alarms, phase alarms, Timed OK channel defeat, Danger Bypass, and Trip Multiply cannot be used. In addition, PLCs attached to the vibration transmitter can only provide peak-to-peak trending data and are not suitable for plant-wide diagnostic systems such as System 1 or Rule Paks.

2. The 990 Vibration Transmitter's "Prox Out" coaxial connector provides a non-isolated dynamic transducer signal for machinery diagnostics. You can connect this signal directly to battery-powered or isolated test equipment to diagnose machinery problems. However, since the "PROX OUT" signal is not isolated from the 4 to 20 mA loop signal, an interface is available (and strongly recommended) for signal isolation. The 990/991 Test Adapter conditions the 990 Transmitter's "PROX OUT" signal for use with ac-powered test equipment. It also inverts and isolates the 990's transducer signal, making it suitable for equipment such as oscilloscopes and analyzers, and preserving industry-standard conventions for signal polarity. We strongly recommend the use of this test adapter for all applications to maintain isolation between test equipment and the loop signal, and ensure that the installation maintains machinery protection integrity.

Specifications

Unless otherwise noted, the following specifications apply at +22 °C (+72 °F) using a 3300 NSv Probe and Extension Cable, and an AISI 4140 steel target.

Note: These specifications also apply to 990 with modifications 147202-01 and 165335-01.

Electrical

Input

Accepts 1 non-contacting 3300 NSv Proximity Probe and extension cable.

Power

Requires +12 to +35 Vdc input at the transmitter terminal.

4 to 20 mA Signal Output

4 to 20 mAdc over specified full-scale range in 2-wire configuration.

4 to 20 mA Loop Accuracy

Within ±1.5% over specified full-scale range. Accuracy is rated from the TEST signal input to the voltage measured across a 250 Ω loop resistance.

Probe Gap

Probe must be gapped between 0.5 and 1.75 mm (20 and 55 mils) from target to ensure full scale range.

Maximum Loop Resistance

1,000 Ω including cable at 35 Vdc.

Current Limiting

23 mA typical.

Zero and Span

Non-interacting external adjustments.

NOT OK/Signal Defeat

Signal output will go to less than 3.6 mA within 100 µs after a Not OK condition occurs. Signal output is restored within 2-3 seconds after the Not OK condition is removed.

Power-up Inhibit

Signal output stays at less than 3.6 mA for 2 to 3 seconds after power is applied.

Proximitor Sensor Output

Compatible with ungrounded, portable test equipment. When using grounded, ac-powered test equipment, use the 122115-01 Test Adapter for signal isolation.

Output Impedance

Prox Out has a 10 kΩ output impedance calibrated for a 10 MΩ load.

Prox Out Linear Range

1.4 mm (55 mils). Begins at approximately 0.25 mm (10 mils) from target surface.

Prox Out Incremental Scale Factor

7.87 mV/µm (200 mV/mil) ± 6.5% typical including interchangeability

errors when measured in increments of 0.25 mm (10 mils) over the linear range using a flat 30 mm (1.2 inch) target. Worst case 7.87 mV/µm ± 10%. Typical Noise Level: 50 mV/pp.

Temperature Stability

Incremental scale factor remains within ±10% of 7.87 mV/µm (200 mV/mil) from 0 °C to +70 °C (+32 °F to +158 °F).

Frequency Response

5 Hz to 6,000 Hz +0, -3 dB.

Minimum Target Size

9.5 mm (0.375 in) diameter.

Leadwire Length

Maximum for Proximitor* Sensor Output (BNC connector), maximum cable distance is 3 metres (10 feet).

Non-Hazardous, Zone 2 or Div 2 Hazardous area locations

13 km (8 miles) maximum between transmitter and receiving device for signal output.

Intrinsically Safe Hazardous area locations

68 metres (225 ft.) maximum between transmitter and receiving device for signal output.

Electrical Classification:

General Purpose Approval by Canadian Standards Association (CSA/NRTL/C) in North America and by VDE in Europe. 990 has the CE mark for Europe.

Hazardous Area Approvals

CSA/NRTL/C

Class I, Div 2
Groups A, B, C, D
T5 @ Ta = 85 °C, Type 4
Per Drawing 128838

ATEX

 II 1 G

Ex ia IIC T4
T4 @ -35°C ≤ Ta ≤ +85°C

 II 3 G

Ex nA IIC T4
T4 @ -35°C ≤ Ta ≤ +85°C

Maritime Approvals

American Bureau of Shipping (ABS) Type Approval

Certification Number

06-HS177078-PDA

Environmental Limits

Transmitter Temperature

Operating Temperature

-35 °C to +85 °C (-31 °F to +185 °F)

Storage Temperature

-51 °C to +100 °C (-60 °F to +212 °F).

Probe Temperature

Operating Temperature

-35 °C to +177 °C (-31 °F to +350 °F).

Storage Temperature

-51 °C to +177 °C (-60 °F to +350 °F).

Relative humidity

100% condensing, non-submerged, with protection of coaxial connectors.

Mechanical

Transducer Tip Material

Polyphenylene sulfide (PPS).

Transducer Case Material

AISI 303 or 304 Stainless Steel (SST).

Probe Cable

75Ω coaxial, fluoroethylene propylene (FEP) insulated.

Cable Armor (optional)

Flexible AISI 302 SST with optional FEP outer jacket.

Tensile Strength

222 N (50 lbf) probe case to probe lead, maximum.

Transmitter Weight:

0.43 kg (0.9 lbm).

Total System Weight:

0.82 kg (1.8 lbm) typical.

Ordering Information

990-AXX-BXX-CXX-DXX

A: Full-scale Option
- **0 4** 0-4 mils pp (0-100 mm pp)
- **0 5** 0-5 mils pp (0-125 mm pp)

B: System Length Option
- **5 0** 5.0 metres (16.4 feet)
- **7 0** 7.0 metres (23.0 feet)

C: Mounting Option
- **0 1** 35 mm DIN rail clips
- **0 2** Bulkhead screws
- **0 3** DIN clips and screws

D: Agency Approval Option
- **0 0** Not required
- **0 1** CSA Division 2
- **0 5** CSA Division 2 , ATEX Zone 0, ATEX Zone 2 and includes ABS maritime approval

3300 NSv Proximity Probes

330901

3300 NSv Probe, 1/4-28 UNF thread, without armor.

330902

3300 NSv Probe, 1/4-28 UNF thread, with armor.

330908

3300 NSv Probe, 3/8-24 UNF thread, without armor.

330909

3300 NSv Probe, 3/8-24 UNF thread, with armor.

Part Number-AXX-BXX-CXX-DXX-EXX

Option Descriptions

A: Unthreaded Length Option

Note: Unthreaded length must be at least 0.7 in less than the case length.

Order in increments of 0.1 in
Length configurations:
Minimum length: 0 in
Maximum length: 9.2 in
Example: 0 4 = 0.4 in

B: Case Length Option

Order in increments of 0.1 in
Threaded length configurations:
Minimum length: 0.8 in
Maximum length: 9.9 in
Example: 3 5 = 3.5 in

C: Total Length Option
- **0 5** 0.5 metre (1.67 feet)
- **1 0** 1.0 metre (3.25 feet)
- **5 0** 5.0 metres (16.4 feet)
- **7 0** 7.0 metres (23 feet)

D: Connector Option
- **0 1** Miniature coaxial ClickLoc™ connector with connector protector, standard cable
- **0 2** Miniature coaxial ClickLoc connector, standard cable
- **1 1** Miniature coaxial ClickLoc connector with connector protector, FluidLoc® cable
- **1 2** Miniature coaxial ClickLoc connector, FluidLoc cable

E: Agency Approval Option
- **0 0** Not required
- **0 5** Multiple Approvals (CSA NRTL/C and BASEEFA/CENELEC, which includes CSA Division 2)

3300 NSv Probes, Metric

330903

3300 NSv Probe, M8 x 1 thread, without armor.

330904

3300 NSv Probe, M8 x 1 thread, with armor.

330905

3300 NSv Probe, M10 x 1 thread, without armor.

330910

3300 NSv Probe, M10 x 1 thread, with armor.

Part Number-AXX-BXX-CXX-DXX-EXX

Option Descriptions

A: Unthreaded Length Option

Note: Unthreaded length must be at least 20 mm less than the case length.

Order in increments of 10 mm
Untreaded length configurations**:**
Minimum length: 0 mm
Maximum length: 230 mm
Example: 0 6 = 60 mm

B: Case Length Option

Order in increments of 10 mm
Minimum length: 20 mm
Maximum length: 250 mm
Example: **2 5** = 250 mm

C: Total Length Option

- **0 5** 0.5 metre (1.67 feet)
- **1 0** 1.0 metre (3.25 feet)
- **5 0** 5.0 metres (16.4 feet)
- **7 0** 7.0 metres (23 feet)

D: Connector Option

- **0 1** Miniature coaxial ClickLoc connector with connector protector, standard cable
- **0 2** Miniature coaxial ClickLoc connector, standard cable
- **1 1** Miniature coaxial ClickLoc connector with connector protector, FluidLoc cable
- **1 2** Miniature coaxial ClickLoc connector attached, FluidLoc cable

E: Agency Approval Option

- **0 0** Not required
- **0 5** Multiple Approvals (CSA NRTL/C and BASEEFA/CENELEC, which includes CSA Division 2)

3300 NSv Reverse Mount Probe

330906-02-12-CXX-DXX-EXX, 3/8-24 UNF threads

330907-05-30-CXX-DXX-EXX, M10 x 1 UNF threads

Option Descriptions

C: Total Length Option

- **0 5** 0.5 metre (1.67 feet)
- **1 0** 1.0 metre (3.25 feet)
- **5 0** 5.0 metres (16.4 feet)
- **7 0** 7.0 metres (23 feet)

D: Connector Option

- **0 2** Miniature coaxial ClickLoc connector, standard cable
- **12** Miniature coaxial ClickLoc connector attached, FluidLoc cable

E: Agency Approval Option

- **0 0** Not required
- **0 5** Multiple Approvals (CSA NRTL/C and BASEEFA/CENELEC, which includes CSA Division 2)

Extension Cable

330930-AXXX-BXX-CXX

A: Cable Length Option

- **0 4 0** 4.0 metres (13.1 feet)
- **0 4 5** 4.5 metres (14.8 feet)
- **0 6 0** 6.0 metres (19.7 feet)
- **0 6 5** 6.5 metres (21.3 feet)

B: Armor Option

- **0 0** Without stainless steel armor
- **0 1** With FEP covered stainless steel armor
- **0 2** With stainless steel armor
- **0 3** Without stainless steel armor, with connector protector
- **0 4** With FEP covered stainless steel armor and connector protector
- **0 5** With stainless steel armor and connector protector

C: Agency Approval Option

- **0 0** Not Required
- **0 5** Multiple Approvals (CSA NRTL/C and BASEEFA/CENELEC (which includes CSA Division 2)

Accessories

122115-01

990/991 Test Adapter. Package includes: 990/991 Test Adapter, 9V battery, Universal ac Adapter, Power Cord (North American), User Guide and Soft Carrying Case.

The 990/991 Test Adapter inverts and isolates the PROX OUT signal from the 990 Transmitter so that you can connect 990 Transmitters to ac-powered diagnostic equipment. The Adapter modifies the PROX OUT signal so that it matches our standard Proximitor sensor signals by performing these functions:

- Shifts the phase of the PROX OUT signal by 180° by changing the voltage from positive to negative
- Isolates the transmitter from diagnostic equipment so that equipment with different grounds will not affect the transmitter's 4-20 mA loop signal
- Reduces noise in the surrounding area from affecting the PROX OUT signal

The 990/991 Test Adapter provides the following benefits:

- Small size and weight for portable operation
- Battery or ac adapter power options
- Automatic shutoff circuit that powers down the unit when the battery is low
- 2 channels, so that you can display an orbit for XY probe configurations.

990/991 Test Adapter Accessories

123266-01

Coaxial Cable Kit. Includes 4 cables with length of 1.5 metres (5 feet) each.

02211505

Single coaxial cable with length of 1.5 metres (5 feet).

990/991 Test Adapter Spare Parts

01810700

Battery (9 volt alkaline).

02270056

Ac adapter. Has universal ac input to 9 volts dc output. Input is 108 to 132 Vac with 120 Vac nominal, or 207 to 253 Vac with 240 Vac nominal.

02198937

Power cord (for North American ac power outlet).

123133-01

User Guide.

Probe and Transmitter Accessories

02173006

Bulk cable (specify length in feet). 1.0 mm^2 (18 AWG), 2-conductor, twisted, shielded cable used for the 4 to 20 mA loop. Also used for the PROX OUT signal on the 990 Transmitter's terminal strip.

123655-01

Manual.

330153-05

Cable Connector Kit. Package Includes 1 set of 75 Ω miniature male and female connectors, shrink tubing and 3300 Isolator Seal for protection of coaxial connectors.

163356

Connector Crimp Tool Kit. Includes one set of 75 Ω ClickLoc inserts and connector installation instructions. Supplied with carrying case.

330951-01

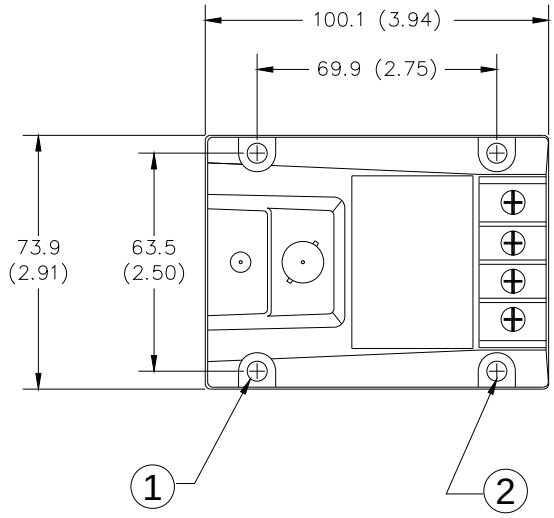
990 Mounting Screws (spares). Contains 4 screws.

284726

DIN rail mounting kit. Installed on the 990 Transmitter to allow mounting on 35 mm DIN rail.

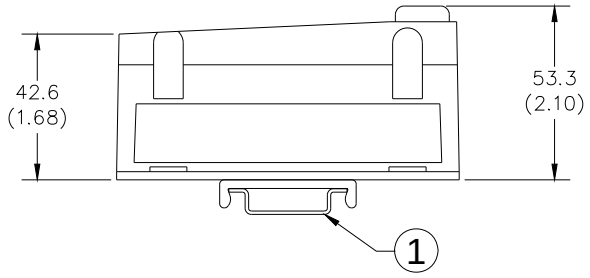
Dimensional drawings

Note: All dimensions shown in millimetres (inches) unless noted otherwise.



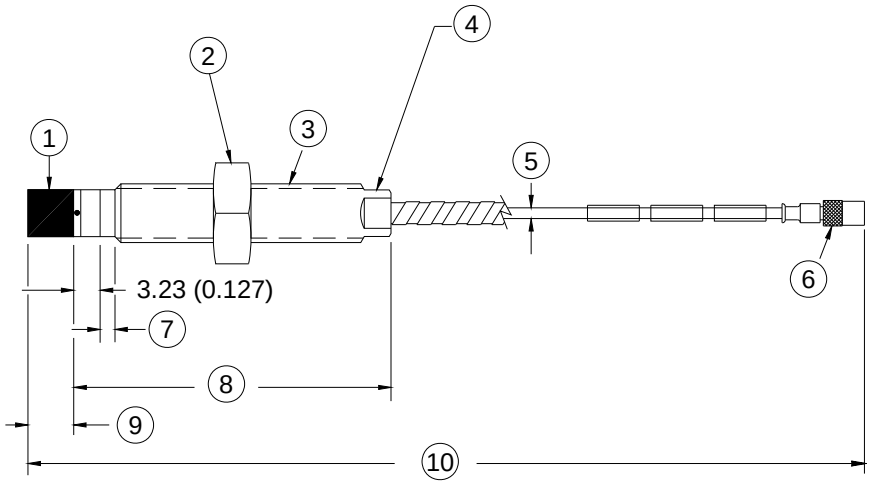
1. Mounting holes, 5.8 mm (0.23 in) diameter, 4 places
2. Bulkhead mount holes, 4 each. 6-32 x 1.326 screws provided when mounting option specified

Figure 1: 990 Vibration Transmitter Dimensions (Top View)



1. 35mm DIN rail DIN mount clips (when DIN rail mounting is specified)

Figure 2: 990 Vibration Transmitter Dimensions (Side View)



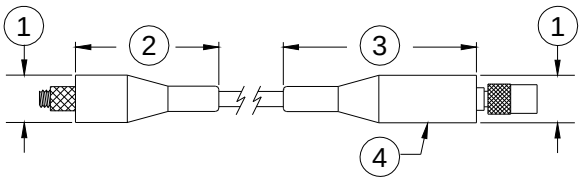
1. Probe tip, 5.26 mm (0.207 in) maximum diameter
2. Hexagonal nut
3. Case Thread
4. Wrench flats
5. 75Ω cable, 2.8 mm (0.11 in) maximum outside diameter, 7.6 mm (0.30 in) maximum outside diameter of armor
6. Miniature male coaxial connector, 7.23 mm (0.285 in) maximum outside diameter "D"
7. Unthreaded length "A"
8. Case length "B"
9. 2.92 mm (0.115 in) maximum
10. Total length "C", +30%, -0%

Figure 3: 3300 NSv Proximity probes, Standard Mount

330901, 1/4-28 UNF-2A, without armor
330902, 1/4-28 UNF-2A, with armor
330903, M8x1 thread, without armor
330904, M8x1 thread, with armor
330905, M10x1 thread, without armor
330908, 3/8-24 UNF-2A, without armor
330909, 3/8-24 UNF-2A, with armor
330910, M10x1 thread, with armor

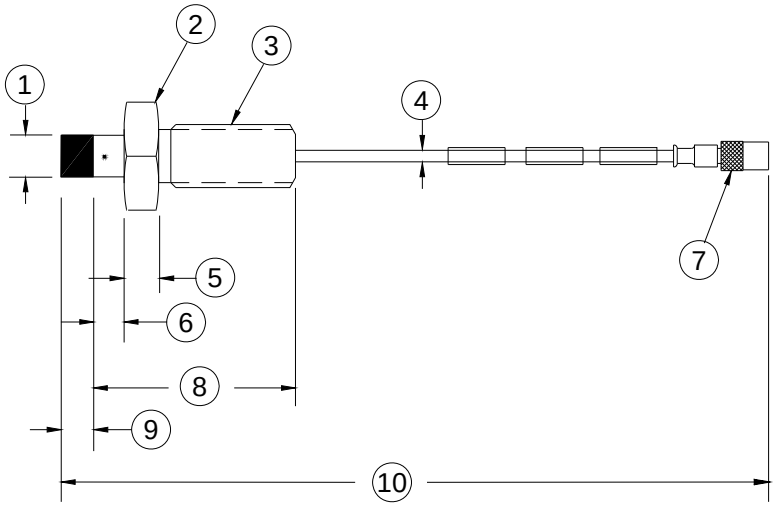
Notes:

Standard mount 1/4-28 UNF thread probes are supplied with a 7/16 inch lock nut and 7/32 inch wrench flats.
Standard mount M8x1 thread probes are supplied with a 13 mm lock nut and 7 mm wrench flats.
Standard mount 3/8-28 UNF thread probes are supplied with a 9/16 inch lock nut and 5/16 inch wrench flats.
Standard mount M10x1 thread probes are supplied with a 17 mm lock nut and 8 mm wrench flats.



1. 12 mm (0.49 in) maximum diameter
2. 36.3 mm (1.43 in) maximum
3. 51.1 mm (2.01 in) maximum
4. Connector protector (fluorosilicone material)

Figure 4: Installed Connector Protectors



1. Probe tip, 5.26 mm (0.207 in) maximum diameter
2. Hexagonal nut
3. Case thread
4. 75Ω cable, 2.8 mm (0.11 in) outside diameter
5. Miniature male coaxial connector, 7.23 mm (0.285 in) maximum outside diameter “D”
6. 5.08 mm (0.20 in)
7. Unthreaded case length “A”, 5.08 mm (0.20 in)
8. Case length “B”, 30.48 mm (1.20 in)
9. 2.92 mm (0.115 in) maximum
10. Total length “C”, +30%, -0%

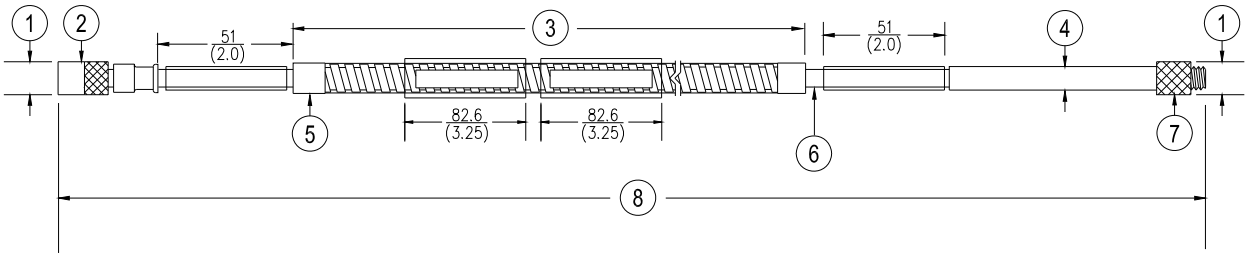
Figure 5: 3300 NSv Proximity Probes, Reverse Mount

330906, 3/8-24 UNF-2A

330907, M10x1 thread

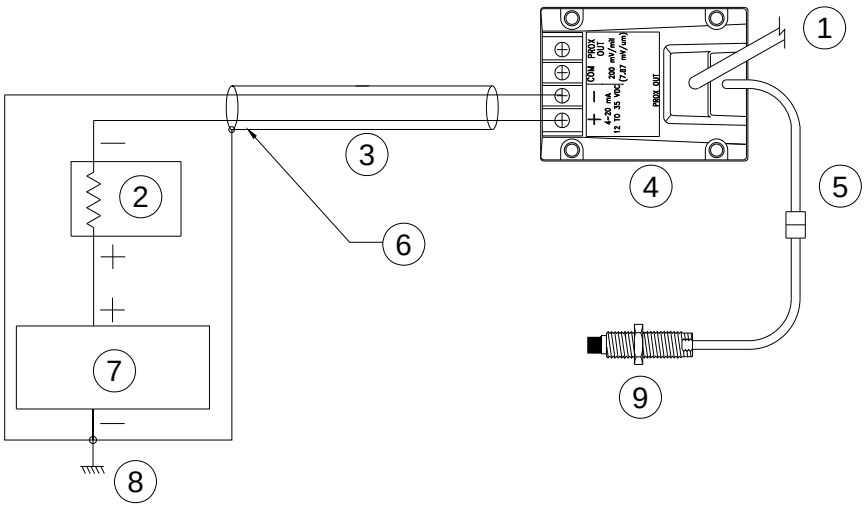
Notes:

Reverse mount probes are not available with armor or connector protector options.



1. 7.2 mm (0.285 in) maximum diameter
2. Miniature male coaxial connector
3. FEP-coated or uncoated armor, armor length is 300 mm (11.8 in) less than cable length
4. 75Ω cable, 2.80 mm (0.11 in) maximum outside diameter, 7.6 mm (0.30 in) maximum outside diameter of armor, 7.0 mm (0.275 in) maximum outside diameter of uncoated armor
5. Stainless steel ferrules, 8.4 mm (0.33 in) diameter
6. FEP-insulated coaxial cable
7. Miniature female coaxial connector
8. Cable length +20%, -0%

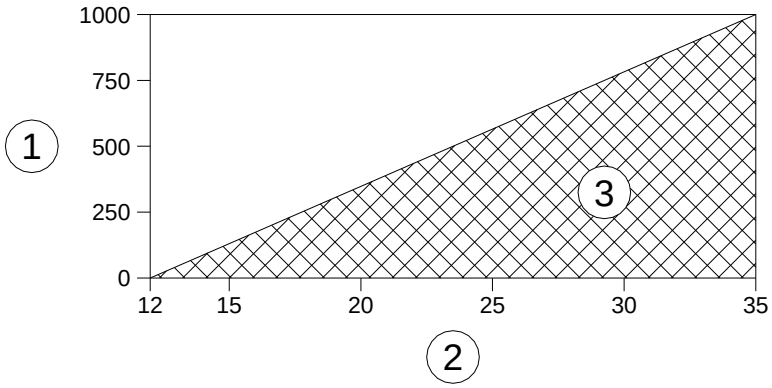
Figure 6: 3300 NSv Extension Cable



1. To test adapter 122115-01
2. Receiver
3. Cable shield
4. Transmitter
5. Extension cable
6. Recommended wiring is shielded, twisted-pair, 1.0 mm (18 AWG) (part number 02173006). Maximum length is 13 km (8 miles).
7. Power supply, V_{PS} = 17 to 35 Vdc
8. Common (ground)
9. Probe

Figure 7: 990 Vibration Transmitter loop wiring connections

Application Advisory
The phase of the PROX OUT signal is inverted from the standard for Bently Nevada™ products. Also, connecting grounded ac-powered equipment to PROX OUT may result in a false alarm. Use test adapter 122115-01 to connect ac equipment to the transmitter. Note that the 122115-01 also inverts the PROX OUT signal.



1. Maximum loop resistance in ohms (R_{LOOP})
2. Power supply voltage (V_{PS})
3. Operating region

Figure 8: 990 Vibration Transmitter maximum loop resistance

Note:

$R_{LOOP} = 43.5 \times (V_{PS} - 12) \Omega$ maximum. If the maximum loop resistance is exceeded, then the full scale current will not reach 20 mA.

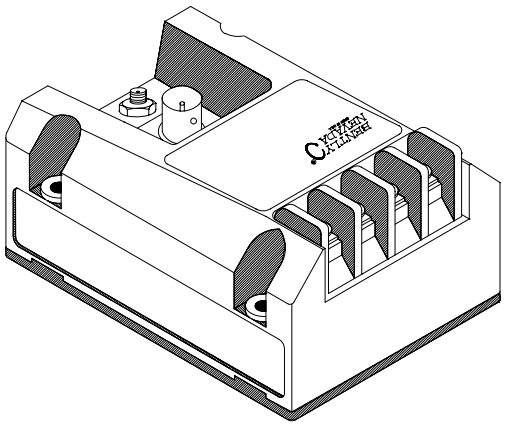
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1631 Bently Parkway South, Minden, Nevada USA 89423
Phone: 775.782.3611 Fax: 775.215.2873
www.ge-energy.com/bently

Part Number 123655-01
Revision F, February 2004

990 Transmitter System
Manual



BENTLY
Nevada

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The following ways of contacting Bently Nevada are provided for those times when you cannot contact your local Bently Nevada representative:

Mailing Address	1631 Bently Parkway South Minden, NV 89423 USA
Telephone	1 775 782 3611 1 800 227 5514
Fax	1 775 215 2876
Internet	www.bently.com

Related Documents

The following documents contain additional information about the transmitter system that you may find helpful when you install the transducer. This manual refers to these documents by number.

Installing the Transducer

AN013 Guidelines for Grounding Bently Rotating

Machinery Information Systems

AN015 Installation of electrical equipment in hazardous areas

Transducer Installation Accessories

31000/32000 Proximity Probe Housing Manual

Electrical and Mechanical Runout

AN002 "Glitch": Definition of and Methods for Correction, including Shaft Burnishing to Remove Electrical Runout.

Reference

157771 Performance Specifications for the 990

133055-01 Bently Nevada Glossary

Customer Service

Bently Nevada provides product service throughout the world. If you cannot contact your local product service representative, call the Bently Nevada corporate headquarters:

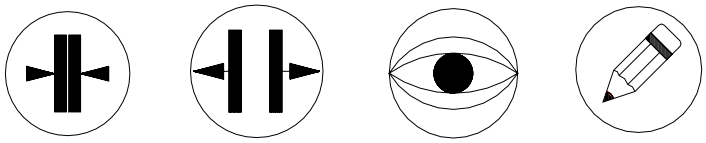
From within the USA:800-227-5514 Monday through Friday, 8:00 a.m. to 5:00 p.m. Pacific time.

International telephone: 775-782-3611 Anytime.

775-782-9253 FAX

Symbols

This manual uses the following symbols:



Connect Disconnect Observe Record Value

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Section 1 — System Description

The System

The 990 series of transmitters consists of two systems, the 990 Vibration Transmitter System and the 991 Thrust Transmitter System. Both systems contain three parts - a 3300 NSv™ or 3300 RAM proximity probe and extension cable (If probe is 5 or 7 metres, no extension cable is required), and a transmitter. Both systems provide two types of output signals - a 4 to 20 mA current loop and a voltage signal.

Note: The 3300 NSv™ Probe and extension cable replaced and assumed the part numbers of the 3300 RAM Probe and extension cable. The 3300 NSv™ Probe and extension cable have blue coaxial cable with gray shrink at the connectors and the 3300 RAM Probe and extension cable have gray coaxial cable with no shrink at the connectors. These products are identical in form, fit, and function.

The 990 Vibration Transmitter System measures the radial vibration of a shaft or other part of a machine in relation to the location of the probe tip. The following equation represents the relationship between the vibration and the loop current.

$$Vibration = \frac{Current\ (mA - 4\ mA)}{16\ mA}\ x\ Full\ \ Scale\ Mils\ (or\ mm)\ pp$$

The 991 Thrust Transmitter System measures the distance between the target and a reference (zero) point. The following equation represents the relationship between the thrust position and the loop current.

$$Thrust\ \ Postion = \frac{Current\ (mA + 12\ mA)}{8\ mA}\ x\ Full\ \ Scale$$

Where Full Scale is 25 mils for the 25 - 0 - 25 mils thrust range or 0.6 mm for the 0.6 - 0 - 0.6 mm thrust range.

Both transmitters provide a voltage proportional to the distance between the target and the probe tip. This voltage is available at the terminal strip and on the BNC connector for use when gapping the probe and for diagnostic purposes. You may apply this voltage to any battery powered instrumentation with a 1 MΩ or larger input impedance or AC powered equipment when using test adapter part number 122115-01. The phase of the Prox Out signal is inverted from the Bently Nevada standard of a signal going positive when there is motion toward the probe. The Prox Out signal is not isolated and a false alarm may result from connecting it directly to grounded AC powered equipment. The test adapter provides isolation to avoid grounding problems, changes the gap voltage to a negative voltage, and corrects the phase of the signal.

Receiving, Inspecting, and Handling the System

The probe, extension cable, and transmitter are shipped as separate units and must be interconnected at the installation site by the user. Carefully remove all equipment from the shipping containers and inspect the equipment for shipping damage. If shipping damage is apparent, file a claim with the carrier and submit a copy to Bently Nevada, LLC. Include part numbers and serial numbers on all correspondence. If no damage is apparent and the equipment is not going to be

used immediately, return the equipment to the shipping containers and reseal until ready for use.

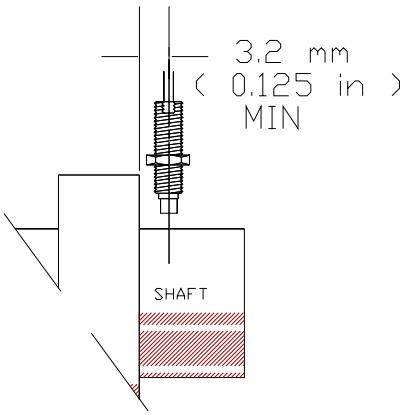
Store the equipment in an environment free from potentially damaging conditions such as high temperature, excessive humidity, or a corrosive atmosphere. See pages 29, 32, and 33 for environmental specifications.

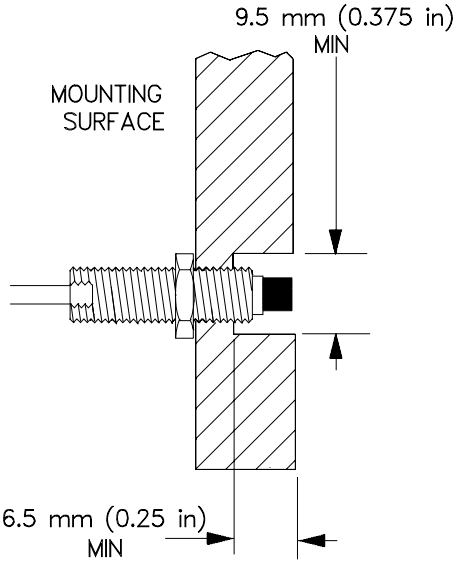
Section 2 — Installation

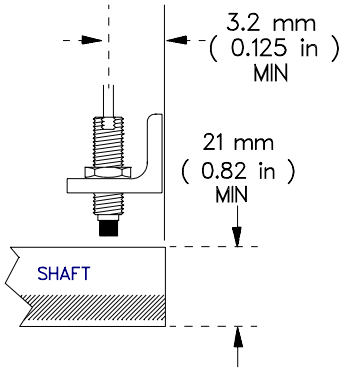
This section contains a checklist of items that you must consider when you install the 990 transmitter system. For detailed information about designing installations for specific applications, refer to document AN013. For more information about the specifications for this transducer, refer to page 29 of this manual or to document 157771.

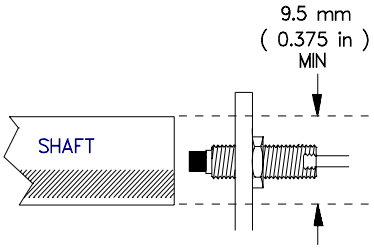
Installing the Probe

The following figures show the minimum values for side clearance and target size. Refer to Specifications, page 31, for proper torque and the dimensions of the thread.

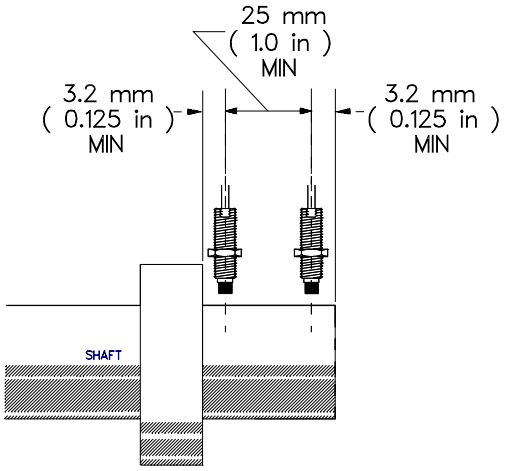


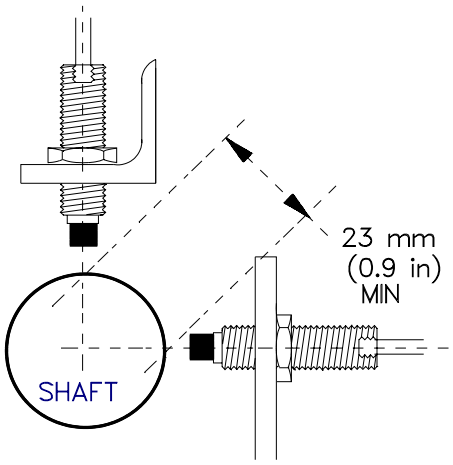


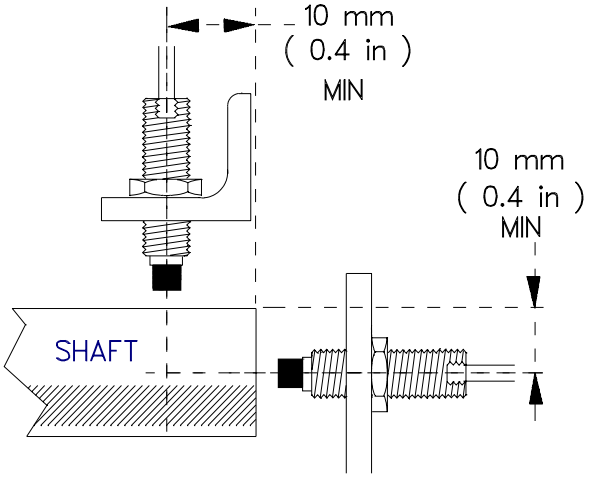




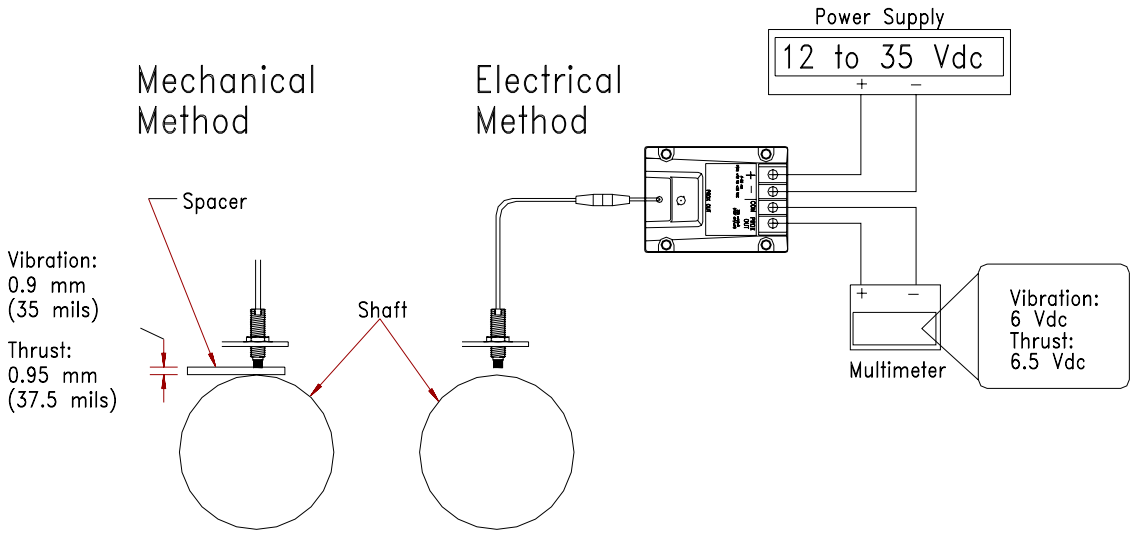
The following figures show the minimum values for probe separation due to crosstalk:





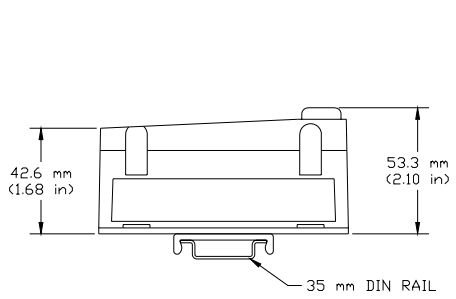


Adjust the distance between the probe tip and the shaft using one of the methods shown in the following figure.

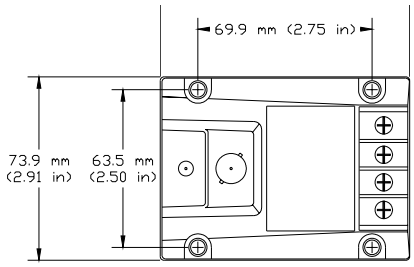


Mounting the transmitter

Mount the transmitter in a location that is compatible with its environmental specifications. Refer to page 29 for the environmental specifications for the transmitter. The following figure shows the dimensions of the transmitter.



DIN MOUNT CLIPS
WHEN -01 DIN RAIL MOUNTING IS SPECIFIED

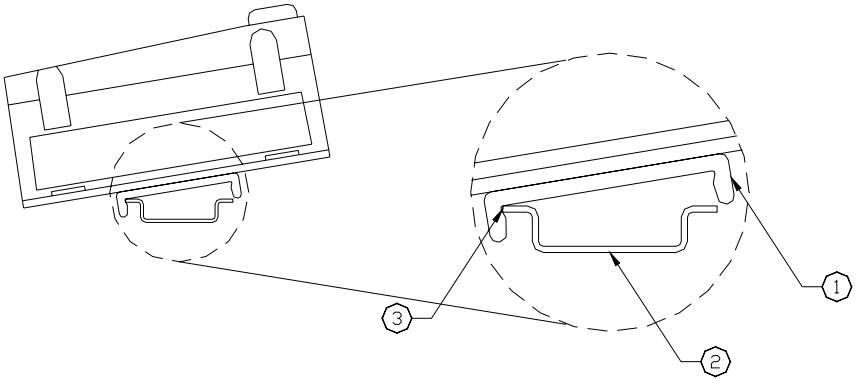


ø5.8 mm (0.23 in) BULKHEAD MOUNT HOLES:
4 EACH 6-32 SCREWS PROVIDED
WHEN -02 BULKHEAD MOUNT SPECIFIED

Mounting the transmitter with DIN Mount Option

To mount the transmitter with DIN Mount option specified:

1. Examine the underneath side of the transmitter to locate the DIN mount clips. During installation onto the DIN rail, the transmitter will need to be angled such that the DIN rail first fits into the gap of each DIN clip as shown.

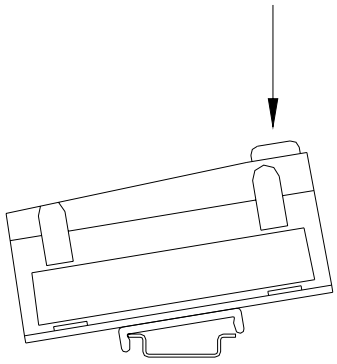


(1) DIN mount clip

(2) DIN rail

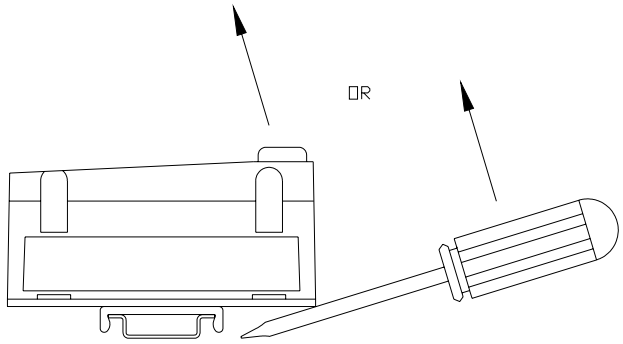
(3) DIN rail must fit into this gap on each DIN clip

2. Push down on transmitter until the unit “snaps” into place. Ensure each clip has “snapped” onto the DIN rail. The unit is now installed.



Removing the transmitter from DIN rail

Remove the transmitter from the DIN rail by either using a screwdriver or pulling the unit at an angle.



Routing the Extension Cable and Field Wiring

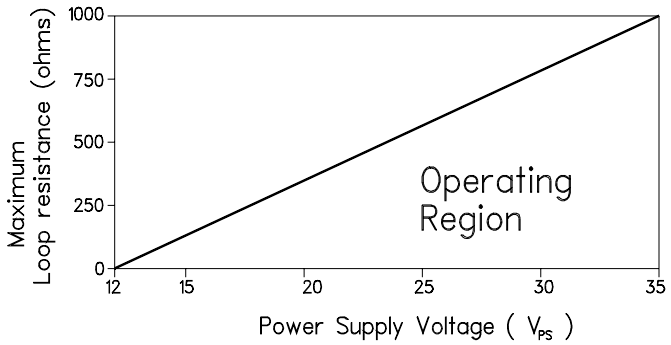
Route the extension cable using the following guidelines.

Check that the Transmitter, extension cable, and probe belong to the same system. The allowable systems are:

Transmitter	Probe Length	Cable Length
5 metre	5 metre	None
5 metre	1.0 metre	4.0 metre
5 metre	0.5 metre	4.5 metre
7 metre	7 metre	None
7 metre	1.0 metre	6.0
7 metre	0.5 metre	6.5

- Secure the extension cable to supporting surfaces by using mounting clips or similar devices.
- Identify both ends of the extension cable by inserting labels under the clear Teflon sleeves and applying heat to shrink the tubing.
- Secure coaxial connectors between the extension cable and the proximity probe (Refer to Connector-to-Connector Torque Requirements on Page 33).
- Insulate the connection between the probe lead and the extension cable by wrapping the connector with Teflon tape.

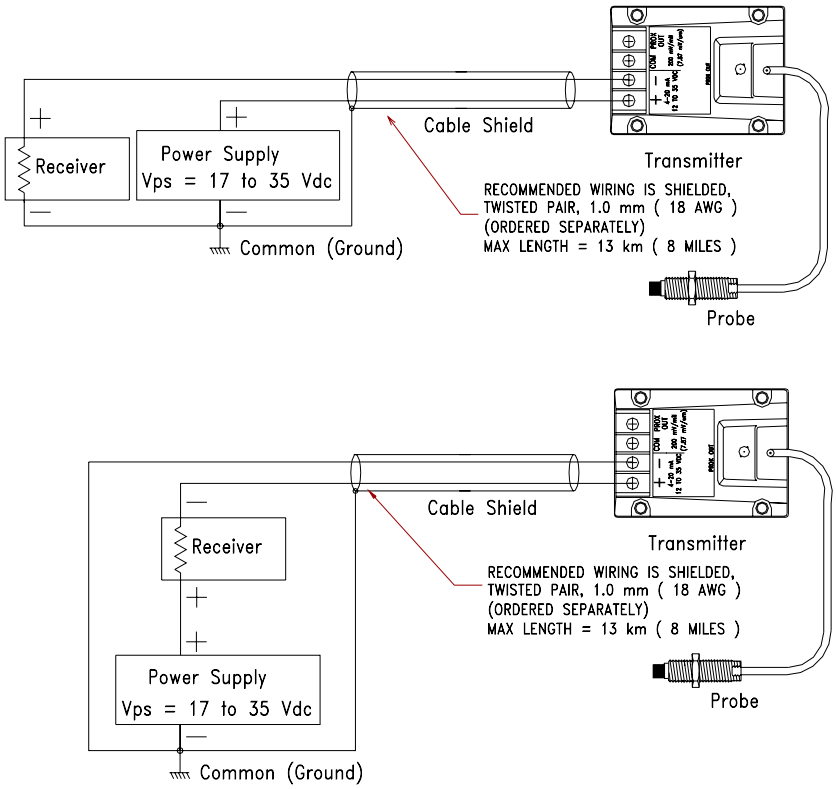
The loop resistance is the total resistance of the power supply output, the receiver, field wiring, and any other devices placed in the loop. Use the following table and equation to determine the maximum loop resistance:



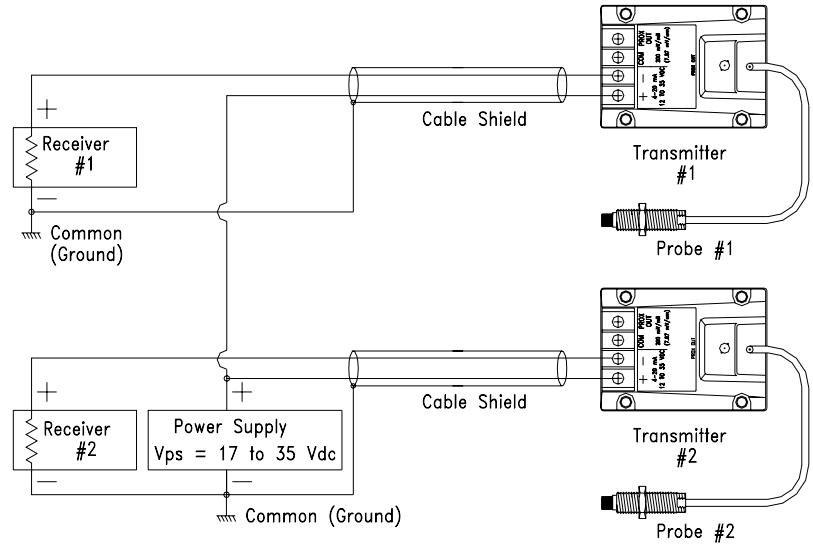
$R_{LOOP} = 43.5 \times (V_{PS} - 12) \Omega$ maximum

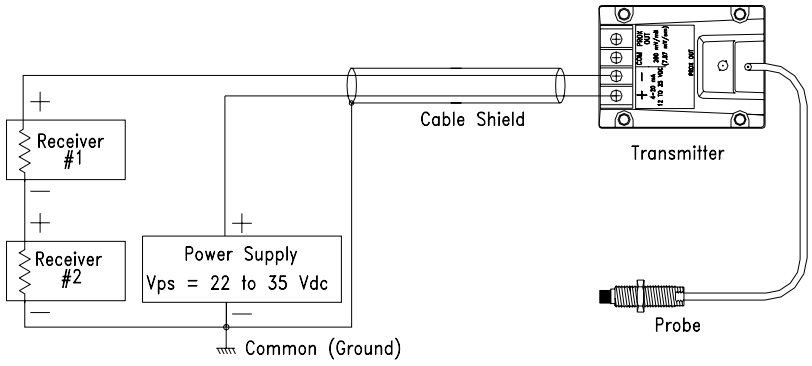
Operation outside of the operating region shown above may result in erratic system behavior.

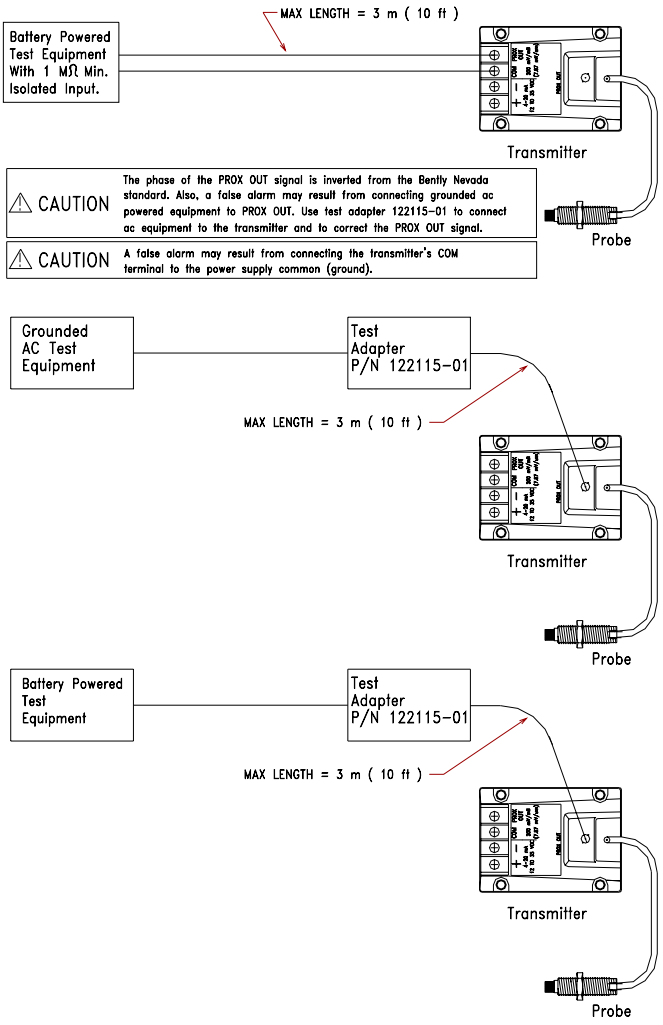
Use the following wiring diagrams to connect the field wiring between the transmitter and the monitoring instruments. Connect the transmitter to an approved source (approved to IEC 1010.1 for example.)


Receiver
Power Supply
Vps = 17 to 35 Vdc
Common (Ground)
Cable Shield
Transmitter
RECOMMENDED WIRING IS SHIELDED,
TWISTED PAIR, 1.0 mm (18 AWG)
(ORDERED SEPARATELY)
MAX LENGTH = 13 km (8 MILES)
Probe

Receiver
Power Supply
Vps = 17 to 35 Vdc
Common (Ground)
Cable Shield
Transmitter
RECOMMENDED WIRING IS SHIELDED,
TWISTED PAIR, 1.0 mm (18 AWG)
(ORDERED SEPARATELY)
MAX LENGTH = 13 km (8 MILES)
Probe


Receiver
#1
Common
(Ground)
Cable Shield
Transmitter
#1
Probe #1
Receiver
#2
Power Supply
Vps = 17 to 35 Vdc
Common (Ground)
Cable Shield
Transmitter
#2
Probe #2


Receiver
#1
Receiver
#2
Power Supply
Vps = 22 to 35 Vdc
Common (Ground)
Cable Shield
Transmitter
Probe


MAX LENGTH = 3 m (10 ft)
Battery Powered Test Equipment With 1 MΩ Min. Isolated Input.
Transmitter
Probe
CAUTION
The phase of the PROX OUT signal is inverted from the Bently Nevada standard. Also, a false alarm may result from connecting grounded ac powered equipment to PROX OUT. Use test adapter 122115-01 to connect ac equipment to the transmitter and to correct the PROX OUT signal.
CAUTION
A false alarm may result from connecting the transmitter's COM terminal to the power supply common (ground).
Grounded AC Test Equipment
Test Adapter P/N 122115-01
MAX LENGTH = 3 m (10 ft)
Transmitter
Probe
Battery Powered Test Equipment
Test Adapter P/N 122115-01
MAX LENGTH = 3 m (10 ft)
Transmitter
Probe

Section 3 — Maintenance and Troubleshooting

Maintenance

This section shows how to verify that the system is operating properly, adjust the system, and identify parts of the system that are not working properly.

The transmitter system does not require verification at regular intervals. You should, however, verify operation by using the scale factor verification on page 13 if any of the following conditions occur:

- components of the system are replaced or disturbed
- the performance of the system changes or becomes erratic
- you suspect that the transmitter is not calibrated correctly.

The adjustment procedures on pages 15 thru 18 are included for your information. For target materials other than 4140 steel and for other special applications, contact your local Bently Nevada office.

The scale factor verification procedure, the scale factor adjustment procedure, and the zero/span adjustment procedure require the following instruments:

digital multimeter (2)
spindle micrometer
power supply

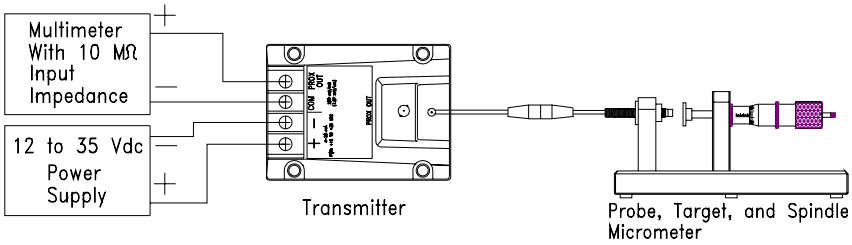
CAUTION

Electrostatic discharge on the exposed calibration resistor terminals can cause the accuracy of the system to go out of specification, or cause the system to fail. Use appropriate precautions for handling static sensitive devices.

The adjustment procedure also requires the following items:

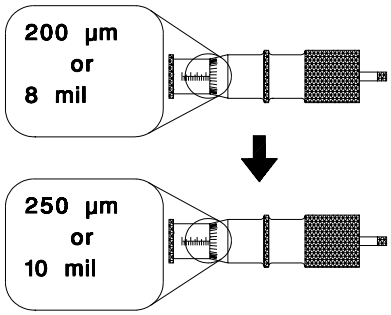
variable resistor, 0 to 100 kΩ
vulcanizing compound (for example, Dow 3110 RTV)
soldering iron (with grounded tip) and soldering supplies

The scale factor verification and the scale factor adjustment procedure both use the test setup as shown in the following figure:



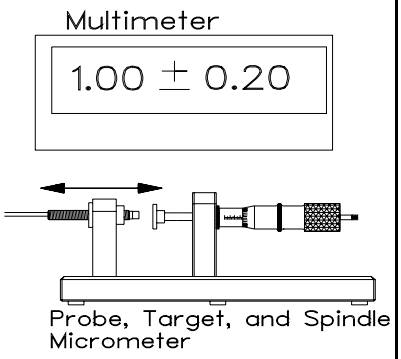
Scale Factor Verification

1



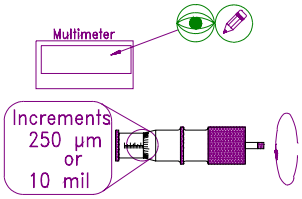
Compensate for mechanical backlash, then adjust the micrometer to the initial gap setting.

2



With the micrometer at the initial gap, adjust the probe position so that the voltage is 1.00 Vdc (Electrical Zero).

3



Record voltages at each gap increment, and calculate scale factors.

4

n	Adjust Micrometer to…		Record Voltages	Calculate Scale Factor	
	mm	Mil	Vdc_n	ISF_n (Incremental Scale Factor)	ASF (Average Scale Factor)
1	0.250	10	_____		
2	0.500	20	_____	_____	
3	0.750	30	_____	_____	
4	1.000	40	_____	_____	
5	1.250	50	_____	_____	
6	1.500	60	_____	_____	
7	1.625	65	_____	_____*	_____

* Calculate ISF for the increment between 1.500 and 1.625 mm (60 - 65 mil) ISF by dividing by 0.125 mm (5 mils).

$$ISF_n = \frac{Vdc_n - Vdc_{n-1}}{10\,mil\,*} \qquad ASF = \frac{Vdc_{65\,mil} - Vdc_{10\,mil}}{55\,mil}$$

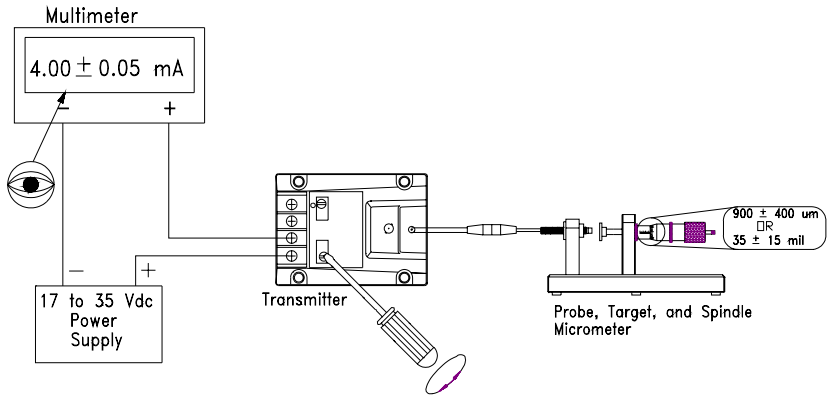
$$ISF_n = \frac{Vdc_n - Vdc_{n-1}}{250\,mm\,*} \qquad ASF = \frac{Vdc_{1.625mm} - Vdc_{0.250mm}}{1.375mm}$$

If the incremental scale factor (ISF) or the average scale factor (ASF) of the system is out of tolerance (refer to page 29), contact Bently Nevada, LLC for further information on possible calibration problems or perform the following adjustment.

Zero/Span Adjustment Procedure - Vibration

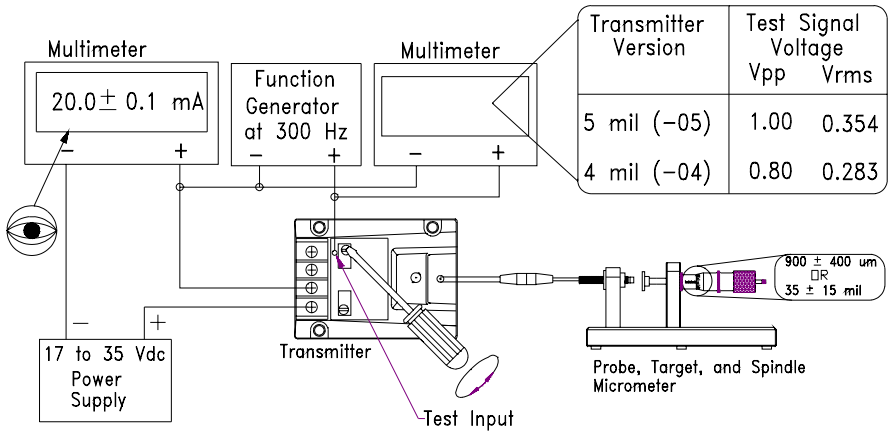
Follow these steps to adjust the zero and span for the 990 vibration transmitter.

1



Adjust zero potentiometer with no input signal.

2



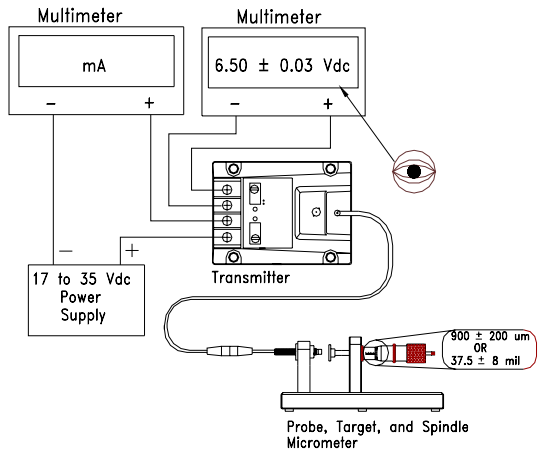
Adjust span potentiometer with full scale input signal.

Zero/Span Adjustment Procedure - Thrust

You may adjust the 991 thrust transmitter zero and span by using either the probe input (Mechanical method) or an external test signal (Test input method). After you install the system at the machine, you may need to readjust the zero.

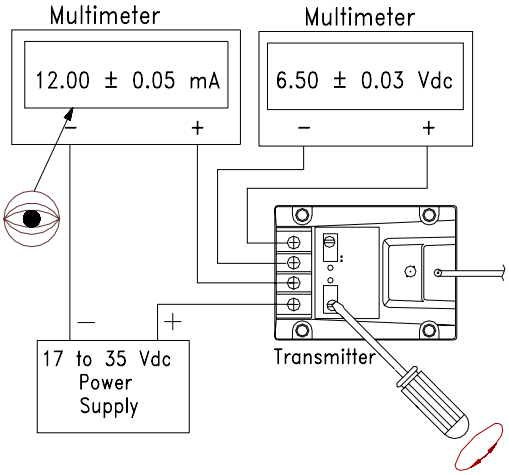
991 Mechanical Method

1



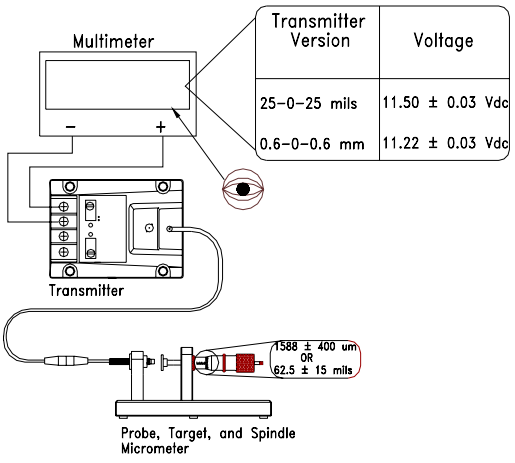
Set probe gap for a 6.5 Vdc signal measured between Prox Out and COM.

2



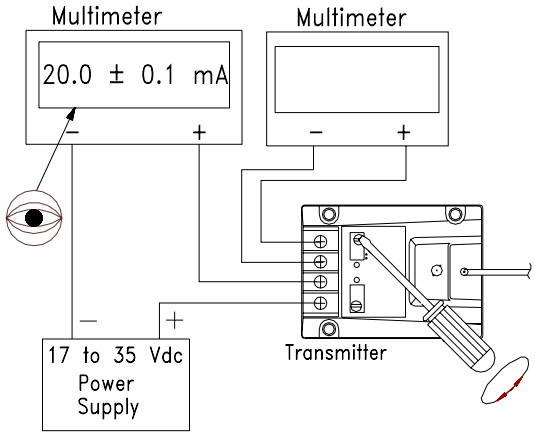
Adjust the zero potentiometer to set the loop current to 12 mA.

3



Set the probe gap for a full scale signal measured between Prox Out and COM.

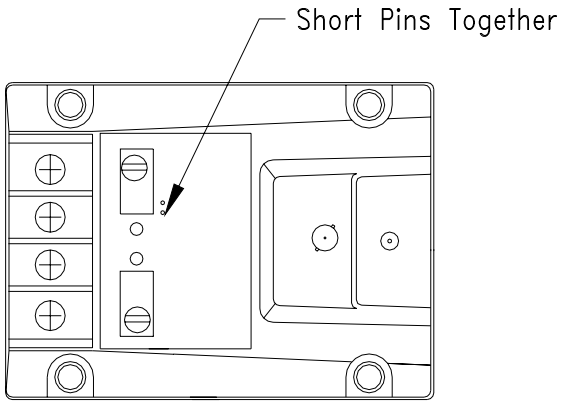
4



Adjust the span potentiometer to set the full scale loop current.

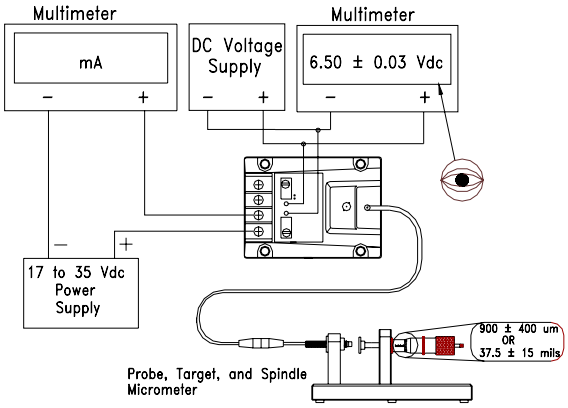
991 Test Input Method

1



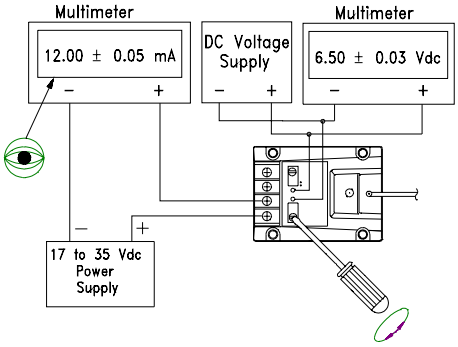
Short the test jumper pins together to enable the test inputs.

2



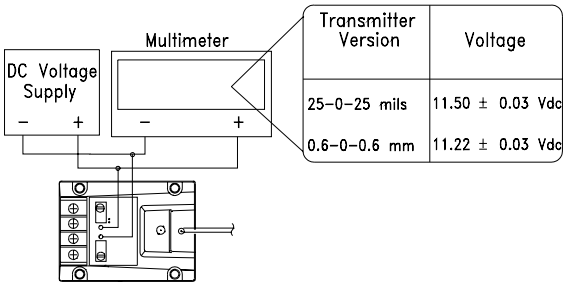
Set the DC test input voltage to 6.5 Vdc.

3



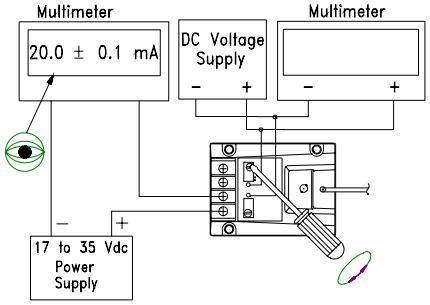
Adjust the zero potentiometer to set the loop current to 12 mA.

4



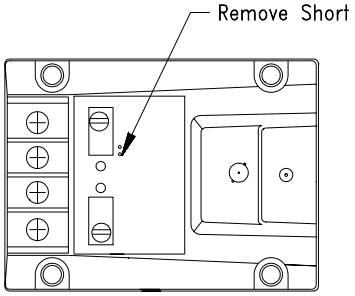
Set the DC test input voltage to the full scale voltage shown.

5



Adjust the span potentiometer to set the full scale loop current.

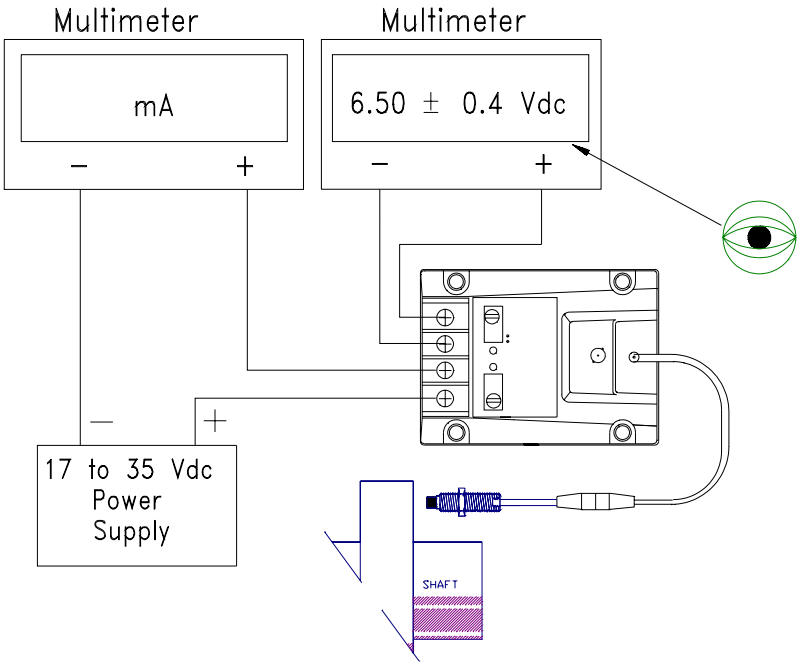
6



Remove the short across the test jumper pins.

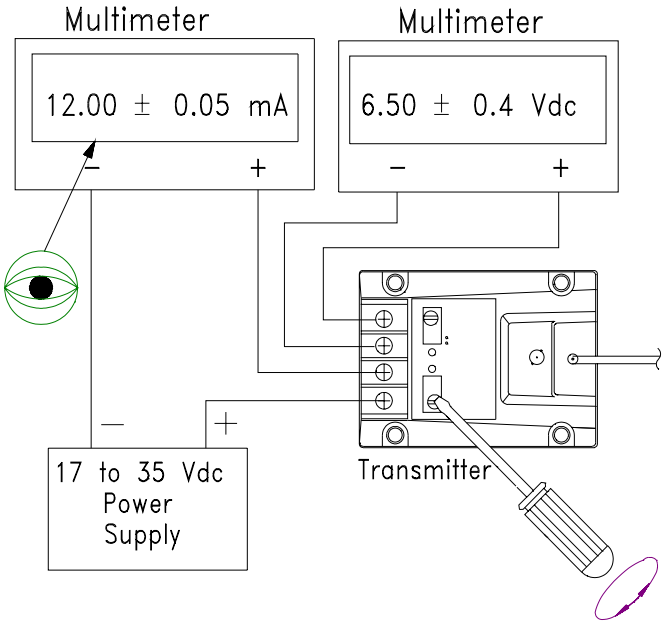
Adjusting the 991 Zero Potentiometer at the Machine.

1



With the rotor set against the active thrust shoe or in the center of the float (depending on your procedure), gap the probe so that the voltage between Prox Out and COM is 6.5 ± 0.4 Vdc.

2



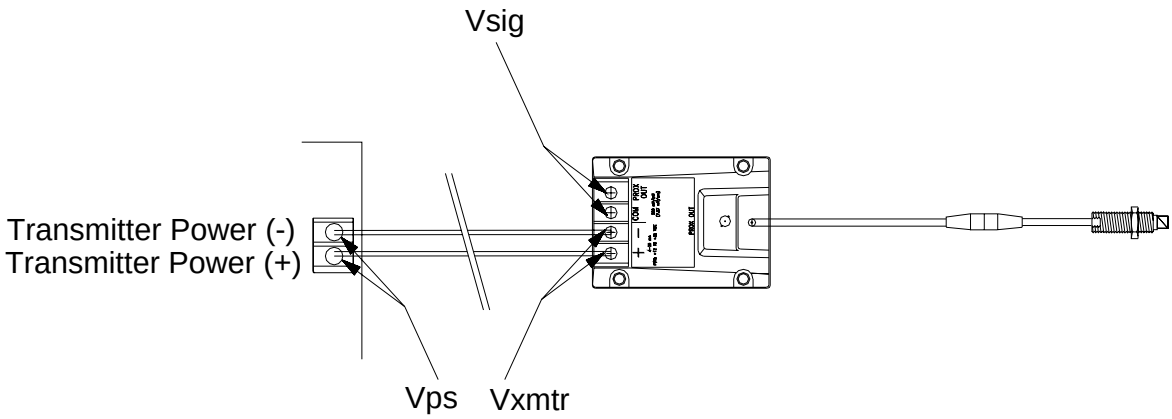
If necessary, adjust the zero potentiometer until the loop current is 12 mA. Do not adjust the span potentiometer.

You may need to readjust the zero after you start the machine.

Troubleshooting

This section shows how to interpret a fault indication and isolate faults in an installed transducer system. Before beginning this procedure, be sure the system has been installed correctly and all connectors have been secured properly in the correct locations.

When a malfunction occurs, locate the appropriate fault, check the probable causes for the fault indication, and follow the procedure to isolate and correct the fault. Use a digital multimeter to measure voltage and resistance. If you find faulty transducers, please return them to the Product Repair Manager at Bently Nevada, LLC for failure analysis.



The troubleshooting procedures use measured voltages as shown in the following figure and table:

Symbols for Measured Voltages

Symbol	Meaning	Voltage measured between...
V_{SIG}	Signal voltage from the transducer	Prox OUT and COM
V_{PS}	Power supply voltage	Power Source (+) and Power Supply (-)
V_{xmtr}	Transmitter supply voltage	Transmitter Power (+) and Transmitter Power (-)

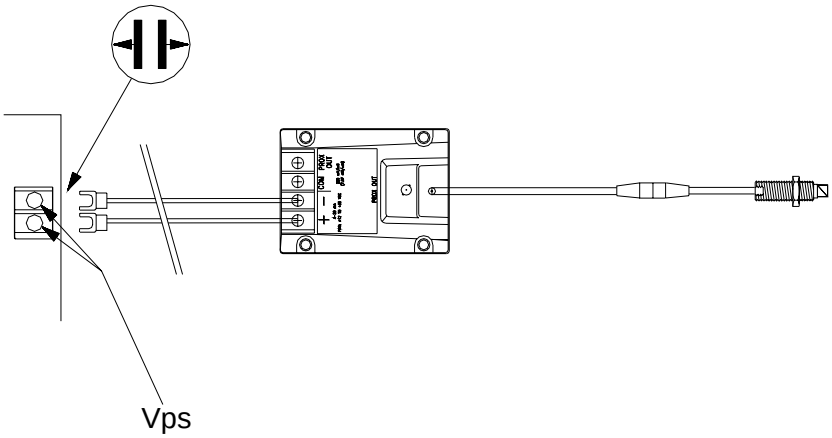
Definitions

Symbol	Definition
A > B	"A" value is more positive than "B"
A < B	"A" value is more negative than "B"
A = B	"A" same value (or very close) to "B"

Fault Type 1: Vxmtr < 12 Vdc or Vxmtr > 35 Vdc

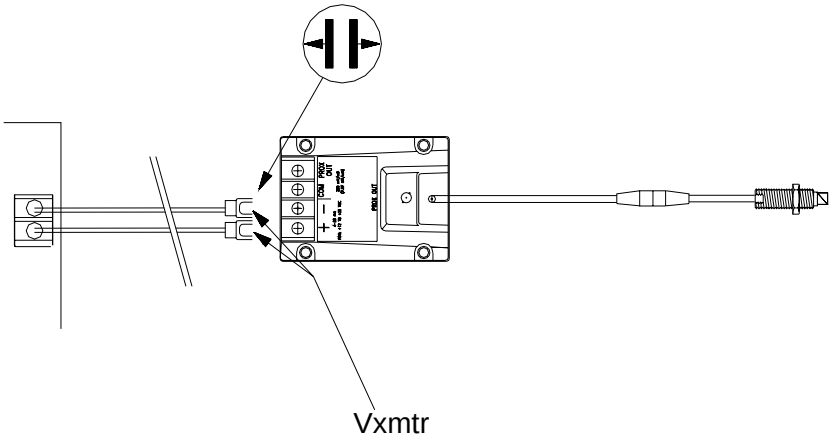
Possible causes:

- Faulty power source
- Faulty field wiring
- Faulty Transmitter



Measure V_{PS}: Is V_{PS} < 12 Vdc or V_{PS} > 35 Vdc?

Yes: Faulty power supply.
No: Go to next step.



Measure Vxmtr: Is Vxmtr < 12 Vdc or Vxmtr > 35 Vdc?

Yes: Faulty Field wiring.
No: Faulty Transmitter.

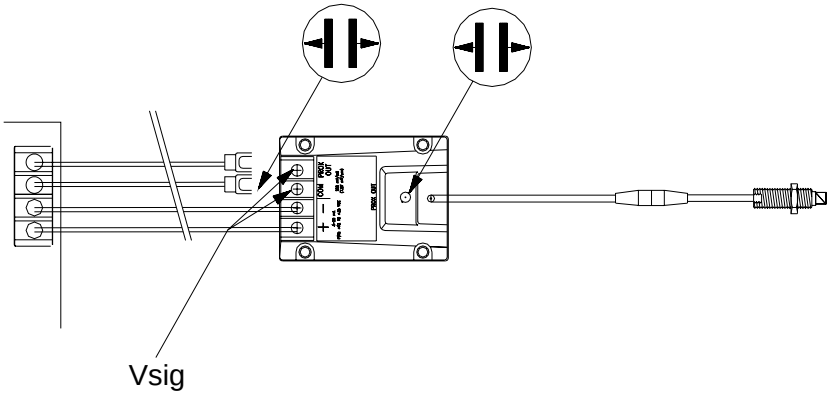
Fault Type 2: V_{SIG} = 0 Vdc

Possible causes:

- Incorrect power source voltage
- Short circuit in field wiring
- Short circuit at Transmitter terminal connection
- Faulty Transmitter

Does fault condition type 1 exist?

Yes: Use the procedure for fault type 1
No: Go to the next step



Measure V_{SIG}: Is V_{SIG} = 0 Vdc?

No: Short in field wiring.
Yes: Test as Fault Type 3.

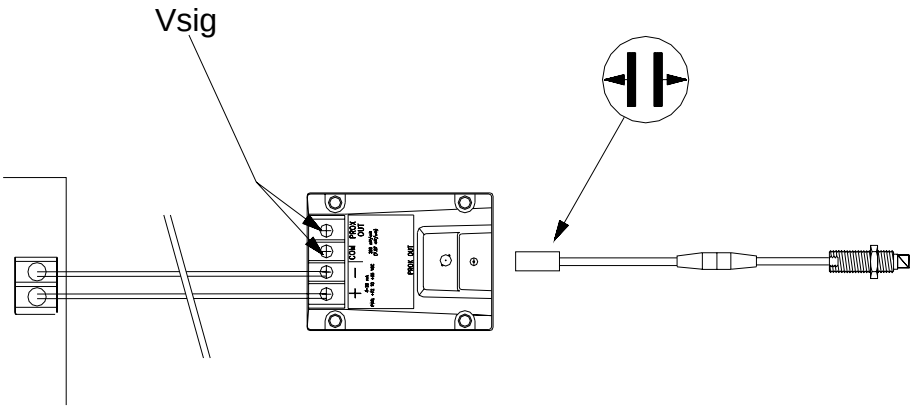
Fault Type 3: 0 Vdc < V_{SIG} < 1 Vdc

Possible causes:

- Incorrect power source voltage
- Faulty Transmitter
- Short circuit in the probe
- Short circuit in the extension cable
- Short circuit in the connector
- Probe is incorrectly gapped (too close to target).
- Probe is detecting other material than target (counterbore or part of machine case)

Does fault condition type 1 exist?

Yes: Use the procedure for fault type 1
No: Go to the next step



Measure Vsig: Is 0 Vdc < Vsig < 1 Vdc

Yes: Faulty Transmitter.
No: Faulty Probe, cable, or connector
See Fault Type 6.

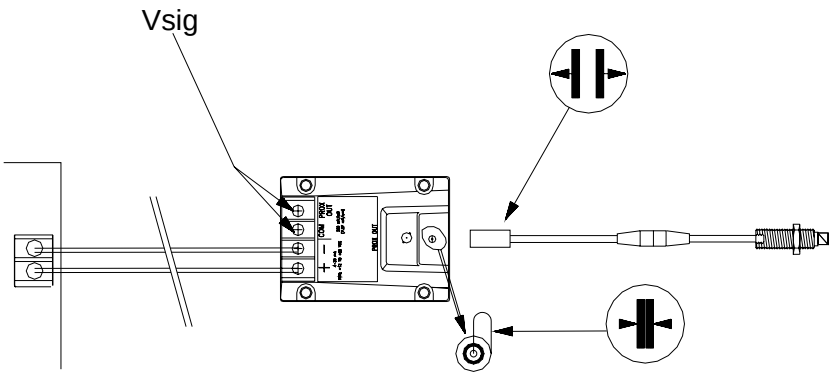
Fault Type 4: 13 Vdc < Vsig

Possible causes:

- Probe is incorrectly gapped (too far from target)
- Open circuit in the probe.
- Open circuit in the extension cable.
- Open circuit in a connector.
- Faulty Transmitter

Does fault condition type 1 exist?

Yes: Use the procedure for fault type 1
No: Go to the next step



Short the BNJR connector

Measure Vsig: Is 0 Vdc < Vsig < 1 Vdc?

No: Faulty Transmitter
Yes: Faulty Probe, cable, or connector
See Fault Type 6.

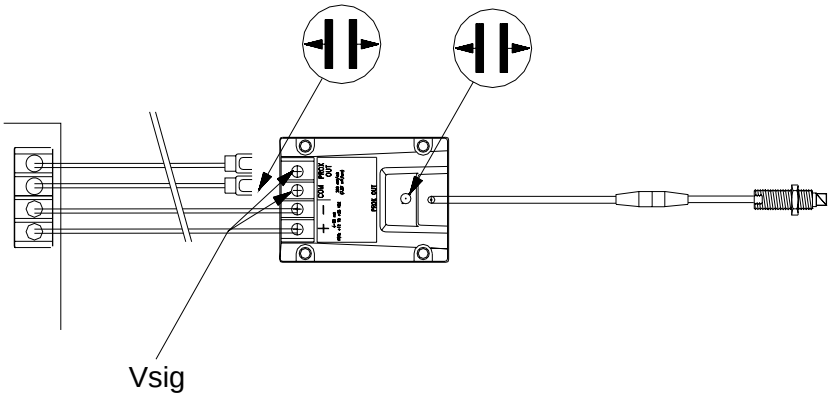
Fault Type 5: V_{SIG} = Vxmtr

Possible causes:

- Incorrect power source voltage
- Faulty field wiring
- Faulty Transmitter

Does fault condition type 1 exist?

Yes: Use the procedure for fault type 1
No: Go to the next step



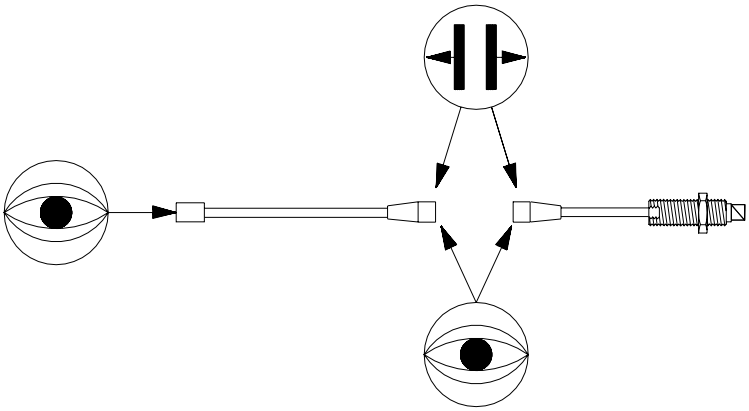
Measure Vsig: is Vsig = Vxmtr?

Yes: Faulty Transmitter.
No: Faulty field wiring.

Fault Type 6: Faulty probe, cable, or connector

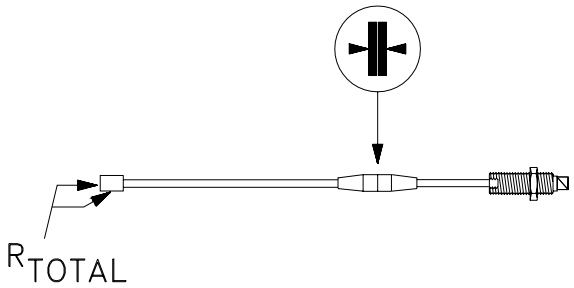
Possible causes:

- Short or open circuit in the probe.
- Short or open circuit in the extension cable
- Short or open circuit in a connector



Inspect for clean connection: Is the connection dirty, rusty, or a poor connection?

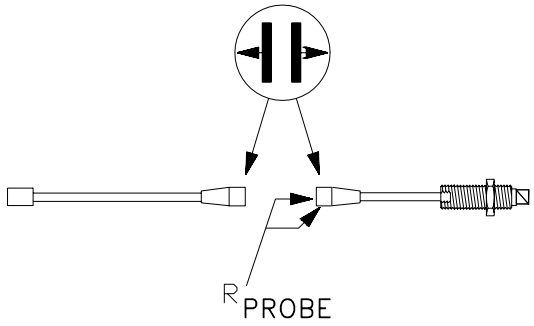
Yes: Clean the connector and retest the original system.
No: Go to the next step.



Measure resistance R_{TOTAL}: Is R_{TOTAL} within specifications?

5 m system: 5.3 ± 0.7 Ω
7 m System: 6.5 ± 0.9 Ω

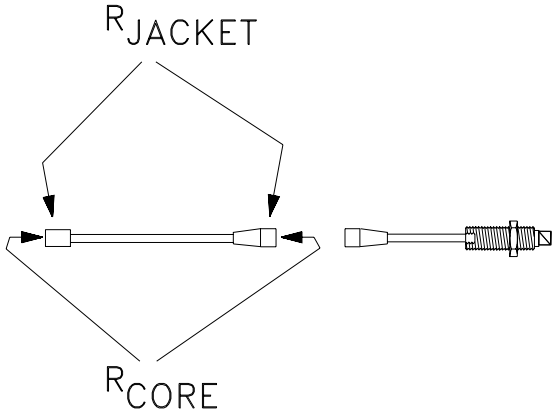
Yes: Retest original system
No: Go to the next step



Measure resistance, R_{PROBE}: Is R_{PROBE} within specifications?

0.5 m Probe: 4.0 ± 0.5 Ω
1.0 m Probe: 4.2 ± 0.5 Ω

No: Faulty probe.
Yes: Go to next step.



Measure the resistance, R_{JACKET} and R_{CORE}: Is the resistance within specifications (see DC resistance, nominal**, page 32)?**

No: Faulty extension cable
Yes: Retest the original system

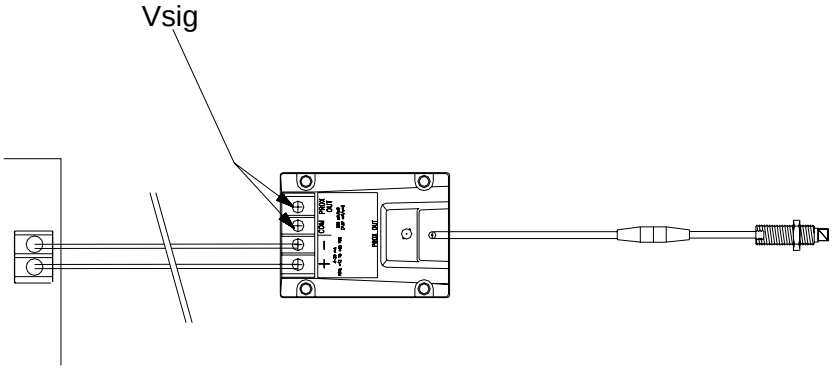
Fault Type 7: Supply Current < 3.6 mA

Possible causes:

- Incorrect power source voltage
- Faulty transmitter
- Short or open circuit in the probe
- Short or open circuit in the extension cable
- Short or open circuit in a connector
- Probe is incorrectly gapped (too close to target)
- Probe is detecting other material than target such as the couterbore or part of the machine case
- Thrust position is over range in the direction toward the probe (991 thrust transitter only)

Does fault condition type 1 exist?

Yes: Use the procedure for fault type 1
No: Go to the next step



Measure V_{SIG}: Is V_{SIG} < 1 Vdc?

Yes: See Fault Type 3
No: Go to next step

Measure V_{SIG}: Is V_{SIG} > 13Vdc?

Yes: See Fault Type 4
No: Faulty Transmitter.

Section 4 — Specifications

Unless otherwise noted, the following specifications are for a 990 and 991 transmitter, extension cable and probe between 18 °C and 27 °C (64 °F and 80 °F) with a -24 Vdc power supply, a 10 kΩ load, a Bently Nevada supplied AISI 4140 steel target that is 31 mm (1.2 in) diameter or larger, and a probe gap of 1.0 mm (40 mils). The system accuracy and interchangeability specifications do not apply when using a transducer system calibrated to any target other than a Bently Nevada AISI 4140 steel target. Typical is defined as 90% of the devices built meeting the specification, and worst case is defined as 99.7% of the devices built meeting the specification. The calibration range is defined as the 1.4 mm (55 mil) range from 1.0 Vdc to 1.4 mm (55 mils) above 1.0 Vdc. This range is approximately equivalent to a calibration range of .25 mm to 1.65 mm (10 to 65 mils).

Note: Operation outside the specified limits will result in false readings and/or loss of machine monitoring.

System

Transducer System specifications refer to the expected performance seen by connecting any cable to any probe and any transmitter unit. The tolerances listed below include interchangeability variations (specified on the following pages).

Average Scale Factor

Typical	7.87 ± 0.2 V/mm (200 ± 5.4 mV/mil)
Worst Case	7.87 ± 0.4 V/mm (200 ± 10 mV/mil)

Incremental scale factor (ISF)

7.87 V/mm (200 mV/mil) ±9.5% including interchangeability error when measured in increments of 0.25 mm (10 mils) over the 55 mil linear range

Deviation from best fit Straight Line (DSL)
Less than ±0.06 mm (±2.3 mils).

Transmitter -- General

Weight	Approximately 0.514 kg (1.1 pounds)

Temperature

Storage	-51 °C to +100 °C (-60 °F to +212 °F)
Operating	0 °C to +70 °C (+32 °F to +158 °F)

The ISF will remain within ±10% of 7.87 V/mm (200 mV/mil) over the calibration range from 0 °C to +70 °C (+32 °F to +158 °F).

Relative Humidity	100% condensing, non-submersible when connector is protected. Tested to IEC 68-2-3 damp heat.

Transmitter -- Proximity Signal Output

Interchangeability Error

Average scale factor (ASF) change

Typical:	Less than 0.09 V/mm (2.3 mV/mil)
Worst Case:	Less than 0.33 V/mm (8.4 mV/mil)

Apparent Gap Change (maximum)

At 0.90 mm (35 mils) gap:	0.18 mm (7 mils)
At 0.25 mm (10 mils) gap:	0.13 mm (5 mils)

Supply Sensitivity	Less than 2 mV change in output voltage per volt change in input voltage.
Cable Length	3 m (10 ft) maximum between transmitter and either test adapter or test equipment.
Output Resistance	10 kΩ
Output Load	Calibrated into a 10 MΩ load (1% error with a 1.0 MΩ load.)
Output Noise	Less than 50 mV pp.

Transmitter -- Current Loop Output

4-20 mA Loop Accuracy
Within ±1.5% over specified full scale range (typical).

Supply Voltage Range
+17 Vdc to +35 Vdc (The voltage drop across the load resistor will be between 0 and 5 V, so the input voltage at the transmitter is +12 Vdc to +35 Vdc.)

Maximum Loop Resistance -- including cable resistance
43.5 X (Supply Voltage - 12) Ω.

Full Scale Loop Current

990 Vibration Transmitter:	
Zero:	4.0 mA ± 0.1 mA
Full Scale:	20.0 mA ± 0.2 mA
991 Thrust Transmitter:	
Zero:	12.0 mA ± 0.1 mA
Upper Full Scale:	20.0 mA ± 0.4 mA
Lower Full Scale:	4.0 mA ± 0.4 mA

Frequency Response

990 Vibration Transmitter:	Less than 3 db down from 5 Hz to 6 kHz at 0.90 mm (35 mils) gap.
991 Thrust Transmitter:	Greater than 3 dB attenuation above 10 Hz.

Current Limiting	26 mA worst case (23 mA typical).

Effect of Shorting BNC "Prox Out" Jack
Less than 1.0 mA error in loop current.

Output Noise
Error less than 0.25% of full scale (10 mV pp with a 250 Ω load resistor) when measured at the output of a low pass RC filter with a 10 Hz corner frequency, and when the power supply ripple is less than 1% of the input voltage when measured at the output of a 120 Hz low pass filter.

Indication of Faults
The loop current will go to less than 3.6 mA if the probe is opened, shorted, gapped outside of the linear range (not OK condition) or if the power supply is low. The 990 vibration transmitter loop current will remain below 3.6 mA for 2 to 3 seconds after the fault is removed. The 991 thrust transmitter will resume normal operation within 0.1 seconds after the probe fault is removed.

3300 NSv™ or 3300 RAM Probe

Interchangeability Error

Average scale factor (ASF) change	
Typical:	Less than 0.24 V/mm (6 mV/mil)
Worst Case:	Less than 0.42 V/mm (11 mV/mil)

Voltage Difference at Same Physical Gap (Maximum)	
At 0.90 mm (35 mils) gap	4.6 Vdc
At 0.25 mm (10 mils) gap	3.6 Vdc

Connector-to-Connector Torque Requirement

Two gold ClickLoc™ connectors	Finger tight
One stainless steel connector and one gold ClickLoc™ connector	Finger tight plus 1/8 turn using pliers
Maximum torque	0.565 N×m (5 in lb)

Case Types and Torque Limits

Probe case torque:	Maximum Rated	Recommended
¼ -28 or M8x1 probe cases	7.3 N•m (65 in•lb)	5.1 N•m (45 in•lb)
3/8-24 or M10x1 probe cases	33.9 N•m (300 in•lb)	11.3 N•m (100 in•lb)
3/8-24 or M10x1 probe cases – first three threads	22.6 N•m (200 in•lb)	7.5 N•m (66 in•lb)
Reverse mount probes	22.6 N•m (200 in•lb)	7.5 N•m (66 in•lb)

Tensile Strength (Maximum Rated)

Probe case to probe lead	34 kg (75 lb)
Probe case to connector	27 kg (60 lb)
Probe case to armor (if used)	22 kg (50 lb)

Minimum cable bend radius 25 mm (1.0 inch)

Weight Approximately 14 to 150 g (0.5 to 5 oz)

Temperature

Storage	-51 °C to +177 °C (-60 °F to +350 °F).
Operating	-34 °C to +177 °C (-30 °F to +350 °F).

Note: Maximum temp. for sealed ETFE armor is 149 °C (300 °F).

Note: Exposing the probe to temperatures below –34 °C (-30 °F) for a sustained period of time may cause premature failure of the probe tip-to-case pressure seal.

The ISF will remain within +14% -19% of 7.87 V/mm (200 mV/mil) at 65 mils gap from –18 °C to +177 °C (0 °F to +350 °F), and the ISF will remain within ±10% of 7.87 V/mm (200 mV/mil) at 35 mils gap from –34 °C to +177 °C (-30 °F to +350 °F).

Relative Humidity 100% condensing, non-submersible when connector is protected.

3300 NSv™ or 3300 RAM Extension Cable

Interchangeability Error

Average scale factor (ASF) change

Typical:	Less than 0.09 V/mm (2 mV/mil)
Worst Case:	Less than 0.19 V/mm (5 mV/mil)

Apparent gap change

At 0.90 mm (35 mil) gap	0.145 mm (5.8 mils)
At 0.25 mm (10 mil) gap	0.100 mm (4.0 mils)

DC resistance, nominal

Center conductor	0.220 Ω/m (0.067 Ω/ft)
Shield	0.066 Ω/m (0.020 Ω/ft)

Capacitance 69.9 pF/m (21.3 pF/ft)

Characteristic Impedance 65 Ω

Minimum bend radius 25 mm (1.0 inch)

Connector-to-Connector Torque Requirement

Two gold ClickLoc™ connectors	Finger tight
One stainless steel connector and one gold ClickLoc™ connector	Finger tight plus 1/8 turn using pliers
Maximum torque	0.565 N×m (5 in lb)

Weight

No Armor	45 g/m (0.5 oz/ft)
With Armor	65 g/m (0.7 oz/ft)

Temperature

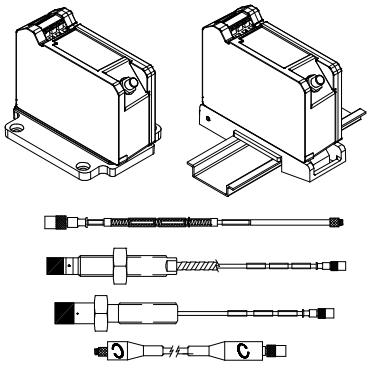
Storage	-51 °C to +177 °C (-60 °F to +350 °F)
Operating	-51 °C to +177 °C (-60 °F to +350 °F)

The ISF will remain within +14% -19% of 7.87 V/mm (200 mV/mil) at 65 mils gap from –18 °C to +177 °C (0 °F to +350 °F), and the ISF will remain within ±10% of 7.87 V/mm (200 mV/mil) at 35 mils gap from –34 °C to +177 °C (-30 °F to +350 °F).

Relative Humidity	100% condensing, non-submersible when connector is protected.

3300 XL NSv* Proximity Transducer System

Bently Nevada* Asset Condition Monitoring



Description

The 3300 XL NSv* Proximity Transducer system is intended for use with centrifugal air compressors, refrigeration compressors, process gas compressors and other machines with tight installation requirements. The 3300 XL NSv Proximity Transducer System consists of:

- a 3300 NSv probe
- a 3300 NSv extension cable
- a 3300 XL NSv Proximitor* Sensor.[1]

The primary uses for the 3300 XL NSv Transducer System are for areas where counter bore, sideview or rearview restrictions limit the use of standard Bently Nevada* 3300 and 3300 XL 5 and 8 mm Transducer Systems. It is also ideal for small target applications, such as measuring radial vibration on shafts smaller than 51 mm (2 in) or axial position on flat targets smaller than 15 mm (0.6 in). It is primarily used in the following applications on fluid-filmed bearing machines where a small shaft or reduced side-view is present:

- Radial vibration and radial position measurements
- Axial (thrust) position measurements
- Tachometer and zero speed measurements
- Phase reference (Keyphasor*) signals

The 3300 XL NSv Transducer System design allows it to replace both the 3300 RAM Transducer Systems and the 3000-series or 7000-series 190 Transducer System. Upgrades from the 3300 RAM system to the 3300 XL NSv system may use the existing probe, extension cable, and monitoring system with 3300 XL NSv Proximitor Sensor. Upgrades from the 3000-series or 7000-series Transducer System must replace the probe, extension cable and Proximitor Sensor with NSv components.

The 3300 XL NSv Transducer System has an Average Scale Factor of 7.87 V/mm (200 mV/mil), which is the most common output for eddy current transducers. Its enhanced side-view and small target characteristics give it a shorter linear range than the Bently Nevada 3300 XL-series 5 and 8 mm Transducer System. With The 1.5 mm (60 mils) of linear range exceeds the linear range of the 3000-series 190 Transducer System.

Application Alert: Although the terminals and connector on the Proximitor Sensor have protection against electrostatic discharge, take reasonable precautions to avoid electrostatic discharge during handling.

Proximitor Sensor

The 3300 XL NSv Proximitor Sensor has similar features to those found in the 3300 XL 8 mm Proximitor Sensor. Its thin design allows the user to mount it in either a high-density DIN-rail installation or a more traditional panel mount configuration. Improved RFI/EMI immunity allows the 3300 XL NSv Proximitor Sensor to achieve European CE mark approvals without any special mounting considerations. This RFI immunity also prevents nearby high frequency radio signals from adversely affecting the transducer system. SpringLoc terminal strips on the Proximitor Sensor require no special installation tools and facilitate faster, highly robust field wiring connections.

Proximity Probe and Extension Cable

The 3300 NSv probe and extension cable are mechanically and electrically compatible and interchangeable with Bently Nevada's previous 3300 RAM proximity probe and extension cable. The NSv probe has increased chemical resistance compared to the 3300 RAM probe, which allows its use in many process compressor applications. The side-view characteristics of the 3300 NSv probe are also superior to those of the 3000-series 190 probe when gapping the 3300 NSv probe at the same distance from the probe target.

The 3300 NSv probe comes in varying probe case configurations, including armored and unarmored ¼ -28, 3⁄8 -24, M8 X 1 and M10 X 1 probe threads. The reverse mount 3300 NSv probe comes standard with either 3⁄8 -24 or M10 X 1 threads. All components of the transducer system have gold-plated brass ClickLoc* connectors. ClickLoc connectors lock into place and prevent the connection from loosening. The patented TipLoc* molding method provides a robust bond between the probe tip and the probe body. Bently Nevada's patented CableLoc* design provides 220 N (50 lb) of pull strength and securely attaches the probe cable to the probe tip. Connector protectors are recommended for use on the probe-to-extension cable connection, as well as on the cable-to-Proximitor Sensor connection. Connector protectors prevent most liquids from entering into the ClickLoc connectors and adversely affecting the electrical signal[2].

Notes:

1. Proximitor Sensors are supplied by default from the factory calibrated to AISI 4140 steel. Calibration to other target materials is available upon request.

2. Silicone tape is also provided with each 3300 NSv extension cable and can be used instead of connector protectors. Silicone tape is not recommended in applications where the probe-to-extension cable connection will be exposed to turbine oil.

Specifications

Unless otherwise noted, the following specifications are for a 3300 XL NSv Proximitor Sensor, extension cable and probe between 0°C and +45°C (+32°F to +113°F), with a -24 Vdc power supply, a 10 kΩ load, a Bently Nevada supplied AISI 4140 steel target that is 31 mm (1.2 in) diameter or larger, and a probe gap of 1.0 mm (40 mils). The system accuracy and interchangeability specifications do not apply when using a transducer system calibrated to any target other than a Bently Nevada AISI 4140 steel target.

Electrical

Proximitor Sensor Input

Accepts one non-contacting 3300 RAM or 3300 NSv Proximity Probe and Extension Cable.

Power

Requires -17.5 Vdc to -26 Vdc without barriers at 12 mA maximum consumption, -23 Vdc to -26 Vdc with barriers. Operation at a more positive voltage than -23.5 Vdc can result in reduced linear range.

Supply Sensitivity

Less than 2 mV change in output voltage per volt change in input voltage.

Output resistance

50 Ω

Probe dc resistance:

Probe Length (m)	Resistance from the Center Conductor to the Outer Conductor (R_{PROBE}) (ohms)
0.5	4.0 ± 0.5
1.0	4.2 ± 0.5
5.0	5.3 ± 0.7
7.0	5.9 ± 0.9

Extension cable dc resistance:

Center conductor: 0.220Ω/m (0.067 Ω/ft)

Shield: 0.066 Ω/m (0.020 Ω/ft)

Extension cable capacitance:

69.9 pF/m (21.3 pF/ft) typical

Field wiring:

0.2 to 1.5 mm^2 (16 to 24 AWG) [0.25 to 0.75 mm^2 (18 to 23 AWG) with ferrules]. Recommend using three-conductor shielded triad cable. Maximum length of 305 metres (1,000 feet) between the 3300 XL NSv Proximitor Sensor and the monitor. See the frequency response graphs Figure 16 and Figure 17 for signal rolloff at high frequencies when using longer field wiring lengths.

Linear Range:

1.5 mm (60 mils). Linear range begins at approximately 0.25 mm (10 mils) from target and is from 0.25 to 1.75 mm (10 to 70 mils) (approximately -1 to -13 Vdc).

Recommended Gap Setting:

1.0 mm (40 mils)

System performance over ambient temperature range (0°C to 45°C):

Incremental Scale Factor (ISF)

7.87 V/mm (200 mV/mil) +12.5%/-20% including interchangeability error when measured in increments of 0.25 mm (10 mils) over the 1.5 mm (60 mil) linear range.

Deviation from best fit straight line (DSL)

Less than ±0.06 mm (±2.3 mils).

Frequency Response:

0 to 10 kHz: +0, -3 dB typical, with up to 305 metres (1000 feet) of field wiring.

Target Size (flat target):

Minimum: 8.9 mm (0.35 in) diameter

Recommended minimum: 13 mm (0.5 in) diameter

Axial position measurements on shaft diameters smaller than 13mm (0.5 in) will generally result in a change in scale factor. Reducing the gap between the probe and target will help limit the change in scale factor. See Figure 12 for additional information.

Shaft Diameter

Minimum (standard X-Y probe configuration): 30 mm (1.2 in)

Minimum (X-Y proximity probes offset axially by 23 mm (0.9 in)): 20 mm (0.8 in)

Measurements on shaft diameters smaller than 30 mm (1.2 in) usually require close spacing of radial vibration or axial position transducers. This creates the potential for their

electromagnetic emitted fields to interact with one another (cross-talk), resulting in erroneous readings. To prevent cross-talk, maintain minimum separation of transducer tips of at least 25 mm (1.0 in) for axial position measurements or 23 mm (0.9 in) for radial vibration measurements (see Figure 14 and Figure 15 for additional information.) Radial vibration or radial position measurements on shaft diameters smaller than 20 mm (0.8 in) will generally result in greater than a 10% change in Average Scale Factor (ASF). See Figure 13 for additional information.

Counterbore

Minimum: 9.5 mm (0.375 in)

Recommended minimum: 13 mm (0.5 in)

Counterbores smaller than 13 mm (0.5 in) generally result in a change in scale factor at far gaps. Reducing the gap between the probe and the target will allow the transducer system to maintain its Average Scale Factor (ASF) over a reduced linear range. See Figure 9 for additional information.

Effects of 60 Hz Magnetic Fields Up to 300 Gauss (5 metre system):

Output voltage in mil pp/gauss:

Gap	Proximitor Sensor	Probe	Ext. Cable
0.25 mm (10 mils)	0.006	0.001	0.001
1.0 mm (40 mils)	0.007	0.002	0.001
1.75 mm (70 mils)	0.008	0.002	0.003

Electrical Classification:

Complies with the European CE mark.

Compliance and Certifications

EMC

Standards:

EN 61000-6-2 Immunity for Industrial Environments

EN 61000-6-4 Emissions for Industrial Environments

European Community Directives:

EMC Directive 2004/108/EC

Hazardous Area Approvals

Multiple approvals for hazardous areas certified by Canadian Standards Association in North America and by BASEEFA in Europe.

North America:

Probes and Proximitor Sensor

Ex ia IIC: Class I, Zone 0: Class 1, Groups A, B, C, D; Class II, Groups E, F, G, Class III, when installed with intrinsically safe zener barriers per drawing 141092 or when installed with galvanic isolators.

Probes and Proximitor Sensor

Ex nA IIC; Class I, Zone 2: Class I, Div 2, Groups A, B, C, D, when installed without barriers per drawing 140979.

T_5 @ T_a = -35°C to +85°C.

Europe:

Probes

II 1 G EEx ia IIC T1. . .T5

Probes

II 3 G EEx nA II T1...T5

Proximitor Sensor

II 1 G EEx ia IIC T5, when installed with intrinsically safe zener barriers or galvanic isolators,

T5 @ Ta= -35°C to +85°C.

II 3 G Ex nA II T4/T5.

IECEx:

Probes

Ex ia IIC TI..T5

Ex nA II TI..T5

Proximitor Sensor

Ex ia IIC T4/T5

Ex nA II T4/T5

Brazil:

Probes

BR-Ex ia IIC T1..T5

Proximitor Sensor

BR-Ex ia IIC T4/T5

For further certification and approvals information please visit the following website:
http://www.ge-energy.com/prod_serv/products/oc/en/bently_nevada.htm

Mechanical

Probe Tip Material:

Polyphenylene sulfide (PPS).

Probe Case Material:

AISI 304 stainless steel (SST).

Probe Cable Specifications:

75 Ω coaxial, fluoroethylene propylene (FEP) insulated probe cable in the following total probe lengths: 0.5, 1, 5, or 7 metres.

Extension Cable Material:

75 Ω coaxial, fluoroethylene propylene (FEP) insulated.

Proximitor Sensor Material:

A380 aluminum

System Length:

5 or 7 metres including extension cable

Extension Cable Armor (optional):

Flexible AISI 302 SST with/without FEP outer jacket.

Tensile Strength (maximum rated):

220 N (50 lb) probe case to probe lead. 220 N (50 lb) at probe lead to extension cable connectors. 220 N (50 lb) probe case to stainless steel armor.

Connector material:

Gold-plated brass

Recommended case hole and tap size for 1/4-28 case

Drill Size

0.213 in

Hole Size

0.218 to 0.222 in

Hole Depth

0.376 to 0.750 in

Tap Drill Size

#3

Recommended case hole and tap size for M8x1 case

Drill Size

7.4mm

Hole Size

7.511 to 7.622 mm

Hole Depth

12 to 24 mm

Tap Drill Size

L

Recommended case hole and tap size for 3/8-24 case

Drill Size

0.332 in

Hole Size

0.338 to 0.343 in

Hole Depth

0.562 to 0.xxx1.125 in

Tap Drill Size

Q

Recommended case hole and tap size for M10x1 case

Drill Size

9.4mm

Hole Size

9.541 to 9.662 mm

Hole Depth

15 to 30 mm

Tap Drill Size

U

Connector-to-connector torque

Probe case	Maximum torque:	Recommended torque:
¼ -28 or M8x1 probe cases	7.3 N•m (65 in•lb)	5.1 N•m (45 in•lb)
3/8-24 or M10x1 probe cases	33.9 N•m (300 in•lb)	11.3 N•m (100 in•lb)
3/8-24 or M10x1 probe cases – first three threads	22.6 N•m (200 in•lb)	7.5 N•m (66 in•lb)
Reverse mount probes	22.6 N•m (200 in•lb)	7.5 N•m (66 in•lb)

Recommended torque: *Finger tight*

Maximum torque: *0.56 N • m (5 in • lb)*

Minimum Bend Radius (with or without sst armor): 25.4 mm (1.0 in)

System Weight (typical):

Probe: *Approximately 14 to 150 g (0.5 to 5.3 oz)*

Extension Cable: *45 g/m (0.5 oz/ft)*

Armored Extension Cable: *64 g/m (0.7 oz/ft)*

Proximitor Sensor: *255 g (9 oz)*

Environmental Limits

Probe Temperature Range

Operating Temperature: *-34°C to +177°C (-30°F to +351°F)*

Storage

Temperature: *-51°C to +177°C (-60°F to +351°F)*

Note: Exposing the probe to temperatures below -34°C (-30°F) for a sustained period of time may cause premature failure of the pressure seal.

Extension Cable Temperature Range

Operating and Storage

Temperature: *-51°C to +177°C (-60°F to +351°F)*

Proximitor Sensor Temperature Range

Operating

Temperature: *-35°C to +85°C (-31°F to +185°F)*

Storage

Temperature: *-51°C to +105°C (-60°F to +221°F)*

Relative Humidity:

100% condensing, non-submersible when connectors are protected. Tested to IEC 68-2-3 damp heat.

Probe Pressure:

3300 NSv probes are designed to seal differential pressure between the probe tip and case. The probe sealing material consists of a Viton® O-ring. Probes are not pressure tested prior to shipment. Contact our custom design department if you require a test of the pressure seal for your application

Note: It is the responsibility of the customer or user to ensure that all liquids and gases are contained and safely controlled should leakage occur from a proximity probe. In addition, solutions with high or low pH values may erode the tip assembly of the probe causing media leakage into surrounding areas. Bently Nevada Inc. will not be held responsible for any damages resulting from leaking 3300 NSv Proximity Probes. In addition, 3300 NSv Proximity Probes will not be replaced under the service plan due to probe leakage.

Patents:

5,016,343

5,126,664

5,351,388

5,685,884

Components or procedures described in these patents apply to this product.

Ordering Information

3300 NSv Proximity Probes

330901 3300 NSv Probe, 1/4-28 UNF thread, without armor

330902 3300 NSv Probe, 1/4-28 UNF thread, with armor

330908 3300 NSv Probe, 3/8-24 UNF thread, without armor

330909 3300 NSv Probe, 3/8-24 UNF thread, with armor

Part Number-AXX-BXX-CXX-DXX-EXX

Option Descriptions

A: Unthreaded Length Option

Note: Unthreaded length must be at least 0.7 inch less than the case length.

Order in increments of 0.1 in
Length configurations:
Maximum unthreaded length: 9.2 in
Minimum unthreaded length: 0.0 in
Example: 0 4 = 0.4 in

B: Overall Case Length Option

Order in increments of 0.1 in
Threaded length configurations:
Maximum case length: 9.9 in
Minimum case length: 0.8 in
Example: 2 4 = 2.4 in

C: Total Length Option

0 5 0.5 metre (20 in)
1 0 1.0 metre (39 in)

5 0 5.0 metres (16.4 feet)
7 0 7.0 metres (23.0 feet)

D: Connector and Cable-Type Option

0 1 Miniature coaxial ClickLoc connector with connector protector, standard cable
0 2 Miniature coaxial ClickLoc connector, standard cable
1 1 Miniature coaxial ClickLoc connector with connector protector, FluidLoc cable
1 2 Miniature coaxial ClickLoc connector, FluidLoc cable

E: Agency Approval Option

0 0 Not required
0 5 Multiple Approvals

3300 NSv Proximity Probes, Metric

330903 3300 NSv Probe, M8 x 1 thread, without armor

330904 3300 NSv Probe, M8 x 1 thread, with armor

330905 3300 NSv Probe, M10 x 1 thread, without armor

330910 3300 NSv Probe, M10 x 1 thread, with armor

Part Number-AXX-BXX-CXX-DXX-EXX

Option Descriptions

A: Unthreaded Length Option

Note: Unthreaded length must be at least 20 mm less than the case length.

Order in increments of 10 mm.
Length configuration:
Maximum unthreaded length: 230 mm
Minimum unthreaded length: 0 mm
Example: 0 6 = 60 mm

B: Overall Case Length Option

Order in increments of 10 mm.
Metric thread configurations:
Maximum length: 250 mm
Minimum length: 20 mm
Example: 0 6 = 60 mm

C: Total Length Option

0 5 0.5 metre (20 in)
1 0 1.0 metre (39 in)
5 0 5.0 metres (16.4 feet)
7 0 7.0 metres (23.0 feet)

D: Connector and Cable-Type Option

0 1 Miniature coaxial ClickLoc connector with connector protector, standard cable
0 2 Miniature coaxial ClickLoc connector, standard cable
1 1 Miniature coaxial ClickLoc connector with connector protector, FluidLoc cable
1 2 Miniature coaxial ClickLoc connector, FluidLoc cable

E: Agency Approval Option

0 0 Not required
0 5 Multiple Approvals

3300 NSv Reverse Mount Probe

330906-02-12- CXX-DXX-EXX, 3/8-24 UNF threads

330907-05-30- CXX-DXX-EXX, M10 x 1 threads

Option Descriptions

C: Total Length Option

0 5 0.5 metre (20 in)
1 0 1.0 metre (39 in)
5 0 5.0 metres (16.4 feet)
7 0 7.0 metres (23.0 feet)

D: Connector Option

0 2 Miniature coaxial ClickLoc connector, standard cable
1 2 Miniature coaxial ClickLoc connector, FluidLoc cable

E: Agency Approval Option

0 0 Not required
0 5 Multiple Approvals

Note: For a shorter delivery time, order commonly stocked probes. Currently, stocked probes consist of the following part numbers: 330901-00-24-05-02-00, 330901-00-90-05-02-00, 330902-00-50-05-02-00, 330902-00-95-05-02-00, 330903-00-02-10-02-00, 330903-00-03-10-02-00, 330906-02-12-05-02-00.

3300 XL NSv Proximitor Sensor

330980-AXX-BXX

Option Descriptions

A: Total Length and Mounting Option

5 0 5.0 metre (16.4 feet) system length, panel mount
5 1 5.0 metre (16.4 feet) system length, DIN mount

5 2 5.0 metre (16.4 feet) system length, no mounting hardware[1]
7 0 7.0 metres (23.0 feet) system length, panel mount
7 1 7.0 metres (23.0 feet) system length, DIN mount
7 2 7.0 metres (23.0 feet) system length, no mounting hardware[1]

B: Agency Approval Option
0 0 Not required
0 5 Multiple approvals

3300 NSv Extension Cable

330930-AXXX-BXX-CXX

Note: Make sure that the extension cable length and the probe length, when added together, equal the Proximitor® Sensor total length.

Option Descriptions

A: Cable Length Option
0 4 0 4.0 metres (13.1 feet)
0 4 5 4.5 metres (14.8 feet)
0 6 0 6.0 metres (19.7 feet)
0 6 5 6.5 metres (21.3 feet)

B: Connector and Cable Option
0 0 Without stainless steel armor
0 1 With stainless steel armor, with FEP jacket
0 2 With stainless steel armor, without FEP jacket
0 3 Without stainless steel armor, with connector protectors
0 4 With stainless steel armor, with FEP jacket, with connector protectors
0 5 With stainless steel armor, without FEP jacket, with connector protectors
0 6 FluidLoc cable without stainless steel armor
0 7 FluidLoc cable with stainless steel armor, with FEP jacket
0 8 FluidLoc cable with stainless steel armor, without FEP jacket
0 9 FluidLoc without stainless steel armor, with connector protectors
1 0 FluidLoc cable with stainless steel armor, with FEP jacket, with connector protectors
1 1 FluidLoc cable with stainless steel armor, without FEP jacket, with connector protectors

C: Agency Approval Option
0 0 Not required
0 5 Multiple Approvals

Accessories

147357-01 **Manual**

02120015 **Bulk field wire**. 1.0 mm^2 (18 AWG), 3 conductor, twisted, shielded cable with drain wire. Specify length in feet.

138492-01 **Replacement panel-mount mounting pad**

138493-01 **Replacement DIN-mount mounting pad**

01609137 **BNC (F) to banana plugs**

01609138 **Proximitor Connector Test Pin wiring** (two test pins to a BNC (F) connector)

40971-04 **50 Ω cable with two BNC (M) connectors**. Use this cable in combination with adapter 01609137 and adapter 01609138 when checking performance of the transducer system from the Proximitor Sensor test pin holes.

04310310 **3300 XL Proximitor Sensor Panel-mount Screws.** Package includes one 6-32 UNC thread forming mounting screw (Supplied standard with 3300 XL Proximitor Housings [3300 XL option]).

03200006 **Silicone self-fusing tape.** A 9.1 metre (10 yard) roll of silicone tape to protect connectors. It is easy to install and provides excellent electrical isolation and protection from the environment. It is not recommended for use inside the casing of the machine.

40113-03 **Connector Protector Kit.** Connector Protector Kit for 3300 NSv probes and extension cables, including connector protectors and installation tools.

136536-01 **Connector Protector Adapter.** Connector Protector Adapter. Allows connector protector installation tools manufactured prior to 1998 to be used with 75 Ω ClickLoc connectors.

40180-03 **Connector Protectors.** Package contains 10 pairs of connector protectors.

03800000 **Male Connector Protector.** Placed on the extension cable to connect to the female connector protector on the probe and provide environmental protection of connectors.

03800001 **Female Connector Protector.** Placed on the probe lead to connect to the male connector protector on the extension cable and provide environmental protection of connectors. Also placed on the extension cable to slide over the Proximitor Sensor connection and protect it from the environment.

330153-05 **3300 NSv Connector Kit.** Used on 3300 NSv probes and extension cables. Contains one set of male and female ClickLoc connectors, sleeves and one strip of silicone tape.

163356 **Connector Crimp Tool Kit.** Includes one set of 75 Ω ClickLoc inserts and connector installation instructions. Supplied with carrying case.

Notes:
1. 330980 Proximitor Sensor A: options 52 and 72 come without a mounting pad and should be ordered only as spares. Each Proximitor Sensor needs a mounting pad to ensure that it is properly isolated from the housing ground.

Graphs and Dimensional Drawings

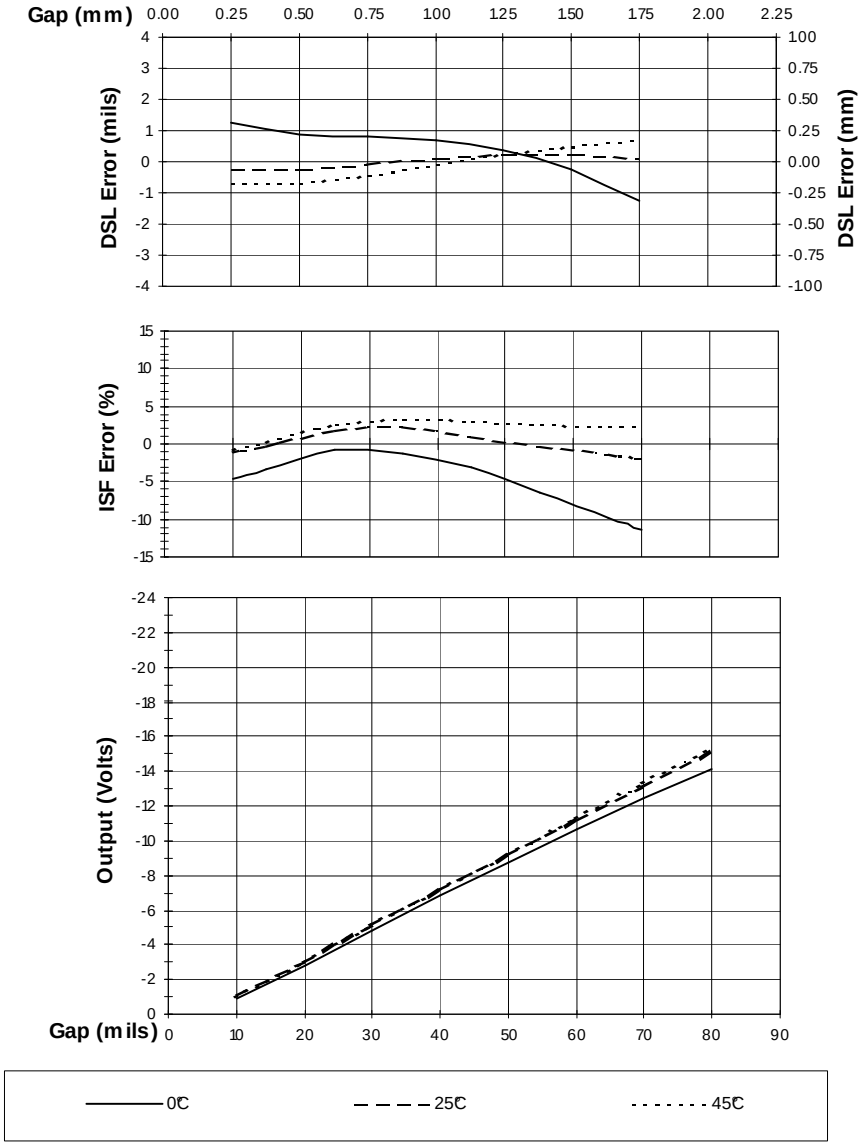


Figure 1 Typical 3300 XL NSv 5 m System over Ambient Temperature Range

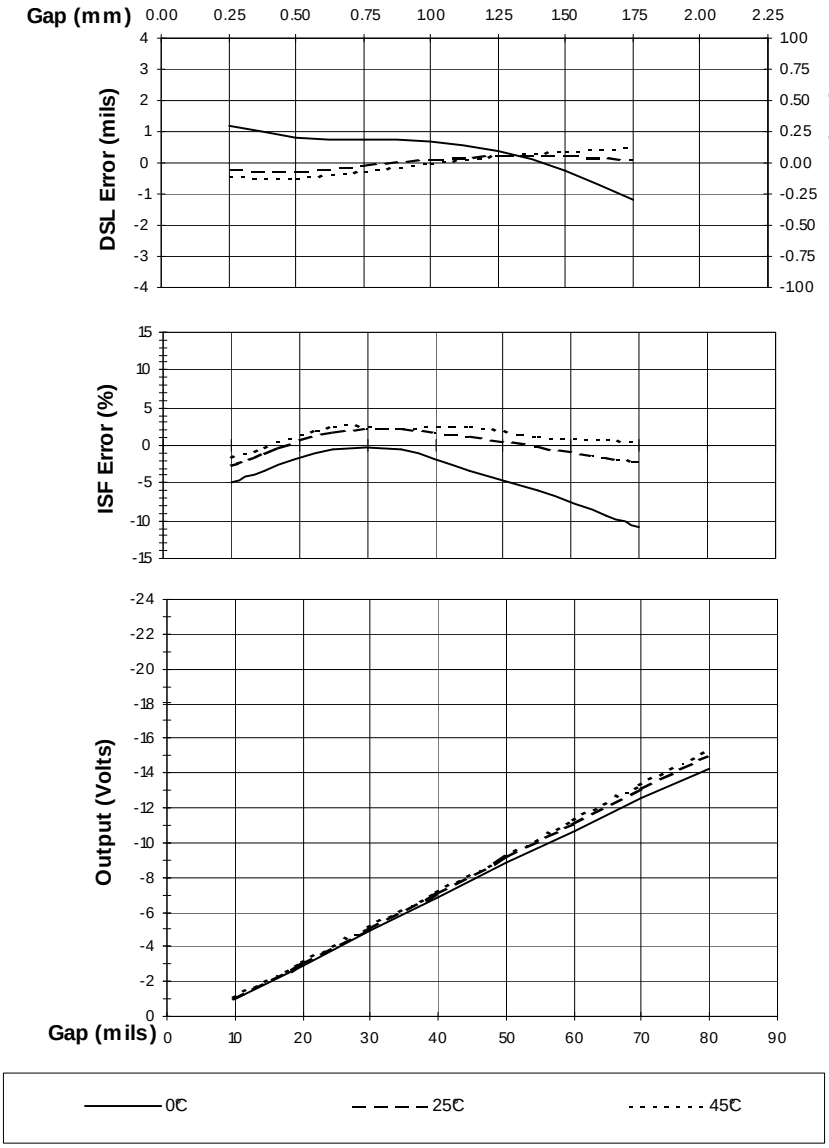


Figure 2 Typical 3300 XL NSv 7 m System over Ambient Temperature Range

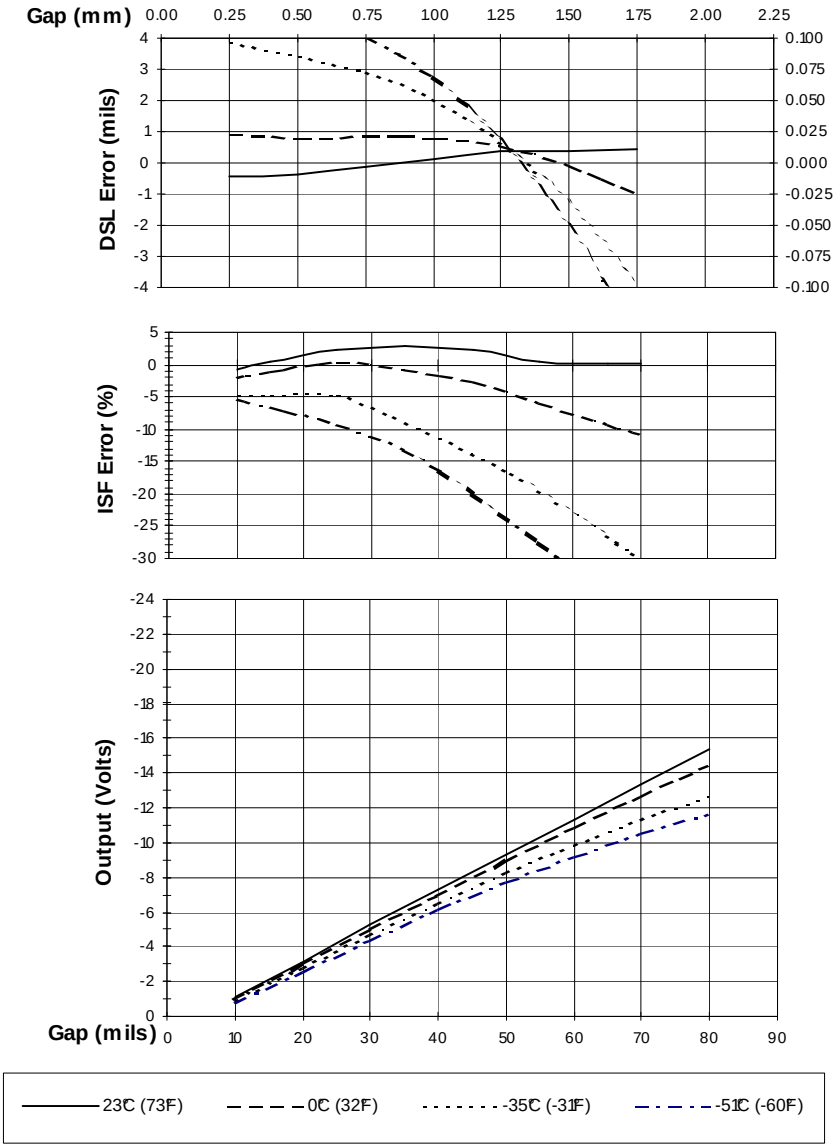


Figure 3 Typical 3300 NSv Probe + 1m Cable @ Low Temperature (Proximitor Sensor + 4m of Extension Cable @ 25 °C)

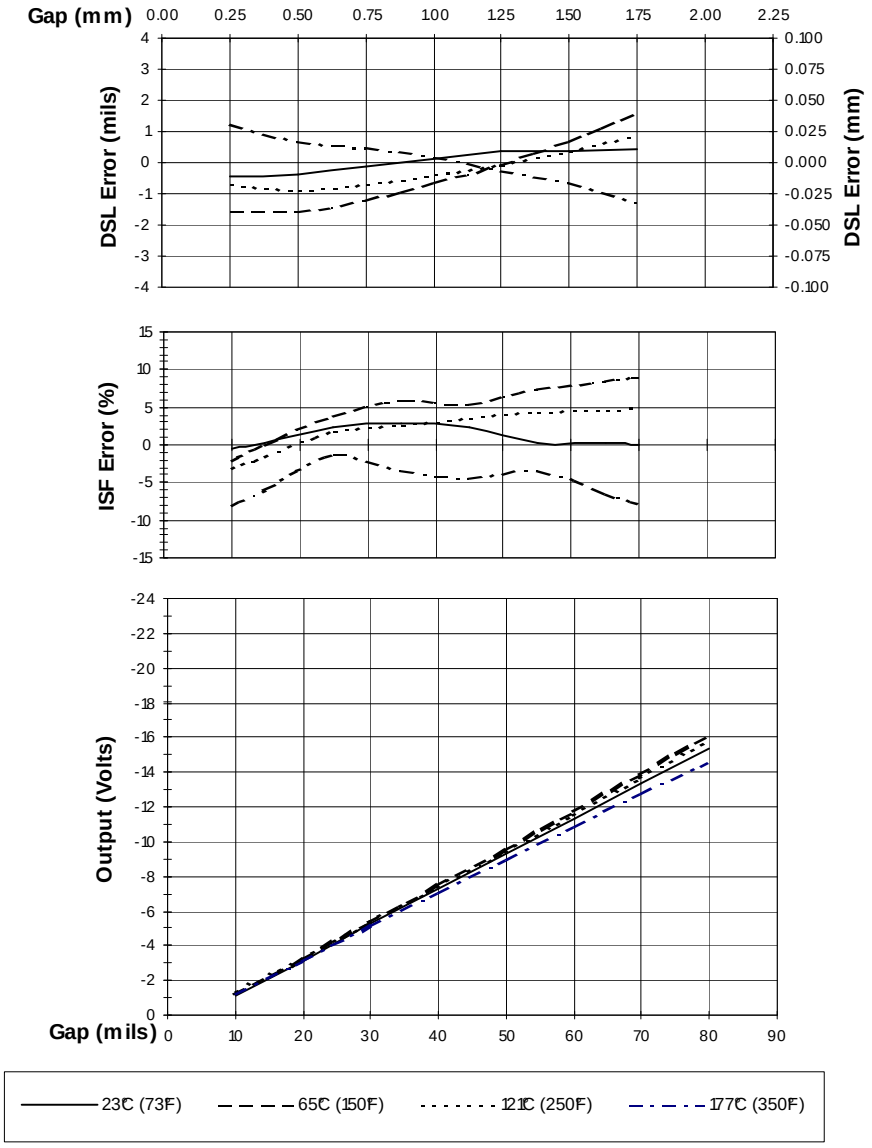


Figure 4 Typical 3300 NSv Probe + 1m Cable @ High Temperature (Proximitor Sensor + 4m of Extension Cable @ 25 °C)

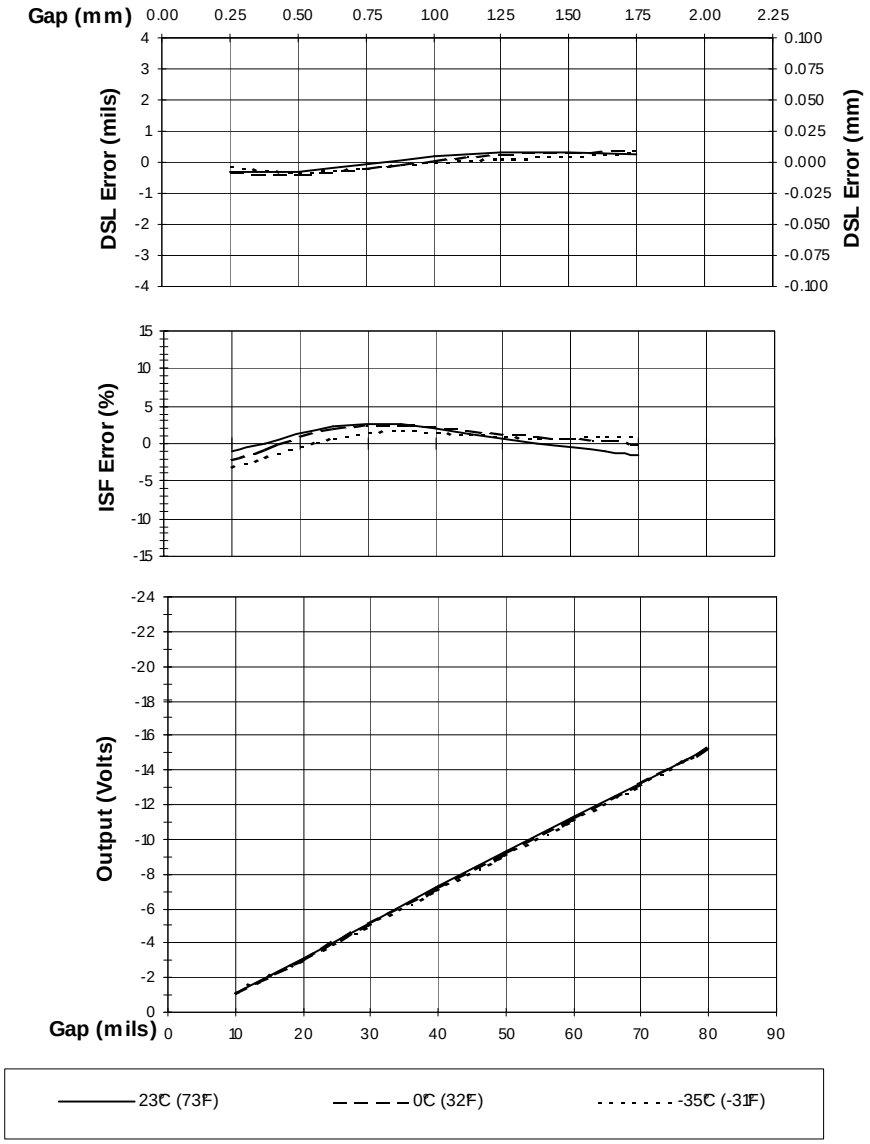


Figure 5 Typical 3300 XL NSv 5 m Proximitor Sensor with 4 m of Extension Cable @ Low Temperature (Probe is at 25°C)

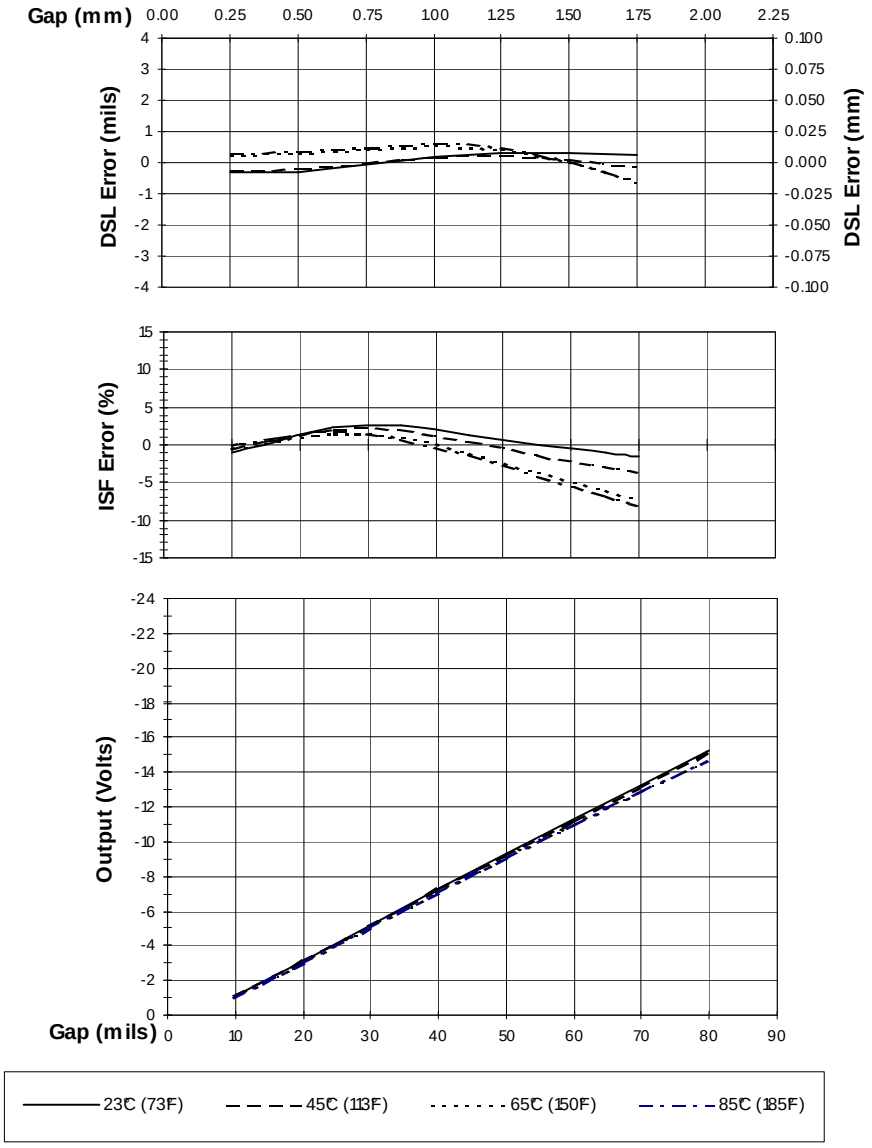


Figure 6 Typical 3300 XL NSv 5 m Proximitor Sensor with 4 m Extension Cable @ High Temperature (Probe is at 25°C)

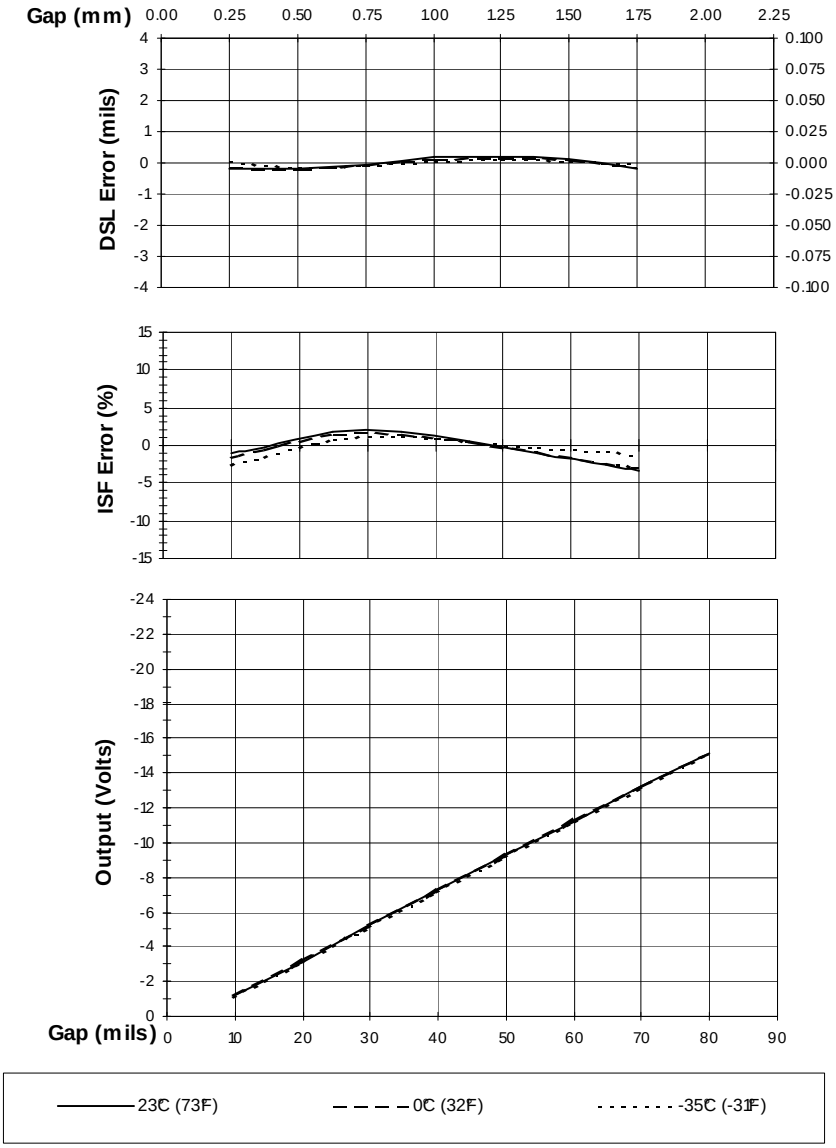


Figure 7 Typical 3300 XL NSv 7 m Proximitor Sensor with 6 m of Extension Cable @ Low Temperature (Probe is at 25°C)

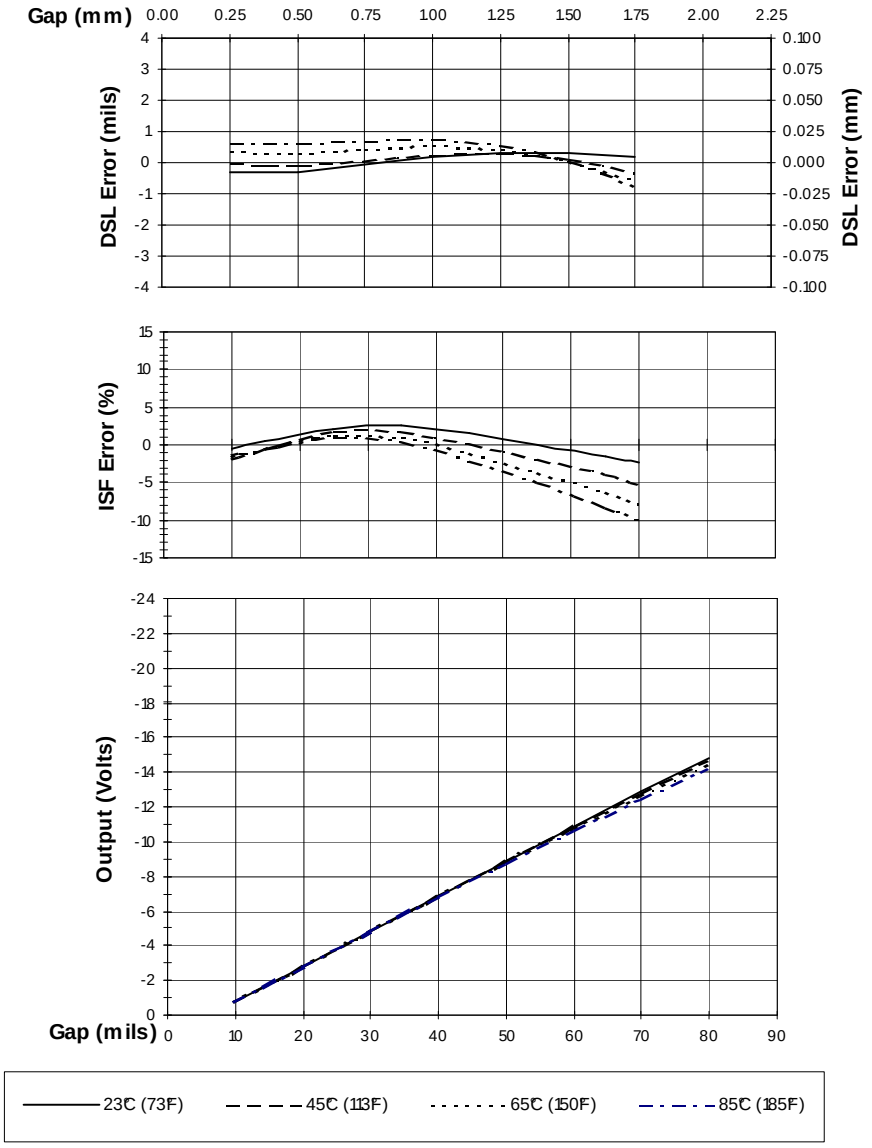


Figure 8 Typical 3300 XL NSv 7 m Proximitor Sensor with 6 m of Extension Cable @ High Temperature (Probe is at 25°C)

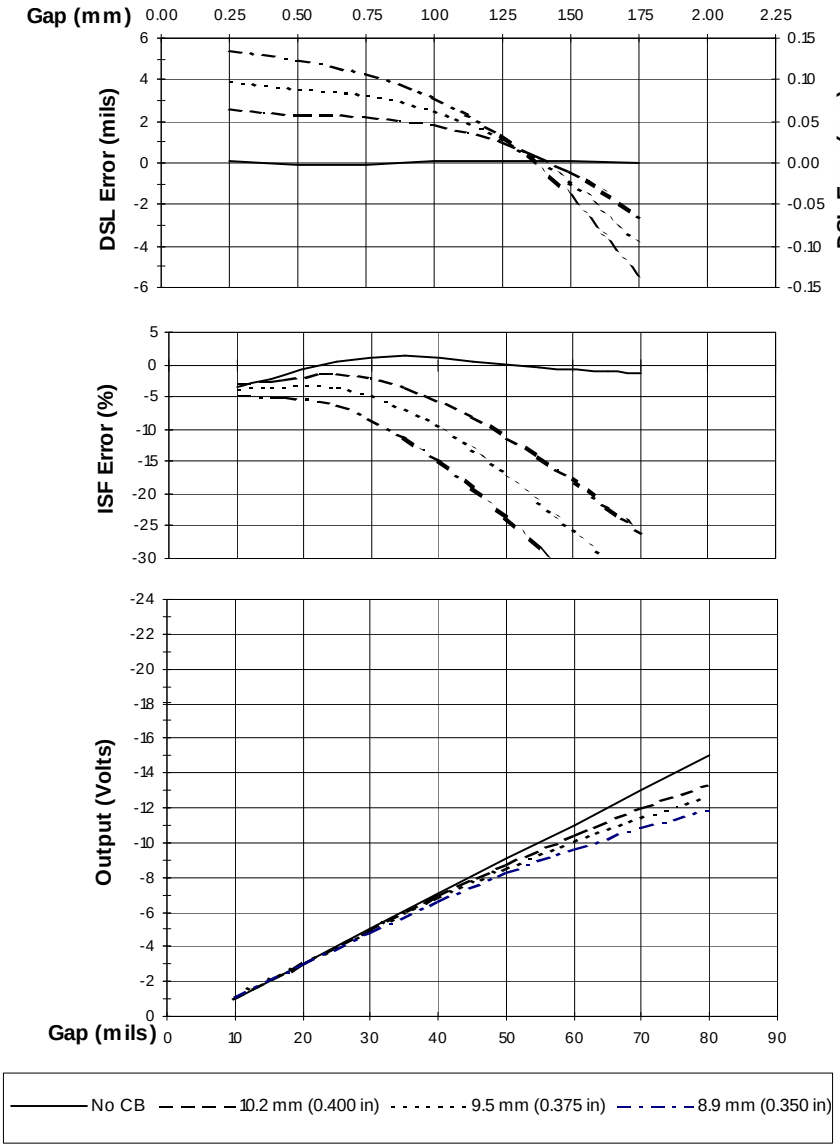


Figure 9 Effect of Counterbore Side Clearance (4140 Material)

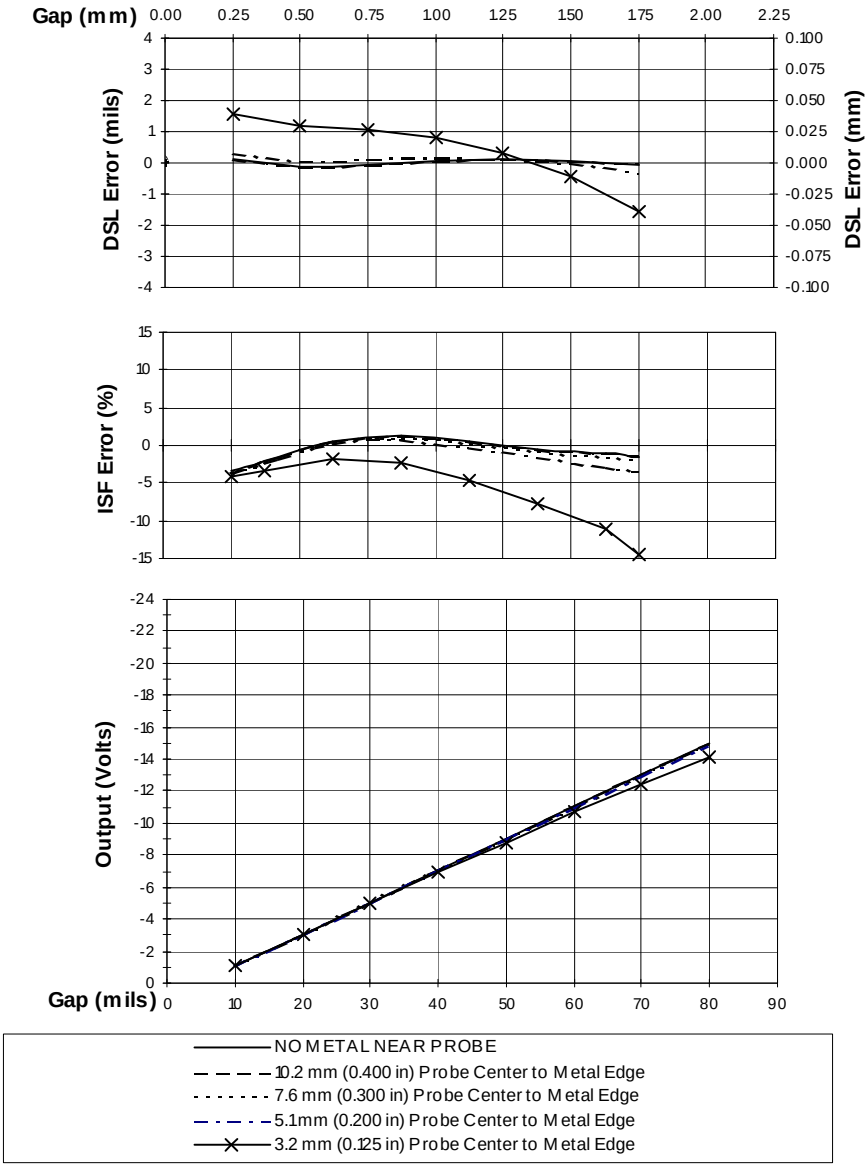


Figure 10 Effect of Flat Surface Side Clearance (4140 Material)

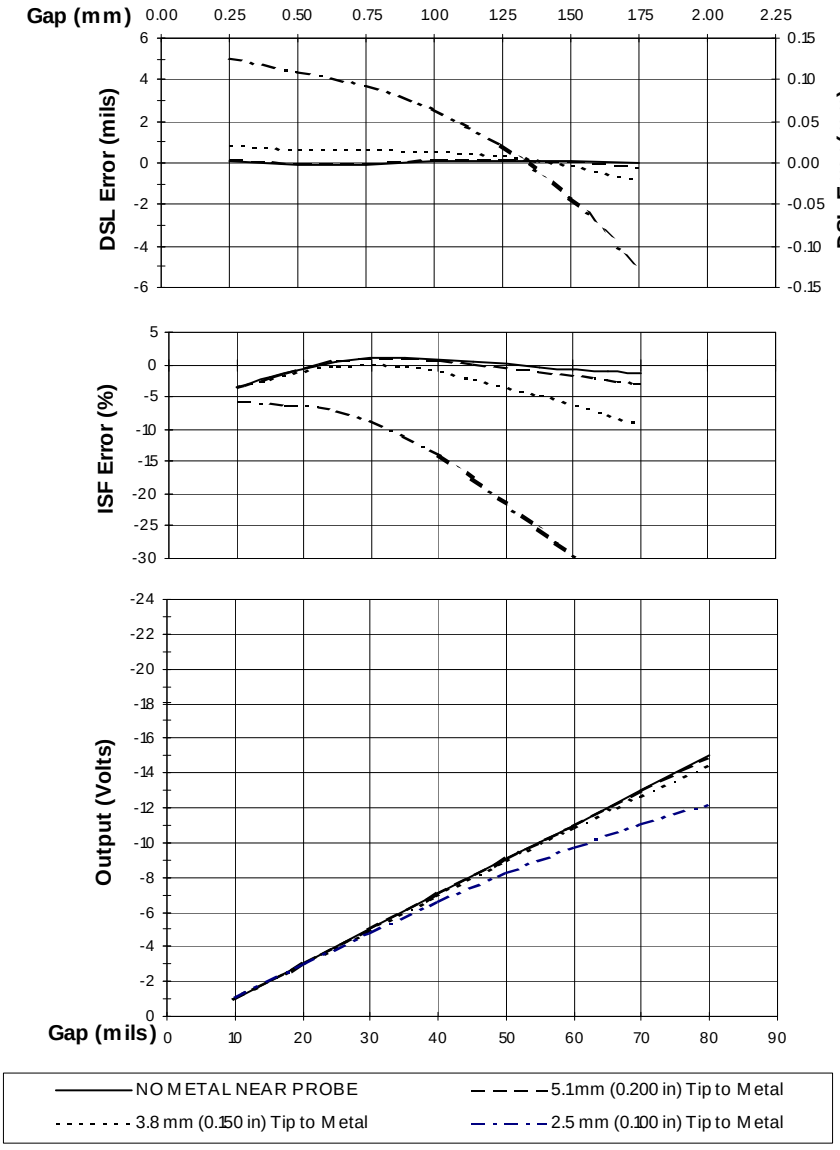


Figure 11 Effect of Rear Surface Clearance (4140 Material)

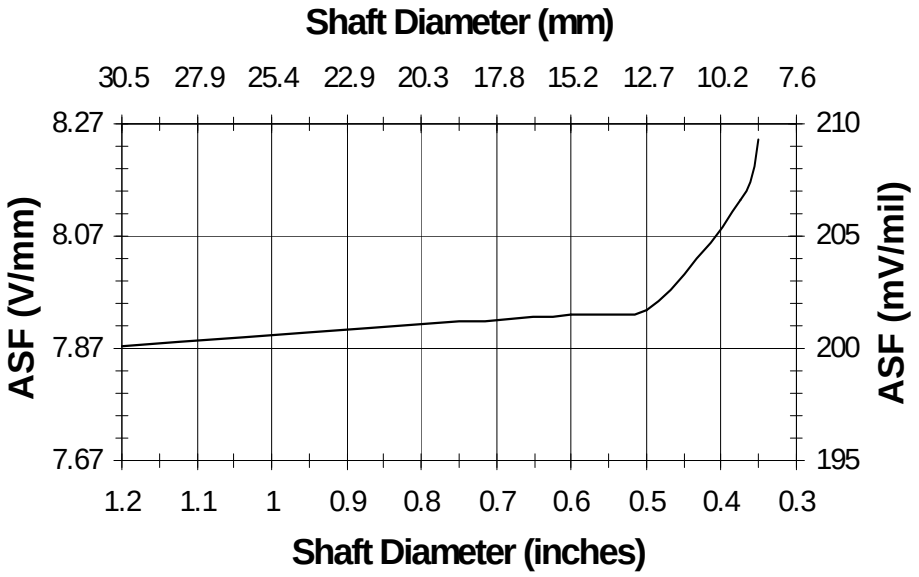


Figure 12 Axial Sensitivity to Shaft Size

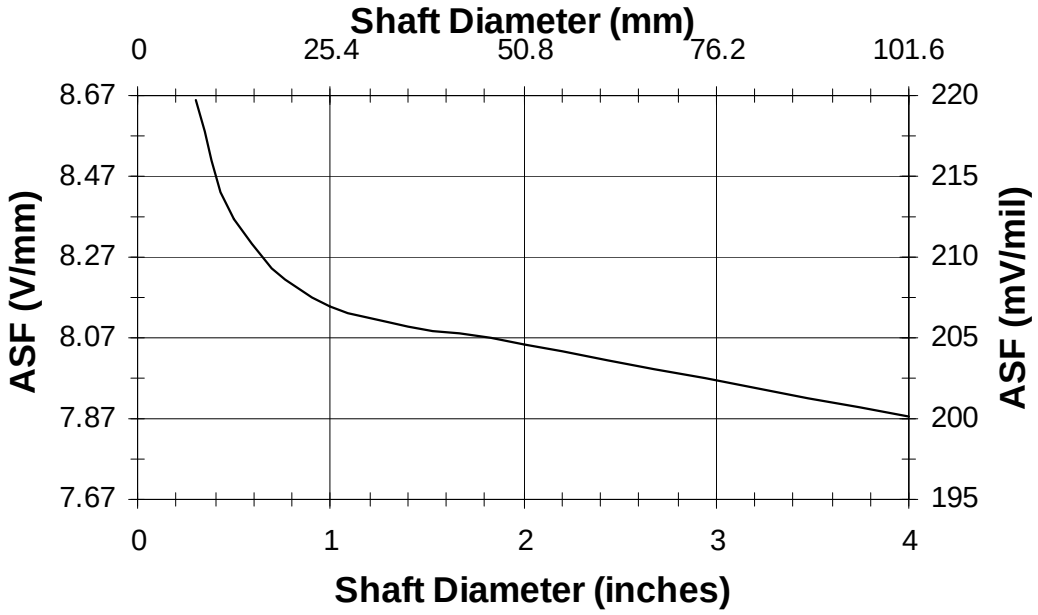


Figure 13 Radial Sensitivity to Shaft Size

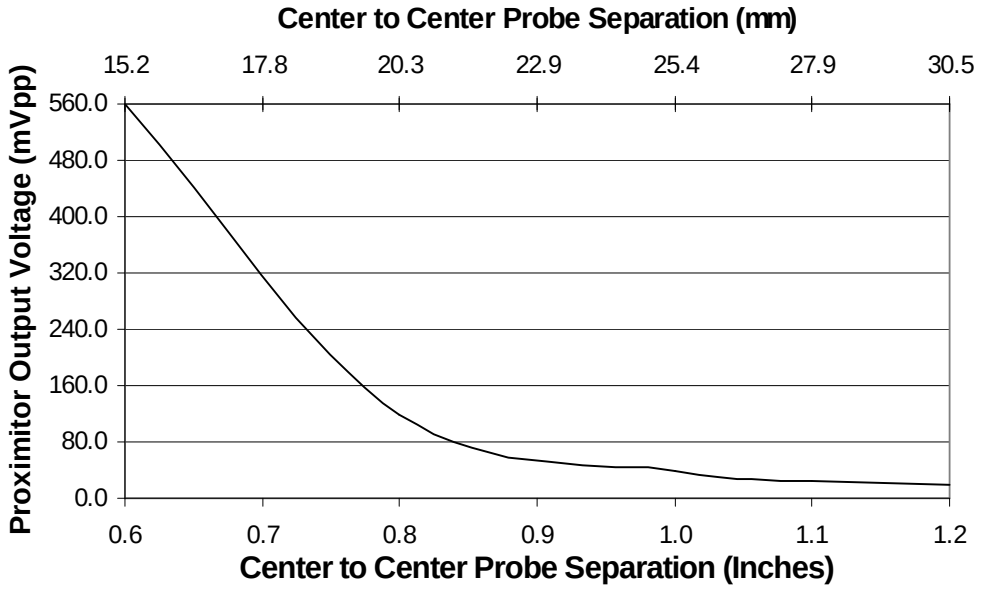


Figure 14 Probe Cross-talk with Probes Mounted in Parallel

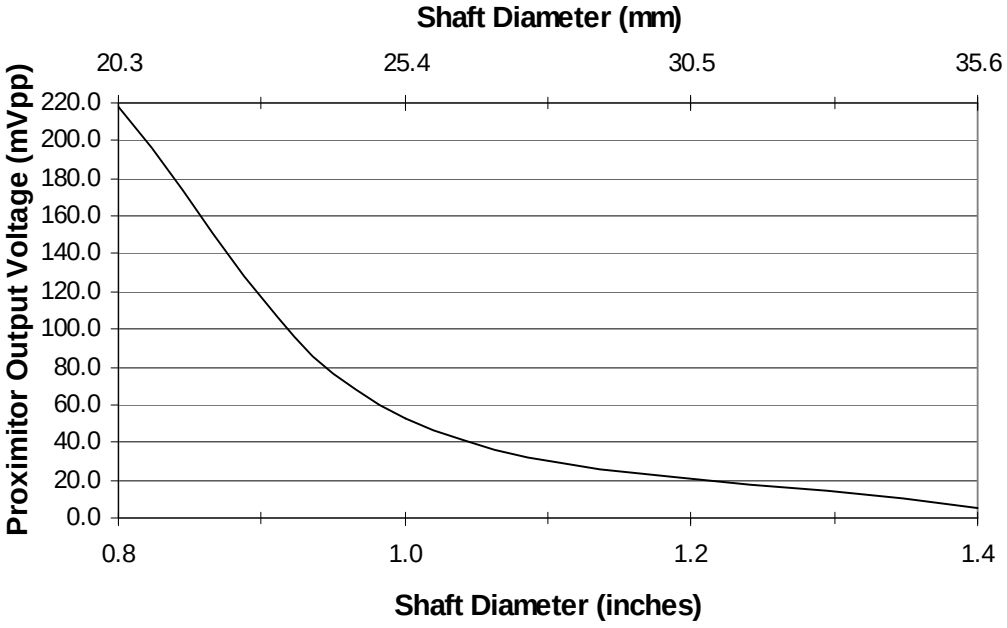


Figure 15 Probe Cross-talk with Probes Mounted in X-Y Configuration

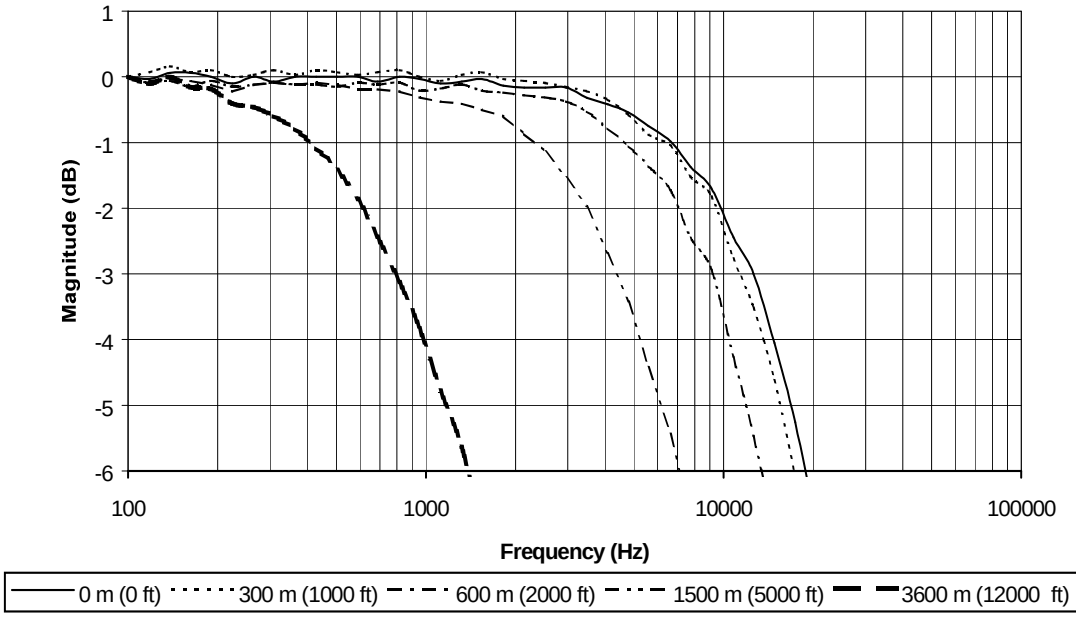


Figure 16 Frequency Response, magnitude of typical 3300 XL NSv System with various lengths of field wiring, no barriers

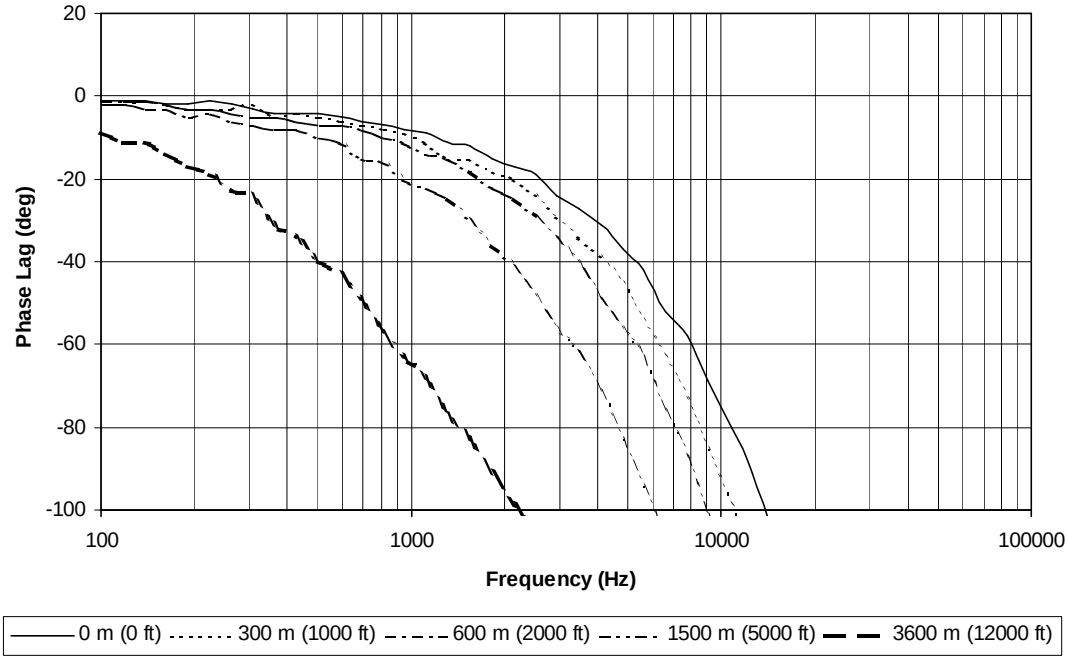


Figure 17 Frequency Response, phase change of typical 3300 XL NSv System with various lengths of field wiring, no barriers

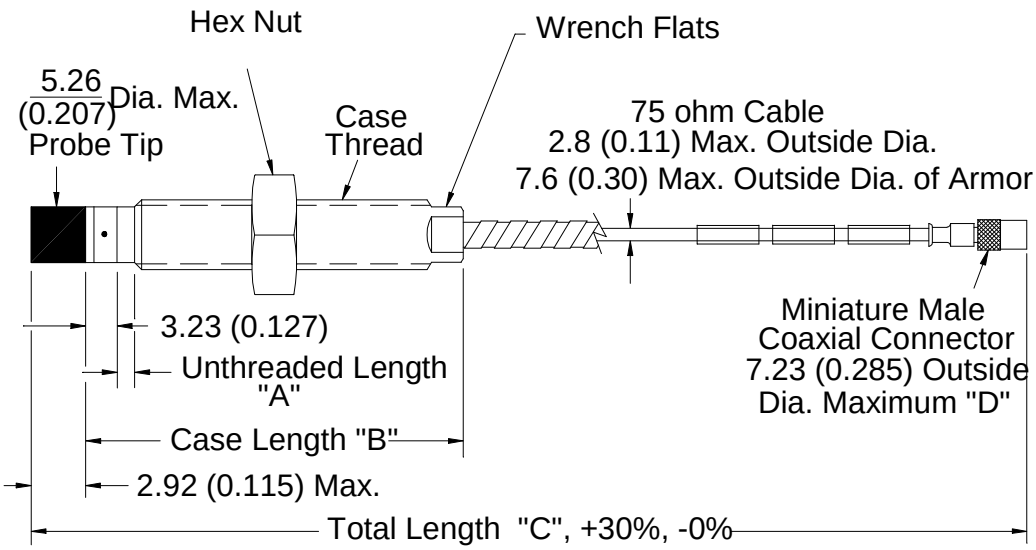


Figure 18 3300 NSv Proximity probes, Standard Mount

330901, ¼ -28 UNF-2A, without armor

330902, ¼ -28 UNF-2A, with armor

330903, M8x1 thread, without armor

330904, M8x1 thread, with armor

330905, M10x1 thread, without armor

330908, 3/8-24 UNF-2A, without armor

330909, 3/8-24 UNF 2A, with armor

330910, M10x1 thread, with armor

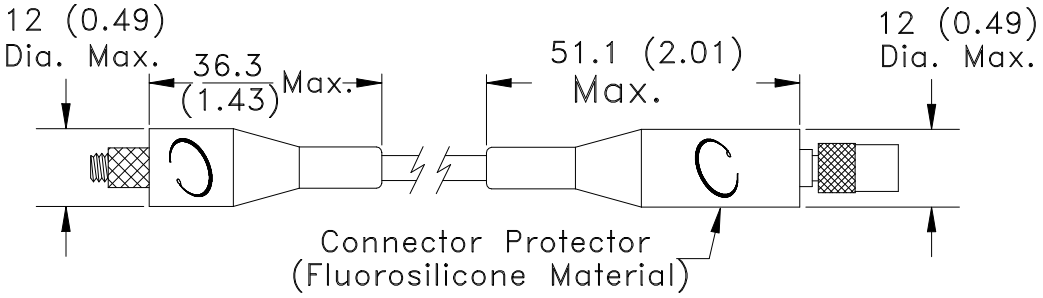


Figure 19 Installed Connector Protectors

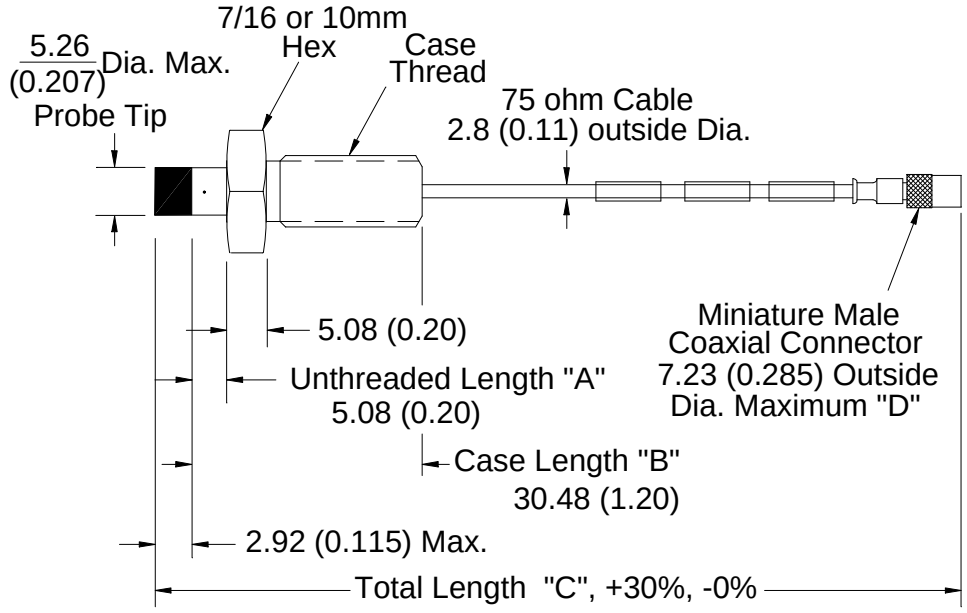


Figure 20 3300 NSv Proximity Probes, Reverse Mount

330906, 3/8-24 UNF-2A threads

330907, M10x1 threads

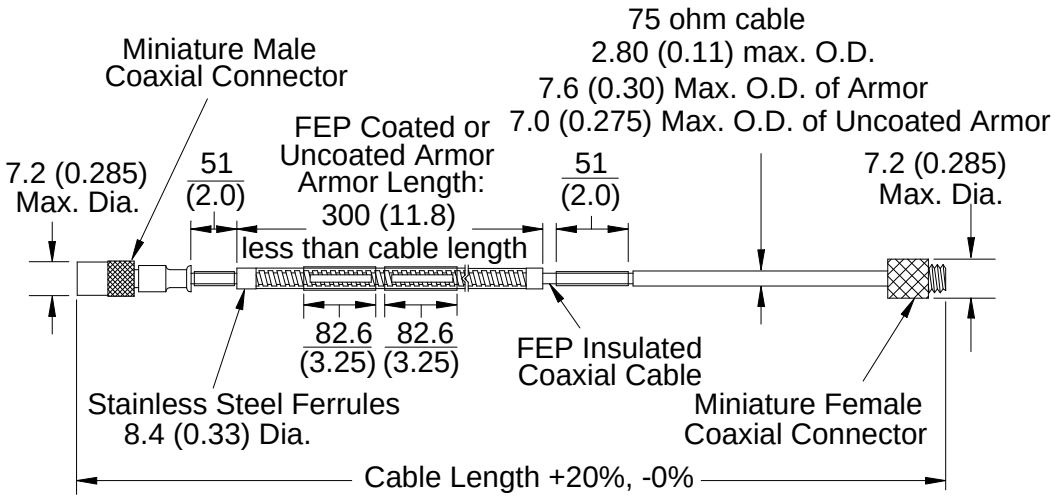


Figure 21 330930, 3300 NSv Extension Cable

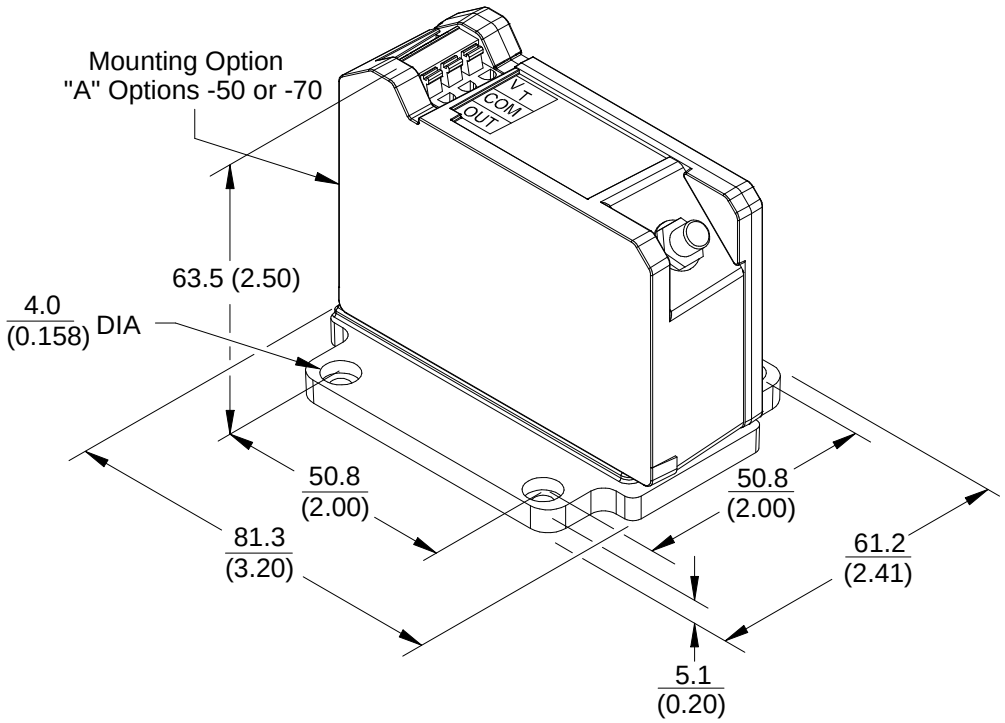


Figure 22 Panel Mount 3300 XL NSv Proximitor Sensor

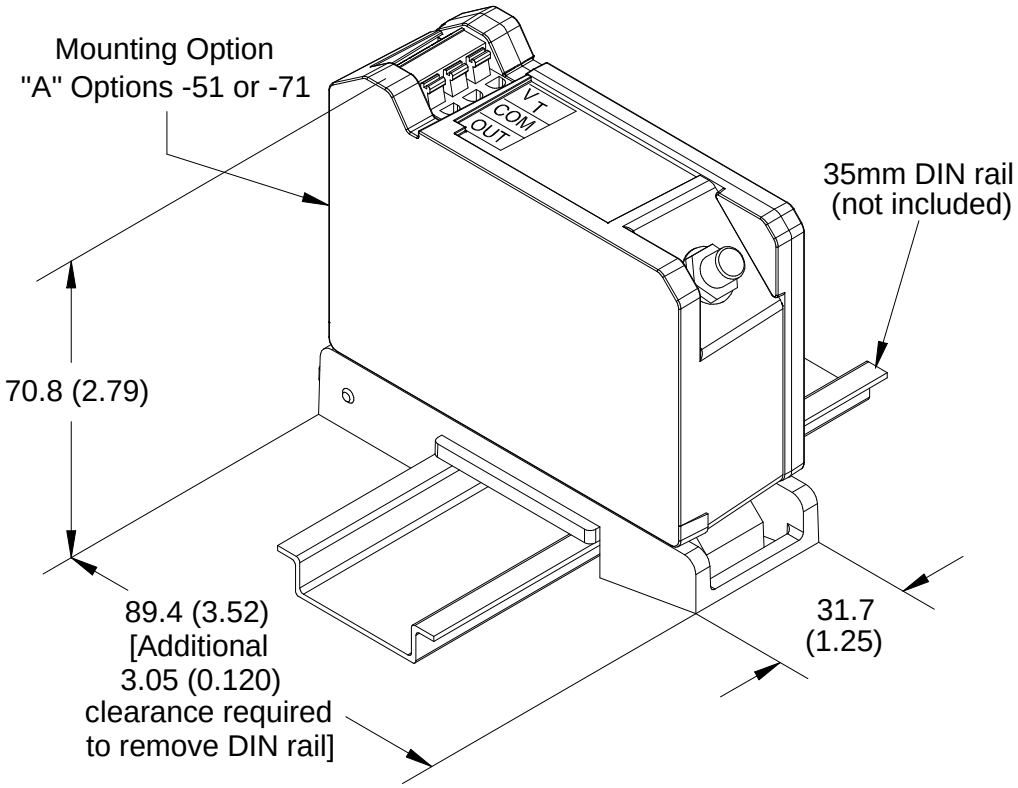


Figure 23 DIN Mount 3300 XL NSv Proximitor Sensor

Notes:

All dimensions on figures are in millimeters (inches) unless otherwise noted.

Standard mount ¼ -28 UNF thread probes are supplied with 7/16 inch lock nut and 7/32 wrench flats.

Standard mount M8x1 thread probes are supplied with 13 mm lock nut and 7 mm wrench flats.

Standard mount 3/8-24 UNF thread probes are supplied with 9/16 inch lock nut and 5/16 wrench flats.

Standard mount M10x1 thread probes are supplied with 17 mm lock nut and 8 mm wrench flats.

Reverse mount probes are not available with armor or connector protector options.

Letters inside quotation marks on figures refer to probe ordering options.

Stainless steel armor is supplied with or without FEP outer jacket.

FEP jacket is standard on all non-armored probes.

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Viton® is a trademark of DuPont.

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1631 Bently Parkway South, Minden, Nevada USA 89423
Phone: 775.782.3611 Fax: 775.215.2873
www.ge-mcs.com/bently

BONNEY FORGE

Forged Steel
Gate Valve
Class 800
Conventional Port
Threaded or Socket Weld ends
Bolted Bonnet, 13Cr/HF trim



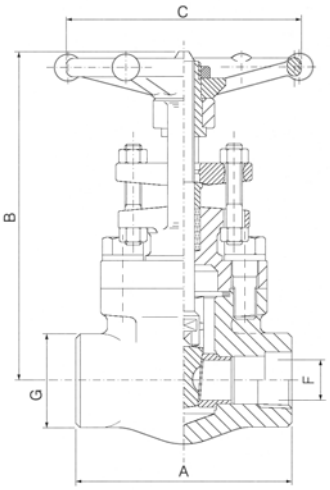


Fig. T8GAF

Design: ANSI B16.34, API 602
Testing: API 598
Meets MSS SP-25 Specifications
Threaded ends to: ASME B1.20.1
Socket weld ends to: ASME B16.11
Butt weld ends to: ASME B16.25

Materials:

No.	Part Name	Specification
1	Handwheel nut	Carbon Steel
2	Handwheel	Carbon Steel
3	Yoke Sleeve	AISI 416
4	Name Plate	Aluminum
5	Gland Nuts	ASTM A194 2H
6	Gland Flange	ASTM A105
7	Packing Gland	AISI 316
8	Bonnet	ASTM A105N
9	Gland Studs	ASTM A193 B6
10	B/B Bolts	ASTM A193 B7
11	Packing	Graphite
12	Stem	ASTM A479 410
13	B/B Gasket	F316L + Graphite
14	Wedge	ASTM A182 F6a
15	Seat Rings	ASTM A479 410 HF
16	Body	ASTM A105N

Rating:
Carbon Steel Class 800 - 1975 psig @ 100°F

Note:
The above figure number (T8GAF) designates a threaded valve. If a socket weld end is required, change the “T” to an “S” (S8GAF).

Other trims and body materials are available upon request.

Dimensions:

Size		A		B (open)		C		F		G		Weight	
in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg
½”	15	3.15	80	5.98	152	3.46	88	.38	9.6	1.26	32	4.25	1.9
¾”	20	3.54	90	6.22	158	3.46	88	.55	14	1.5	38	5	2.3
1"	25	4.33	110	7.72	196	3.82	97	.71	18	1.89	48	7.75	3.6
1½”	40	5	127	10.04	255	5.43	138	1.18	30	2.52	64	16	7.3
2"	50	5.28	134	11.42	290	5.43	138	1.48	36.5	3.07	78	16.75	7.6

BONNEY FORGE

Forged Steel
Globe Valve
Class 800
Conventional Port
Threaded or Socket Weld ends
Bolted Bonnet, 13Cr/HF trim



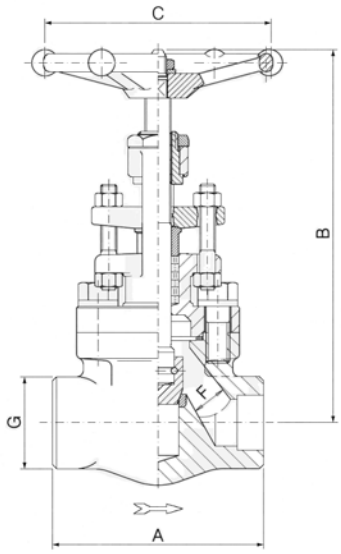


Fig. T8GLF

Design: ANSI B16.34, API 602
Testing: API 598
Meets MSS SP-25 Specifications
Threaded ends to: ASME B1.20.1
Socket weld ends to: ASME B16.11
Butt weld ends to: ASME B16.25

Materials:

No.	Part Name	Specification
1	Handwheel nut	Carbon Steel
2	Handwheel	Carbon Steel
3	Yoke Sleeve	AISI 416
4	Name Plate	Aluminum
5	Gland Nuts	ASTM A194 2H
6	Gland Flange	ASTM A105
7	Packing Gland	AISI 316
8	Bonnet	ASTM A105N
9	Gland Studs	ASTM A193 B6
10	B/B Bolts	ASTM A193 B7
11	Packing	Graphite
12	Stem	ASTM A479 410
13	B/B Gasket	F316L + Graphite
14	Wedge	ASTM A182 F6a
15	Seat Rings	ASTM A479 410 HF
16	Body	ASTM A105N

Rating:
Carbon Steel Class 800 - 1975 psig @ 100°F

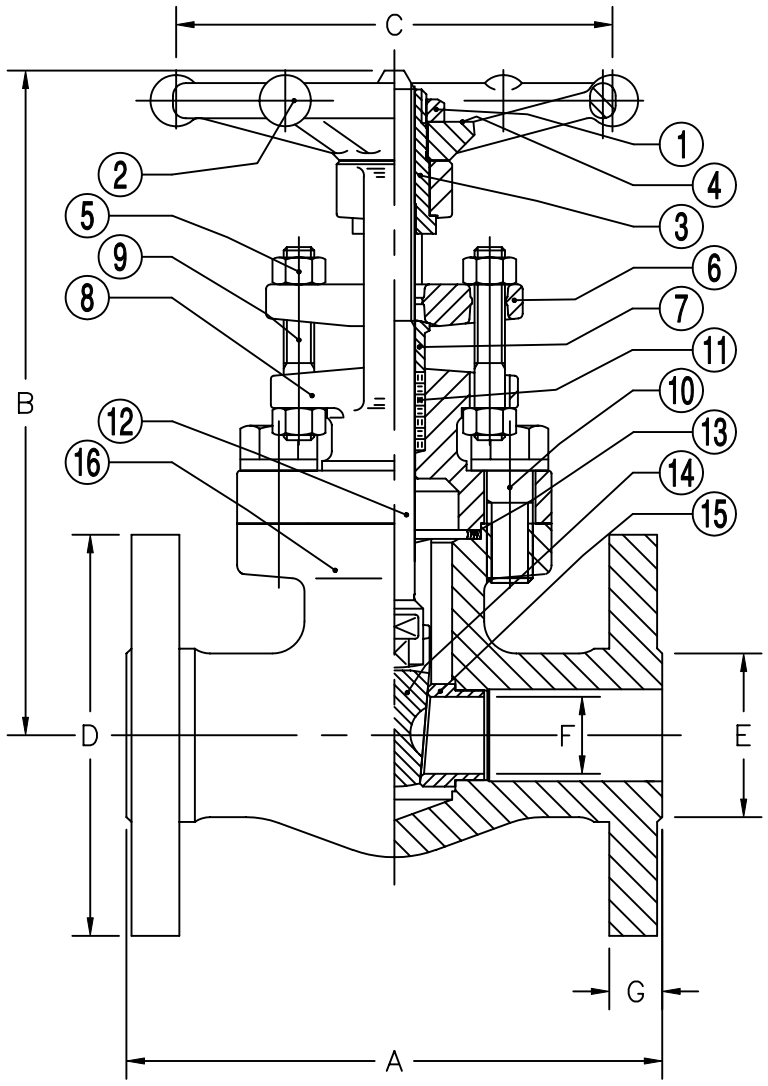
Note:

The above figure number (T8GLF) designates a threaded valve. If a socket weld end is required, change the “T” to an “S” (S8GLF).

Other trims and body materials are available upon request.

Dimensions:

Size		A		B (open)		C		F		G		Weight	
in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg
½”	15	3.15	80	6.54	166	3.46	88	.35	9	1.26	32	4.5	2.1
¾”	20	3.54	90	6.73	171	3.46	88	.51	13	1.5	38	5.0	2.3
1"	25	4.33	110	8.39	213	3.82	97	.69	17.5	1.89	48	8.0	3.7
1½”	40	6	150	10.16	258	5.42	138	1.16	29.5	2.52	64	16.25	7.4
2"	50	7.09	180	11.81	300	6.77	172	1.38	35	3.07	78	26.25	11.9



IT.	DESCRIPTION	MATERIAL
1	HANDWHEEL NUT	CARBON STEEL
2	HANDWHEEL	CARBON STEEL
3	YOKE SLEEVE	AISI–416
4	NAME PLATE	ALUMINUM
5	GLAND NUTS	A194–2H
6	GLAND FLANGE	A105
7	PACKING GLAND	AISI–410
8	BONNET	A105N
9	GLAND STUDS	AISI–410
10	B/B BOLTS	A193–B7
11	PACKING	GRAPHITE
12	STEM	AISI–410
13	B/B GASKET	316L + GRAPHITE
14	WEDGE	AISI–410
15	SEAT RINGS	AISI–410 + STELLITE
16	BODY	A105N

(125–250 AARH)
SERRATED SPIRAL FINISH

DIMENSION \ VALVE SIZE	1/2	3/4	1	1 1/2	2			
A	5 1/2	6	6 1/2	7 1/2	8 1/2			
B open	6 13/16	7 3/16	8 3/8	10	11 7/16			
C	3 7/16	3 7/16	3 13/16	5 7/16	5 7/16			
D	3 3/4	4 5/8	4 7/8	6 1/8	6 1/2			
E	1 3/8	1 11/16	2	2 7/8	3 5/8			
F	.378	.551	.709	1.181	1.441			
G	9/16	5/8	11/16	13/16	7/8			
ITEM#								
APPROX. WT.	8	12	15 1/4	27 1/2	33 3/4			

CUSTOMER:
P.O. NUMBER:
TAG NUMBER:
JOB NUMBER:
BB/TRIM: A105N / 13% CR.

BONNEY FORGE
U.S. ROUTE 522 SOUTH
P.O. BOX 330
MOUNT UNION, PA 17066

ABS Quality Evaluations, Inc. ★ Quality Assurance Certification ★
ISO 9001
Certificate Number: 30116

GATE VALVE B.B. OS & Y
INTEGRAL FLANGED ENDS
1/2" to 2" CL.300# RED. BORE

REV	DESCRIPTION	DATE	BY

REVISIONS

DR. BSG | DATE 10-29-98
APPD. GW | SCALE NONE
DRAWING NO. L3-11-RF
REV. 0

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR TYPE CX & DX – IMMERSION HEATERS

ISO 9001:2000 QMI REGISTERED Certificate No. 003640

CAUTION

ELECTRIC SHOCK HAZARD. All electric heating equipment installations must be performed by qualified personnel in accordance with the local electrical codes and standards and must be effectively grounded to eliminate shock hazard.

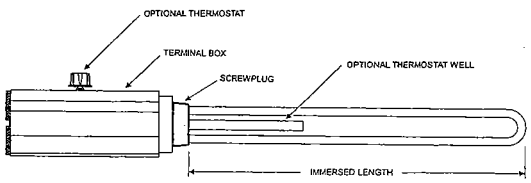
WARNING

FIRE/EXPLOSION HAZARD. Do not exceed the ratings of the flange as listed in ANSI B16.5. Do not operate the heater in the presence of combustible gases, vapours, dusts or fibres unless the heater is specifically marked for the hazardous location and heater operating temperature does not exceed the temperature code rating. Corrosion of the sheath could result in a ground fault which, depending upon the fluid being heated, could cause a fire or an explosion.

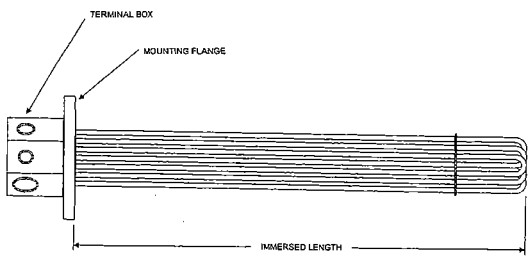
FIRE HAZARD. If a thermostat is provided, it is designed for temperature control service only. Since the thermostat does not fail safe, it should not be used for temperature limiting duty. Wiring to this device is the users responsibility.

Heaters are capable of developing high temperatures, therefore extreme care should be taken to:

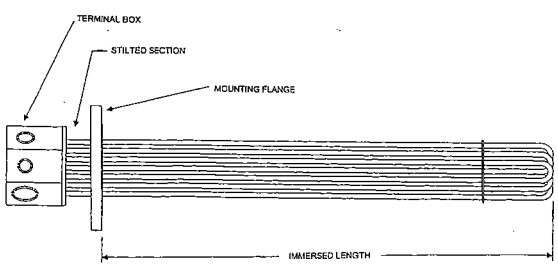
a) use explosion-proof terminal enclosures in hazardous locations;
b) maintain distance between heater and combustible materials.



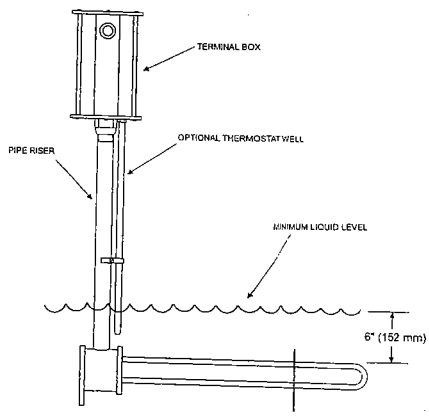
SCREWPLUG IMMERSION HEATER



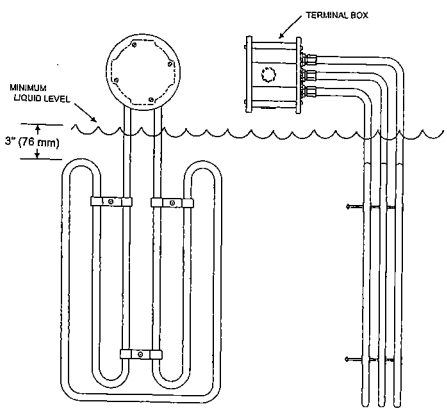
FLANGE IMMERSION HEATER



FLANGE IMMERSION HEATER
(WITH OPTIONAL STILTED TERMINAL BOX)



OVER-THE-SIDE IMMERSION HEATER (BOTTOM MOUNT)



OVER-THE-SIDE IMMERSION HEATER (SIDE MOUNT)

DESCRIPTION

1.0 Immersion heaters for liquid service are designed for operation only while completely immersed in liquids. Never allow the heating elements to be exposed while energized or failure will result.



Use the heater only in liquids and at pressures for which it was designed (unless specifically designed for non-liquid applications). Normally copper sheath is recommended in water, steel or alloy sheath in oil, and the appropriate alloy sheath for heating chemical solutions. Check factory for recommendations.

2.0 In the case of flanged (and some screwplug type) heaters where a gasket seal is required, the gasket surface should be clean and dry before the heater is seated.



DO NOT insulate over the heater flange, stilted area and terminal enclosure.

3.0 The terminals must be protected at all times from moisture or vapour. In hazardous locations, explosion resistant terminal housings must be used. In outdoor locations, moisture resistant housings are required. It is recommended to use a drip loop to prevent moisture from entering the terminal box via the wire.

4.0 Protect terminals of heating elements from drippings, condensation, fumes, spray or any other substance which could result in element contamination.

5.0 When melting solids by direct immersion, a surface vent should be provided to allow gases to escape. Operate the heater on ½ voltage until melted material completely covers the heating elements. Heaters used for this purpose may require special design features. Check factory for recommendations.

INSTALLATION



Heaters with overtemperature devices require specific installation orientation.



ELECTRIC SHOCK HAZARD. Disconnect all power before installing or servicing the heater. Failure to do so could result in personal injury and/or property damage. All maintenance and installation should be done by qualified personnel in compliance with local codes.



FIRE OR SHOCK HAZARD: Moisture accumulation on the dielectric material of the elements sheath corrosion or overtemperature on the heaters could cause a fault to ground generating arcing and molten metal. Install proper ground fault protections to prevent personal injury or property damage.



Heaters are electrical components, designers are responsible for the proper integration to the electrical systems, including protections, back-ups and controls.

6.0 Unpack and check heater for any damage that may have been caused during shipping.

7.0 Remove any protective packaging in the screw or flange connecting fitting.

8.0 Remove any dessicant material in the electrical box.

9.0 Insert heater into vessel/reservoir and verify that the heating elements are not making contact with the surface of the vessel.

10.0 Check that all terminal connections are tight.



Use copper conductors only with sufficient current carrying capacity for the heater circuit load and in accordance with the local electrical code. Check the heater nameplate for minimum conductor temperature rating. Temperature deration factors must be applied for heaters operating above 30°C(86°F).

11.0 Check supply voltage for compliance with heater nameplate voltage. DO NOT connect the heater to a voltage source other than listed on the heater nameplate.

12.0 A line voltage or pilot duty thermostat should be used to control the heater. The pilot duty thermostat must be used with a contactor and (if required) a transformer. Generally, heaters supplied with built-in thermostats will be factory prewired if suitable for line voltage operation. Integral thermostats not factory prewired are usually intended for pilot duty.

13.0 It is recommended that the control circuits be supplied from the isolated secondary windings of transformers avoiding the need for two supply circuits, or as an alternative, that mechanical or electrical interlocking be provided so that both supplies must be disconnected before live parts can be made accessible.

14.0 If there is even the slightest possibility that the liquid level may fall below the elements, a level control switch or over-temperature sensing device affixed to the uppermost heating element is required. Check factory for recommendations.

15.0 If the heater is installed in a pressurized system, a safety relief valve must be used to prevent a hazardous pressure build-up.

16.0 Horizontal element support bundles may be necessary with an immersed length over 1270 mm (50").

17.0 For flange heaters installed in a pressurized system, proper bolting hardware must be used that is suitable for the pressures and temperatures of the equipment. Use an appropriate gasket for the pressure and temperature; torque the bolts on an even clockwise or counter clockwise pattern.

18.0 Heaters with explosion resistant terminal housings must only be used in locations for which the heaters are certified.

a) Check heater nameplate information for approval code.
b) Never energize an explosion resistant heater unless the terminal housing cover is properly tightened.
c) An immersion heater for hazardous locations is approved for use only if an approved liquid level control and/or temperature limiting device is used to de-energize the heater under low liquid conditions.

OPERATION


CAUTION

RISK OF EXPLOSION. Do not operate heater at voltages higher than the rating specified on the nameplate. Failure to do this will cause elevated temperatures.


WARNING

For metal sheathed heaters, prior to operation an insulation resistance check must be performed. Heater with values less than .5 MΩ should follow a drying process. Please contact factory for details on procedure if heater is under .5 MΩ.


WARNING

FIRE HAZARD. Heater should be submersed in the fluid for proper operation and to avoid element overheating that could result in fire or damage of the heater.


WARNING

When operating the heaters in a closed system or vessel, system designers must ensure that proper controls are used to maintain the temperature and pressure at normal levels.


WARNING

Low megohm on heating elements with epoxy or hermetic seals cannot be serviced in the field. Typical resistance values when sealed are 1000 MΩ or greater.

19.0 Check that all connections are tight.

20.0 If a thermostat is provided, verify that it is operating properly by cycling it and verifying cutout.

21.0 Perform an IR test prior to energization and verify that levels are acceptable 500,000 ohms.

22.0 Energize the heater and check for signs of hotspots in the electrical connections or vessel.

23.0 Retorque all bolted fitting connections and all electrical connections after 10 cycles.

24.0 Always maintain a minimum of 51 mm (2") of liquid above the heated portion of the element or element failure may result.

25.0 Heating elements should be kept above sediment deposits or it may overheat and shorten life expectancy.

MAINTENANCE


WARNING

Disconnect all power before installing or servicing the heater. Failure to do so could result in personal injury and/or property damage. All maintenance and installation should be done by qualified personnel in compliance with local codes.

26.0 Heaters stored for prolonged periods may absorb moisture. Using a 500VDC megger (insulation resistance tester) check the value of the insulation resistance to ground for each circuit. Initial readings of over 500,000 ohms to ground are normally acceptable. Should lower readings be observed, check factory for instructions.

27.0 Periodically check electrical connections for tightness and check wire insulation for any damage and replace if necessary.

28.0 Remove the immersion heater periodically to inspect for corrosion, sludge build-up and for scale removal. Do not continue to use a heater showing visible signs of damage.

WARRANTY & LIMITATION OF LIABILITY

CCI Thermal Technologies Inc. warrants to the purchaser of each new product that any part thereof which proves to be defective in material or workmanship under normal use within 18 months of the date of shipment or 12 months from the date of start of operation (whichever occurs first) will be repaired or replaced without charge. Any such defect should be brought to the attention of the company's office from which the product was purchased, which is authorized to furnish or replacement within the terms of this warranty.

The Company will not be responsible for any expenses incurred in installation, removal from service, transportation cost, or damages of any type whatsoever, including incidental or consequential damages.

Since we cannot anticipate or control the condition under which our products may be used, we accept no responsibility for the safety and suitability of our products when used alone or in combination with other products. Tests for safety and suitability of the products should be done by the user.

This warranty will not apply if, in the judgement of the Company damage or failure has resulted from accident, alteration, misuse, abuse or operation on an incorrect power supply. The foregoing is in lieu of other warranties expressed or implied. CCI Thermal Technologies Inc. neither assumes no authorizes any person to assume for it any other obligation, during transportation, installation and operation or liability in connection with the said product.

Since the paint finish may be damaged in use, no warranty applies to such paint finish except for manufacturing defects which become apparent within 30 days from date of installation.

Heaters are not guaranteed against damage caused by corrosion.

CCI Thermal Technologies INC.
A Leader in Advanced Heating Solutions

INSTRUCTIONS D'INSTALLATION, DE FONCTIONNEMENT ET D'ENTRETIEN DES THERMOPLONGEURS MODELÈS CX ET DX

ISO 9001:2000
QMI REGISTERED
Certificate No. 003640

MISE EN GARDE

RISQUE D'ÉLECTROCUTION. Toutes les installation d'équipment électrique de chauffage doivent être réalisées par un personnel qualifié, conformément aux codes et normes électriques locaux, et doivent être dûment mises à la terre afin de suppreimer les risques d'électrocution.

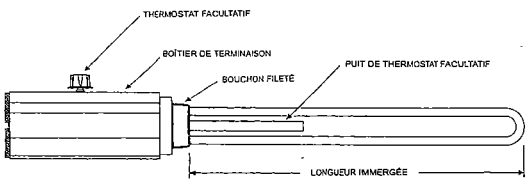
ATTENTION

RISQUE D'INCENDIE ET D'EXPLOSION. Ne depassez pas les puissances nominales de la bride figurant dans la norme B16.5 ANSI. Ne faites pas fonctionner le thermoplongeur en presence de gaz combustibles, de vapeurs combustibles, de poussieres combustibles ou de fibres combustibles, a moins que le thermoplongeur ne soit specialement prevu pour un tel emplacement dangereux, et que la temperature de fonctionnement du thermoplongeur ne depasse pas le code de temperature. La corrosion de la gaine peut resulter en un defaut a la terre, qui, selon la nature du liquide en cours de rechauffement, pourrait causer un incendie ou une explosion.

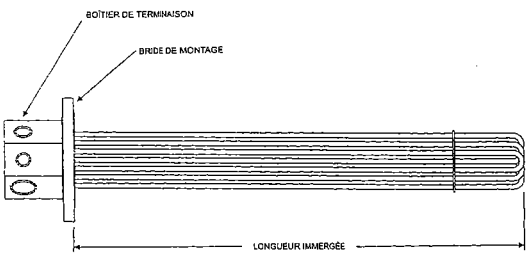
RISQUE D'ICENDIE. Si un thermostat est fourni, il est conçu uniquement à des fins de contrôle de la température. Puisque le thermostat ne dispose daucun système le protégeant des défaillances, il ne faut pas s'en servir pour limiter la température. C'est à l'utilisateur qu'il revient d'effectuer le câblage de ce dispositif.

Les thermoplongeurs peuvent atteindre des températures élevées, c'est pourquoi il faut faire extrêmement attention de prendre les mesures suivantes:

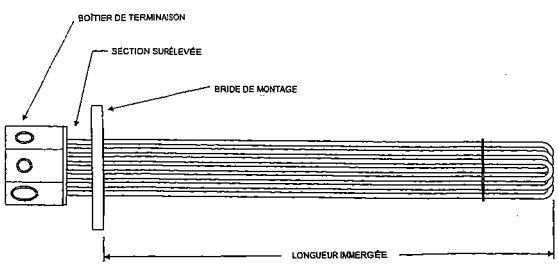
a) se servir de boîtiers de terminaison antidéflagrants dans les lieux à risques,
b) conserver une certaine distance entre le thermoplongeur et les matières combustibles.



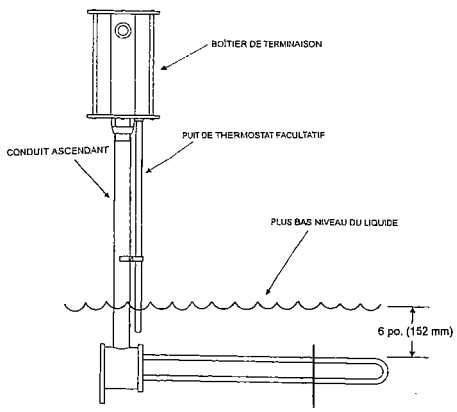
THERMOPLONGEUR À BOUCHON FILETÉ



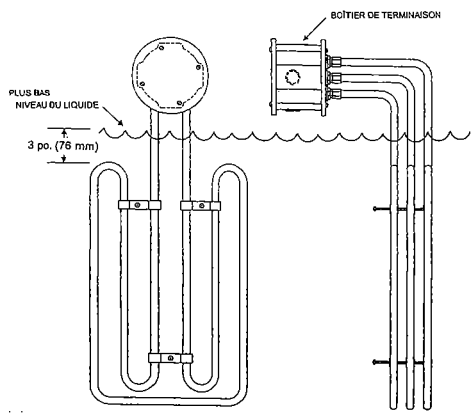
THERMOPLONGEUR À BRIDE



THERMOPLONGEUR À BRIDE
(AVEC BOÎTIER DE TERMINAISON SURÉLEVÉE FACULTATIF)



THERMOPLONGEUR AMOVIBLES POUR MONTAGE DE FOND



THERMOPLONGEUR AMOVIBLES POUR MONTAGE LATÉRAL

DÉSCRIPTION

1.0 Les thermoplongeurs employés pour des liquides sont conçus pour ne fonctionner que s'ils sont complètement immergés dans des liquides. Ne laissez jamais les éléments chauffants à l'air libre tandis qu'ils fonctionnent, sans quoi une panne se produira.



Ne vous servez du thermoplongeur que dans des liquides, et à des pressions pour lesquelles il a été conçu (à moins qu'il n'ait été conçu particulièrement pour des applications non liquides). Normalement, la gaine en cuivre est recommandée dans l'eau, la gaine en acier ou en alliage dans l'huile, et la gaine en alliage appropriée sert à chauffer les solutions chimiques. Demandez à l'usine de vous donner ses recommandations.

2.0 Dans le cas des thermoplongeurs à bride (et certains modèles à bouchon fileté), si un joint d'étanchéité est nécessaire, la surface du joint d'étanchéité doit être propre et sèche avant que le thermoplongeur ne soit mis en place.



DÉFENSE d'isoler par-dessus la bride, la zone surélevée et le boîtier de terminaison du thermoplongeur.

3.0 Les bornes doivent être protégées à tout moment de l'humidité et des émanations. Dans les lieux à risques, il faut employer des boîtiers de terminaison antidéflagrants. À l'extérieur, des boîtiers résistants à l'humidité sont obligatoires. Il est recommandé d'employer un anneau d'écoulement pour empêcher l'humidité de pénétrer dans le boîtier de terminaison à travers le câble.

4.0 Protégez les bornes des éléments chauffants contre les écoulements, la condensation, les émanations, les pulvérisations ou contre toute autre substance qui pourrait provoquer une contamination des éléments.

5.0 Lorsque vous faites fusionner des solides par immersion directe, il faut prévoir un orifice de ventilation à la surface, afin de laisser les gaz s'échapper. Faites fonctionner le thermoplongeur à ½ tension, jusqu'à ce que la matière fusionnée recouvre complètement les éléments chauffants. Les thermoplongeurs utilisés dans ce but peuvent nécessiter des caractéristiques de conception spéciales. Demandez à l'usine de vous donner ses recommandations.

INSTALLATION



Les thermoplongeurs dotés de dispositifs de surchauffe nécessitent une orientation particulière d'installation.



RISQUE D'ÉLECTROCUTION. Débranchez toute l'alimentation électrique avant d'installer, de réparer ou d'entretenir le thermoplongeur. Faute de quoi, il y a un risque de blessures physiques et/ ou d'endommagement des lieux et objets qui s'y trouvent. L'entretien et l'installation, dans leur ensemble, doivent être effectués par un personnel qualifié et se conformer aux codes locaux.



RISQUE D'INCENDIE OU RISQUE D'ÉLECTROCUTION: L'accumulation d'humidité sur la matière diélectrique des éléments, la corrosion des gaines, ou la surchauffe des thermoplongeurs peut provoquer un défaut de la mise à la terre, ce qui produira des étincelles et la fusion du métal. Pour éviter toute blessure physique ou tout endommagement des lieux et objets qui s'y trouvent, installez des protections adéquates contre les défauts de mise à la terre.



Les thermoplongeurs sont des composants électriques. Les concepteurs sont responsables de l'intégration correcte dans les systèmes électriques, ce qui englobe les protections, les systèmes de relève et les contrôles.

6.0 Déballez le thermoplongeur. Vérifiez-le pour détecter tout dégât qui aurait pu survenir pendant le transport.

7.0 Retirez le conditionnement de protection du raccord de couplage à bouchon fileté ou à bride.

8.0 Retirez le produit dessicant situé dans le coffret électrique.

9.0 Insérez le thermoplongeur dans la cuve ou le réservoir. Vérifiez que les éléments chauffants ne sont pas en contact avec la surface de la cuve.

10.0 Vérifiez que tous les raccordements des bornes sont bien serrés.



Utilisez uniquement des conducteurs en cuivre dont l'intensité de courant admissible est suffisante pour la charge du circuit du thermoplongeur, conformément au code électrique local. Consultez la plaque signalétique du thermoplongeur pour connaître les caractéristiques thermiques minimales du conducteur. Les facteurs de réduction de la valeur nominale du courant doivent être appliqués pour les thermoplongeurs fonctionnant à plus de 30°C (soit 86°F).

11.0 Vérifiez que la tension de l'alimentation est conforme à la tension figurant sur la plaque signalétique du thermoplongeur. NE BRANCHEZ PAS le thermoplongeur à une source de tension autre que celle figurant sur la plaque signalétique du thermoplongeur.

12.0 Il faut se servir d'un thermostat de circuit de commande ou de tension de ligne pour commander le thermoplongeur. Le thermostat de circuit de commande doit être utilisé avec un contacteur et (au besoin) un transformateur. En général, les thermoplongeurs fournis avec des thermostats intégrés seront câblés d'avance à l'usine si cela convient à un fonctionnement sur tension de secteur. Les thermostats intégraux qui ne sont pas câblés d'avance à l'usine sont normalement prévus pour une fonction avec un circuit de commande.

13.0 Il est recommandé d'alimenter les circuits de commande à partir des bobinages secondaires isolés des transformateurs, en évitant le besoin de deux circuits d'alimentation. Autrement, il est recommandé de fournir l'enclenchement électrique afin que les deux alimentations soient débranchées avant que des parties électrifiées ne puissent être rendues accessibles.

14.0 S'il existe une possibilité, même faible, de voir le niveau de liquide tomber au-dessous des éléments, il est obligatoire d'avoir un commutateur de contrôle du niveau ou un dispositif de détection de surchauffe, fixé sur l'élément chauffant le plus haut. Demandez à l'usine de vous donner ses recommandations.

15.0 Si le thermoplongeur est installé dans un système pressurisé, une soupape de sûreté et de décharge doit être employée pour empêcher une accumulation dangereuse de la pression.

16.0 Des faisceaux horizontaux de soutien des éléments peuvent s'avérer nécessaires si la longueur immergée dépasse 1270 mm (50 po).

17.0 Pour les thermoplongeurs à bride installés dans un système pressurisé, la quincaillerie de boulonnage adéquate doit être employée. Elle doit convenir aux pressions et aux températures de l'équipement. Employez un joint d'étanchéité adéquat pour la pression et la temperature de l'équipment. Serrez les boulons selon un schéma uniforme, soit dans le sens des aiguilles d'une montre, soit dans le sens inverse des aiguilles d'une montre.

18.0 Les thermoplongeurs dotés de boîtiers de terminaison antidéflagrants ne doivent être employés que dans les lieux pour lesquels ces thermoplongeurs sont certifiés.

a) Voyez les renseignements figurant sur la plaque signalétique du thermoplongeur pour connaître le code d'homologation.
b) Ne mettez jamais sous tension un thermoplongeur antidéflagrant sans vous assurer que le couvercle du boîtier de terminaison est correctement serré.
c) Un thermoplongeur pour les emplacements dangereux n'est approuvé à l'utilisation que si un dispositif homologué de contrôle du niveau du liquide, et/ou un dispositif homologué de haute-limite de température sont employés pour mettre le thermoplongeur hors tension au cas où le niveau du liquide baisserait.

FONCTIONNEMENT



RISQUE D'EXPLOSION. Ne faites pas fonctionner le thermoplongeur à des tensions supérieures à la puissance nominale figurant sur la plaque signalétique. Faute de quoi, vous provoquerez des températures élevées.



Pour les thermoplongeurs à gaine de métal, il faut effectuer une vérification de la résistance de l'isolation avant le fonctionnement. Un thermoplongeur dont les valeurs sont inférieures à 0,5 MΩ doit être soumis à un processus d'assèchement. Adressez-vous à l'usine qui vous expliquera la procédure si les valeurs du thermoplongeur sont inférieures à 0,5 MΩ.



RISQUE D'INCENDIE. Pour que le thermoplongeur fonctionne bien, et pour éviter la surchauffe des éléments chauffants, qui pourrait provoquer un incendie ou endommager le thermoplongeur, il faut que le thermoplongeur soit immergé dans le liquide.



Quand on fait fonctionner les thermoplongeurs dans un système fermé ou dans une cuve, les concepteurs du système doivent faire attention que les contrôles adéquats sont employés pour conserver la température et la pression à un niveau normal.



Le problème d'un relevé faible des mégohms sur les éléments chauffants dotés de sceaux en époxy or hermétiques ne peut pas être résolu sur place. Les valeurs normales de la résistance, en présence de sceaux, sont de 1000 MΩ ou plus.

19.0 Vérifiez que tous les branchements sont serrés.

20.0 Si un thermostat est fourni, vérifiez qu'il fonctionne correctement en le faisant passer par son cycle et en vérifiant la coupure du circuit.

21.0 Effectuez un test IR avant la mise sous tension. Vérifiez que les niveaux sont acceptables, à 500,000 ohms.

22.0 Mettez le thermoplongeur sous tension. Vérifiez les signes de pointes locales de température dans les raccords électriques ou dans la cuve.

23.0 Au bout de dix cycles, resserrez toutes les raccords de coupage à boulons, et tous les raccords électriques.

24.0 Maintenez toujours un minimum de 51 mm (2 po) de liquide au-dessus de la partie chauffée de l'élément, sans quoi l'élément peut tomber en panne.

25.0 Les éléments chauffants doivent être gardés au-dessus des dépôts de sédiments, sans quoi, ils peuvent surchauffer et s'user prématurément.

ENTRETIEN ET RÉPARATION



Débranchez toute l'alimentation électrique avant d'installer, de réparer ou d'entretenir le thermoplongeur. Faute de quoi, il y a un risque de blessures physiques et/ou d'endommagement des lieux et objets qui s'y trouvent. L'entretien et l'installation, dans leur ensemble, doivent être effectués par un personnel qualifié et se conformer aux codes locaux.

26.0 Les thermoplongeurs entreposés pendant de longues périodes peuvent absorber de l'humidité. À l'aide d'un mégohmmètre 500 VDC (appareil de mesure de résistance de l'isolation), vérifiez la valeur de la résistance de l'isolation à la terre pour chaque circuit. Des relevés initiaux de plus de 500.000 ohms à la terre sont normalement acceptables. Si vous obtenez des relevés inférieurs, consultez l'usine qui vous donnera ses instructions.

27.0 De temps en temps, vérifiez que les branchements électriques sont serrés. Vérifiez que l'isolation des câbles n'est pas endommagée. Remplacez-la au besoin.

28.0 De temps en temps, retirez le thermoplongeur afin de l'inspecter et de détecter toute corrosion ou accumulation de dépôts, et de retirer le calcaire. Ne continuez pas à vous servir d'un thermoplongeur sur lequel des signes de dommages sont visibles.

GARANTIE - LIMITATION DE LA RESPONSABILITÉ

CCI Thermal Technologies Inc. garantit à l'acheteur de chaque produit neuf que toute pièce dudit produit qui présente un vice de fabrication ou de matériau au cours d'un usage normal, dans les 18 mois qui suivent la date d'expédition, ou bien dans les 12 mois à compter de la date du début de la mise en service (selon la première éventualité), sera réparé ou remplacé sans frais. Tout vice de cette sorte doit être porté à l'attention de la compagnie où le produit a été acheté, qui est autorisée à effectuer des échanges ou remplacements aux termes de cette garantie.

La compagnie ne sera pas tenue responsable de tous les frais engagés pour l'installation, le retrait du service, les frais de transport ou les dommages en tous genres, y compris les dommages accessoires ou indirects.

Étant donné que nous ne pouvons ni prévoir ni maîtriser les conditions dans lesquelles seront employés nos produits, nous n'acceptons aucune responsabilité pour la sécurité ou l'aptitude de nos produits quand ils sont employés seuls ou en même temps que d'autres produits. Il incombe à l'utilisateur d'effectuer des tests concernant la sûreté et l'aptitude des produits.

Cette garantie n'est pas applicable pas si la compagnie estime que les dommages ou la défaillance résultent d'un accident, d'une altération, d'un mauvais usage, d'un usage abusif, d'un maniement fautif ou d'une alimentation électrique erronée. Ce qui précède remplace toutes les autres garanties formelles ou tacites. CCI Thermal Technologies Inc. n'assume pas, et n'autorise personne à assumer en son nom toute autre obligation durant le transport, l'installation et le fonctionnement, pas plus que toute responsabilité en rapport avec le produit indiqué.

CCI Thermal
Technologies INC.
A Leader in Advanced Heating Solutions

Caloritech™
Engineered Electric Heat

IMMERSION HEATERS SUPPLIED WITH *x-Max*® TERMINAL ENCLOSURES & BUILT-IN THERMOSTATS

CAUTION

ELECTRIC SHOCK HAZARD. All electric heating equipment installations must be performed by qualified personnel in accordance with the local electrical codes and standards and must be effectively grounded to eliminate shock hazard.

1.0 GENERAL

1.1 For information on the general installation, wiring and control of immersion heaters see bulletin MI110 enclosed.

1.2 Immersion heaters fitted with ***x-Max®*** enclosures are suitable for weather resistant applications or hazardous locations. Check the heater nameplate to ensure that the unit you have is suited to your application and operating conditions and environment.

1.3 Specific installation and operation information on the XT Thermostat factory installed on your unit is found in MI133 enclosed.

2.0 CONVERTING FROM KNOB-ADJUST TO TAMPER-PROOF MODE:

To convert to tamper-proof mode you will require a factory supplied socket head cap screw.

2.1 Disconnect the power to the device. Remove the knurled cover from the housing assembly. Using finger pressure, gently spring the thermostat away from the bracket assembly, as shown in Fig. 1 (DO NOT press down on the steel bracket). While the thermostat is sprung down, rotate the thermostat knob counterclockwise to remove the operating shaft.

2.2 Ensuring that the thermostat shaft remains aligned with the operating shaft hole, place the socket-head cap screw into the hole at the front of the housing and tighten. Replace the knurled cover.

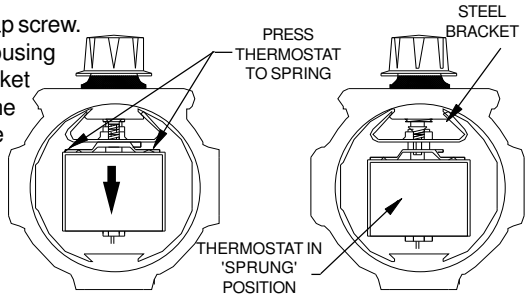


Figure 1: 'Springing' the thermostat

3.0 CONVERTING FROM TAMPER-PROOF TO KNOB-ADJUST MODE

To convert to knob-adjust mode you will require a knob, an operating shaft and a rubber seal to place on the shaft below the knob.

3.1 Disconnect the power to the device. Remove the knurled cover from the housing assembly. Remove the socket-head cap screw.

3.2 Ensuring that the thermostat shaft remains aligned with the cap screw hole, place the knob onto the operating shaft and thread it into the cap screw hole.

3.3 When the operating shaft engages with the thermostat shaft, with light finger pressure, gently spring the thermostat away from the bracket assembly, as shown in Figure 1 (DO NOT press down on the steel bracket). Rotate the knob one more full revolution to assure a positive engagement of the thermostat. Release the thermostat.

3.4 Upon release, the thermostat should spring back into its original position. If the thermostat remains sprung down, a slight twisting of the knob in both directions should create a positive engagement. The knob should be able to turn through the entire temperature range but should not turn one full revolution. If the knob turns completely around, repeat.

4.0 OPERATION

CAUTION

ELECTRIC SHOCK HAZARD. Disconnect all power before installing or servicing. Failure to do so could result in personal injury and/or property damage. All maintenance and installation should be done by qualified personnel in compliance with local codes.

4.1 TAMPER-PROOF MODE: To set the thermostat temperature:

4.1.1 Disconnect the power to the unit.

4.1.2 Completely remove the socket-head cap screw from the housing assembly.

4.1.3 Insert a flat-head screwdriver into the slot cut in the thermostat shaft.

4.1.4 Rotate the screwdriver to set the thermostat to the desired temperature. See Figure 2 to determine the temperature setting. Turning the shaft clockwise increases the set point temperature, counterclockwise rotation decreases the set point temperature (As a quick check, note that the thermostat will switch at the ambient temperature when the shaft is rotated).

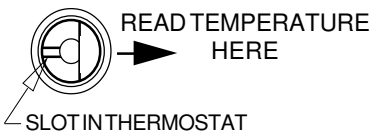


Figure 2: Thermostat temperature setting

4.1.5 Read the temperature from the front face of unit, as shown in Figure 2.

4.2 KNOB-ADJUST MODE: To set the thermostat temperature:

4.2.1 Rotate the knob to set the thermostat to the desired temperature. Turning the shaft clockwise increases the set point temperature, counterclockwise rotation decreases the set point temperature.

Caloritech™
Engineered Electric Heat

WARRANTY & LIMITATION OF LIABILITY

CCI Thermal Technologies Inc. warrants to the purchaser of each new product that any part thereof which proves to be defective in material or workmanship under normal use within 18 months of the date of shipment or 12 months from the date of start of operation (whichever occurs first) will be repaired or replaced without charge. Any such defect should be brought to the attention of the company's office from which the product was purchased, which is authorized to furnish or replacement within the terms of this warranty.

The Company will not be responsible for any expenses incurred in installation, removal from service, transportation cost, or damages of any type whatsoever, including incidental or consequential damages.

Since we cannot anticipate or control the condition under which our products may be used, we accept no responsibility for the safety and suitability of our products when used alone or in combination with other products. Tests for safety and suitability of the products should be done by the user.

This warranty will not apply if, in the judgement of the Company damage or failure has resulted from accident, alteration, misuse, abuse or operation on an incorrect power supply. The foregoing is in lieu of other warranties expressed or implied. CCI Thermal Technologies Inc. neither assumes no authorizes any person to assume for it any other obligation, during transportation, installation and operation or liability in connection with the said product.

Since the paint finish may be damaged in use, no warranty applies to such paint finish except for manufacturing defects which become apparent within 30 days from date of installation.

CCI Thermal Technologies INC.
Heating and Filtration Solutions

Caloritech™
Engineered Electric Heat

THERMOPLONGEURS AVEC THERMOSTATS INTÉGRÉS ET MUNIS DE BOÎTIERS DE TERMINAISON *x-Max*®

MISE EN GARDE

RISQUE D'ÉLECTROCUTION. Toutes les installation d'équipment électrique de chauffage doivent être réalisées par un personnel qualifié, conformément aux codes et normes électriques locaux, et doivent être dûment mises à la terre afin de suppreimer les risques d'électrocution.

1.0 GÉNÉRALITÉ

1.1 Pour les informations générales relatives à l'installation, le raccordement et la régulation des thermoplongeurs, veuillez référer au bulletin MI110 sous-pli.

1.2 Les thermoplongeurs munis de boîtiers de terminaison ***x-Max®*** sont utilisés lorsque l'application nécessite un boîtier de terminaison à l'épreuve des intempéries ou un boîtier antidéflagrant dans un endroit classifié dangereux. Vérifier la plaque signalétique du thermoplongeur pour vous assurer que l'appareil est adéquat pour votre application, les conditions d'opération et pour l'endroit spécifique d'utilisation.

1.3 Des informations spécifiques relatives à l'installation et l'opération du thermostat intégré XT sont détaillées au bulletin MI133 sous-pli.

2.0 CONVERSION D'UN BOUTON DE RÉGLAGE EXTERNE À UN MÉCANISME ANTI-VANDALISME:

Pour convertir au mode anti-vandalisme, vous aurez besoin de la vis à tête cylindrique à six pans creux (incluse avec l'unité).

2.1 Couper l'alimentation à l'appareil. Retirer le couvercle carrelé de l'appareil. D'une pression du doigt, dégager le thermostat du support, voir Fig. 1 (NE PAS POUSSER le support vers le bas). Avec le thermostat en position inférieure, effectuer une rotation anti-horaire du bouton du thermostat pour retirer la tige de commande.

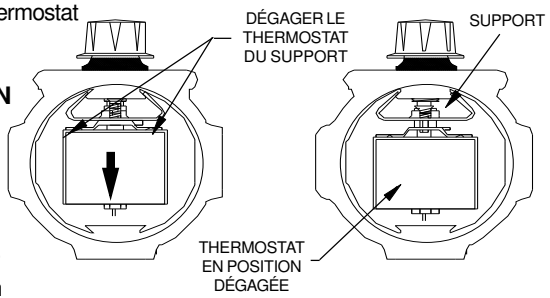


Figure 1: Dégagement du thermostat

2.2 Vous assurer de conserver l'alignement de la tige du thermostat avec le trou de la tige de commande, et visser fermement la vis à tête cylindrique à six pans creux dans le trou frontal du boîtier. Replacer le couvercle carrelé.

3.0 CONVERSION D'UN MÉCANISME ANTI-VANDALISME À UN BOUTON DE RÉGLAGE EXTERNE

Pour convertir à un bouton de réglage externe, vous avez besoin d'un bouton, une tige de commande et un joint d'étanchéité en caoutchouc à placer sur la tige sous le bouton de réglage.

3.1 Couper l'alimentation électrique. Retirer le couvercle carrelé de l'appareil. Retirer la vis à tête cylindrique à six pans creux.

3.2 Vous assurer de conserver l'alignement de la tige du thermostat avec le trou de la vis cylindrique. Placer le bouton sur la tige de commande et visser à l'intérieur du trou de la vis cylindrique.

3.3 Lorsque la tige de commande est engagée avec la tige du thermostat, d'une légère pression du doigt, dégager le thermostat du support, voir Figure 1 (NE PAS POUSSER le support vers le bas). Tourner le bouton d'un autre tour complet pour assurer l'accouplement positif avec le thermostat et relâcher le thermostat.

3.4 Dès la relâche, le thermostat devrait reprendre sa position originale. Si le thermostat demeure en sa position inférieure, une légère rotation du bouton dans les deux directions devrait être suffisante pour assurer l'accouplement du thermostat. La rotation du bouton doit couvrir complètement la plage de température sans toutefois pouvoir effectuer une rotation complète. Si le bouton effectue une rotation complète, recommencer la procédure.

4.0 OPÉRATION

MISE EN GARDE

RISQUE D'ÉLECTROCUTION. Débranchez toute l'alimentation électrique avant d'installer, de réparer ou d'entretenir le thermoplongeur. Faute de quoi, il y a un risque de blessures physiques et/ou d'endommagement des lieux et objets qui s'y trouvent. L'entretien et l'installation, dans leur ensemble, doivent être effectués par un personnel qualifié et se conformer aux codes locaux.

4.1 ANTI-VANDALISME: Réglage du thermostat:

4.1.1 Couper l'alimentation à l'unité.
4.1.2 Retirer complètement la vis à tête cylindrique à six pans creux.
4.1.3 Insérer un tournevis plat dans la rainure de la tige du thermostat.
4.1.4 Régler la température de consigne du thermostat à l'aide du tournevis. Voir Figure 2 pour déterminer le point de consigne. Pour élever la température, effectuer un mouvement horaire, pour abaisser la température, effectuer un mouvement anti-horaire (comme vérification rapide, noter le déclic du thermostat à la température ambiante).

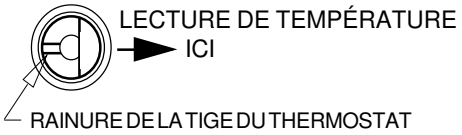


Figure 2: Réglage du thermostat

4.1.5 La lecture de la température est établie sur la face frontale de l'appareil, voir Figure 2.

4.2 BOUTON DE RÉGLAGE EXTERNE: Réglage de température:

4.2.1 À l'aide du bouton, régler le thermostat à la température désirée. Pour élever la température effectuer un mouvement horaire, pour abaisser la température effectuer un mouvement anti-horaire.

GARANTIE - LIMITATION DE LA RESPONSABILITÉ

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CCI Thermal Technologies INC.
Heating and Filtration Solutions

MODEL 123-1+6+S DIFFERENTIAL
BACK PRESSURE / RELIEF REGULATOR

SECTION I

I. DESCRIPTION AND SCOPE

The Model 123-1+6+S Differential is designed for high pressure liquid or gas applications to Cashco drawing nos. 32934 (NACE construction) and 32935 (Non-NACE construction). It is used to control differential upstream (inlet or P_1) pressure and a loading (P_{Load}) pressure to a rotating shaft seal. Sizes are 1/2", 3/4", 1", and 1-1/2" (DN15, 20, 25, and 40).

⚠ CAUTION A

This is not a safety device and must not be substituted for a code approved pressure safety relief valve or rupture disc. NOT FOR STEAM SERVICE. NOT FOR OXYGEN SERVICE.

SECTION II

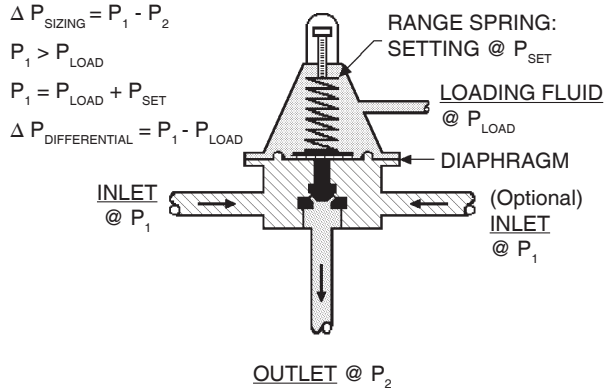
II. INSTALLATION

This unit was designed and is used almost exclusively on compressor and turbo expander seal systems. **REFER TO COMPRESSOR/EXPANDER MANUFACTURER'S MANUAL FOR DETAILED INSTALLATION, START-UP AND SHUTDOWN OF THIS UNIT.** Install regulator with Inlet (P_1) pressure coming in the side body (1) connection in accordance with the directional flow arrow cast on body (1).

SECTION III

III. PRINCIPLE OF OPERATION

1. Movement occurs as pressure variations register on the diaphragm (3). The registering pressure is the inlet (P_1) or upstream pressure which registers on the "underneath" side of the diaphragm (3). The second pressure registered is the loading (P_{LOAD}) pressure in the spring chamber (2) "above" the diaphragm (3). The range spring (18) determines the differential pressure setpoint (P_{SET}). As inlet (P_1) pressure drops, the range spring (18) pushes the diaphragm (3) down, closing the port; as inlet (P_1) pressure increases, the diaphragm (3) pushes up and the port opens. As the loading (P_{LOAD}) pressure varies, the inlet (P_1) pressure tends to follow. An increase in (P_{LOAD}) will increase inlet (P_1) pressure by nearly an equal amount ; a decrease in (P_{LOAD}) will decrease the inlet (P_1) pressure.
2. A complete diaphragm (3) failure will cause the fluids to mix in the spring chamber (2) or loading pressure piping. Regulator action will "fail close" under a diaphragm (3) failure.
3. Under normal operating conditions, the inlet (P_1) pressure should be greater than the loading (P_{LOAD}) pressure by the range spring (P_{SET}) setpoint.



Model 123-1+6+S Differential Schematic

⚠ CAUTION B

Limit any field hydrostatic test to 1-1/2 times the Maximum Pressure Rating (See Table 1). Ensure that the test pressure is applied uniformly to the body inlet, body outlet, and spring chamber.

ISO 9001 Registered

TABLE 1

MAX OPERATING PRESSURES & TEMPERATURE RATING SPECIFICATIONS												
DESCRIPTION	NPT and 1500# ANSI Flg.				600# ANSI Flg.				900# ANSI Flg.			
	100°F (38°C)		400°F (205°C)		100°F (38°C)		400°F (205°C)		100°F (38°C)		400°F (205°C)	
	psig	(Barg)	psig	(Barg)	psig	(Barg)	psig	(Barg)	psig	(Barg)	psig	(Barg)
Max. Pressure for **CS Body/Spg. Ch,**	1500	(103)	1500	(103)	1480	(102)	1270	(88)	1500	(103)	1500	(103)
Max. Pressure for **SST Body/Spg. Ch.**	1500	(103)	1500	(103)	1440	(99)	995	(69)	1500	(103)	1500	(103)
Operating Temperature Range -20°F (-28°C) to +400F (+204C)												

SECTION IV

IV. STARTUP

REFER TO THE COMPRESSOR/EXPANDER MANUFACTURER'S MANUAL FOR DETAILED STARTUP OF THIS UNIT.

1. On initial start-up with your system operating at normal conditions, check the differential gauge to ensure the desired differential pressure is being maintained. If not, go to step 2 and make one final adjustment. (This should only be necessary on first start-up.) ***NOTE:*** *It is crucial that the adjusting screw (17) threads not be damaged. Do not use pliers or locking pliers on the adjusting screw (17).*

2. To adjust differential setting, use one of these two methods:

   a. Loosen the closing cap (22) by turning CCW 3-4 complete revolutions. Loosen lock nut (9) by turning CCW until it is tight (double-nutted) against closing cap (22). Now the differential setting may be adjusted by turning the closing cap (22) CW to increase differential or CCW to decrease. After desired setting is reached, loosen lock nut (9) from closing cap (22) and tighten each securely to spring chamber (2).

   b. Remove closing cap (22) from adjusting screw (17) by turning CCW. Loosen lock nut (9) by turning CCW. Turn the adjusting screw (17) CW to increase differential pressure or CCW to decrease. Tighten lock nut (9) and replace closing cap (22).

SECTION V

V. SHUTDOWN

REFER TO THE COMPRESSOR/EXPANDER MANUFACTURER'S MANUAL FOR DETAILED SHUTDOWN OF THIS UNIT.

SECTION VI

VI. MAINTENANCE

⚠ WARNING 1

SYSTEM UNDER PRESSURE. Prior to performing any maintenance, isolate the regulator from the system and relieve all pressure(s). Failure to do so could result in personal injury.

A. General:

1. Maintenance procedures hereinafter are based upon removal of the regulator unit from the pipeline where installed.
2. Owner should refer to owner's procedures for removal, handling, cleaning and disposal of nonreusable parts, i.e. gaskets, etc.
3. Refer to Figure 5 for differential regulator cutaway drawing.

⚠ WARNING 2

SPRING UNDER COMPRESSION. Prior to removing spring chamber subassembly (2), relieve range spring (18) compression by backing out the adjusting screw (17). Failure to do so may result in flying parts that could cause personal injury.

⚠ CAUTION C

DO NOT ATTEMPT TO REMOVE ADJUSTING SCREW (6) FROM TOP OF SPRING CHAMBER (2). The adjusting screw (6) is threaded up from inside the spring chamber (2) and the CCW rotation used to relieve range spring (14) tension will come to a stop. At the stopping point, do not apply any torque to adjusting screw (6) or damage may occur and render the unit inoperable. See Figure 1.

B. Disassembly:

1. Securely install the body (1) in a vise with the spring chamber (2) directed upwards.
2. Remove closing cap (22).
3. Loosen sealing locknut (9) by rotating CCW. Relax range spring (18) by turning adjusting screw (17) CCW.
4. Draw or embed a match mark between body (1) casting and spring chamber (2) subassembly along flanged area.
5. Remove all body flange hardware (7,8,30,41,42).
6. Remove spring chamber (2) and connected parts, range spring (18) and spring button (19).

⚠ CAUTION D

When body flange hardware (7,8,30,41,42) is removed from this unit it should always be replaced with new. The new hardware (7,8,30,41,42) must have the proper grade specification identification markings and meet the following standards:

1. **All cap screws (7,30) and flange stud nuts (8) must have "heavy hex heads".**
2. **All studs (41,42) and cap screws (7,30) must comply with or exceed the requirements of ASTM-A-193, Grade B7.**
3. **All flange stud nuts (8) must comply with or exceed the requirements of ASTM A-194, Grade 2H.**

New body flange hardware (7,8,30,41,42) may be purchased from Cashco, Inc. or through the OEM.

7. Adjusting screw (17) o-ring inspection:
   a. With locknut (9) and closing cap (22) removed, turn adjusting screw (17) CW as far as possible by grasping the flats on top end. Carefully reach inside spring chamber (2) and grasp adjusting screw (17) by hand. Remove adjusting screw (17) by rotating CCW. See Figure 1A.

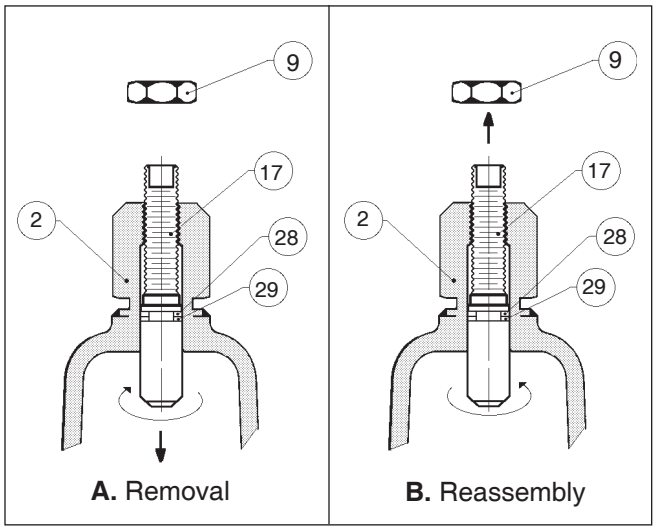


Figure 1: Adjusting screw (17) o-ring inspection.

   b. Inspect the backup ring (28) and quad ring (29) for wear. If nicked or torn - replace. NOTE: Make certain the teflon backup ring (28) will insert into spring chamber (2) first, before the quad ring (29). (See Figure 7 blow-up illustration). Make sure the quad ring (29) is on straight with no twist. Use a good grade lightweight grease on the ring seals (28,29).

   c. Lubricate adjusting screw (17) threads. Carefully reinstall adjusting screw (17) up into the spring chamber (2) by rotating adjusting screw (17) CW until top of adjusting screw (17) protrudes from top of spring chamber (2) (See Figure 1B.). NOTE: Care should be taken when holding and rotating adjusting screw (6) so the quad ring (29) and backup ring (28) are not inadvertently nicked or torn. Grasp top of adjusting screw (17) and turn CCW until rotation stops **(see CAUTION C)**.

   d. Loosely install the lock nut (9) and closing cap (22).

8. Lift up and remove the diaphragm subassembly consisting of the piston (14), piston nut (6), diaphragm (3), diaphragm covers (24) (NACE unit only, Cashco Dwg. 32934), pressure plate (20), pusher plate (21), sealing washer (27), pressure plate o-ring (31) and pusher plate o-ring (34). Remove the flange o-ring (32).
9. Loosen piston nut (6) and separate all parts (3,24 (NACE units only),14,20,21,27,31,34) of the diaphragm (3) subassembly.

10. Inspect pressure plate (20) and pusher plate (21) to assure no deformation due to over-pressurization. Inspect diaphragm (3). If deformed, replace.

11. Remove cylinder subassembly (12) by rotating CCW. ***NOTE:*** *For 1-1/2" (DN40) body reduced orifice only, also remove the cylinder bushing (33) at this time. See Figure 6.*

12. Inspect cylinder seat (12.2). If seat shows erosion or wear, the entire cylinder/seat assembly (12) must be replaced.

13. Remove body (1) from vise.

14. Clean all parts to be reused according to owner's procedures. Use special care cleaning the flat mating surfaces of the body (1), cylinder (12) and cylinder bushing (33) shoulders (1-1/2" (DN40) size only) as these pressurized joints are metal-to-metal.

C. Reassembly:

1. Place body (1) back into vise.

2. a. For standard orifice: Lubricate the cylinder (12) threads lightly with thread sealant, insert the cylinder (12) into the body (1) and screw CW until finger tight. Impact the cylinder (12) into the body (1).

   b. For 1-1/2" (DN40) body reduced orifice ONLY: Lubricate cylinder (12) and cylinder bushing (33) threads lightly with thread sealant. Screw the cylinder (12) into the cylinder bushing (33) until finger tight. Then screw the cylinder (12) and cylinder bushing (33) "subassembly" into the body (1) until finger tight. Impact this cylinder (12)/cylinder bushing (33) "assembly" into the body (1). See Figure 6.

3. Place diaphragm flange o-ring (32) on body (1) flange.

4. Place piston (14) in a vise with threaded post portion directed upwards, grasping on the hexagonal surface.

5. Position properly oriented pusher plate (21) over piston (14) post.

6. Place pusher plate o-ring (34) into recess of pusher plate (21). Lubricrate with good grade lightweight grease.

7. Place diaphragm (3) and diaphragm covers (24) (NACE construction only) according to following instructions:

   a. NACE variation only (Cashco Dwg. #32934): Place one of the two diaphragm cover(s) (24) over piston (14) post. Place diaphragm (3) and second diaphragm cover (24) over piston (14) post.

   b. NON-NACE variation only (Cashco Dwg. #32935): Place diaphragm (3) over piston (14) post.

8. Place pressure plate o-ring (31) into recess of pressure plate (20). Lubricrate with a good grade lightweight grease. Position pressure plate (20) over the piston (14) post.

9. Place the sealing washer (27) (metal side up) over the piston (14) post.

10. Thread piston nut (6) onto piston (14) post. Torque to the following value:
    All sizes: 45-50 Ft-lbs (61-68 N-m).

11. Release the piston (14) from vise. Insert the piston/diaphragm subassembly into the body (1) with piston (14) engaging the cylinder (12). Align diaphragm (3) and body (1) bolt holes.

12. Place the range spring (18) onto the retainer hub of the pressure plate (20).

13. Place multipurpose, high temperature grease into depression of spring button (19) where adjusting screw (17) bears. Set spring button (19) onto range spring (18); ensure spring button (19) is laying flat.

14. Aligning matchmarks, place spring chamber (2) over the stacked parts. Rotate adjusting screw (17) CW into spring chamber (2) until contact is made with the spring button (19). NOTE: Contact will begin to lift the spring chamber (2) up from body (1). Relax adjustment screw (17) so that spring chamber (2) and body (1) just make contact. (This will keep the range spring (18) from falling over while the body (1) and spring chamber (2) are bolted back together).

15. Using "NEW" studs (41,42) and nuts (8) **(see CAUTION D)**, thread one nut (8) onto each stud (41,42) approximately 1.25" (32 mm). Drop the studs (41,42) with nuts (8) through holes in spring chamber (2). (This will assist in keeping the spring chamber (2) centered on valve body (1) and prevent parts from moving during reassembly).

    Using "match marks" made in Step B.4 as a guide, replace spring chamber (2) onto body (1). Thread lower nuts (8) onto studs (41,42) and tighten by hand. Adjust length of studs (41,42) by using the top nut (8) to allow at least 3-4 threads protruding from the lower nut (8).

    Torque body flange hardware (7,8,30,41,42) using small increments in a 180° alternating pattern until flange mating surfaces of body (1) and spring chamber (2) are metal to metal. This creates a "fixed compression" on the diaphragm (12) and o-ring seal (32). Recommended torque values are listed in Table 2.

TABLE 2

BODY SIZE		ITEM NO.	THREAD SIZE	TORQUE VALUE	
in	(DN)			Ft-lbs	(N-m)
1/2" - 1-1/2"	(15-40)	7, 8, 30, 41, 42	7/16-20	32-36	(43-49)

D. Bench test for suitable operation (Test Fluid: Air or compressed gas).

1. Check for desired differential spring setting and regulator performance (with no loading pressure):

    a. Close No. 1, No. 2, and No. 4 shut-off valves. Open No. 3 and No. 5 shut-off valves.

    b. Apply inlet (P_1) pressure to No. 1 shut-off valve (10-15 psig (.69-1.0 Barg) above desired differential spring setting). Crack open No. 1 shut-off valve and check for valve opening at desired differential setting. Refer to SECTION IV-2. if range spring (18) adjustment is required.

    c. Check for performance. ***NOTE:*** *A metal seat will experience a slight seat leakage). Seat leakage should be quantified at 40% deviation from setpoint. For example: For a 15 psid (1.0 Bard) differential setting, check seat leakage at 40% below 15 psig (1.0 Barg); or 9 psig (.62 Barg). Seat leakage should be minimal (less than 20 SCFH).* See SECTION VII-5. TROUBLE SHOOTING GUIDE if seat leakage is excessive.

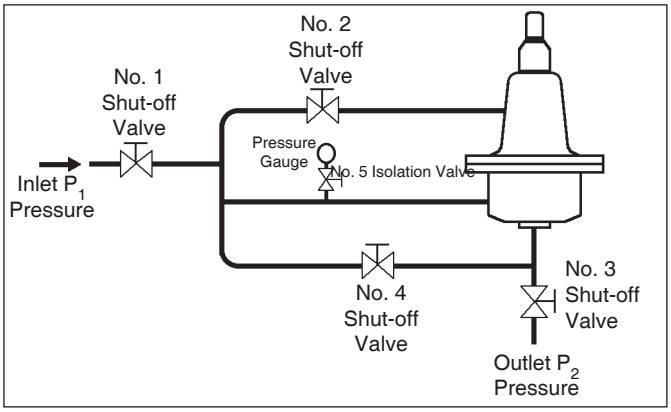


Figure 2: Recommended Bench Test Piping Schematic for 123-1+6+S

2. Proof test to check for external leakage.

    a. Close No. 1, No. 3, and No. 5 shut-off valves. Open No. 2 and No. 4 shut-off valves. Build inlet pressure to No. 1 shut-off valve to 1-1/2 times maximum inlet pressure, but not to exceed 1-1/2 times Maximum Pressure Rating (See Table 1).

    b. Crack open No.1 shut-off valve and allow a pressure buildup simultaneously in the body (1) and spring chamber (2). Spray the entire regulator with a liquid leak detector and visually inspect for external leakage. Repair unit if leak is detected. See SECTION VI MAINTENANCE.

    c. Shut off line pressure to No. 1 shut-off valve. Open No. 3 shut-off valve to relieve all pressure from the test valve and all shut-off valves.

3. Return to Section II for Installation and Section IV for Startup.

SECTION VII

VII. TROUBLE SHOOTING GUIDE

1. Erratic Operation; chattering	
Possible Causes	**Remedies**
A. Oversized regulator.	A1. Check actual flow conditions, resize regulator for minimum and maximum flow. A2. Increase flow rate. A3. Install next step higher range spring. Contact factory. A4. Before replacing regulator, contact factory.
B. Inadequate rangeability.	B1. Increase flow rate. B2. Decrease regulator pressure drop. B3. Install next step higher range spring. Contact factory.
C. Worn piston/cylinder; inadequate guiding.	C. Replace trim.
D. Unstable loading pressure.	D1. Stabilize loading pressure; i.e. pump, control, valve, etc. D2. Air in loading piping in liquid service. Vent as fully as possible.

2. Regulator inlet (upstream) pressure too high.	
Possible Causes	**Remedies**
A. Regulator undersized.	A1. Confirm by opening bypass valve together with regulator. A2. Check actual flow conditions, resize regulator; if regulator has inadequate capacity, replace with larger unit.
B. Plugged inlet strainer.	B. Remove strainer screen and clean; consider leaving screen out.
C. Plugged trim.	C. Remove trim and check for plugged holes in cylinder.
D. Incorrect range spring (screwing out CCW of adjusting screw does not allow bringing pressure level to a stable and proper level).	D. Replace range spring with proper lower range. Contact factory.
E. Too much propotional band (rise).	E1. Review Proportional Band (rise) expected. E2. Contact factory.
F. Restricted diaphragm movement.	F1. Ensure no moisture in spring chamber at temperatures below freezing. F2. Ensure no dust or debris entering vent opening. If rainwater or debris can enter, re-orient spring chamber.
G. Diaphragm failure.	G. Replace diaphragm.

3. Main valve fluid in loading fluid piping.	
Possible Causes	**Remedies**
A. Normal-life diaphragm failure.	A. Replace diaphragm.
B. Abnormal short-life diaphragm failure.	B1. Can be caused by excessive chattering. See No. 1 to remedy chatter. B2. Ensure not subjecting diaphragm to over-temperature conditions. B3. Upstream (inlet) pressure buildup occurring that overstresses diaphragms.

4. Sluggish operation.	
Possible Causes	**Remedies**
A. Plugged piston guides.	A. Remove trim and clean.
B. Fluid too viscous.	B. Heat fluid. Contact factory.
C. Diaphragm failure.	C. Replace diaphragm.

5. Excessive seat leakage.	
Possible Causes	**Remedies**
A. Foreign matter on seating surface.	A. Remove trim and clean.
B. Erosion/damage to seating surface.	B1. Relap seating surface. B2. Replace cylinder sub-assembly and piston.

SECTION VIII

VIII. ORDERING INFORMATION:
NEW REPLACEMENT UNIT vs PARTS "KIT" FOR FIELD REPAIR

To obtain a quotation or place an order, please retrieve the Serial Number and Product Code that was stamped on the metal name plate and attached to the unit. This information can also be found on the Bill of Material (parts list) that was provided when unit was originally shipped.) (Serial Number typically 6 digits). Product Code typical format as follows: (last digit is alpha character that reflects revision level for the product).

□□□–□□□7–□□□□□□□□□

NEW REPLACEMENT UNIT:

Contact your local Cashco, Inc., Sales Representative with the Serial Number and Product code. With this information they can provide a quotation for a new unit including a complete description, price and availability.

CAUTION

Do not attempt to alter the original construction of any unit without assistance and approval from the factory. All purposed changes will require a new name plate with appropriate ratings and new product code to accomodate the recommended part(s) changes.

PARTS "KIT" for FIELD REPAIR:

Contact your local Cashco, Inc., Sales Representative with the Serial Number and Product code. Identify the parts and the quantity required to repair the unit from the Bill of Materials sheet that was provided when unit was originally shipped.

NOTE: *Those part numbers that have a quantity indicated under "Spare Parts" in column "A" reflect minimum parts required for inspection and rebuild, - "Soft Goods Kit". Those in column "B" include minimum trim replacement parts needed plus those "Soft Goods" parts from column "A".*

If the "BOM" is not available, refer to the cross-sectional drawings included in this manual for part identification and selection.

Local Sales Representative will provide quotation for appropriate Kit Number, Price and Availability.

POSITION OF MOUNTING BRACKET STUDS

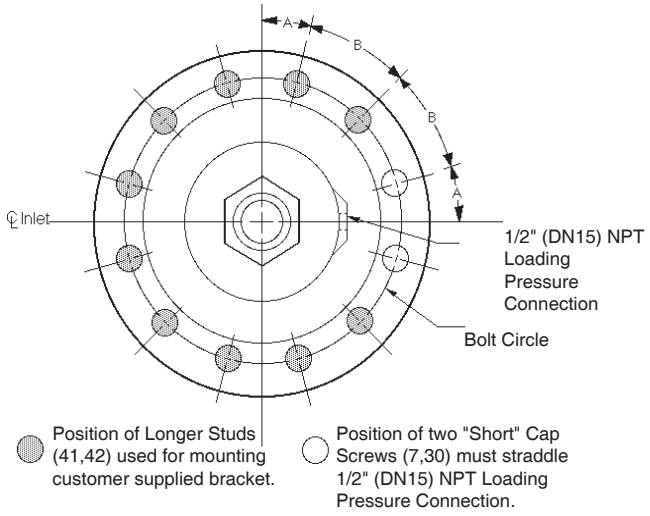


Figure 3: 1/2" & 3/4" (DN15 & DN20) Body Sizes

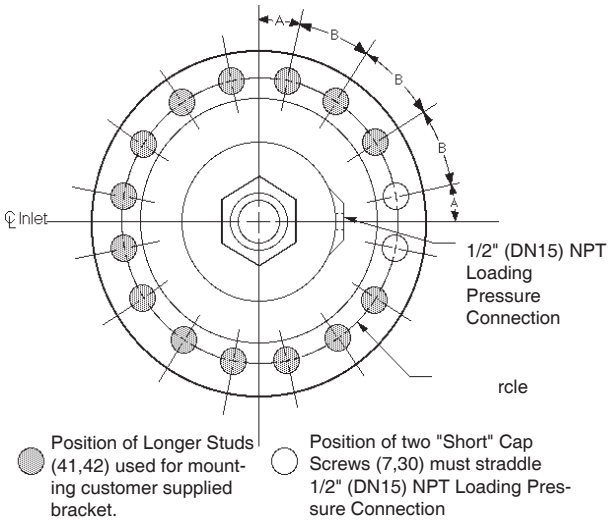


Figure 4: 1-1/2" (DN40) Body Size

Body SIze		No. of 1/2" (12.7 mm) Dia. Bolt Holes	Bolt Circle		Position	
in	(DN)		in	(mm)	A	B
1/2", 3/4", 1"	(15, 20, 25)	12	6-1/4"	(159 mm)	15°	30°
1-1/2"	(40)	16	7-1/2"	(191 mm)	11.25°	22.5°

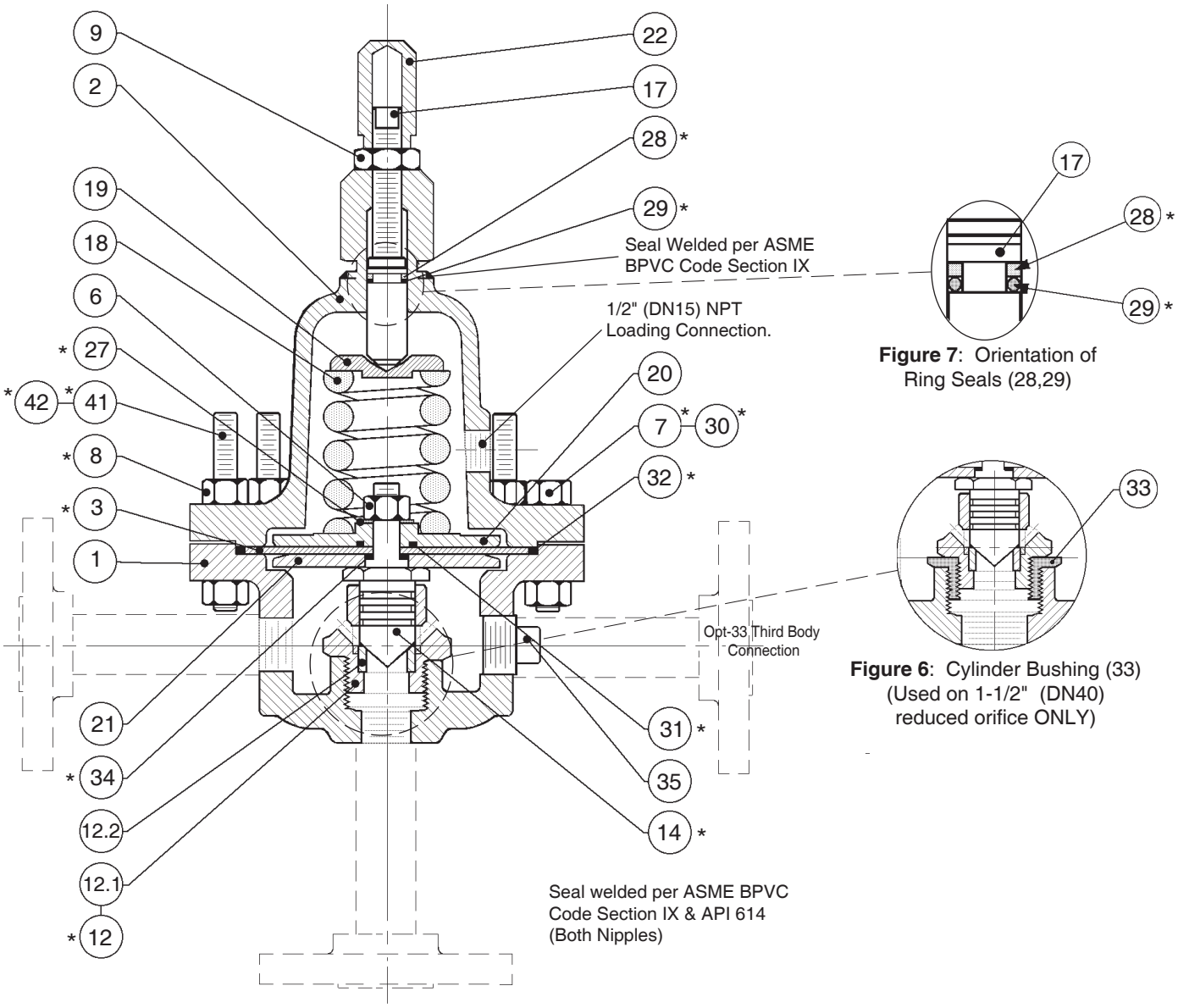


Figure 5: Model 123-1+6+S
(Non-NACE Construction)

Figure 7: Orientation of
Ring Seals (28,29)

Figure 6: Cylinder Bushing (33)
(Used on 1-1/2" (DN40)
reduced orifice ONLY)

Item No.	Description	Repair Parts
1	Body	
2	Spring Chamber	
3	Diaphragm	*
6	Piston Nut	
7	Cap Screw (Hex Head)	*
8	Nut (Hex)	*
9	Lock Nut	
10	Name Plate (not shown)	
12	Cylinder Sub-Assembly	*
12.1	Cylinder	
12.2	Seat	
14	Piston	*
17	Adjusting Screw	
18	Range Spring	
19	Spring Button	

Item No.	Description	Repair Parts
20	Pressure Plate	
21	Pusher Plate	
22	Closing Cap	
24	Diaphragm Covers[1]	*
27	Sealing Washer	*
28	Backup Ring	*
29	Quad Ring	*
30	Cap Screw (Hex head)	*
31	Pressure Plate O-ring	*
32	Diaphragm Flange O-ring	*
33	Cylinder Bushing (Used on 1-1/2" Reduced Orifice only)	
34	Pusher Plate O-ring	*
35	Pipe Plug	
41	Stud	*
42	Stud	*

[1] NACE Construction only (not shown).

Cashco, Inc.
P.O. Box 6.
Ellsworth, KS 67439-0006
PH (785) 472-4461
Fax. (785) 472-3539
www.cashco.com
E-mail: sales@cashco.com
exportsales@cashco.com
Printed in U.S.A. IOM-123-1+3+S

MODEL HP-1+6+S
HIGH PRESSURE DIFFERENTIAL
REDUCING REGULATOR

SECTION I

I. DESCRIPTION AND SCOPE

The Model HP-1+6+S is a heavy duty, high pressure differential reducing regulator used to control differential pressure between downstream outlet (P_2) pressure and a loading (P_{LOAD}) pressure to the spring chamber. This unit applies to Cashco drawing nos. 32911 (Non-NACE construction), 32909 (CS NACE construction), or 32907 (SST NACE construction). Sizes are 1/2", 3/4", and 1-1/2" (DN15, 20, and 40).

This unit is most commonly applied to develop a constant differential pressure across a rotating shaft seal to provide proper sealing and lubricating conditions over varying pressure ranges. Refer to Technical Bulletin HP-S-DIFF-TB for design conditions and selection recommendations.

⚠ CAUTION A

NOT FOR STEAM SERVICE. NOT FOR OXYGEN SERVICE.

SECTION II

II. INSTALLATION

This unit was designed and is used almost exclusively on compressor and turbo expander seal gas systems. **REFER TO COMPRESSOR / EXPANDER MANUFACTURER'S MANUAL FOR DETAILED INSTALLATION, START-UP AND SHUTDOWN OF THIS UNIT.** Install regulator in accordance with direction of flow arrow cast on body (1).

⚠ CAUTION

Option-1+6 contains single diaphragm construction. In the event of diaphragm failure, the process fluid will mix with the loading fluid. Please alert your representative so an alternative product can be selected.

⚠ CAUTION

Installation of adequate overpressure protection is recommended to protect the regulator from overpressure and all downstream equipment from damage in the event of regulator failure.

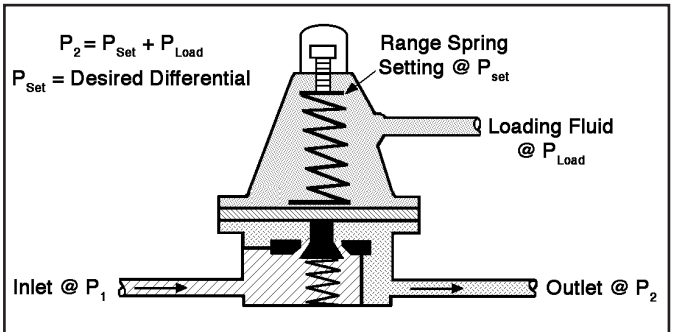
⚠ CAUTION

For welded installations, all internal trim parts, seals and diaphragm(s) must be removed from regulator body prior to welding into pipeline. The heat of fusion welding will damage non-metallic parts if not removed. NOTE: This does not apply to units equipped with extended pipe nipples.

SECTION III

III. PRINCIPLE OF OPERATION

1. The HP-1+6+S is used to maintain a constant differential pressure across the seals of a compressor/expander. A differential pressure reducing regulator senses the downstream or outlet (P_2) pressure on the lower side of the diaphragm and is opposed by the force of the range spring plus an additional loading (P_{LOAD}) pressure connected to the spring chamber. The loading (P_{LOAD}) pressure plus the range spring (14) setting (P_{SET}) equals the outlet (P_2) pressure of the regulator. The range spring setting (P_{SET}) is the differential setting.



HP-1+6+S DIFFERENTIAL SCHEMATIC

ISO 9001 Registered

2. A complete diaphragm failure will cause the regulator to fail open.

⚠ CAUTION B

Limit any field hydrostatic test to 1-1/2 times the Maximum Outlet and Spring Chamber Pressure Rating (See Table 2 in HP-S-DIFF TB). Ensure that the test pressure is applied uniformly to the body inlet, body outlet, and spring chamber.

SECTION IV

IV. STARTUP

REFER TO THE COMPRESSOR / EXPANDER MANUFACTURER'S MANUAL FOR DETAILED START-UP OF THIS UNIT.

**** NOTE:*** *Systems sequencing operations at startup, normal operation, failure mode(s), and shutdown must assure that the pressure (P_{Load}) on the spring chamber does not exceed the pressure registering on the wetted side of the diaphragm. Should this "pressure reversal" occur, particularly to metal diaphragms, the diaphragm may be permanently damaged and cause improper operation.*

$$P_1 > P_2 > P_{Load}$$

Pressure reversal is normally caused by the inlet pressure to a regulator being interrupted (automatically or manually).

1. On initial start-up with your system operating at normal conditions, check the differential gauge to ensure the desired differential pressure is being maintained. If not, go to step 2 and make one final adjustment. (This should only be necessary on first start-up.) ***NOTE:*** *It is crucial that the adjusting screw (6) threads not be damaged. Do not use any type of pliers on the adjusting screw (6).*

2. To adjust differential setting, use one of the two following methods: (***NOTE:*** *Both methods require a flowing condition.*)

   a. Loosen the closing cap (28) by turning CCW (as viewed from above) 3 to 4 complete revolutions. Loosen lock nut (7) by turning CCW until it is tight (double-nutted) against closing cap (28). Now the differential setting may be adjusted by turning the closing cap (28) CW to increase differential or CCW to decrease. After desired setting is reached, loosen lock nut (7) from closing cap (28) and tighten each securely to spring chamber (2).

   b. Remove closing cap (28) from adjusting screw (6) by turning CCW. Loosen lock nut (7) by turning CCW. Adjust the differential setting by turning the adjusting screw (6) CW to increase differential pressure or CCW to decrease. Tighten lock nut (7) securely to spring chamber (2). Replace closing cap (28) and tighten.

SECTION V

V. SHUTDOWN

REFER TO THE COMPRESSOR / EXPANDER MANUFACTURER'S MANUAL FOR DETAILED SHUTDOWN OF THIS UNIT.

SECTION VI

VI. MAINTENANCE

⚠ WARNING 1

SYSTEM UNDER PRESSURE. Prior to performing any maintenance, isolate the regulator from the system and relieve all pressure. Failure to do so could result in personal injury.

A. General:

1. Maintenance procedures hereinafter are based upon removal of the regulator unit from the pipeline where installed.

2. Owner should refer to owner's procedures for removal, handling, cleaning and disposal of nonreusable parts, i.e. gaskets, etc.

3. Refer to Figure 3 for view of regulator.

⚠ WARNING 2

SPRING UNDER COMPRESSION. Relieve spring compression prior to removing diaphragm flange bolts . Failure to so may result in flying parts that could cause personal injury.

⚠ CAUTION C

DO NOT ATTEMPT TO REMOVE ADJUSTING SCREW (6) FROM TOP OF SPRING CHAMBER (2). The adjusting screw (6) is threaded upward from inside the spring chamber (2). The CCW rotation used to relieve range spring (14) tension will come to a stop. At the stopping point, do not apply any torque to adjusting screw (6) or damage may occur and render the unit inoperable. See Figure 1.

B. Diaphragm Replacement:

1. Securely install the body (1) in a vise with the spring chamber (2) directed upwards.

2. To relieve range spring (14) compression, remove closing cap (28) by turning CCW. Remove lock nut (7) by turning CCW. Turn adjusting screw (6) CCW until range spring (14) compression is relieved. **NOTE: See CAUTION C)**.

3. Draw or embed a match mark between body (1) casting, body spacer (24), and spring chamber (2) casting along flanged area.

4. Remove all body flange hardware (9,23,34,35).

5. Remove spring chamber (2), range spring (14), spring button (4), pressure plate (3), body spacer (24), diaphragm (12), and o-rings (30).

⚠ CAUTION D

When body flange hardware (9,23,34,35) is removed from this unit it should always be replaced with new. The new hardware (9,23,34,35) must have the proper grade specification identification markings and meet the following standards:

1. **All cap screws (23) and flange stud nuts (9) must have "heavy hex heads".**
2. **All studs (34,35) and cap screws (23) must comply with or exceed the requirements of ASTM A-193, Grade B7.**
3. **All flange stud nuts (9) must comply with or exceed the requirements of ASTM A-194, Grade 2H.**

New body flange hardware (9,23,34,35) may be purchased from Cashco, Inc. or through the OEM.

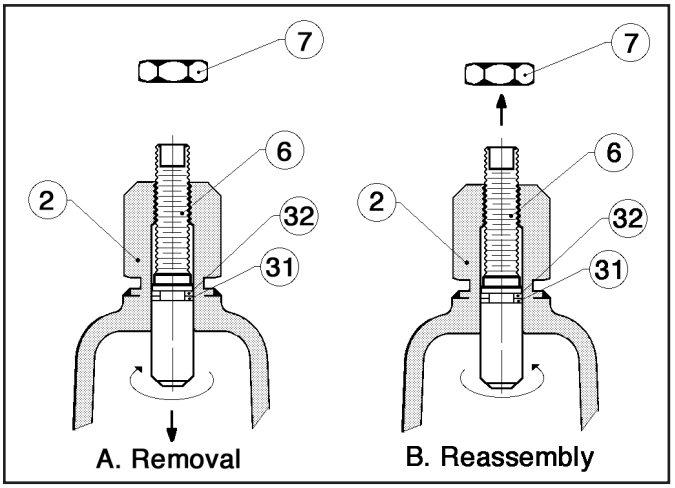


Figure 1: Adjusting screw (6) o-ring inspection.

6. **Adjusting screw (6) o-ring inspection**:

   a. With locknut (7) and closing cap (28) removed, turn adjusting screw (6) CW as far as possible by turning flats on top end. Carefully reach inside spring chamber (2) and grasp adjusting screw (6) by hand. ***NOTE:*** *For 1/2" (DN15) and 3/4" (DN20) size regulators a small piece of plastic tubing with a 3/4" (19 mm) inside diameter may be used to grasp the adjusting screw (6).* Complete adjusting screw (6) removal by rotating CCW. See Figure 1.

   b. Inspect the backup ring (32) and quad ring (31) for wear. If nicked or torn - replace. ***NOTE:*** *Make certain the teflon backup ring (32) will insert into spring chamber (2) before the quad ring (31). (See Figure 3 blow-up illustration). Make sure the quad ring (31) is on straight with no twist. Use a good grade lightweight grease on both ring seals (31,32).*

c. Lubricate adjusting screw (6) threads. Carefully reinstall the adjusting screw (6) up into the spring chamber (2) by rotating the adjusting screw (6) CW until top of adjusting screw (6) protrudes from top of spring chamber (2). ***NOTE:*** *Care should be taken when holding and rotating the adjusting screw (6) so the quad ring (31) and backup ring (32) are not inadvertently nicked or torn.* Grasp top of adjusting screw (6) and turn CCW until rotation stops **(see CAUTION C)**. See Figure 1.

d. Loosely install the lock nut (7) and closing cap (28).

7. Inspect pressure plate (3) for defects due to over-pressurization. Replace if defective.

8. Clean all parts to be re-used according to owner's procedures.

9. Place first o-ring (30) on body (1) and lubricate with a lightweight multi-purpose grease. Position body spacer (24) on body with match marks aligned. Place pusher plate (11) on body spacer (24) and check for vertical movement. ***NOTE:*** *The vertical movement should be free and unobstructed as the pusher plate (11) is pushed down and the lower piston spring (17) contracts and expands. If movement is not free, go to Subsection C following to inspect the inner trim parts.*

10. Place second o-ring (30) on body spacer (24) and lubricate with lightweight multi-purpose grease. Position diaphragm (12) on body spacer (24) inside of o-ring (30).

11. Visually center the pressure plate (3) on diaphragm (12). Place range spring (14) onto retainer hub of pressure plate (3).

12. Place multi-purpose, high temperature grease into depression of spring button (4) where adjusting screw (6) bears. Set spring button (4) onto range spring (14); ensure spring button (4) is laying flat.

13. Using "NEW" studs (34,35) and nuts (9) **(see CAUTION D)**, thread a nut onto each stud approximately 1.25" (32 mm). Drop the studs (34,35) with nuts (9) through the holes in spring chamber (2). (This will assist in keeping the spring chamber (2) centered on body (1) and prevent parts from moving during reassembly).

    Using the "match marks" made in Step 3 as a guide, replace spring chamber (2) onto body spacer (24). Thread on lower nuts (9) and tighten by hand. Adjust length of studs (34,35) by using the top nut (9) so that there are at least 3 to 4 threads protruding from the lower nut (9).

    Torque body flange hardware (9,23,34,35) using small increments in a 180° alternating pattern until flange mating surfaces of body (1), body spacer (24) and spring chamber (2) are metal to metal. This creates a "fixed compression" on the diaphragm (12) and o-ring (30) seals. Recommended torque values are listed in Table 1.

TABLE 1

Body Size in. (DN)	Item No.	Thread Size	Torque Values Ft-lbs	(N-m)
1/2"-1" (15-25)	9,23,34	3/8"-24	35-40	(47-54)
1-1/2" (40)	9,23,34,35	7/16"-20	55-60	(75-81)

14. With locknut (7) tight against closing cap (28), turn closing cap (28) CW until tension is applied to range spring (14).

15. Proceed to Section D. for bench test.

C. Trim Replacement:

NOTE: *Do not release tension on range spring (14). (Only necessary when removing spring chamber). The range spring (14) tension keeps pusher plate (11) in alignment and assures proper fit upon replacement of trim.*

1. Install body (1) in a vise with the body cap (5) on top and spring chamber (2) downwards.

2. Loosen and remove body cap (5). ***NOTE:*** *Piston spring (17) may stick in body cap (5) when removing.*

3. Remove piston spring (17), piston (15) and cylinder (16). Inspect parts for excessive wear, especially at piston (15) seat surface. Ensure there are no nicks or foreign particles embedded in the piston (15) TFE seat. Replace piston w/ TFE seat (15) if necessary. Inspect the backup ring (27) and quad ring (26) on piston (15). Replace rings if worn, nicked, or depressed.

4. Remove the body cap O-ring (25). Clean contacting surfaces of body (1) and body cap (5). Be careful not to scratch either surface. Inspect the inside surface of the body cap (5) for scratches or nicks. These could result in leakage past the quad ring (26) and backup ring (27). If worn or scratched replace body cap (5).

5. Clean debris from within the regulator body (1) cavity. Make certain the old cylinder gasket (18) is cleaned out of the body (1) recess. Clean all parts to be reused according to owner's procedures.

6. Reinstall a new cylinder gasket (18). Press firmly and evenly into place using the cylinder (16). Do not use a “homemade” cylinder gasket. Pipe sealant may be lightly coated to the gasket (18) surfaces prior to installation. Inspect to see that cylinder gasket (18) is completely pressed into place and cylinder (16) is centered with body cap (5) opening.

7. Install a new back up ring (27) and quad ring (26) on piston (15). Make certain the teflon back up ring (27) will insert the body cap (5) first, before the quad ring (26) (See Figure 3). Make sure the quad ring (26) is on straight with no twist**.** Use a good grade lightweight grease on both ring seals (26,27). Slide piston (15) into cylinder (16).

8. Place piston spring (17) into the cavity of the piston (15).

9. Insert new body cap o-ring (25) into groove of body cap (5). Use a good grade lightweight grease on body cap o-ring (25). Use pipe thread sealant applied to the body cap (5) threads. Screw body cap (5) into body (1). Impact until body cap (5) is metal to metal against body (1) at the body cap (5) shoulder.

D. Bench test for suitable operation (Test Fluid: Air or compressed gas).

NOTE: *Regulators are not tight shutoff devices. Even if pressure builds up beyond setpoint, a regulator may or may not develop tight shutoff.*

1. Check for internal trim leakage: With No. 1 shut-off valve closed and No. 2 shut-off valve cracked open, turn on inlet operating pressure. Follow instructions from SECTION IV-2. and set a differential pressure of 20 psig (1.4 Barg) in the downstream line (No. 2 Gauge). Close No. 2 shut-off valve and check for tight shutoff. ***NOTE:*** *Seat leakage not to exceed 15 bubbles per minute. Do not allow excessive buildup if seat leakage exists (crack open No. 2 shut-off valve to prevent buildup).* If seat leakage is excessive, proceed with the following steps to determine location of leak:

   a. Close No. 1 shut-off Valve.
   b. Turn off inlet operating pressure (P_1).
   c. Remove entire topworks per SECTION VI-B., steps 1-5.

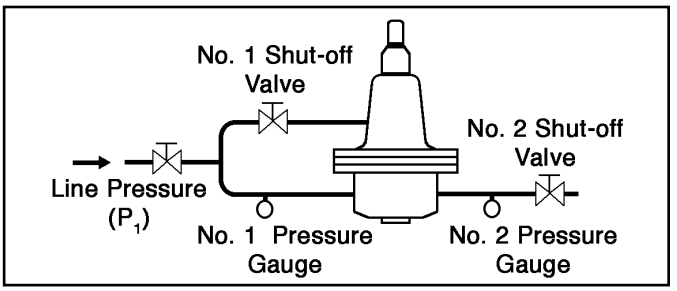


Figure 2: Recommended Bench Test Piping Schematic for HP-1+6+S

   e. Turn inlet operating pressure (P_1) on.
   f. Spray liquid leak detector in the space between cylinder (16) and body (1) to check for cylinder gasket (18) leakage.
   g. Pour a few drops into recess along piston post (15) to check for seat leakage.
   h. Fill the recess to check for quad ring (26) leakage.

   Once location of leak is detected, proceed to SECTION VII-6 for Cause/Remedy and SECTION VI-C. for internal trim replacement. After leak is remedied, proceed to SECTION VI-B., steps 8-15 to reassemble topworks.

2. Check regulator performance: With Step No. 1 conditions met, open and close No. 2 shut-off valve to check regulator's performance for smoothness and repeatability.

3. Proof test to check for external leakage:

   a. Build inlet pressure to 1-1/2 times maximum outlet pressure; but not to exceed 1-1/2 times the Max. Outlet and Spring Chamber Pressure Rating (See HP-S-DIFF TB, Table 2). Close No. 2 shut-off valve and crack open No. 1 shut-off valve until full inlet pressure exists in the spring chamber (2) and downstream line (No. 2 gauge will register same pressure as No. 1 gauge).

   b. Spray the entire regulator with a liquid leak detector and visually inspect for external leakage. Repair unit if leak is detected. See SECTION VI MAINTENANCE.

   c. To relieve all pressures simultaneously (preventing diaphragm (12) damage due to excessive ΔP across diaphragm (12)), crack open No. 2 shut-off valve and shut off inlet pressure. This will uniformly bleed off all pressure contained within the regulator.

4. Return to Section II for Installation and Section IV for Startup.

SECTION VII

VII. TROUBLE SHOOTING GUIDE

1. Erratic operation; chattering.

Possible Cause	Remedy
A. Oversized regulator; inadequate rangeability.	A1. Check actual flow conditions, resize regulator for minimum and maximum flow. A2. Increase flow rate. A3. Decrease regulator pressure drop; decrease inlet pressure by placing a throttling orifice in inlet piping union. A4. Install next step higher range spring. Contact factory. A5. Before replacing regulator, contact factory.
B. Worn piston; inadequate guiding.	B. Replace trim.
C. Weakened/broken piston spring.	C. Replace piston spring. Determine if corrosion is causing the failure. If so, consider NACE acceptable trims.
D. Unstable loading pressure.	D. Stabilize loading pressure; i.e. pump, control valve, etc.

2. Downstream pressure will not reach desired setting.

Possible Cause	Remedy
A. Regulator undersized;	A1. Confirm by opening bypass valve together with regulator. A2. Check actual flow conditions, resize regulator; if regulator has inadequate capacity, replace with larger unit.
B. Plugged trim.	B. Remove trim and check for plugged holes in cylinder.
C. Incorrect range spring (screwing in adjusting screw CW does not bring pressure up to proper level).	C. Replace range spring with proper higher range.Contact factory.
D. Too much proportional band (droop); outlet (P_2) pressure droops below load pressure (P_{LOAD}).	D1. Review Proportional Band (droop) expected. D2. Contact factory.
E. Restricted diaphragm movement.	E. Ensure no moisture in spring chamber at temperatures below freeze point.

3. Leakage through body spacer vent hole, or mixing of fluids.

Possible Cause	Remedy
A. Normal-life diaphragm failure.	A1. Replace diaphragm. A2. Check actual flow conditions, resize regulator; if regulator has inadequate capacity, replace with larger unit.
B. Abnormal short-life diaphragm failure.	B1. Can be caused by excessive chattering. See VII - 1. to remedy chatter. B2. Can be caused by corrosive action. Consider NACE acceptable trims. B3. Ensure not subjecting to over-temperature conditions. B4. Downstream outlet (P_2) pressure buildup occurring that overstresses diaphragms. Protect with safety relief valve. B5. Inlet (P_1) pressure valve is shutoff while loading (P_{LOAD}) pressure is still on.

4. Excessive pressure downstream.

Possible Cause	Remedy
A. Regulator not closing tightly.	A1. Inspect the seating. Replace if depressed, nicked or embedded with debris. A2. Inspect guides in body cap. If damaged, replace body cap and/or piston.
B. Downstream block.	B. Check system; isolate (block) flow at regulator inlet - not outlet. Relocate regulator if necessary.
C. No pressure relief protection.	C. Install safety relief valve, or rupture disc.
D. Restricted diaphragm movement.	D1. Ensure no moisture in spring chamber at temperatures below freeze point.

5 Sluggish operation.

	Possible Cause		Remedy
A.	Plugged body spacer vent hole.	A.	Clean vent opening.
B.	Plugged piston balance port.	B.	Remove trim and clean balance port.
C.	Fluid too viscous.	C.	Heat fluid. Contact factory.

6. Excessive seat leakage.

	Possible Cause		Remedy
A.	Foreign matter on seating surface, erosion of seating surface.	A.	Inspect and replace damaged parts.
B.	Quad ring/backup ring damaged, scratched body cap.	B.	Inspect and replace damaged parts.
C.	Cylinder gasket damaged.	C.	Inspect and replace damaged part.

SECTION VIII

VIII. ORDERING INFORMATION:
NEW REPLACEMENT UNIT vs PARTS "KIT" FOR FIELD REPAIR

To obtain a quotation or place an order, please retrieve the Serial Number and Product Code that was stamped on the metal name plate and attached to the unit. This information can also be found on the Bill of Material (parts list) that was provided when unit was originally shipped.) (Serial Number typically 6 digits). Product Code typical format as follows: (last digit is alpha character that reflects revision level for the product).

□□□-□□□7-□□□□□□□□□

NEW REPLACEMENT UNIT:

Contact your local Cashco, Inc., Sales Representative with the Serial Number and Product code. With this information they can provide a quotation for a new unit including a complete description, price and availability.

⚠ CAUTION

Do not attempt to alter the original construction of any unit without assistance and approval from the factory. All purposed changes will require a new name plate with appropriate ratings and new product code to accomodate the recommended part(s) changes.

PARTS "KIT" for FIELD REPAIR:

Contact your local Cashco, Inc., Sales Representative with the Serial Number and Product code. Identify the parts and the quantity required to repair the unit from the Bill of Materials sheet that was provided when unit was originally shipped.

NOTE: *Those part numbers that have a quantity indicated under "Spare Parts" in column "A" reflect minimum parts required for inspection and rebuild, - "Soft Goods Kit". Those in column "B" include minimum trim replacement parts needed plus those "Soft Goods" parts from column "A".*

If the "BOM" is not available, refer to the cross-sectional drawings included in this manual for part identification and selection.

Local Sales Representative will provide quotation for appropriate Kit Number, Price and Availability.

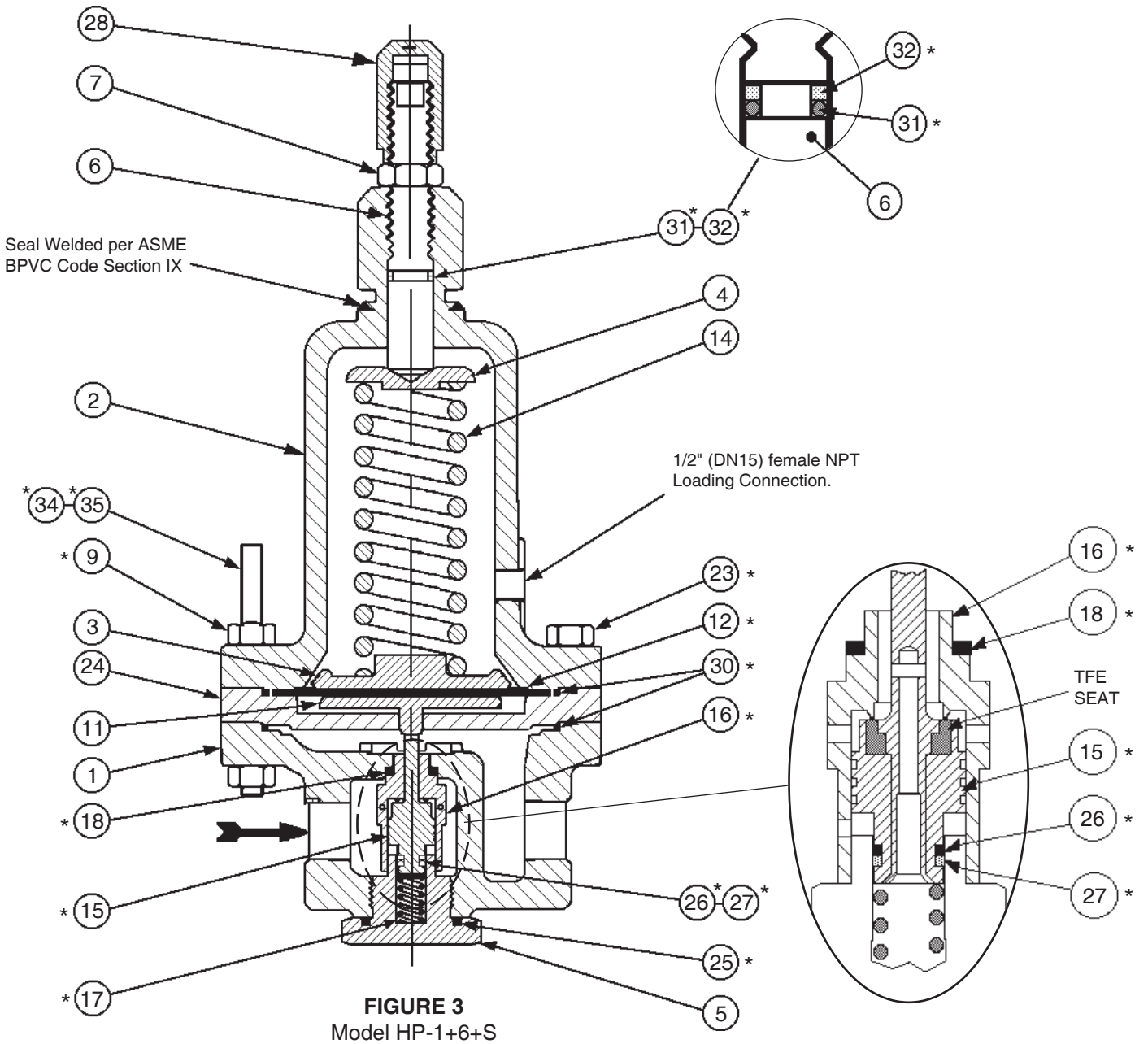


FIGURE 3
Model HP-1+6+S

Item No.	Description	Repair Parts
1	Body	
2	Spring Chamber	
3	Pressure Plate	
4	Spring Button	
5	Body Cap	
6	Adjusting Screw	
7	Lock Nut	
9	Flange Stud Nut	*
11	Pusher Plate	
12	Diaphragm	*
14	Range Spring	

Item No.	Description	Repair Parts
15	Piston w/ TFE Seat	*
16	Cylinder	*
17	Piston Spring	*
18	Cylinder Gasket	*
23	Cap Screw	*
24	Body Spacer	
25	Body Cap O-Ring	*
26	Quad Ring	*
27	Backup Ring	*
28	Closing Cap	
30	O-ring (2 req'd)	*
31	Quad Ring	*
32	Backup Ring	*
34	Stud	*
35	Stud	*

Cashco, Inc.
P.O. Box 6.
Ellsworth, KS 67439-0006
PH (785) 472-4461
Fax. (785) 472-3539
www.cashco.com
E-mail: sales@cashco.com
exportsales@cashco.com
Printed in U.S.A. IOM-HP-S-DIFF

1/16 DIN Controller with HBA
Quick Start Manual (0037-75487 rev2)

CAUTION: Installation should be only performed by technically competent personnel. Local Regulations regarding electrical installation & safety must be observed.

1. INSTALLATION

Installing Option Modules

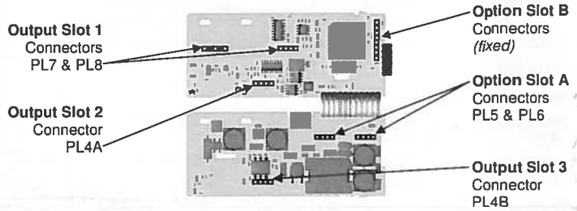


To access modules 1 or A, first detach the PSU and CPU boards from the front by lifting first the upper, and then lower mounting struts. Gently separate the boards.

a. Plug the required option modules into the correct connectors, as shown below.
b. Locate the module tongues in the corresponding slot on the opposite board.
c. Hold the main boards together while relocating back on the mounting struts.
d. Replace the instrument by aligning the CPU and PSU boards with their guides in the housing, then slowly push the instrument back into position.

Note: Option modules are automatically detected at power up.

Option Module Connectors



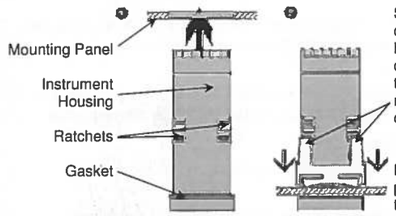
Panel-Mounting

The mounting panel must be rigid, and may be up to 6.0mm (0.25inch) thick.

For *n* multiple instruments mounted side-by-side, cut-out is 48*n*-4mm wide.



Tolerance +0.5, -0.0mm



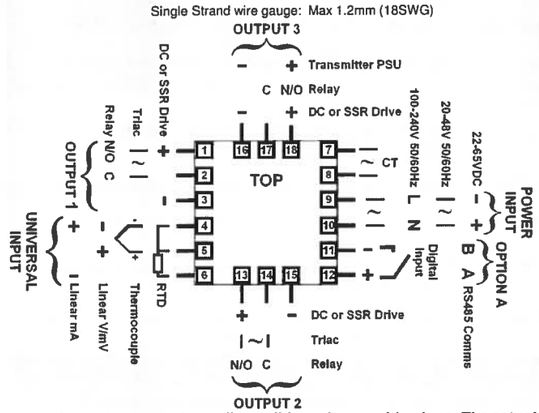
Slide mounting clamp over the instrument housing towards rear face of mounting panel until the tongues engage in ratchets and instrument is clamped in position.

Hold instrument firmly in position (apply pressure to bezel only)

CAUTION: Do not remove the panel gasket; it is a seal against dust and moisture.

Rear Terminal Wiring

USE COPPER CONDUCTORS (EXCEPT FOR T/C INPUT)
Single Strand wire gauge: Max 1.2mm (18SWG)



These diagrams show all possible option combinations. The actual connections required depends on the exact model and options fitted.

CAUTION: Check information label on housing for correct operating voltage before connecting supply to Power Input
Fuse: 100 – 240V ac – 1amp anti-surge
24/48V ac/dc – 315mA anti-surge

Note: At first power-up the message Goto Conf is displayed, as described in section 7 of this manual. Access to other menus is denied until configuration mode is completed.

2. SELECT MODE

Select mode is used to access the configuration and operation menu functions.
It can be accessed at any time by holding down ↻ and pressing ↑.
In select mode, press ↑ or ↓ to choose the required mode, press ↻ to enter.
An unlock code is required to prevent unauthorised entry to Configuration, & Setup modes. Press ↑ or ↓ to enter the unlock code, then press ↻ to proceed.

Mode	Upper Display	Lower Display	Description	Default Unlock Codes
Operator	OPEr	SLCt	Normal operation	None
Set Up	SEtP	SLCt	Tailor settings to the application	10
Configuration	Conf	SLCt	Configure the instrument for use	20
Product Info	inFo	SLCt	Check manufacturing information	None
Auto-Tuning	AtUn	SLCt	Invoke Pre-Tune or Self-Tune	0

Note: The instrument will always return automatically to Operator mode if there is no key activity for 2 minutes.

3. CONFIGURATION MODE

First select Configuration mode from Select mode *(refer to section 2)*.
Press ↻ to scroll through the parameters, then press ↑ or ↓ to set the required value. Press MAN/AUTO to accept the change, otherwise parameter will revert to previous value. To exit from Configuration mode, hold down ↻ and press ↑, to return to Select mode.

Note: Parameters displayed depends on how instrument has been configured. Refer to user guide (available from your supplier) for further details. Parameters marked * are repeated in Setup Mode.

Parameter	Lower Display	Upper Display	Adjustment range & Description	Default Value
Input Range/Type	inPt	See following table for possible codes		JF

Code	Input Type & Range	Code	Input Type & Range	Code	Input Type & Range
bC	B: 100 - 1824 °C	H.C	K: –128.8 - 537.7 °C	P24F	PtRh20% vs 40%: 32 - 3362 °F
bF	B: 211 - 3315 °F	H.F	K: –199.9 - 999.9 °F	PtC	Pt100: –199 - 800 °C
CC	C: 0 - 2320 °C	nC	N: 0 - 1399 °C	PtF	Pt100: –328 - 1472 °F
CF	C: 32 - 4208 °F	nF	N: 32 - 2551 °F	Pt.C	Pt100: –128.8 - 537.7 °C
EC	E: –200 - 1000 °C	rC	R: 0 - 1759 °C	Pt.F	Pt100: –199.9 - 999.9 °F
EF	E: –400 – 1832 °F	rF	R: 32 - 3198 °F	0.20	0 - 20 mA DC
E.C	E: –199.0 – 999.0 °C	SC	S: 0 - 1762 °C	4.20	4 - 20 mA DC
E.F	E: –199.0 – 999.0 °F	SF	S: 32 - 3204 °F	0.50	0 - 50 mV DC
JC	J: –200 - 1200 °C	tC	T: –240 - 400 °C	10.50	10 - 50 mV DC
JF	J: –328 - 2192 °F	tF	T: –400 - 752 °F	0.5	0 - 5 V DC
J.C	J: –128.8 - 537.7 °C	t.C	T: –128.8 - 400.0 °C	1.5	1 - 5 V DC
J.F	J: –199.9 - 999.9 °F	t.F	T: –199.9 - 752.0 °F	0. 10	0 - 10 V DC
KC	K: –240 - 1373 °C	P24C	PtRh20% vs. 40%: 0 - 1850 °C	2. 10	2 - 10 V DC
KF	K: –400 - 2503 °F				

Note: Decimal point shown in table indicates temperature resolution of 0.1 °

Parameter	Lower Display	Upper Display	Adjustment range & Description	Default Value
Scale Range Upper Limit	rUL	Scale Range Lower Limit +100 to Range Maximum		Range max (Lin=1000)
Scale Range Lower Limit	rLL	Range Minimum to Scale Range Upper Limit -100		Range min (Linear=0)
Decimal Point Position	dPoS	0=XXXX, 1=XXX.X, 2=XX.XX, 3=X.XXX (non-temperature ranges only)		1
Control Type	CtyP	SnGL	Primary only	SnGL
		duAL	Primary & Secondary (e.g. heat & cool)	
Primary Output Control Action	Ctrl	rEu	Reverse Acting	rEu
		dir	Direct Acting	
Alarm 1Type	AL1	P_H	Process High Alarm	P_H
		P_Lo	Process Low Alarm	
		dE	Deviation Alarm	
		bAnd	Band Alarm	
		nonE	No alarm	
High Alarm 1 Value*	PhA1	Range Minimum to Range Maximum in display units		Range Max
Low Alarm 1 Value*	PLA1			Range Min
Band Alarm 1 Value*	bAL1	1 LSD to span from setpoint in display units		5
Dev. Alarm 1 Value*	dAL1	+/- Span from setpoint in display units		5
Alarm 1 Hysteresis*	AHY1	1 LSD to full span in display units		1
Alarm 2 Type*	AL2	Options as for alarm 1		P_Lo
High Alarm 2 Value*	PhA2			Range Max
Low Alarm 2 Value*	PLA2			Range Min
Band Alarm 2 Value*	bAL2			5
Dev. Alarm 2 Value*	dAL2			5
Alarm 2 Hysteresis*	AHY2			1
Loop Alarm Time Type	LAEn	dISA (disabled), Auto (2x ArSt time) or MAn (LAt time value)		dISA
Manual Loop Alarm Time*	LAt	0.01 to 99.59 (1s to 99m 59s)		99.59
Alarm Inhibit	Inh	nonE	No alarms Inhibited	nonE
		AL1	Alarm 1 inhibited	
		AL2	Alarm 2 inhibited	
		both	Alarm 1 and alarm 2 inhibited	
Output 1 Usage	USE1	Pr	Primary Power	Pr
		SEc	Secondary Power	
		A1_d	Alarm 1, Direct	
		A1_r	Alarm 1, Reverse	
		A2_d	Alarm 2, Direct	
		A2_r	Alarm 2, Reverse	
		LP_d	Loop Alarm, Direct	
		LP_r	Loop Alarm, Reverse	
		Or_d	Logical Alarm 1 OR 2, Direct	
		Or_r	Logical Alarm 1 OR 2, Reverse	
		Ad_d	Logical Alarm 1 AND 2, Direct	
		Ad_r	Logical Alarm 1 AND 2, Reverse	
		rEtS	Retransmit SP Output	
		rEtP	Retransmit PV Output	
		hb_d	Heater Break Alarm Direct	
		hb_r	Heater Break Alarm Reverse	
		AnyD	Any Alarm Direct	
		AnyR	Any Alarm Reverse	
Linear Output 1 Range	tyP1	0_5	0 to 5 V DC output	0_10
		0_10	0 to 10 V DC output	
		2_10	2 to 10 V DC output	
		0_20	0 to 20 mA DC output	
		4_20	4 to 20 mA DC output	
Retransmit Output 1 Scale Maximum	roIH	-1999 to 9999 (display value at which output will be maximum)		Range max
Retransmit Output 1 Scale Minimum	roIL	-1999 to 9999 (display value at which output will be minimum)		Range min
Output 2 Usage	USE2	As for output 1		Sec or AI2
Linear Output 2 Range	tyP2	As for output 1		0_10
Retransmit Output 2 Scale Maximum	ro2H	-1999 to 9999 (display value at which output will be maximum)		Range max
Retransmit Output 2 Scale Minimum	ro2L	-1999 to 9999 (display value at which output will be minimum)		Range min
Output 3 Usage	USE3	As for output 1		AI_d

Parameter	Lower Display	Upper Display	Adjustment range & Description	Default Value
Linear Output 3 Range	tyP3	As for output 1		0_10
Retransmit Output 3 Scale Maximum	ro3H	-1999 to 9999 (display value at which output will be maximum)		Range max
Retransmit Output 3 Scale Minimum	ro3L	-1999 to 9999 (display value at which output will be minimum)		Range min
Display Strategy	diSP	1, 2, 3, 4, 5 or 6 *(refer to section 8)*		1
Serial Communications Protocol	Prot	Mbn	Modbus with no parity	Mbn
		MbE	Modbus with Even Parity	
		Mbo	Modbus with Odd Parity	
Serial Communications Bit Rate	bAud	1.2	1.2 kbps	4.8
		2.4	2.4 kbps	
		4.8	4.8 kbps	
		9.6	9.6 kbps	
		19.2	19.2 kbps	
Comms Address	Addr	1	1 to 255	1
Comms Write	CoEn	r_W	Read/Write	r_W
		r_O	Read only	
Digital Input 1 Usage	diG1	dIS1	Setpoint 1 / Setpoint 2 select	dIS1
		dIAS	Automatic / Manual select	
Configuration Lock Code	CLoc	0 to 9999		20

4. SETUP MODE

Note: Configuration must be completed before adjusting Setup parameters.
First select Setup mode from Select mode *(refer to section 2)*. The MAN LED will light while in Setup mode. Press ↻ to scroll through the parameters, then press ↑ or ↓ to set the required value.
To exit from Setup mode, hold down ↻ and press ↑ to return to Select mode.
Note: Parameters displayed depends on how instrument has been configured.

Parameter	Lower Display	Upper Display Adjustment Range & Description	Default Value
Input Filter Time Constant	FiLt	OFF or 0.5 to 100.0 secs	2.0
Process Variable Offset	OFFS	±Span of controller	0
Primary Power	PPoW	Current power levels *(read only)*	N/A
Secondary Power	SPoW		
Primary Proportional Band	Pb_P	0.0% (ON/OFF) and 0.5% to 999.9% of input span	10.0
Secondary Proportional Band	Pb_S		
Automatic Reset (Integral Time)	ArSt	1 sec to 99 mins 59 secs and OFF	5.00
Rate (Derivative Time)	rAtE	00 secs to 99 mins 59 secs	1.15
Overlap/Deadband	OL	-20 to +20% of Primary and Secondary Proportional Band	0
Manual Reset (Bias)	bIAS	0%*(-100% if dual control)* to 100%	25
Primary ON/OFF Differential	dIFP	0.1% to 10.0% of input span centered about the setpoint. (*Entered as a percentage of span*)	0.5
Secondary ON/OFF Diff.	dIFS		
Prim. & Sec. ON/OFF Differential	dIFF		
Setpoint Upper Limit	SPuL	Current Setpoint to Range max	R/max
Setpoint Lower limit	SPLL	Range min to Current Setpoint	R/min
Primary Output Power Limit	OPuL	0% to 100% of full power	100
Output 1 Cycle Time	Ct1	0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256 or 512 secs.	32
Output 2 Cycle Time	Ct2		
Output 3 Cycle Time	Ct3		
High Alarm 1 Value	PhA1	Range Minimum to Range Maximum	R/max
Low Alarm 1 Value	PLA1		R/min
Deviation Alarm 1 Value	dAL1	±Span from SP in display units	5
Band Alarm 1 Value	bAL1	1 LSD to span from setpoint	5
Alarm 1 Hysteresis	AHY1	1 LSD to full span in display units	1
High Alarm 2 Value	PhA2	Range Minimum to Range Maximum	R/max
Low Alarm 2 Value	PLA2		R/min
Deviation Alarm 2 Value	dAL2	±Span from SP in display units	5
Band Alarm 2 Value	bAL2	1 LSD to span from setpoint	5
Alarm 2 Hysteresis	AHY2	1 LSD to full span in display units	1
Manual Loop Alarm Time*	LAt	0.01 to 99.59 (1s to 99m 59s)	99.59
Auto Pre-tune	APt	dISA (disabled) or EnAb (enabled)	dISA
Auto/Manual Control Selection	PoEn		
Setpoint Select Shown In Operator Mode	SSEn		
Setpoint Ramp Adjustment Shown In Operator Mode	SPr	dISA (disabled) or EnAb (enabled)	dISA

Continued on next page...

Parameter	Lower Display	Upper Display Adjustment Range & Description	Default Value
SP Ramp Rate Value	rP	1 to 9999 units/hour or Off (blank)	Off
Setpoint Increment Value	SP in	0 to +input span	1
Programmable Sensor Break	PSb	d iSA (disabled) or EnAb (enabled)	EnAb
Preset Power Output	PPo	0%*(-100% if dual control)* to 100%	0
Heater Current High Scale Limit	HtrH	10.0 to 100.0	50.0
Low Heater Break Alarm Value	L_hb	0 to Heater Current High Scale Limit	0.0
High Heater Break Alarm Value	H_hb		0.0
Short Circuit Heater Break Alarm	S_hb	d iSA (disabled) or EnAb (enabled)	EnAb
Soft Start Setpoint	SSSP	Setpoint upper limit to setpoint lower limit*	R/min
Soft Start Time	SSt i	0 to 99min 59secs	0
Soft Start Output Power Limit	SSOL	0 to Output Power Limit	Output Power Limit
Setpoint Value	SP	Scale range upper to lower limits. (when dual or remote setpoint options are used, SP is replaced by SP 1 or SP2 - or = before the legend indicates the currently active SP)	Scale Range Minimum
Setpoint 1 Value	_SP 1		
Setpoint 2 Value	_SP2		
Setup Lock Code	SLoc	0 to 9999	10

Note: Soft start will not run if the process variable is greater than the soft start setpoint. Soft start will be held if Pre-tune does not complete by the soft start time

5. AUTOMATIC TUNING MODE

First select Automatic tuning mode from Select mode *(refer to section 2).*
Press ↻ to scroll through the modes, then press ↑ or ↓ to set the required value.
To exit from Automatic tuning mode, hold down ↻ and press ↑, to return to Select mode.
Pre-tune is a single-shot routine and is thus self-disengaging when complete.
If APt in Setup mode = EnAb, Pre-tune will attempt to run at every power up*.
Refer to the full user guide (available from your supplier) for details on controller tuning.

Parameter	Lower Display	Upper Display	Default Value
Pre-Tune	Ptun	On or OFF. Indication remains OFF if automatic tuning cannot be used at this time*	OFF
Self-Tune	Stun		
Tune Lock	tLoc	0 to 9999	0

**** Note: Automatic tuning will not engage if either proportional band = 0. Also, Pre-tune will not engage if setpoint is ramping, the PV is less than 5% of input span from the setpoint.***

6. PRODUCT INFORMATION MODE

First select Product information mode from Select mode *(refer to section 2).*
Press ↻ to view each parameter. To exit from Product Information mode, hold down ↻ and press ↑ to return to Select mode.
Note: These parameters are all read only.

Parameter	Lower Display	Upper Display	Description
Input type	In_1	Un i	Universal input
Output 1 Module Type Fitted	OPn1	nonE	No option fitted
		rLY	Relay output
		SSr	SSR drive output
		tr i	Triac output
		L in	Linear DC voltage / current output
Output 2 Module Type Fitted	OPn2	As Option 1	
Output 3 Module Type Fitted	OPn3	nonE	No option fitted
		rLY	Relay output
		SSr	SSR drive output
		L in	Linear DC voltage / current output
		dc24	Transmitter power supply
Auxiliary Option A Module Type Fitted	OPnA	nonE	No option fitted
		r485	RS485 communications
		d iG i	Digital Input*
Auxiliary Option B Module Type Fitted	OPnb	nonE	No option fitted
		HC iP	Heater Current input
Firmware Type	FWJ	Value displayed is firmware type number	
Firmware Issue	ISS	Value displayed is firmware issue number	
Product Revision Level	PrL	Value displayed is Product Revision level	

Parameter	Lower Display	Upper Display	Description
Date Of Manufacture	dOM		Manufacturing date code *(mmyy)*
Serial Number 1	Sn 1		First four digits of serial number
Serial Number 2	Sn2		Middle four digits of serial number
Serial Number 3	Sn3		Last four digits of serial number

7. MESSAGES & ERROR INDICATIONS

These messages indicate that an error has occurred or there is a problem with the process variable input signal or its wiring.
Caution: Do not continue with the process until the issue is resolved.

Parameter	Upper Display	Lower Display	Description
Instrument Parameters Are In Default Conditions	Goto	ConF	Configuration & Setup required. This screen is seen at first turn on, or if hardware configuration has been changed. Press ↻ to enter the Configuration Mode, next press ↑ or ↓ to enter the unlock code number, then press ↻ to proceed
Automatic Loop Alarm Overridden	AErr	LAEn	Loop Alarm set for Auto but Pb_P is set to 0.0% (ON/OFF control). Loop Alarm uses the manual Loop Alarm Time until PID control is restored. Ensure LAt i is set correctly
Input Over Range	CHHJ	Normal	Process variable input > 5% over-range
Input Under Range	CLLJ	Normal	Process variable input > 5% under-range
Input Sensor Break	OPEN	Normal	Break detected in process variable input sensor or wiring
Output 1 Error	Err	OPn1	Output 1 module fault
Output 2 Error		OPn2	Output 2 module fault
Output 3 Error		OPn3	Output 3 module fault
Option A Error		OPnA	Option A module fault
Option B Error		OPnb	Option B module fault

8. OPERATOR MODE

This mode is entered at power on, or accessed from Select mode *(see section 2).*
Note: All Configuration mode and Setup mode parameters must be set as required before starting normal operations.
Press ↻ to scroll through the parameters, then press ↑ or ↓ to set the required value.
Note: All Operator Mode parameters in Display strategy 6 are read only (see d iSP in configuration mode), they can only be adjusted via Setup mode.

Upper Display	Lower Display	Display Strategy and When Visible	Description
PV Value	Active SP Value	1 & 2 *(initial screen)*	PV and target value of selected SP *Local Setpoints are adjustable in Strategy 2*
PV Value	Actual SP Value	3 & 6 *(initial screen)*	PV and actual value of selected SP (e.g. ramping SP value). *Read only*
PV Value	Heater Current	1 & 2 *(initial screen)*	PV and heater current value. ---A shown when soft start running
PV Value	*(Blank)*	4 *(initial screen)*	Process variable only *Read only*
Active SP Value	*(Blank)*	5 *(initial screen)*	Target value of selected setpoint only. *Read only*
SP1 Value	_SP 1	- lit if active SP = SP1	Target value of SP1 *Adjustable except in Strategy 6*
SP2 Value	_SP2	- lit if active SP = SP2	Target value of SP2 *Adjustable except in Strategy 6*
Actual SP Value	SPrP	rP is not blank	Actual (ramping) value of selected SP. *Read only*
Ramp Rate	rP	SPr enabled in Setup mode	SP ramping rate, in units per hour *Adjustable except in Strategy 6*
Soft Start Time Remaining	SSrE	Only visible when soft start is running	The time remaining until soft start finishes
Active Alarm Status	ALSt	When one or more alarms are active. ALM indicator will also flash	Alarm 2 active / Alarm 1 active / Loop Alarm active L / Short Circuit Alarm S / High HB Alarm H / Low HB Alarm L

Manual Control

If PoEn is set to EnAb in Setup mode, manual control can be selected/de-selected by pressing the MAN/AUTO key in Operator mode, or by changing the status of a digital input if d iG i has been configured for d iAS in Configuration mode.
While in Manual Control mode, the MAN indicator will flash and the lower display will show Pxxx (where xxx is the current manual power level). Switching to/from manual mode is via Bumpless Transfer. Press ↑ or ↓ to set the required output power.
Caution: Manual power level is not restricted by the OPuL or SSOL power limit

9. SOFT START FEATURE

Soft start is used when a gentle start-up phase is required before rising to the full working temperature. During soft-start, a dedicated soft start setpoint (SSSP) is used that controls the process to a lower temperature. The period for which the soft start setpoint is applied is set by Soft Start Time (SSt i). During the soft start time the output power is limited by the Soft Start Output Power Limit (SSOL) and setpoint ramping is inhibited.

Start-up Setpoint: Bounded by Scale Range Maximum and Scale Range Minimum. Setpoint ramping is not applied

Time Remaining: 0 (Soft start disabled) to 99mins 59secs in 1 second increments

Soft Start Power Limit: Primary output power limit used during soft start -100% to 100%

Cycle Time: Cycle time used during soft start equals ¼ displayed cycle time, but is never less than 0.5 seconds.

Operating mode: Assumes reverse-acting control. Heater current monitoring is suspended while soft start is running.

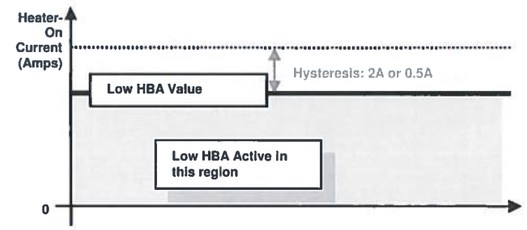
10. PROGRAMMABLE SENSOR BREAK

When the Programmable Sensor Break feature is enabled, and a sensor break is detected, the output is set to an average power value calculated by the instrument. When the Programmable Sensor Break (PSb) feature is disabled, and a sensor break is detected, the output is set to the Preset Power Output value (PPo).

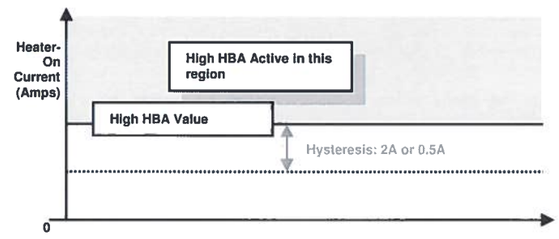
11. HEATER BREAK ALARMS

The heater current monitor is used to diagnose faults in the heater elements. A Low Heater Break Alarm is typically used for early detection of heater element failure; it detects whether the heater current is lower than it should be. A High Heater Break Alarm can sometimes be useful for detecting partial shorts between heater elements, etc; it detects whether the heater current is higher than it should be. Short Circuit Heater Break Alarm is typically used to detect if the heater control device is stuck in the ON condition - welded relay contacts, failed SSR etc. This alarm is based on the heater current acquired whilst the Output is off. When soft start is running Heater current monitoring is suspended. This is because for soft start the output is cycled very fast, and a valid heater current reading may not be possible.

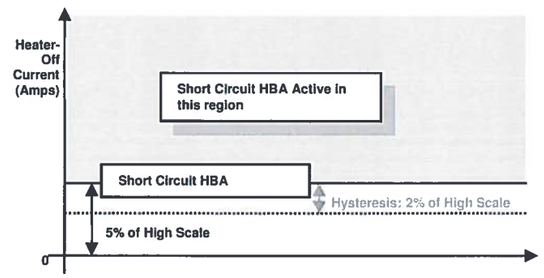
Low Heater Break Alarm



High Heater Break Alarm



Short Circuit Heater Break Alarm



12. SERIAL COMMUNICATIONS

Refer to the full user guide (available from your supplier) for details.

13. SPECIFICATIONS

UNIVERSAL INPUT

Thermocouple Calibration: ±0.1% of full range, ±1LSD (±1°C for Thermocouple CJC). BS4937, NBS125 & IEC584. Linearization better than ±0.2°C any point, for 0.1° resolution ranges (±0.05°C typical). Better than ±0.5°C any point, for 1° resolution ranges. NOTE: Reduced performance for B thermocouple from 100 to 600°C NOTE: Reduced performance for E thermocouple below -100°C

PT100 Calibration: ±0.1% of full range, ±1LSD. BS1904 & DIN43760 *(0.00385Ω/Ω/°C).*

DC Calibration: ±0.1% of full range, ±1LSD.

Sampling Rate: 4 per second.

Impedance: >10MΩ resistive, except DC mA (5Ω) and V (47kΩ).

Sensor Break Detection: Thermocouple, RTD, 4 to 20 mA, 2 to 10V and 1 to 5V ranges only. *Control outputs go to a calculated average power value or to the programmable output power.*

Isolation: Isolated from all outputs (except SSR driver).
Universal input must not be connected to operator accessible circuits if relay outputs are connected to a hazardous voltage source. Supplementary insulation or input grounding would then be required.

HEATER CURRENT INPUT

Accuracy: ±2% of input range ±1 LSD.

Sampling Rate: 2 per second.

Internal burden: 15Ω

Heater current span: 0 to 50mA, rms (sinusoidal input waveform). Scaleable up to 100A

Isolation: Via external current transformer.

DIGITAL INPUTS

Volt-free(or TTL): Open (2 to 24VDC) = SP1, Local SP or Auto Mode, Closed (<0.8VDC) = SP2, Remote SP or Manual Mode.

Isolation: Reinforced safety isolation from inputs and other outputs.

OUTPUTS

Relay

Contact Type & Rating: Single pole (SP); 2A resistive at 120/240VAC.

Lifetime: >500,000 operations at rated voltage/current.

Isolation: Isolated from input and other outputs.

SSR Driver

Drive Capability: SSR drive voltage >10V into 500Ω min.

Isolation: Not isolated from universal input or other SSR driver outputs.

Triac

Operating Voltage: 20 to 280Vrms (47 to 63Hz).

Current Rating: 0.01 to 1A (full cycle rms on-state @ 25°C); derates linearly above 40°C to 0.5A @ 80°C.

Isolation: Reinforced safety isolation from inputs and other outputs.

Linear DC

Resolution: 8 bits in 250mS (10 bits in 1s typical, >10 bits in >1s typical).

Isolation: Reinforced safety isolation from inputs and other outputs.

Transmitter PSU

Power Rating: 19 to 28V DC (24V nominal) into 910Ω minimum resistance.

Isolation: Reinforced safety isolation from inputs and other outputs.

SERIAL COMMUNICATIONS

Physical: RS485, at 1200, 2400, 4800, 9600 or 19200 bps.

Protocols: Modbus/RTU.

Isolation: Reinforced safety isolation from all inputs and outputs.

OPERATING CONDITIONS (FOR INDOOR USE)

Ambient Temperature: 0°C to 55°C (Operating), –20°C to 80°C (Storage).

Relative Humidity: 20% to 95% non-condensing.

Supply Voltage and Power: 100 to 240VAC ±10%, 50/60Hz, 7.5VA *(for mains powered versions)*, or 20 to 48VAC 50/60Hz 7.5VA or 22 to 65VDC 5W *(for low voltage versions)*.

ENVIRONMENTAL

Standards: CE, UL, ULC.

EMI: Complies with EN61326 (Susceptibility & Emissions).

Safety Considerations: Complies with EN61010-1 & UL3121. Pollution Degree 2, Installation Category II.

Front Panel Sealing: To IP66 (IP20 behind the panel).

PHYSICAL

Front Bezel Size: 48 x 48mm

Depth Behind Panel: 110mm

Weight: 0.21kg maximum.

0037-75487 rev2
PK506
June 2014

1/16 - 1/8 - 1/4 DIN Temperature / Process Controller Quick Start Manual (0037-75484 rev2)

CAUTION: Installation should be only performed by technically competent personnel. It is the responsibility of the installing engineer to ensure that the configuration is safe. Local regulations regarding electrical installation & safety must be observed - e.g. US National Electrical Code (NEC) and/or Canadian Electrical Code. Impairment of protection will occur if the product is used in a manner not specified by the manufacturer.

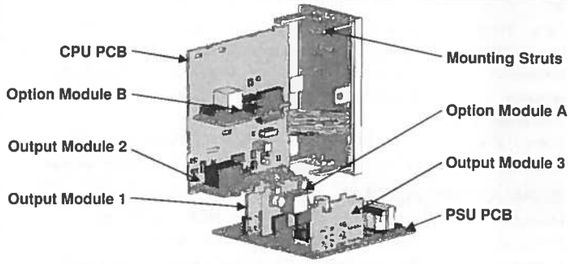
1. INSTALLATION

Some installation details vary between the three model sizes covered by this manual *(refer to section 10)*. These differences have been clearly shown.

Installing Option Modules: 1/16 Din Size Instruments



Installing Option Modules: 1/8 & 1/4 Din Size Instruments

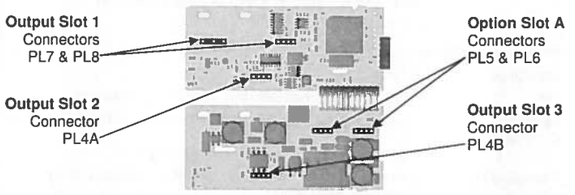


To access modules 1, A or B, first detach the PSU and CPU boards from the front by lifting first the upper, and then lower mounting struts. Gently separate the boards.

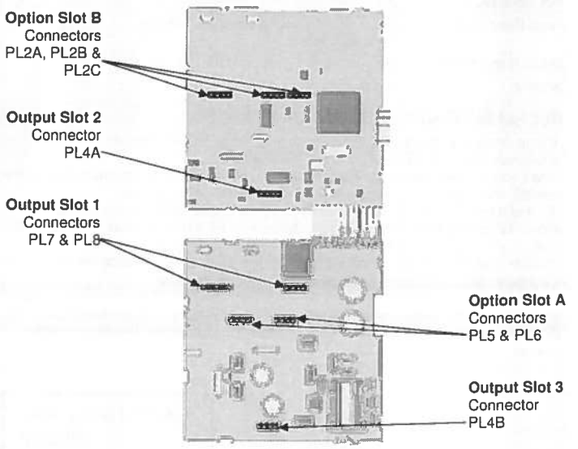
a. Plug the required option modules into the correct connectors, as shown below.
b. Locate the module tongues in the corresponding slot on the opposite board.
c. Hold the main boards together while relocating back on the mounting struts.
d. Replace the instrument by aligning the CPU and PSU boards with their guides in the housing, then slowly push the instrument back into position.

Note: Option modules are automatically detected at power up.

Option Module Connectors: 1/16 Din Size Instruments



Option Module Connectors: 1/8 & 1/4 Din Size Instruments

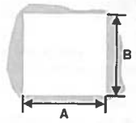


Panel-Mounting

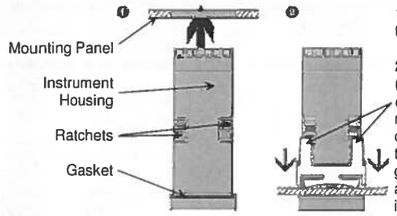
The mounting panel must be rigid, and may be up to 6.0mm (0.25inch) thick. Cut-out sizes are:

Cut-Out Dim A	Cut-Out Dim B
1/16 & 1/8 Din = 45mm	1/16 Din = 45mm
1/4 Din = 92mm	1/8 & 1/4 Din = 92mm

For *n* multiple instruments mounted side-by-side, cut-out A is 48*n*-4mm (1/16 & 1/8 Din) or 96*n*-4mm (1/4 Din)



Tolerance +0.5, -0.0mm



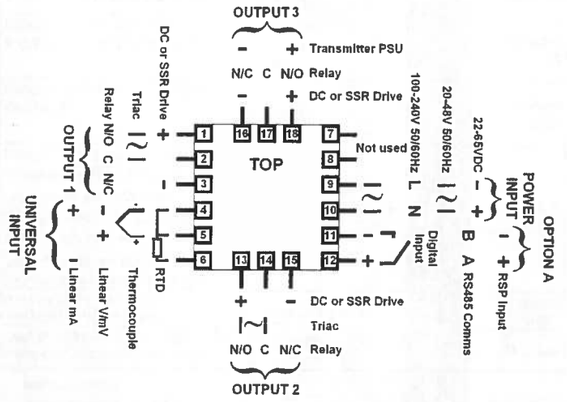
1. Insert instrument into the panel cut-out.
2. Hold front bezel firmly (*without pressing on display area*), and re-fit mounting clamp. Push clamp forward, using a tool if necessary, until gasket is compressed and instrument held firmly in position.

CAUTION: For an effective IP66 seal against dust and moisture, ensure gasket is well compressed against the panel, with the 4 tongues located in the same ratchet slot.

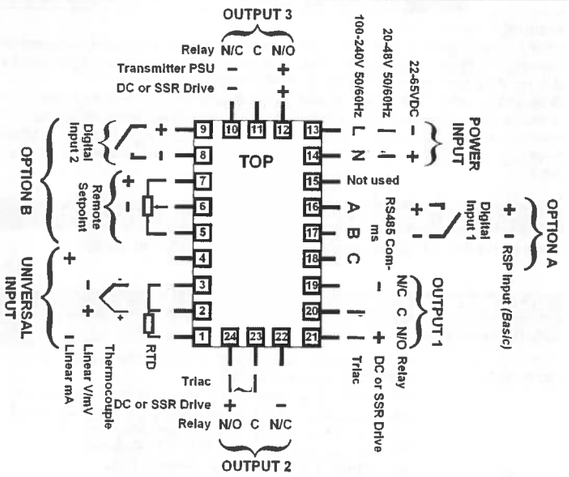
Rear Terminal Wiring: 1/16 Din Size Instruments

USE COPPER CONDUCTORS (EXCEPT FOR T/C INPUT)

Single Strand wire gauge: Max 1.2mm (18SWG)



Rear Terminal Wiring: 1/8 & 1/4 Din Size Instruments



These diagrams show all possible option combinations. The actual connections required depends on the exact model and options fitted.

CAUTION: Check information label on housing for correct operating voltage before connecting supply to Power Input
Fuse: 100 – 240V ac – 1amp anti-surge
24/48V ac/dc – 315mA anti-surge

Note: At first power-up the message Goto ConF is displayed, as described in section 7 of this manual. Access to other menus is denied until configuration mode is completed

2. SELECT MODE

Select mode is used to access the configuration and operation menu functions.
It can be accessed at any time by holding down ↻ pressing ↑.
In select mode, press ↑ or ↓ to choose the required mode, press ↻ to enter.
An unlock code is required to prevent unauthorised entry to Configuration, & Setup modes. Press ↑ or ↓ to enter the unlock code, then press ↻ to proceed.

Mode	Upper Display	Lower Display	Description	Default Unlock Codes
Operator	OPtr	SLCt	Normal operation	None
Set Up	SEtP	SLCt	Tailor settings to the application	10
Configuration	ConF	SLCt	Configure the instrument for use	20
Product Info	inFo	SLCt	Check manufacturing information	None
Auto-Tuning	AtUn	SLCt	Invoke Pre-Tune or Self-Tune	0

Note: The instrument will always return automatically to Operator mode if there is no key activity for 2 minutes.

3. CONFIGURATION MODE

First select Configuration mode from Select mode *(refer to section 2)*.
Press ↻ to scroll through the parameters, then press ↑ or ↓ to set the required value. Press MAN/AUTO to accept the change, otherwise parameter will revert to previous value. To exit from Configuration mode, hold down ↻ and press ↑, to return to Select mode.

Note: Parameters displayed depends on how instrument has been configured. Refer to user guide (available from your supplier) for further details. Parameters marked * are repeated in Setup Mode.

Parameter	Lower Display	Upper Display	Adjustment range & Description	Default Value
Input Range/Type	inPt	See following table for possible codes		JF

Code	Input Type & Range	Code	Input Type & Range	Code	Input Type & Range
bC	B: 100 - 1824 °C	K.C	K: –128.8 - 537.7 °C	P24F	PtRh20% vs 40%: 32 - 3362 °F
bF	B: 211 - 3315 °F	K.F	K: –199.9 - 999.9 °F		
CC	C: 0 - 2320 °C	nC	N: 0 - 1399 °C	PtC	Pt100: –199 - 800 °C
CF	C: 32 - 4208 °F	nF	N: 32 - 2551 °F	PtF	Pt100: –328 - 1472 °F
EC	E: –200 - 1000 °C	rC	R: 0 - 1759 °C	Pt.C	Pt100: –128.8 - 537.7 °C
EF	E: –400 – 1832 °F	rF	R: 32 - 3198 °F	Pt.F	Pt100: –199.9 - 999.9 °F
E.C	E: –199.0 – 999.0 °C	SC	S: 0 - 1762 °C	0_20	0 - 20 mA DC
E.F	E: –199.0 – 999.0 °F	SF	S: 32 - 3204 °F	4_20	4 - 20 mA DC
JC	J: –200 - 1200 °C	tC	T: –240 - 400 °C	0_50	0 - 50 mV DC
JF	J: –328 - 2192 °F	tF	T: –400 - 752 °F	10.50	10 - 50 mV DC
J.C	J: –128.8 - 537.7 °C	t.C	T: –128.8 - 400.0 °C	0_5	0 - 5 V DC
J.F	J: –199.9 - 999.9 °F	t.F	T: –199.9 - 752.0 °F	1_5	1 - 5 V DC
KC	K: –240 - 1373 °C	P24C	PtRh20% vs. 40%: 0 - 1850 °C	0_10	0 - 10 V DC
KF	K: –400 - 2503 °F			2_10	2 - 10 V DC

Note: Decimal point shown in table indicates temperature resolution of 0.1°

Parameter	Lower Display	Upper Display	Adjustment range & Description	Default Value
Scale Range Upper Limit	rnH	Scale Range Lower Limit +100 to Range Maximum		Range max (Lin=1000)
Scale Range Lower Limit	rnL	Range Minimum to Scale Range Upper Limit -100		Range min (Linear=0)
Decimal point position	dPoS	0=XXXX, 1=XXX.X, 2=XX.XX, 3=X.XXX (non-temperature ranges only)		1
Control Type	CtyP	SnGL	Primary only	SnGL
	duAL	Primary & Secondary (e.g. heat & cool)		
Primary Output Control Action	CtrL	rEv	Reverse Acting	rEv
	dir	Direct Acting		
Alarm 1Type	AL1	P_Hi	Process High Alarm	P_Hi
		P_Lo	Process Low Alarm	
		dE	Deviation Alarm	
		bAnd	Band Alarm	
		nonE	No alarm	
High Alarm 1 value*	PhA1	Range Minimum to Range Maximum in display units		Range Max
Low Alarm 1 value*	PLA1			Range Min
Band Alarm 1 value*	bAL1	1 LSD to span from setpoint in display units		5
Dev. Alarm 1 value*	dAL1	+/- Span from setpoint in display units		5
Alarm 1 Hysteresis*	AHy1	1 LSD to full span in display units		1
Alarm 2 Type*	AL2	Options as for alarm 1		P_Lo
High Alarm 2 value*	PhA2			Range Max
Low Alarm 2 value*	PLA2			Range Min
Band Alarm 2 value*	bAL2			5

Parameter	Lower Display	Upper Display	Adjustment range & Description	Default Value
Dev. Alarm 2 Value*	dAL2	Options as for alarm 1		5
Alarm 2 Hysteresis*	AHy2			1
Loop Alarm	LAEn	d iSA (disabled) or EnAb (enabled)		d iSA
Loop Alarm Time*	LAt i	1 sec to 99 mins. 59secs		99.59
Alarm Inhibit	Inh i	nonE	No alarms Inhibited	nonE
		AL1 i	Alarm 1 inhibited	
		AL2	Alarm 2 inhibited	
		both	Alarm 1 and alarm 2 inhibited	
Output 1 Usage	USE1	Pr i	Primary Power	Pr i
		SEc	Secondary Power	
		A1_d	Alarm 1, Direct	
		A1_r	Alarm 1, Reverse	
		A2_d	Alarm 2, Direct	
		A2_r	Alarm 2, Reverse	
		LP_d	Loop Alarm, Direct	
		LP_r	Loop Alarm, Reverse	
		Or_d	Logical Alarm 1 OR 2, Direct	
		Or_r	Logical Alarm 1 OR 2, Reverse	
		Ad_d	Logical Alarm 1 AND 2, Direct	
		Ad_r	Logical Alarm 1 AND 2, Reverse	
		rEtS	Retransmit SP Output	
		rEtP	Retransmit PV Output	
Linear Output 1 Range	tyP1	0_5	0 to 5 V DC output	0_10
		0_10	0 to 10 V DC output	
		2_10	2 to 10 V DC output	
		0_20	0 to 20 mA DC output	
		4_20	4 to 20 mA DC output	
Retransmit Output 1 Scale maximum	roIH	-1999 to 9999 (display value at which output will be maximum)		Range max
Retransmit Output 1 Scale minimum	roIL	-1999 to 9999 (display value at which output will be minimum)		Range min
Output 2 Usage	USE2	As for output 1		Sec or AI2
Linear Output 2 Range	tyP2	As for output 1		0_10
Retransmit Output 2 Scale maximum	ro2H	-1999 to 9999 (display value at which output will be maximum)		Range max
Retransmit Output 2 Scale minimum	ro2L	-1999 to 9999 (display value at which output will be minimum)		Range min
Output 3 Usage	USE3	As for output 1		AI_d
Linear Output 3 Range	tyP3	As for output 1		0_10
Retransmit Output 3 Scale maximum	ro3H	-1999 to 9999 (display value at which output will be maximum)		Range max
Retransmit Output 3 Scale minimum	ro3L	-1999 to 9999 (display value at which output will be minimum)		Range min
Display Strategy	diSP	1, 2, 3, 4, 5 or 6 *(refer to section 8)*		1
Serial Communications Protocol	Prot	ASCI	ASCII	rtbn
		rtbn	Modbus with no parity	
		rtbE	Modbus with Even Parity	
		rtbo	Modbus with Odd Parity	
Serial Communications Bit Rate	bAud	1.2	1.2 kbps	4.8
		2.4	2.4 kbps	
		4.8	4.8 kbps	
		9.6	9.6 kbps	
		19.2	19.2 kbps	
Comms Address	Addr	1	1 to 255 (Modbus), 1 to 99 (ASCII)	1
Comms Write	CoEn	r_Wd	Read/Write	r_Wd
		r_O	Read only	
Digital Input 1 Usage	di1	di S1	Setpoint 1 / Setpoint 2 select*	di S1
		di AS	Automatic / Manual select	
Digital Input 2 Usage	di2	di S1	Setpoint 1 / Setpoint 2 select*	di rS
		di AS	Automatic / Manual select	
		di rS	Remote / Local setpoint select	

Note: di2 has priority over di1 if both are configured for the same usage. If di1 or di2 =di S1 the remote setpoint input is disabled.

Continued on next page...

Parameter	Lower Display	Upper Display	Adjustment range & Description	Default Value
Remote Setpoint Input Range	rinP	0_20	0 to 20 mA DC input	0_10
		4_20	4 to 20 mA DC input	
		0_10	0 to 10 V DC input	
		2_10	2 to 10 V DC input	
		0_5	0 to 5 V DC input	
		1_5	1 to 5 V DC input	
		100	0 to 100mV DC input	*Available on full RSP (Slot B) only*
		Pot	Potentiometer (2KΩ minimum)	
RSP Upper Limit	rSPu	-1999 to 9999		Range max
RSP Lower Limit	rSPL	-1999 to 9999		Range min
RSP Offset	rSPo	Constrained within Scale Range Upper & Scale Range Lower limits		0
Configuration Lock Code	CLoc	0 to 9999		20

4. SETUP MODE

Note: Configuration must be completed before adjusting Setup parameters.
First select Setup mode from Select mode *(refer to section 2)*. The MAN LED will light while in Setup mode. Press ↻ to scroll through the parameters, then press ↑ or ↓ to set the required value.
To exit from Setup mode, hold down ↻ and press ↑ to return to Select mode.
Note: Parameters displayed depends on how instrument has been configured.

Parameter	Lower Display	Upper Display Adjustment Range & Description	Default Value
Input Filter Time Constant	FiLt	OFF or 0.5 to 100.0 secs	2.0
Process Variable Offset	OFFS	±Span of controller	0
Primary Power	PPuU	Current power levels *(read only)*	N/A
Secondary Power	SPuU		
Primary Proportional Band	Pb_P	0.0% (ON/OFF) and 0.5% to 999.9% of input span	10.0
Secondary Proportional Band	Pb_S		
Automatic Reset (Integral Time)	ArSt	1 sec to 99 mins 59 secs and OFF	5.00
Rate (Derivative Time)	rAtE	00 secs to 99 mins 59 secs	1.15
Overlap/Deadband	OL	-20 to +20% of Primary and Secondary Proportional Band	0
Manual Reset (Bias)	biAS	0%*(-100% if dual control)* to 100%	25
Primary ON/OFF Differential	diFP	0.1% to 10.0% of input span centered about the setpoint. (*Entered as a percentage of span*)	0.5
Secondary ON/OFF Diff.	diFS		
Prim. & Sec. ON/OFF Differential	diFF		
Setpoint Upper Limit	SPuL	Current Setpoint to Range max	R/max
Setpoint Lower limit	SPLL	Range min to Current Setpoint	R/min
Primary Output Power Limit	OPuL	0% to 100% of full power	100
Output 1 Cycle Time	Ct1	0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256 or 512 secs.	32
Output 2 Cycle Time	Ct2		
Output 3 Cycle Time	Ct3		
High Alarm 1 value	PhA1	Range Minimum to Range Maximum	R/max
Low Alarm 1 value	PLA1		R/min
Deviation Alarm 1 Value	dAL1	±Span from SP in display units	5
Band Alarm 1 value	bAL1	1 LSD to span from setpoint	5
Alarm 1 Hysteresis	AHy1	1 LSD to full span in display units	1
High Alarm 2 value	PhA2	Range Minimum to Range Maximum	R/max
Low Alarm 2 value	PLA2		R/min
Deviation Alarm 2 Value	dAL2	±Span from SP in display units	5
Band Alarm 2 value	bAL2	1 LSD to span from setpoint	5
Alarm 2 Hysteresis	AHy2	1 LSD to full span in display units	1
Loop Alarm Time	LAt	1 LSD to full span in display units	99.59
Auto Pre-tune	APt	**diSA** (disabled) or **EnAb** (enabled)	diSA
Auto/manual Control selection	PoEn		
Setpoint Select shown in Operator Mode	SSEn		
Setpoint ramp adjustment shown in Operator Mode	SPr		
SP Ramp Rate Value	rP	1 to 9999 units/hour or Off (blank)	Off
Setpoint Value	SP	Scale range upper to lower limits. (when dual or remote setpoint options are used, SP is replaced by SP 1 & SP2 or LSP = or ≡ before the legend indicates the currently active SP)	Scale Range Minimum
Local Setpoint Value	LSP		
Setpoint 1 Value	SP 1		
Setpoint 2 Value	SP2		
Setup Lock Code	SLoc	0 to 9999	10

5. AUTOMATIC TUNING MODE

First select Automatic tuning mode from Select mode *(refer to section 2)*.
Press ↻ to scroll through the modes, then press ↑ or ↓ to set the required value.
To exit from Automatic tuning mode, hold down ↻ and press ↑ to return to Select mode.
Pre-tune is a single-shot routine and is thus self-disengaging when complete.
If APt in Setup mode = EnAb, Pre-tune will attempt to run at every power up*.
Refer to the full user guide (available from your supplier) for details on controller tuning.

Parameter	Lower Display	Upper Display	Default Value
Pre-Tune	Ptun	On or OFF. Indication remains OFF if automatic tuning cannot be used at this time*	OFF
Self-Tune	Stun		
Tune Lock	tLoc	0 to 9999	0

**** Note: Automatic tuning will not engage if either proportional band = 0. Also, Pre-tune will not engage if setpoint is ramping, or the PV is less than 5% of input span from the setpoint.***

6. PRODUCT INFORMATION MODE

First select Product information mode from Select mode *(refer to section 2)*.
Press ↻ to view each parameter. To exit from Product Information mode, hold down ↻ and press ↑ to return to Select mode.
Note: These parameters are all read only.

Parameter	Lower Display	Upper Display	Description
Input type	In_1	Un i	Universal input
Output 1 module type fitted	OPn1	nonE	No option fitted
		rLy	Relay output
		SSr	SSR drive output
		tri	Triac output
		L in	Linear DC voltage / current output
Output 2 module type fitted	OPn2	As Option 1	
Output 3 module type fitted	OPn3	nonE	No option fitted
		rLy	Relay output
		SSr	SSR drive output
		L in	Linear DC voltage / current output
		dc24	Transmitter power supply
Auxiliary Option A module type fitted	OPnA	nonE	No option fitted
		r485	RS485 communications
		di G i	Digital Input*
		rSP i	Remote Setpoint Input *(basic)**
Auxiliary Option B module type fitted	OPnb	nonE	No option fitted
		rSP i	Remote Setpoint Input *(full)* and Digital Input 2*
Firmware type	FtU	Value displayed is firmware type number	
Firmware issue	ISS	Value displayed is firmware issue number	
Product Revision Level	PrL	Value displayed is Product Revision level	
Date of manufacture	dOM	Manufacturing date code *(mmyy)*	
Serial number 1	Sn 1	First four digits of serial number	
Serial number 2	Sn2	Middle four digits of serial number	
Serial number 3	Sn3	Last four digits of serial number	

7. MESSAGES & ERROR INDICATIONS

These messages indicate that an error has occurred or there is a problem with the process variable signal or its wiring.
Caution: Do not continue with the process until the issue is resolved.

Parameter	Upper Display	Lower Display	Description
Instrument parameters are in default conditions	Goto	ConF	Configuration & Setup required. This screen is seen at first turn on, or if hardware configuration has been changed. Press ↻ to enter the Configuration Mode, next press ↑ or ↓ to enter the unlock code number, then press ↻ to proceed
Input Over Range	CHHJ	Normal	Process variable input > 5% over-range
Input Under Range	CLLJ	Normal	Process variable input > 5% under-range
Input Sensor Break	OPEN	Normal	Break detected in process variable input sensor or wiring
RSP Over Range	Normal	CHHJ **	RSP input over-range
RSP Under Range	Normal	CLLJ **	RSP input under-range
RSP Break	Normal	OPEN **	Break detected in RSP input signal
Output 1 Error	Err	OPn1	Output 1 module fault
Output 2 Error		OPn2	Output 2 module fault
Output 3 Error		OPn3	Output 3 module fault
Option A Error		OPnA	Option A module fault or RSP in both A & B
Option B Error		OPnb	Option B module fault

*** also seen wherever RSP value would be displayed*

8. OPERATOR MODE

This mode is entered at power on, or accessed from Select mode *(see section 2)*.
Note: All Configuration mode and Setup mode parameters must be set as required before starting normal operations.
Press ↻ to scroll through the parameters, then press ↑ or ↓ to set the required value.
Note: All Operator Mode parameters in Display strategy 6 are read only (see d iSP in configuration mode), they can only be adjusted via Setup mode.

Upper Display	Lower Display	Display Strategy and When Visible	Description
PV Value	Active SP Value	1 & 2 *(initial screen)*	PV and target value of selected SP *Local Setpoints are adjustable in Strategy 2*
PV Value	Actual SP Value	3 & 6 *(initial screen)*	PV and actual value of selected SP (e.g. ramping SP value). *Read only*
PV Value	*(Blank)*	4 *(initial screen)*	Process variable only *Read only*
Active SP Value	*(Blank)*	5 *(initial screen)*	Target value of selected setpoint only. *Read only*
SP Value	SP	1, 3, 4, 5 & 6 if digital input is not d iS I and RSP not fitted	Target value of SP *Adjustable except in Strategy 6*
SP1 Value	_SP 1	Digital input = d iS I. _ lit if active SP = SP1	Target value of SP1 *Adjustable except in Strategy 6*
SP2 Value	_SP2	Digital input = d iS I. _ lit if active SP = SP2	Target value of SP2 *Adjustable except in Strategy 6*
Local SP Value	_LSP	RSP fitted. _ or ≡ lit if the active SP = LSP	Target value of local setpoint *Adjustable except in Strategy 6*
Remote SP Value	_rSP	RSP fitted. _ or ≡ lit if the active SP = rSP	Target value of remote setpoint *Read only*
d iG i, LSP or rSP	SPS	RSP is fitted, digital input is not d iS I and SSEn is enabled in Setup mode	Selects local/remote active setpoint LSP = local SP, rSP = remote SP d iG i = selection via digital input (if configured). *Note: selecting LSP or rSP will override digital input, active SP indication changes to ≡ Adjustable except in Strategy 6*
Actual SP Value	SPrP	rP is not blank	Actual (ramping) value of selected SP. *Read only*
Ramp Rate	rP	SPr enabled in Setup mode	SP ramping rate, in units per hour *Adjustable except in Strategy 6*
Active Alarm Status	ALSt	When one or more alarms are active. **ALM** indicator will also flash	Alarm 2 active / Alarm 1 active / Loop Alarm active (L2 1)

Manual Control

If PoEn is set to EnAb in Setup mode, manual control can be selected/de-selected by pressing the MAN/AUTO key in Operator mode, or by changing the status of a digital input if d iG i or d iG2 have been configured for d iAS in Configuration mode.
While in Manual Control mode, the MAN LED indicator will flash and the lower display will show Pxxx (where xxx is the current manual power level). Switching to/from manual mode is via Bumpless Transfer. Press ↑ or ↓ to set the required output power. ***Caution: Manual power level is not restricted by the OPuL power limit.***

9. SERIAL COMMUNICATIONS

Refer to the full user guide (available from your supplier) for details.

10. SPECIFICATIONS

UNIVERSAL INPUT

Thermocouple Calibration:	±0.1% of full range, ±1LSD (±1°C for Thermocouple CJC). BS4937, NBS125 & IEC584. Linearization better than ±0.2°C any point, for 0.1° resolution ranges (±0.05°C typical). Better than ±0.5°C any point, for 1° resolution ranges. NOTE: Reduced performance for B thermocouple from 100 to 600°C NOTE: Reduced performance for E thermocouple below -100°C
PT100 Calibration:	±0.1% of full range, ±1LSD. BS1904 & DIN43760 *(0.00385Ω/Ω/°C)*.
DC Calibration:	±0.1% of full range, ±1LSD.
Sampling Rate:	4 per second.
Impedance:	>10MΩ resistive, except DC mA (5Ω) and V (47kΩ).
Sensor Break Detection:	Thermocouple, RTD, 4 to 20 mA, 2 to 10V and 1 to 5V ranges only. *Control outputs turn off.*
Isolation:	Isolated from all outputs (except SSR driver). Universal input must not be connected to operator accessible circuits if relay outputs are connected to a hazardous voltage source. Supplementary insulation or input grounding would then be required.

REMOTE SETPOINT INPUT

Accuracy:	±0.25% of input range ±1 LSD.
Sampling Rate:	4 per second.
Sensor Break Detection:	4 to 20 mA, 2 to 10V and 1 to 5V ranges only. *Control outputs turn off if RSP is the active SP.*
Isolation:	Slot A - Basic isolation, Slot B - Reinforced safety isolation from other inputs and outputs.

DIGITAL INPUTS

Volt-free(or TTL):	Open(2 to 24VDC) = SP1, Local SP or Auto Mode, Closed(<0.8VDC) = SP2, Remote SP or Manual Mode.
Isolation:	Reinforced safety isolation from inputs and other outputs.

OUTPUTS

Relay

Contact Type & Rating:	Single pole double throw (SPDT); 2A resistive at 120/240VAC.
Lifetime:	>500,000 operations at rated voltage/current.
Isolation:	Basic Isolation from universal input and SSR outputs.

SSR Driver

Drive Capability:	SSR drive voltage >10V into 500Ω min.
Isolation:	Not isolated from universal input or other SSR driver outputs.

Triac

Operating Voltage:	20 to 280Vrms (47 to 63Hz).
Current Rating:	0.01 to 1A (full cycle rms on-state @ 25°C); derates linearly above 40°C to 0.5A @ 80°C.
Isolation:	Reinforced safety isolation from inputs and other outputs.

DC

Types / Ranges	0 to 20mA, 4 to 20mA, 0 to 5V, 0 to 10V or 2 to 10V
Load Resistance:	Current Output 500Ω max, Voltage Output 500Ω min.
Resolution:	8 bits in 250mS (10 bits in 1s typical, >10 bits in >1s typical).
Isolation:	Reinforced safety isolation from inputs and other outputs.

Transmitter PSU

Power Rating:	20 to 28V DC (24V nominal) into 910Ω minimum resistance.
Isolation:	Reinforced safety isolation from inputs and other outputs.

SERIAL COMMUNICATIONS

Physical:	RS485, at 1200, 2400, 4800, 9600 or 19200 bps.
Protocols:	Selectable between Modbus and West ASCII.
Isolation:	Reinforced safety isolation from all inputs and outputs.

OPERATING CONDITIONS (FOR INDOOR USE)

Ambient Temperature:	0°C to 55°C (Operating), –20°C to 80°C (Storage).
Relative Humidity:	20% to 95% non-condensing.
Altitude	<2000m
Supply Voltage and Power:	100 to 240VAC ±10%, 50/60Hz, 7.5VA (*for mains powered versions*), or 20 to 48VAC 50/60Hz 7.5VA or 22 to 65VDC 5W (*for low voltage versions*).

ENVIRONMENTAL

Standards:	CE, UL, ULC, CSA
EMI:	Complies with EN61326 (Susceptibility & Emissions).
Safety Considerations:	Complies with EN61010-1, UL61010-1 & CSA 22.2 No 1010.1 92 Pollution Degree 2, Installation Category II.
Panel Sealing:	Front to IP66 when correctly mounted – *refer to section 1.* Rear of panel to IP20.

PHYSICAL

Front Bezel Size:	1/16 Din = 48 x 48mm, 1/8 Din = 96 x 48mm, 1/4 Din = 96 x 96mm.
Depth Behind Panel:	1/16 Din = 110mm, , 1/8 & 1/4 Din = 100mm.
Weight:	0.21kg maximum.

SUPPLEMENTARY INFORMATION FOR CSA

-Compliance shall not be impaired when fitted to the final installation.
-Designed to offer a minimum of Basic Insulation only.
-The body responsible for the installation is to ensure that supplementary insulation suitable for Installation Category II is achieved when fully installed.
-To avoid possible hazards, accessible conductive parts of the final installation should be protectively earthed in accordance with EN6010 for Class 1 Equipment.
-Output wiring should be within a Protectively Earthed cabinet.
-Sensor sheaths should be bonded to protective earth or not be accessible
-Live parts should not be accessible without the use of a tool.
-When fitted to the final installation, an IEC/CSA APPROVED disconnecting device should be used to disconnect both LINE and NEUTRAL conductors simultaneously. Do not to position the equipment so that it is difficult to operate the disconnecting device.

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intelliTRACE®

HTLS

Two, Three and Four-Loop Heat Tracing Line Sensing Control Panel

- **Solid State Relay Outputs Rated 30 Amps or Two-Pole Contactor Control Outputs**
- **Universal Inputs**
- **NEMA 4/4X Enclosure**
- **Ground Fault Alarm/Trip Monitors or GFI Circuit Breakers**
- **Programmable High/Low Temperature Alarms**
- **Programmable Low Current Alarm**
- **Optional RS-485 MODBUS® Communications**
- **120, 208, 240, and 277 VAC**
- **Optional Heater for Sub-Zero Ambients**

Applications

- Freeze Protection
- Fuel Gas Preheating and Superheating
- Fuel Oil Preheating
- Hydrocarbon and Chemical Product Piping
- Power Generation Plants

Description

The Chromalox HTLS series panels are microprocessor based temperature control and monitoring units for heat tracing used in freeze protection and process temperature control applications.

This series of panels can be configured for ambient or line sensing control. The HTLS series implement a scaleable design such that they can be configured with or without communications, ground fault monitoring or enclosure heater.

This unique format offers a design that can be tailored both by price and features to meet the most challenging demands in heat trace applications. For example: The HTLS series can be networked together via RS-485 MODBUS and the Chromalox Windows based Chromasoft SpecView software package.

Two options are available for Ground Fault Protection. The Ground Fault Monitoring system has a reset pushbutton on the panel door that illuminates when a ground fault has occured. As an alternative, ground fault circuit breakers are also available. Both Ground Fault systems are rated for Equipment Protection. In the event of sub-zero temperatures, the optional enclosure heater is available.

The HTLS series have programmable inputs (thermocouple, RTD, mA, VDC), On/Off or PID control, Auto-tune function, High/Low temperature alarms, current alarm, and sensor failure indication. The heat tracing circuit is switched by a 30 Amp solid state relays rated at 40˚C ambient or optional 2-pole contactors.

The Chromalox HTLS series panel comes ready to install and includes control and power wiring terminal blocks for field connections.

Technical Specifications

Supply Voltage:	120, 208, 240, and 277 Vac
Operating Environment:	32 to 104˚F (0 to 40˚C) -32 to 104˚F (-34 to 40˚C) with enclosure heater option
Communications:	RS-485 MODBUS®
Input:	Thermocouple J, K, L, N, R, S, RTD, Current, Voltage Field Programmable for C or F
Output:	Solid State Relay rated @ 30 amps @ 40˚C or optional 2-pole contactors
Current Alarm (Low):	0 - 30 amps in 1 amp increments
Ground Fault Alarm Trip:	5 - 100mA
Temperature Alarms:	Process, Deviation, Band, High/Low, Latching/ Non-Latching (Manual/Automatic Reset) Programmable.
Control Modes:	Field Selectable On/Off, PID, Auto Tune

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HTLS

Dual-Loop Heat Tracing Line Sensing Control Panel *(cont'd.)*

Model

HTLS **IntelliTRACE 20000 Series Line Sensing Heat Trace Panel**

Panel Configuration

cUL and UL Listed Dual Loop Line Sensing/Ambient Sensing Temperature/Monitor Heat Trace Panel. Factory pre-wired for quick installation. Includes: Solid State Relays or Contactor Control, Current Transformers, High-Low Temperature Alarms, Low Current Alarms, On/Off or PID Control, Universal Sensor Inputs, Dual Digital Displays, Terminal Blocks for Field Connections, Loop Enable/Disable, NEMA 4/4X rated Enclosure (16"H x 14"W x 8"D) for Indoor/Outdoor Applications. Options Include: Ground Fault Monitoring and Selectable Shutdown, GFI Thermal Magnetic Circuit Breakers, Enclosure Heater and RS-485 MODBUS Communications.

Code **Dual Loop of Heat Trace Control**

- **2** Solid State Relay Control Per Loop Rated 30 Amps @ 40˚C Ambient (NEMA 4)
- **2C** Electromechanical Contactor Control Per Loop Rated 30 Amps Per Loop @ 40˚C Ambient (NEMA 4X)

Code	Line Voltage (Single Phase)	Load Voltage (Single Phase)
0	120 Vac	120 Vac
1	240 Vac	240 Vac
2	277 Vac	277 Vac (240 Vac Cable)
3	208 Vac	208 Vac (240 Vac Cable)
4	480 Vac	480 Vac

Code **Controller Options**

- **0** IntelliTRACE Controllers (Code 2 Solid State Relay)
- **1** IntelliTRACE Controllers with Communications (Code 2 Solid State Relay)
- **2** IntelliTRACE Controllers (Code 2C Contactor Control)
- **3** IntelliTRACE Controllers with Communications (Code 2C Contactor Control)

Code **Ground Fault Monitoring Options**

- **0** None
- **1** Ground Fault Monitor 120 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
- **2** Ground Fault Monitor 240 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
- **3** Ground Fault Monitor 277 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
- **4** Ground Fault Monitor 208 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
- **5** 15 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
- **6** 20 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
- **7** 25 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
- **8** 30 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
- **A** 15 Amp, 277 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
- **B** 20 Amp, 277 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
- **C** 30 Amp, 277 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
- **E** 15 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)
- **F** 20 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)
- **G** 25 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)
- **H** 30 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)

Code **Enclosure Heater**

- **0** None
- **1** Thermostat Controlled Enclosure Heater

HTLS - 2 0 0 0 0 **Typical Model Number**

Stock PCN Chart

Model	PCN
HTLS-20000	329674

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HTLS

Three-Loop Heat Tracing Line Sensing Control Panel *(cont'd.)*

Model

HTLS **IntelliTRACE 30000 Series Line Sensing Heat Trace Panel**

Panel Configuration

cUL and UL Listed Three Loop Line Sensing Temperature/Monitor Heat Trace Panel. Factory pre-wired for quick installation. Includes: Three-Pole Door-Interlocked Disconnect Switch, Solid State Relay or Contactor Control, High or Low Temperature Alarms, Low Current Alarms, On/Off or PID Control, Universal Sensor Inputs, Dual Digital Display, Terminal Blocks for Field Connections, Loop Standby Mode, NEMA 4 Steel Enclosure (20"H x 20"W x 8"D) for Indoor/Outdoor Applications. Options Include: Ground Fault Monitoring and Selectable Shutdown, GFI Thermal Magnetic Circuit Breakers, Enclosure Heater and RS-485 MODBUS Communications.

Code	Three Loop Heat Trace Control
3	Solid State Relay Control Per Loop Rated 30 Amps @ 40˚C Ambient
3C	Electromechanical Contactor Control Per Loop Rated 30 Amps Inductive Per Loop @ 40˚C Ambient

Code	Line Voltage (Three Phase)	Load Voltage
0	208/120 Vac, 3-Phase, 4 Wire	120 Vac
1	240 Vac, 3-Phase	240 Vac
2	480/277 Vac, 3-Phase, 4 Wire	277 Vac (240 Vac Cable)
3	208/120 Vac, 3-Phase, 4 Wire	208 Vac (240 Vac Cable)

Code	Controller Options
0	IntelliTRACE Controllers (Code 3 Solid State Relay)
1	IntelliTRACE Controllers with Communications (Code 3 Solid State Relay)
2	IntelliTRACE Controllers (Code 3C Contactor Control)
3	IntelliTRACE Controllers with Communications (Code 3C Contactor Control)

Code	Ground Fault Monitoring Options
0	None
1	Ground Fault Monitor 120 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
2	Ground Fault Monitor 240 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
3	Ground Fault Monitor 277 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
4	Ground Fault Monitor 208 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
5	15 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
6	20 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
7	25 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
8	30 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
A	15 Amp, 277 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
B	20 Amp, 277 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
C	30 Amp, 277 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
E	15 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)
F	20 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)
G	25 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)
H	30 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)

Code	Enclosure Heater
0	None
1	Thermostat Controlled Enclosure Heater

HTLS	**3**	**1**	**0**	**2**	**0**	**Typical Model Number**

intelliTRACE®

HTLS

Four-Loop Heat Tracing Line Sensing Control Panel *(cont'd.)*

Model

HTLS **IntelliTRACE 40000 Series Line Sensing Heat Trace Panel**

Panel Configuration

cUL and UL Listed Four Loop Line Sensing Temperature/Monitor Heat Trace Panel. Factory pre-wired for quick installation. Includes: Three-Pole Door-Interlocked Disconnect Switch, Solid State Relay or Contactor Control, High or Low Temperature Alarms, Low Current Alarms, On/Off or PID Control, Universal Sensor Inputs, Dual Digital Display, Terminal Blocks for Field Connections, Loop Standby Mode, NEMA 4 Steel Enclosure (30"H x 24"W x 8"D) for Indoor/Outdoor Applications. Options Include: Ground Fault Monitoring and Selectable Shutdown, GFI Thermal Magnetic Circuit Breakers, Enclosure Heater and RS-485 MODBUS Communications.

Code	Three Loop Heat Trace Control
4	Solid State Relay Control Per Loop Rated 30 Amps @ 40˚C Ambient
4C	Electromechanical Contactor Control Per Loop Rated 30 Amps Inductive Per Loop @ 40˚C Ambient

Code	Line Voltage (Three Phase)	Load Voltage
0	208/120 Vac, 3-Phase, 4 Wire	120 Vac
1	240 Vac, 3-Phase	240 Vac
2	480/277 Vac, 3-Phase, 4 Wire	277 Vac (240 Vac Cable)
3	208/120 Vac, 3-Phase, 4 Wire	208 Vac (240 Vac Cable)

Code	Controller Options
0	IntelliTRACE Controllers (Code 4 Solid State Relay)
1	IntelliTRACE Controllers with Communications (Code 4 Solid State Relay)
2	IntelliTRACE Controllers (Code 4C Contactor Control)
3	IntelliTRACE Controllers with Communications (Code 4C Contactor Control)

Code	Ground Fault Monitoring Options
0	None
1	Ground Fault Monitor 120 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
2	Ground Fault Monitor 240 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
3	Ground Fault Monitor 277 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
4	Ground Fault Monitor 208 Vac w/Shutdown & Contactor door mounted GFI Illuminated Reset Switch
5	15 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
6	20 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
7	25 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
8	30 Amp, 120 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
A	15 Amp, 277 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
B	20 Amp, 277 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
C	30 Amp, 277 Vac, 1-Pole GFI Circuit Breaker (1/Loop)
E	15 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)
F	20 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)
G	25 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)
H	30 Amp, 208/240 Vac, 2-Pole GFI Circuit Breaker (1/Loop)

Code	Enclosure Heater
0	None
1	Thermostat Controlled Enclosure Heater

HTLS	**-**	**4**	**1**	**0**	**E**	**0**	**Typical Model Number**

S/N 0037-75264

TECHNICAL MANUAL

MAINTENANCE, OPERATION, AND INSTALLATION INSTRUCTIONS

SCR CONTROL PANEL

Chromalox
1382 Heil-Quaker Blvd.
LaVergne, TN 37086

Issue Date: July 1995

WARNING

HIGH VOLTAGE is used in the operation of this equipment, DEATH ON CONTACT may result if personnel fail to observe safety precautions. Learn the areas containing high-voltage connections when installing or operating this equipment. Be careful not to contact high-voltage connections when installing or operating this equipment. Before working inside the equipment, turn power off and ground points of high potential before touching them.

RECORD OF CHANGES/REVISIONS

CHANGE NO.	DATE	TITLE OR BRIEF DESCRIPTION	ENTERED BY
4	06/12/95	Complete Re-Write	
5	07/19/95	Added notes for 2 leg controllers on pages 18, 19, 20 and 21	
6	01/29/01	Re-written to make generic Manual for all SCR Panels	
7	10/18/04	Remove Emerson P1 & P5	

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*Pages not numbered for attachments at the end of this manual.

FOREWORD

This manual provides operation, installation, and maintenance instructions for the SCR Control Panel(s) manufactured by Chromalox s of LaVergne, Tennessee. This manual is prepared in accordance with Chromalox Standard Operating Procedure (S.O.P.) 9091-12006. The chapters are arranged as follows:

Chapter 1 - General Information and Safety Precautions
Chapter 2 - Operation
Chapter 3 - Description
Chapter 4 - Scheduled Maintenance
Chapter 5 - Troubleshooting
Chapter 6 - Maintenance
Chapter 7 - Installation

SAFETY SUMMARY

General safety precautions listed in the plant Safety Manual should be closely complied with to prevent injury to personnel or damage to equipment.

KEEP AWAY FROM LIVE CIRCUIT.

Operating personnel must at all times observe all safety precautions. Do not replace components or make adjustments inside the equipment with the high voltage supply turned on. Under certain conditions, dangerous potential exists when the power control is off, due to charges retained by capacitors. To avoid electrical shock or injury, always remove power and discharge capacitors before touching a circuit.

DO NOT SERVICE OR ADJUST ALONE.

Under no circumstances should any person reach into an enclosure for the purpose of servicing or adjusting the equipment except in the presence of someone who is capable of rendering aid.

RESUSCITATION.

Personnel working with or near high voltages should be familiar with modern methods of resuscitation. Such information may be obtained from the Bureau of Medicine and Surgery. Contact area supervisor or safety personnel for more information.

The following warnings and cautions appear in this manual and are repeated here for emphasis:

WARNING

Prior to working on the controller ensure that circuit breaker has been locked in the open (off) position and tagged: "DANGER-SHOCK HAZARD. Do not change position of switch except by direction of NAME.....

WARNING

When power is on and the controller door is open, dangerous voltages are exposed. Be careful. Do not touch terminals or bare conductors in cabinet. Contact with high voltages could cause death or injury.

WARNING

Only one hand should be used when servicing live equipment. Accidental death or severe injury may occur if a current path is created through the body from one hand to the other.

WARNING

Before handling and connecting any power cable to the equipment, make sure the power supply is turned off. Then check voltage levels on the wiring to ensure the wiring is not carrying hazardous voltage.

CAUTION

Some free standing panels may tend to tip before anchoring. Take due care to avoid tipping.

CHAPTER 1

GENERAL INFORMATION AND SAFETY PRECAUTIONS

1-1 SAFETY PRECAUTIONS

All safety precautions necessary for the protection of personnel and equipment are listed in the safety summary. The definition of warning, caution, and note are as follows:

WARNING

An operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in injury or death of personnel.

CAUTION

An operating or maintenance procedure, practice, condition, statement, etc., which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of production.

NOTE

An essential operating or maintenance procedure, condition, or statement, which must be highlighted.

1-2 INTRODUCTION

This technical manual provides the necessary data for installation, operation, maintenance, repair, and parts support of the SCR Control Panels.

1-2.1 WARRANTY INFORMATION. The seller warrants all equipment manufactured by it to be free from defects in workmanship or material under normal use and service. If any part of the equipment proves to be defective in workmanship or material and if such part is, within 12 months of the date of shipment from sellers factory, transportation charges prepaid, and if the same is found by the seller to be defective in workmanship or material, it will be replaced or repaired, free of charge, f.o.b. the sellers factory. The seller assumes no liability for the consequences of its use or misuse by the buyer, his employees or others. A defect within the meaning of this warranty in any part of any piece of equipment shall not, when such part is capable of being renewed, repaired, or replaced, operate to condemn such piece of equipment. This warranty is in lieu of all other warranties (including without limiting the generality of the foregoing warranties of merchantability and fitness for a particular purpose), guarantees, obligations, or liabilities expressed or implied by the seller or its representatives and by statue or rule of law.

1-2.2 REFERENCE DATA. Reference data that applies to the SCR Control Panels is listed in Table 1-1.

1-3 EQUIPMENT DESCRIPTION.

The unit(s) described in this manual is/are to be used for industrial heating. These unit(s) is/are designed to control electric heaters. Application is limited by the maximum kilowatt rating of the controller. The heating load is not to exceed this maximum.

1-3.1 MECHANICAL ASSEMBLY. The components of the controller are mounted on an open back steel, stainless steel or aluminum panel. The panel is housed in a steel, stainless steel, aluminum or non-metallic cabinet. Access to the panel is normally through the top, bottom, sides, or front of the cabinets.

TABLE 1-1. REFERENCE DATA

CHARACTERISTICS

Manufacturer:	Chromalox Precision Heat and Controls
Modes of Operation:	Continuous
Operating Ambient Temperature:	4° F to 122° F
Humidity:	0 - 100% Non-condensing

CHAPTER 2

OPERATION

SCOPE.

This manual applies to Chromalox SCR Control Panel(s). The first few pages contain general information regarding SCR control panels.

OPERATION.

The Chromalox SCR Control Panel is a complete feed-back/closed loop/control system. The solid state power controller provides accurate temperature control very efficiently. Fast acting fuses are included to protect the solid state devices, (see note).

External indications include a "Power On" lamp which illuminates at any time power is applied to the control panel. The temperature controller (if included) provides temperature indication. The overtemp controller (if included) has a setpoint indication and a red LED to indicate the overtemp condition.

NOTE: Fast acting (I^2T Fuses) when included in panel, are not intended for wiring protection under overload, for example at 150% of rated fuse load it may take over 15 minutes to clear the fuse. However, the fuse blows very fast to protect thyristors under short circuit conditions (less than one hundredth of a second to clear at 500% rated fuse load).

CHAPTER 3

DESCRIPTION

Chromalox SCR control panel consists of a power controller, temperature controller, overtemp controller and a fused control transformer that provides control power for 120 vac devices. Positive power shut down is provided in case of overtemp condition, by using a contactor or shunt trip and a disconnect switch.

The panel is completely wired as shown on the attached assembly drawing. Dashed lines on the assembly drawing indicate customer field connections. All these connections must be made according to the national, state, and local electrical and safety codes.

The manuals for model power controller, temperature controller and overtemp controller are enclosed.

CHAPTER 4

SCHEDULED MAINTENANCE

4-1 INTRODUCTION.

Preventative maintenance consists of inspections, tests and cleaning of equipment at scheduled intervals. It helps detect and correct conditions that could cause equipment malfunction. The scheduled maintenance instructions in this manual are intended to duplicate those furnished in the Planned Maintenance System (PMS). In case of conflicts, the PMS documentation takes precedence. Such conflicts should be reported immediately.

4-2 SAFETY PRECAUTIONS.

WARNING

Prior to working on controller ensure that circuit breaker has been locked in the open (off) position and tagged: "DANGER-SHOCK HAZARD. Do not change position of switch except by direction of NAME....."

The controllers use high voltage. It is important that only experienced and authorized technicians who observe standard safety precautions perform all phases of installation, operation, and maintenance. Before conducting any preventive maintenance, fully de-energize and ground the equipment. Tag the controller OUT OF SERVICE only after it has been fully de-energized.

4-2.1 SERVICE LIVE EQUIPMENT. If it is necessary to service live equipment, the following general instructions must be followed:

WARNING

Only one hand should be used when servicing live equipment. Accidental death or severe injury may occur if a current path is created through the body from one hand to the other.

a. De-energize the equipment. To de-energize any capacitors connected to these terminals, temporarily ground the terminals to be measured.

b. Connect the Multimeter to the terminals to be measured, using a range higher than the expected voltage. Make sure that you are not grounded whenever you adjust equipment or use measuring equipment. Do not use test equipment known to be in poor condition.

c. Without touching the meter or test leads, energize the equipment and read the meter.

d. Remove the test leads after de-energizing the equipment.

4-3 PREVENTIVE MAINTENANCE SCHEDULE.

The schedule for conducting preventative maintenance depends on how much the equipment is used. Table 4-1 lists the suggested maintenance schedule, which is based on average conditions. This schedule should be adjusted for each application as experience dictates.

4-4 REQUIRED TOOLS AND TEST EQUIPMENT.

Table 4-2 lists the tools and test equipment required for using the preventive maintenance procedures in this chapter.

4-5 CONTROLLER MAINTENANCE.

Make sure that inspection will not interfere with presently required on-line operation of equipment. Then remove power as follows:

a. De-energize all incoming sources of power, and tag OUT OF SERVICE.

b. Test equipment with Multimeter to ensure that power is off.

TABLE 4-1. PREVENTIVE MAINTENANCE SCHEDULE

FREQUENCY	TITLE	APPLICABLE PARAGRAPH
6 months	Enclosure Exterior	4-5.1
6 months	Enclosure Interior	4-5.2
6 months	Wiring and Connections	4-5.3
6 months	Lights and Fuses	4-5.4
1 year	Contactors	4-5.5

TABLE 4-2. REQUIRED MAINTENANCE TOOLS, MATERIALS, AND TEST EQUIPMENT

TOOLS
1. Flashlight
2. Vacuum cleaner with a nonmetallic nozzle
3. Screwdrivers--normal duty (6-inch) and heavy duty (10-inch)
4. Controller crowfoot wrenches, 3/8- and 7/16-inch
5. Fuse extractor
6. Stiff bristle brush
7. Wooden scraper
8. Long handled paint brush (1/4-inch)
9. Plastic scale (6-inch)
10. Needlenose pliers
11. Fine contact file
12. Soldering iron
MATERIALS
1. Safety tags
2. Dry, lint free rags
3. Freon TF cleaning agent
4. Medium sandpaper
5. Touch-up paint
6. Machine oil
7. Grease
8. Electrical tape (good grade)
9. Solder
TEST EQUIPMENT
1. Multimeter

4-5.1 ENCLOSURE EXTERIOR. Inspect the panel exterior as follows:

a. Wipe off all dust, moisture, and oil with a lint free cloth. Remove corrosion with sandpaper.

b. Remove heavy dusts or grease with a wooden scraper.

c. Remove lint.

d. Touch up all bare spots with primer and paint.

e. Inspect door gaskets and replace if worn and/or deteriorated.

f. Oil door hinges and latches with machine oil.

4-5.2 ENCLOSURE INTERIOR. Clean and inspect the panel interior as follows:

a. Remove dust and dirt from electrical components with a vacuum cleaner.

CAUTION

Do not soak parts such as coils or insulation in Freon-TF; use just enough to loosen grease so that it can be immediately wiped off. Failure to comply could damage electrical components.

NOTE: Pay special attention to contact mating and magnet face surfaces because dirt particles can interfere with satisfactory operation.

b. Remove sticky dust, grease, and oil with a dry lint free rag or small paint brush dampened with Freon-TF. Wipe off excess.

c. Inspect for corrosion of metal parts. Repair or replace if found.

d. Inspect for worn or broken parts. Repair or replace if found.

e. Inspect for evidence of dripping water or liquids falling on equipment parts. If found, determine the cause and correct.

f. Make sure that moving parts move freely and do not stick.

4-5.3 WIRING AND CONNECTIONS. Check wiring and connections as follows:

a. Inspect wiring for wear, fraying, chipping, nicks, and evidence of overheating. Repair minor defects with a good grade of electrical tape, or replace if needed.

b. Inspect for loose electrical and mechanical connections. Tighten or replace defective crimp-style lugs. Resolder loose solder connections. Tighten or replace all loose or missing hardware.

4-5.4 LIGHTS AND FUSES. Check lights and fuses as follows:

a. Check indicating lights for burned out lamps. Replace as required.

b. Check fuses for correct ratings. Replace as required.

4-5.5 CONTACTORS. If contactor(s) is/are used, operate contactors by hand to check that linkages operate freely from mechanical binding in the normal operating position. When released from the energized position, the contactor must drop out to the full de-energized position. If there is a question about these positions, first energize the contactors electrically, then de-energize

them and check that the contactor drops out to the full de-energized position. Sticky operation may be improved by cleaning the parts with Freon-TF then applying a light coat of grease to all bearing points.

4-6 ON-LINE CHECK.

Apply power to the controller and operate. Check for proper operation. Refer to Chapter 2.

4-7 PLANNED OVERHAUL MAINTENANCE

The above preventive maintenance procedures should eliminate the need for planned overhaul maintenance. Under normal service conditions, many of the components should not require replacement parts. Should the need occur for overhaul, see Chapter 6.

CHAPTER 5

TROUBLESHOOTING

5-1 INTRODUCTION.

This chapter includes troubleshooting tables, for use in repairing the heater power controller. A volt ohmmeter will be required to perform certain steps in the troubleshooting charts.

5-2 TROUBLESHOOTING CHART.

WARNING

When power is on and the controller door is open, dangerous voltages are exposed. Be careful. Do not touch terminals or bare conductors in the cabinet. Contact with high voltages could cause death or injury.

5-2.1 When incorrect operation is observed, it is often possible to reduce the overall servicing time by studying all the symptoms and applying the following trouble analysis charts:

5-2.2 To use the troubleshooting charts:

a. Select the chart that most closely describes the malfunction.

b. Look for the symptoms listed in the first column.

c. Take appropriate action listed under immediate action.

d. Follow the instructions listed under remedy column

TABLE 5-1. NO OUTPUT TROUBLE ANALYSIS

SYMPTOMS	IMMEDIATE ACTION	PROBABLE CAUSE	REMEDY
1. No output voltage thus no heat.	1. Check power source and disconnects.	1. Loss of source power.	1. Check the system, if there is no source voltage available. Determine the cause of loss of power, then correct and reenergize the unit.
		2. Blown fuse(s).	2. With power off, check the fuses. If fuse(s) is/are blown, determine the cause of blown fuse, then after correcting the problem, replace the fuse.
		3. Defective temperature controller.*	3. If temperature controller is not providing appropriate control signal, replace as needed.
		4. Defective firing package or SCR module.*	4. Measure voltage across G1, K1, G2 and K2, and G3 and K3. If it is not between 0.5 VDC and 1.0 VDC, replace firing package.**
		5. Defective SCR module.	5. Measure the gating signal. Measure the voltage at input (line) side of the SCR. If the voltage at the line side is proper and the gate signal is present replace the defective SCR.

* Certain control panels may not be equipped with these parts.

** Check G4 and K4 also if 2 Leg Control is used, i.e. 4 SCRs instead of 6 SCRs in case of 3 Leg Control.

TABLE 5-2. FULL OUTPUT TROUBLE ANALYSIS

SYMPTOMS	IMMEDIATE ACTION	PROBABLE CAUSE	REMEDY
1. Heater stays on 100%	1. Turn power OFF.	1. Defective sensor.	1. Check wiring and appropriate signal. Replace or repair as needed.
		2. Defective SCR(s) or firing package.	2. If the output stays full ON in Step 1, measure voltage across G1-K1 on the firing package; if it is OVDC measure voltage across G2-K2 and G3-K3. For solid state relays, check for proper control input. If they are all 0 DC, replace the SCR(s); otherwise, replace the firing package.*
		3. Defective temperature controller.	3. If thermocouple sensor was correctly wired and was found intact, replace the temperature controller.

* Check G4 and K4 also if 2 Leg Control is used, i.e. 4 SCRs instead of 6 SCRs in case of 3 Leg Control.

TABLE 5-3. INACCURATE TEMPERATURE CONTROL TROUBLE ANALYSIS

SYMPTOMS	IMMEDIATE ACTION	PROBABLE CAUSE	REMEDY
1. The unit maintains a temperature other than the correct temperature.	1. Turn the power OFF and check all connections and make sure heater is not burnt out or improperly sized.	1. Improper heater size or improper wiring.	1. With power off, check heater size and connections. Correct any error found.
		2. Blown fuse(s).	2. Check the fuses. If fuse(s) is/are blown, determine the cause of blown fuse, then after correcting the problem, replace the fuse.
	2. Check the power source for proper voltages.	3. Loss or drop in incoming voltage.	3. Check the incoming voltages. Correct if necessary.
		4. SCR(s) bad.	4. With power applied to the control panel, measure voltage from L1 to T1, L2 to T2, and L3 to T3. All phases should read approximately 0 VAC. Any phase that reads high voltage has a bad SCR module. Replace the SCR(s) as required.
		5. Firing package bad.	5. Measure gate to cathode voltages. All phases should read 0.5 to 1.0 volts. If not, replace the firing package.
		6. Temperature controller bad.	6. Refer to controller manual.

* Only applicable for 3 Phase 3 Leg Controller Firing Package.

TABLE 5-4. ERRATIC OUTPUT TROUBLE ANALYSIS

SYMPTOMS	IMMEDIATE ACTION	PROBABLE CAUSE	REMEDY
1. Output of the control panel is unstable.	1. Turn the power OFF and check all connections.	1. Loose connection.	1. With power off, check all terminals. Tighten all loose connections.
2. Temperature fluctuates excessively.		2. Blown fuse.	2. With power off, check the fuses. If fuse(s) is/are blown, determine the cause of blown fuse, then after correcting the probe, replace the fuse.
		3. Erratic power source.	3. Check power source for erratic operation. Repair if needed.
		4. Defective temperature controller or firing package.	4. Check the command signal by monitoring voltage at control input terminals of firing package. If the command signal is erratic, replace the temperature controller, otherwise, replace the firing package.

*Only Applicable for 3 Phase 3 Leg Controller Firing Packages.

TABLE 5-5. CONTACTOR TROUBLE ANALYSIS

SYMPTOMS	IMMEDIATE ACTION	PROBABLE CAUSE	REMEDY
1. Contacts chatter. Control panel is unstable.	1. Turn OFF power and check all connections.	1. Poor contact in controller.	1. Check contact wear. Replace worn contacts.
		2. Low voltage.	2. Correct voltage source.
1A. Contactor picks up but does not seal.	1. None required.	1. Defective auxiliary contact.	1. Replace auxiliary contacts.
		2. Open wiring of coil or shorted turns.	2. Replace coil.
2. Contactor will not drop out.	1. None required.	1. Short circuit.	1. Correct short circuit.
		2. Dirty contacts.	2. Clean contacts.
		3. Interlock problems.	3. Correct interlock problems.
3. Over heating.	1. Turn OFF power.	1. Insufficient contact pressure.	1. Replace worn contacts.
		2. Over load.	2. Reduce load current.

CHAPTER 6

CORRECTIVE MAINTENANCE

6-1 INTRODUCTION

6-1.1 This chapter provides instructions for the adjustment and repair of the SCR control panel.

6-1.2 Observe all safety precautions and tag all wires to be disconnected.

6-2 TOOLS, TEST EQUIPMENT AND MATERIAL

Refer to table 6-1 for the list of tools, test equipment and material required to maintain the controllers.

Table 6-1.
Tools, Test Equipment and Materials

D.C. Milliamp Meter
Adjustable D.C. Power Supply
6" Flat Tip Screwdriver
3/8" Combination Wrench
Fuse Pliers
Thermal Compound or Thermostrate Material
Unitemp Grease
Lint Free Cloth

SECTION I. ADJUSTMENTS AND ALIGNMENTS

6-3 CALIBRATION CHECK AND ADJUSTMENT.

6-3.1 No maintenance adjustments are required on the temperature controller.

6-3.2 To check calibration and operation of the firing package, an adjustable DC power supply and a DC milliamp meter are required.

WARNING

When the power is on and the controller door is open, dangerous voltages are exposed. Be careful. Do not touch terminals or bare conductors in the cabinet. Contact with high voltages could cause death or injury.

a. Disconnect control input wires from terminals of firing package.

b. Connect wires to DC milliamp meter and to D.C. adjustable power supply as input to the 4 to 20 mA terminal of step a.

c. Adjust power supply to obtain a reading of 4 ± 0.2 MA DC. The red LED on the firing package should be off.
d. Adjust power supply to obtain a reading of 5 ± 0.2 MA DC. The red LED on the firing package should just blink on.

e. Adjust power supply to obtain a reading of 20 ± 0.2 MA DC. The red LED on the firing package should be fully on.

f. Adjust power supply to obtain a reading of 19 ± 0.2 MA DC. The red LED on the firing package should just blink off.

g. If the above result was not satisfactory continue with step h.

h. Repeat steps c and d. Adjust zero pot for correct light response.

6.3.3 For solid state relays check the control input, when on, (3 to 30 VDC is typical), no further calibration is necessary.

6-4 MAINTENANCE.

There is no special maintenance required for the unit. Following are a few simple procedures that describe general maintenance required for long trouble free service.

CAUTION

DISCONNECT ALL POWER BEFORE SERVICING THIS UNIT.

6-4.1 Accumulated dust should be cleaned off periodically. Conductive build-up may lead to an arcing condition in the high-voltage section.

6-4.2 Check for pitting and corrosion caused by arcing at loose terminal connections. Check wire terminations for secure, tight connections.

6-4.3 Check periodically for rodent damage to wiring and internal materials.

6-4.4 Systems used in a corrosive atmosphere should have the electrical connections periodically inspected and tarnished connections should be cleaned.

Due to the simplicity of this unit, a failure can be easily detected. Reference to the schematic and wiring diagrams and logical application of standard troubleshooting technique should resolve any problems.

6-5 SITE AND STORAGE PREPARATION.

The input controller package may be stored in its shipping container until ready for installation.

Storage site should be an indoor, cool, dry location.

There are no specific requirements for site preparation. User needs should dictate any site preparations.

6-7 RETURN OF MATERIAL.

Material returned for repair, whether in or out of warranty, should be shipped prepaid to:

Chromalox Precision Heat and Control
1382 Heil-Quaker Boulevard
LaVergne, Tennessee 37086-3536
Attn: Customer Service Department

Contact factory for "Return Authorization" identification number. The packing slip should be marked:

Return for Repair RA-_____
Model_____

The returned material should be accompanied by a letter of transmittal which should include the following information.

1. Location, type of service and length of time in service of the device;

2. Description of the faulty operation of the device and the circumstances of the failure;
3. Name and telephone number of the person to contact if there are questions about the returned material;
4. State as to whether warranty or non-warranty service is requested;
5. Complete shipping instructions for return of material.

Adherence to these procedures will expedite handling of the returned material and will prevent unnecessary additional charges for inspection and testing to determine the problem with the device. If the material is returned for out of warranty repairs, a purchase order for repairs should be enclosed.

It is not advisable to attempt to modify any panel without first consulting the factory.

CHAPTER 7

INSTALLATION

Use 3/8" hex bolts to mount the control panel on a wall, bulkhead, or channels. For free standing/floor mounted panels, prepare foundation and use proper anchoring. For proper cooling of the solid state devices do not block the air intakes or exhaust(louvers) by any means. Allow work space and door swing space in front of the panel. Avoid temperature extremes and humid or dusty environments.

Electrical installation requires customer connection of incoming power lines, heater load lines, and sensor leads. (See schematic for connections.) The customer must provide openings for wiring entrance and exit of suitable size and positioned to suit individual needs.

CAUTION

Some free standing panels may tend to tip before anchoring. Take due care to avoid tipping.

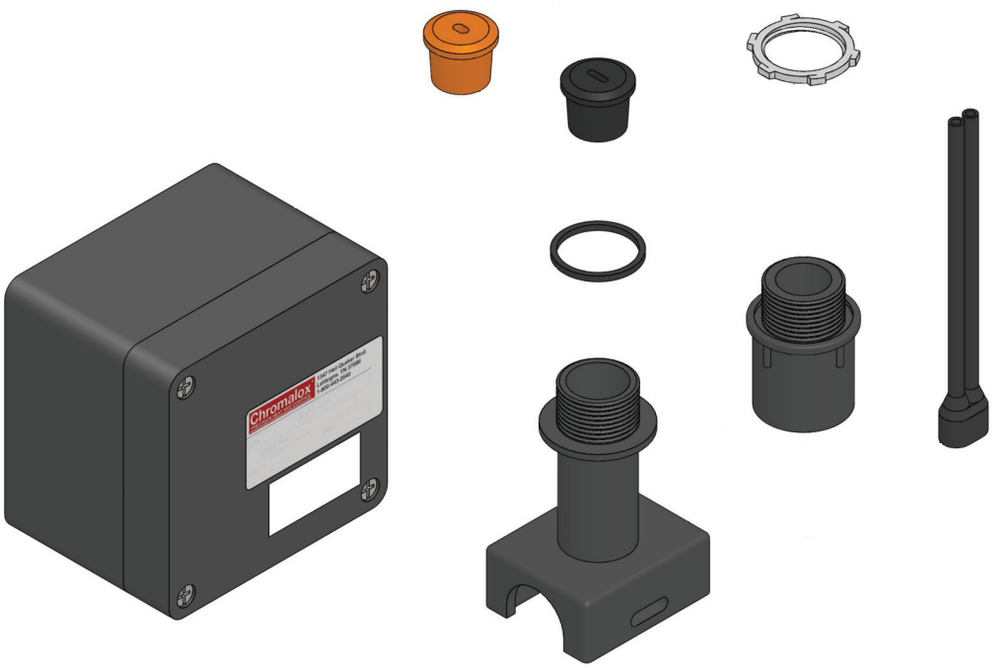
NOTES AND OTHER PERTINENT INFORMATION

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UPC Power Connection Kit

Installation Instructions

For Self-Regulating & Constant Wattage Heating Cables

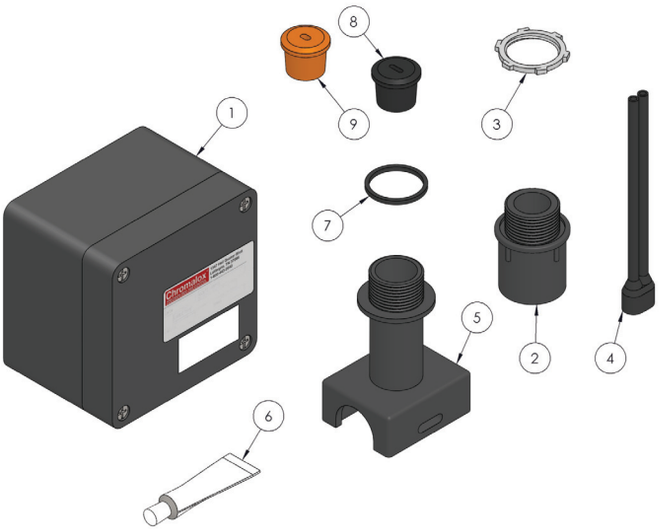


Chromalox®
PRECISION HEAT AND CONTROL

PJ495-3
161-562581-029
January 2012

UPC Power Connection Kit

Self-Regulating & Constant Wattage Heating Cable Installation Instructions



Item	Qty	Description
1	1	Junction Box
2	1	Compression Fitting
3	1	Locknut
4	1	Silicone Termination Boot
5	1	Pipe Standoff
6	1	RTV
7	1	O-Ring
8	1	Self-Regulating Cable Grommet
9	1	Constant Wattage Cable Grommet

General

The UPC power connection kit is used for electrical termination of one self-regulating and constant wattage cables. Each kit contains the terminations needed to make all electrical connections.

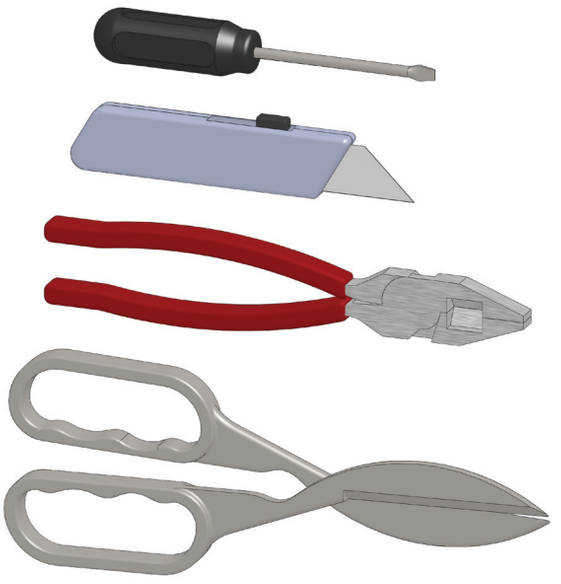
Certifications & Approvals

IP66 NEMA/Type 4x –60˚C < Ta < +55˚C
Ordinary & Hazardous Locations
Class I, Division 2 Groups A,B,C, & D, Zone 2 IIC
Class II, Division 2, Groups F & G, Class III

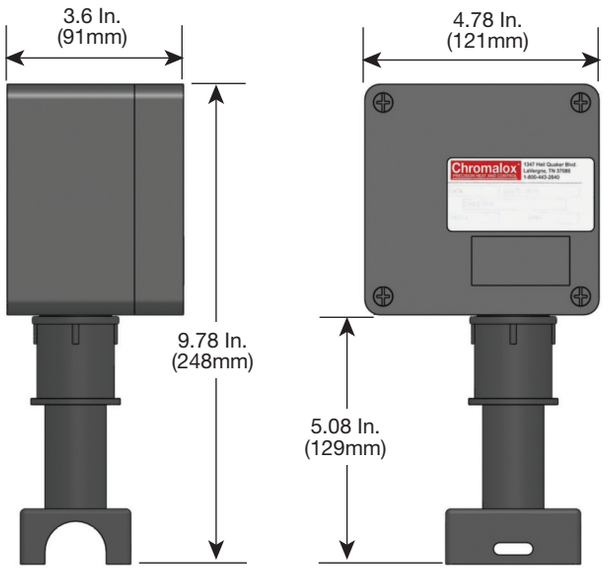
Ordinary areas only

ITS08ATEX36059X CE0389
IIG Exe II T6 Ta -60˚C ti 170˚C
IECEx ITS 07.0018X
Exe II T6 GbTa -60˚C to 170˚C

Tools Required for Kit Installation



Actual Kit Dimensions



⚠WARNING

HAZARD OF ELECTRIC SHOCK. Disconnect all power before opening. All installations must be effectively grounded in accordance with the National Electrical Code to eliminate shock hazard. To avoid electrostatic discharge. Wipe with damp cloth.

⚠WARNING

Turn off power before removing junction box cover at all times.

⚠WARNING

Users should install adequate controls and safety devices with their electric heating equipment. Where the consequences of failure may be severe, back-up controls are essential. Although the safety of the installation is responsibility of the user, Chromalox will be glad to assist in making equipment recommendations.

Order Separately

Pipe Straps

PS - 1 (382352) - 1/2” to 3/4” pipes
PS - 3 (382360) - 1” to 3-1/2” pipes
PS - 10 (382379) - 2-1/2” to 9” pipes



Caution Label CL-1 (382424)



Fiberglass Tape FT-3 (389941)

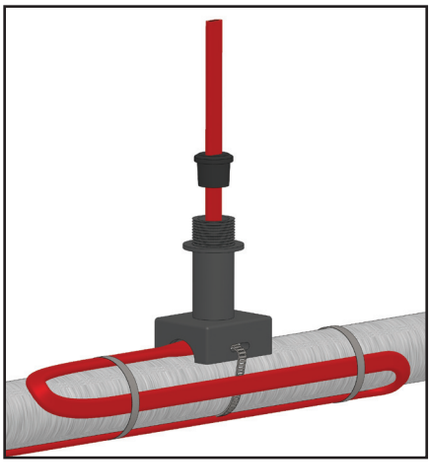


SPA - Small Pipe Adapter

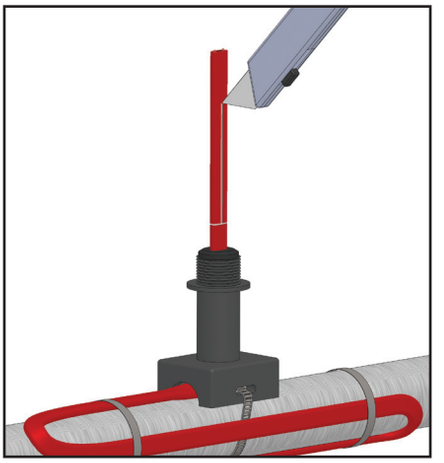
(393609)



Cable installation instructions: SRL, SRF, SRM/E, SRP
CWM cable special instructions denoted by *

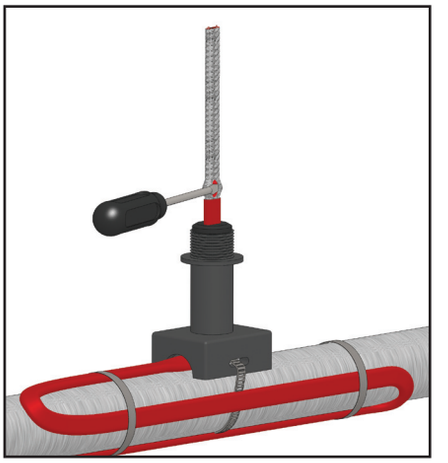


1. Insert heating cable through pipe standoff and grommet as shown. 8 inches of cable should extend past the grommet. Strap pipe standoff to pipe with pipe strap (Chromalox type PS not included) and attach extra cable to pipe as appropriate. For pipes smaller than 1-1/2" diameter a small pipe adapter (Chromalox model SPA not included) is required.

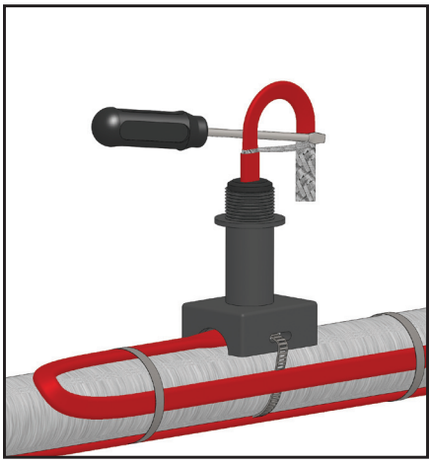


2. Score the outer insulation 7 inches from the end of the cable. Lightly cut the outer jacket up the center to the end of heating cable and remove the outer jacket from the cable. **WARNING: DO NOT CUT METAL BRAID.**

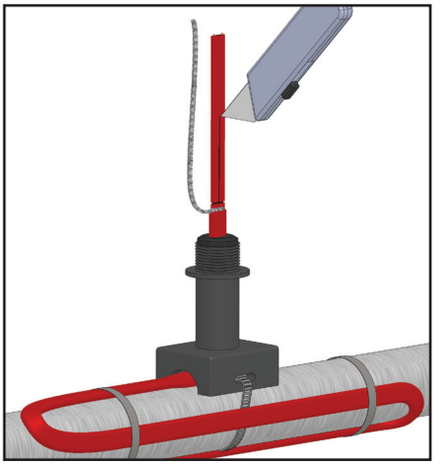
Note: If using braid only cable (-c), skip this step.



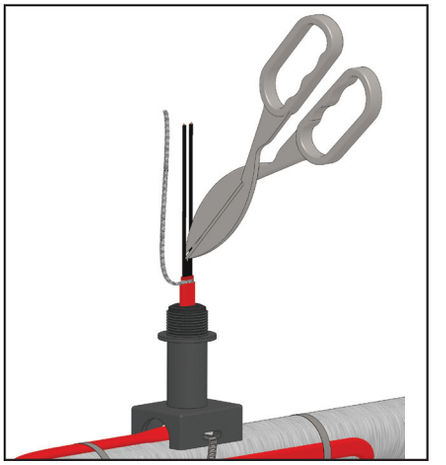
3. Move braid back toward the overjacket, creating a bulge. At the bulge, separate the braid to make an opening.



4. While bending the heating cable, work the cable through the braid opening. Pull the braid tight.

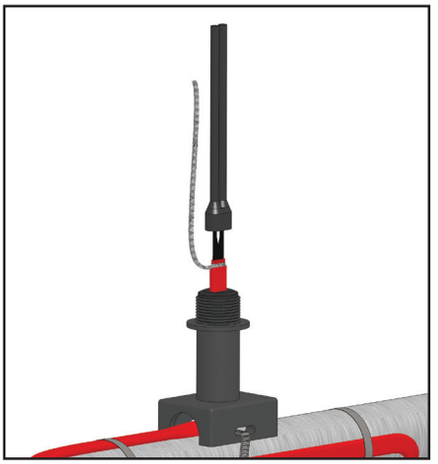


5. Score the inner insulation 6 inches from the end. Lightly cut the inner jacket up the center to end of heating cable and remove the inner jacket from the cable.

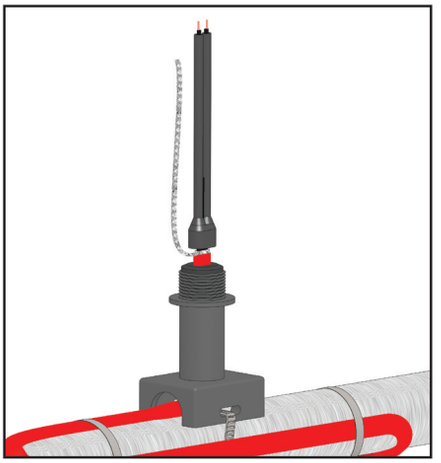


6. Use tin snips or similar tool to cut excess material from between the buss wires.

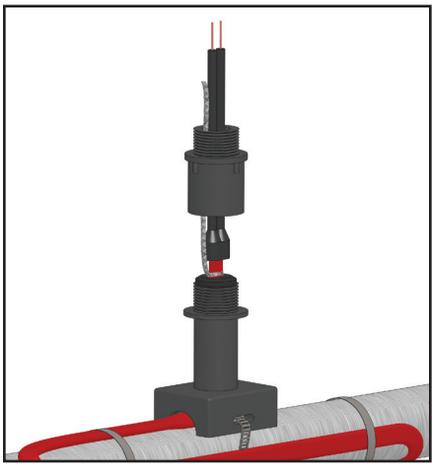
*Separate CWM leads



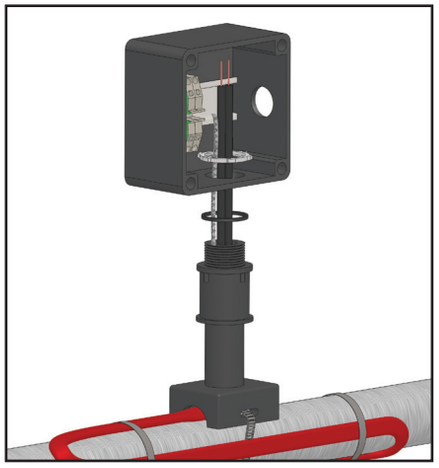
7. Liberally apply RTV over the exposed matrix and leads. Push the rubber boot over the heating cable.



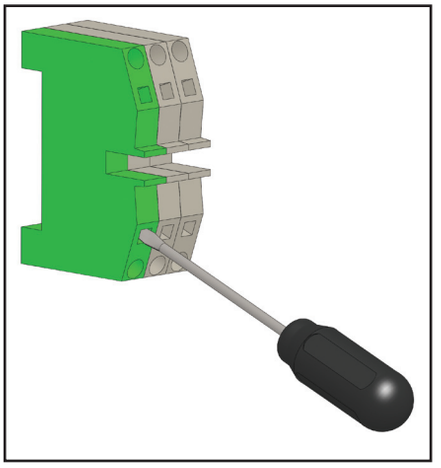
8. Strip each bus wire so that no black matrix material shows above the end of the rubber boot. Trim lead ends as needed.



9. Slide compression fitting over cable. Grommet should be placed inside pipe standoff. Termination boot should be spaced 1/2” from sealing grommet.

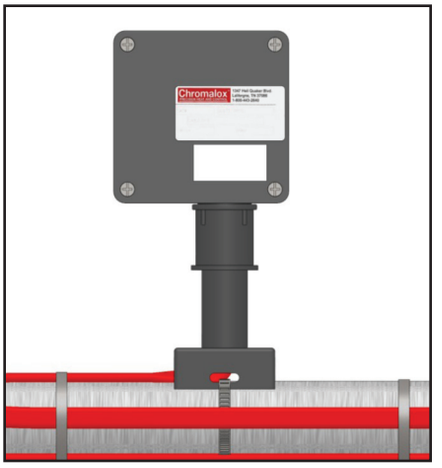


10. Assemble junction box to compression fitting as shown. Tighten locknut until the junction box bottoms out against the lip of the compression fitting.



11. Attach 3/4” conduit hub. Use a flathead screwdriver to release the terminal spring clamps and insert cable leads and grounding braid as per wiring diagram on next page. Supply power electrical connections to terminals as shown on wiring diagram on next page. For ATEX and IECEx installations, conduit hub must be an ATEX or IECEx certified component.

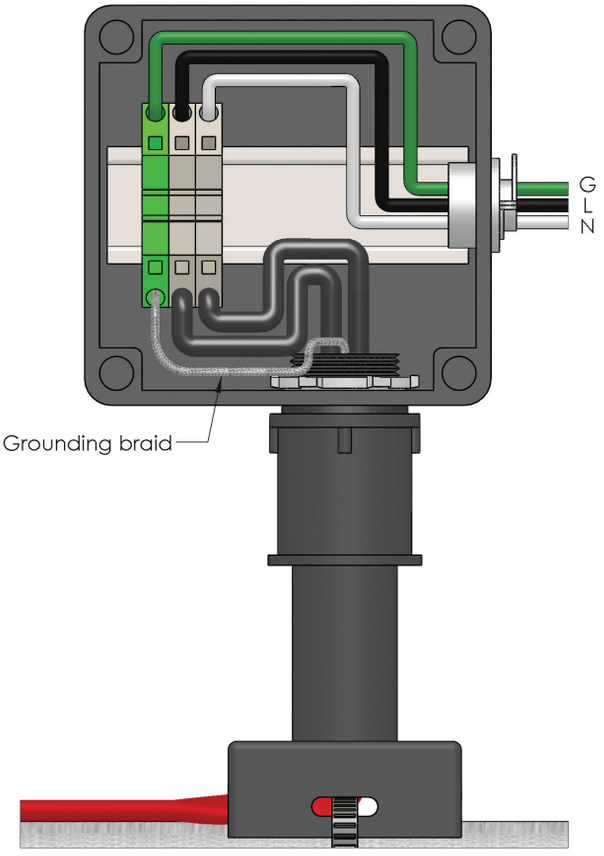
NOTE: Conduit hub should be approved for:
Class I, Div. 2
Class II Div. 1 & 2
Class III Div 1 & 2
NEMA 4X
and rated by a nationally recognized laboratory.



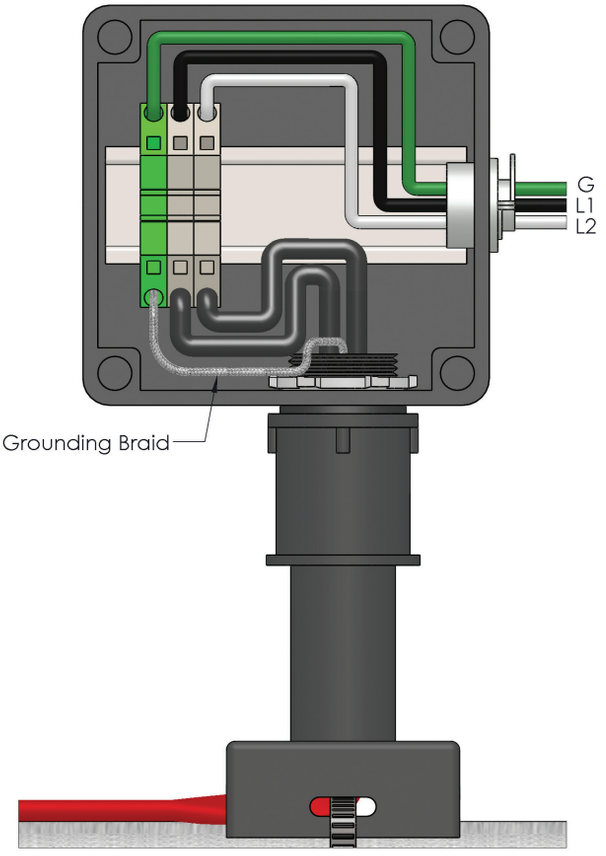
12. Once Locknut is secure and wires are secured in terminal, place cover on box and secure the lid to the box by tightly fastening screws.

Wiring Diagrams

120V, 277V



240V, 208V, 480V



Limited Warranty:

Please refer to the Chromalox limited warranty applicable to this product at http://www.chromalox.com/customer-service/policies/termsofsale.aspx.

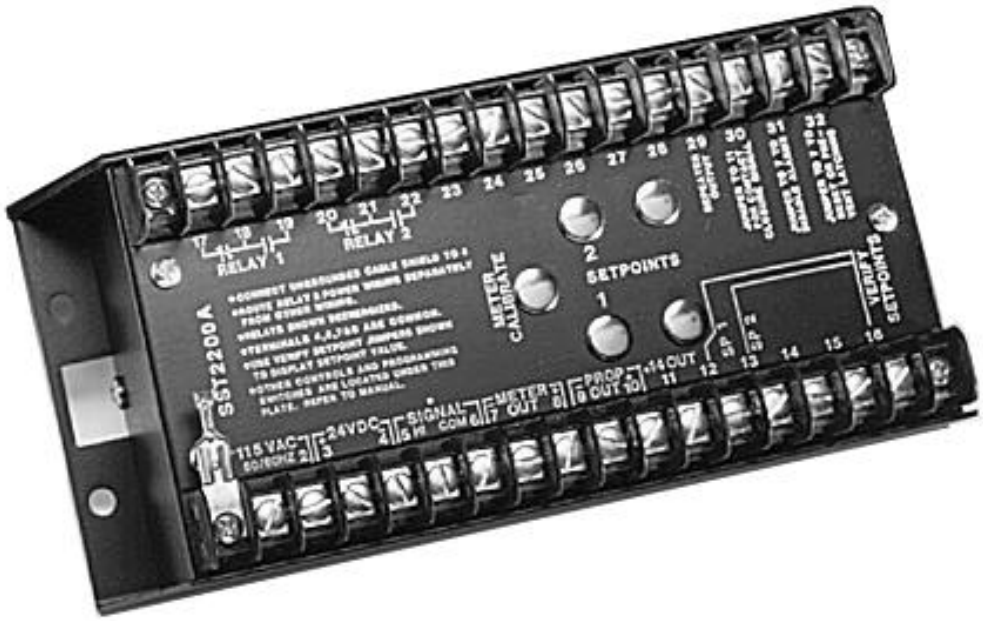
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1347 HEIL QUAKER BLVD., LAVERGNE, TN 37086
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SST-2000 Series

Universal Speed Switch & Speed Transmitter

An Operator's Guide



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Dynalco Controls
3690 N.W. 53rd Street,
Fort Lauderdale, FL 33309 U.S.A.
☎ (954) 739-4300
Fax (954) 484-3376
www.dynalco.com • mailbox@dynalco.com

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Chapter **1**

Getting Started

About your speed switch

WARNING

When the SST-2000A/H Series Speed Switch/Transmitter is used as the primary overspeed shutdown device, it *must* be tested regularly.

The SST-2000A/H series is a speed switch and signal transmitter that provides alarm set points for over- and underspeed control for sequential, startup, and shutdown switching for:

- engines
- machines
- I/P drivers
- instrumentation
- process control
- recording
- measurement

How it works

The SST-2000A/H accepts a full-scale frequency input value from 0–0.1 Hz (6 pulses per minute) to 0–50,000 Hz. Standard: 0–80 Hz to 0–20,000 Hz.

Examples of input devices include:

- passive or active magnetic pickups
- shaft encoders
- contact closures
- flow meters
- photocells

The speed switch converts frequency input (speed, rate) into linear proportional dc outputs:

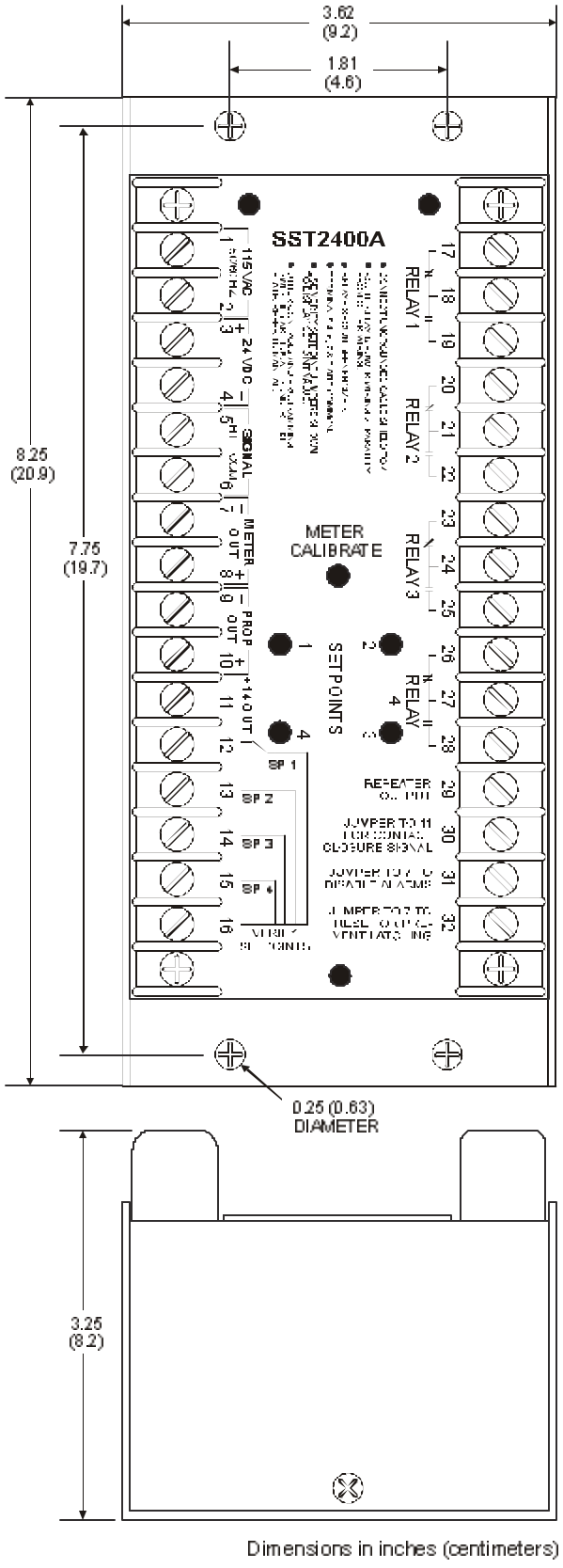
- 0–1 mA (standard - meter out)
- 4–20 mA (standard - proportional out)
- 0–5 Vdc (switch selectable)
- 0–10 Vdc (switch selectable)

It provides 0, 2, or 4 relay trip set points (depending on the model)

Physical Dimensions

Fig. 1-1 Top and side view of the SST-2000A/H. Dimensions in inches and (centimeters).

Special explosion proof housings kits (complete with mounting hardware) are also available. See XP rated housings on page 6.



Dimensions in inches (centimeters)

Models

Model	No. Of Set Points	3rd Party Certification(s)
A series – standard relays		
SST-2000A	0	CSA: general certification LR 92270 ABS: type approval CE: 89/336/EEC, Light Industrial CE: 72/23/EEC, Low Voltage Directive
SST-2200A	2	
SST-2400A	4	
H series – hermetically sealed relays		
SST-2000H	0	CSA: Class I, Div. 2, Grp. D, LR 45322* CE: 89/336/EEC, Light Industrial CE: 72/23/EEC, Low Voltage Directive
SST-2200H	2	
SST-2400H	4	
* Approval contingent upon housing an SST-2000H series device in a CSA-certified enclosure.		

Features

Signal Sources	Field-programmable for: sensors, including contact closure input, magnetic pickups, ac generators, contact closures, photocells.
Input Frequency	♦ Full-scale values from 0–0.1 Hz (6 pulses/minute) to 0-20 kHz. ♦ Field-adjustable range and sensitivity control.
Alarm Set Points	0 SST-2000A/H (when only proportional output is required) 2 SST-2200A/H 4 SST-2400A/H
Alarm Settings	Alarms are field-configurable for overspeed, underspeed, energize, de-energize, latch, auto-reset.
Alarm Disable	Disable all alarms (for startup conditions and special functions)
Alarm Reset	♦ Momentarily reset all latched alarms ♦ Permanently converts all latching alarms to auto-reset
Set Point Verification	Integral VERIFY permits viewing and setting of set point value without actuating the relays. Requires an external meter.
Proportional Outputs	0–1 mA and 4–20 mA (standard) 0–5 Vdc or 0–10 Vdc (field-selectable)
Output Power	Repeater output drives counters and self-powered tachometers. Regulated 14 Vdc output powers active pickups, accessories, and meters (e.g. DPM-105; MTH-103D; SPD-100L; LST-100L).
Output Range	Current source up to 50 mAdc output always included.

Specifications

Electrical

Input Signal Frequency Range	♦ 0-20 kHz (standard) (field-adjustable) ♦ 0-0.1 Hz (special order) ♦ 0-80 Hz (special order) ♦ 0-50K Hz (special order)
Waveforms	♦ Accepts pulsed, sinusoidal, square, TTL, or CMOS
Input Signal Sensitivity	♦ 25 mVrms (typical factory setting) ♦ 5 mVrms to 100 mVrms (field-adjustable) ♦ 50 Vrms (maximum for standard units) ♦ 1.0 volt threshold (requires input signal desensitizing)
Input Impedance	♦ Nearly infinite at low signal levels ♦ 10 kΩ (min.) at signals exceeding +15.0 V peak, –1.0 V peak
Power Input	♦ 115 Vac ±10%, 47-420 Hz ♦ 22–30 Vdc, maximum 5 W or 150 mAdc ♦ 220 Vac, 50/60 Hz (optional)
Proportional Output	♦ 0–1 mAdc (standard) ♦ 4–20 mAdc (standard) ♦ 0–5 Vdc or 0–10Vdc (field-selectable; for external load resistance of 20 kΩ or higher) ♦ Custom ranges available MAXIMUM LOAD ♦ 1 kΩ with 115/ 220 Vac or 30 Vdc power ♦ 750 ohms with 22 Vdc power ♦ linear between 22 and 30 Vdc
Output Current	Independent of load resistance up to the rated load resistance
Span/zero adj.	±5% (minimum) of full-scale
Auxiliary Meter Output	Proportional 0–1 mAdc, filtered, for meter or recorder loads up to 750 Ω.
Supply Output	Regulated +14 Vdc ±5%; 40 mAdc (maximum load)
Repeater Output	Square wave 14 V peak-to-peak, zero based, positive going
Output Ripple and Noise	0.1% of full-scale maximum over 10% to 100% of full-scale.
Response Time	150 milliseconds, 10% to 90% rise (standard). Full-scale frequency ranges below 80 Hz are proportionally slower.
Linearity	0.1% of full-scale (0.05%, typical), all outputs.
Stability	Less than 0.05% of full-scale change with a 10% change in supply voltage. Temp. coeff. ±0.01% per °F (±0.018% per °C)

Relays

Logic	Field-programmable by switches for: ♦ overspeed/underspeed ♦ energize/de-energize ♦ latch/auto-reset ♦ SPST/DPDT (2 DPDT set points maximum)
A Series Contact Rating	♦ 6.0 A @ 28 Vdc or 115 Vac (resistive) ♦ 2.0 A @ 220 Vac ♦ 1.0 A into 500 mH for up to 100,000 cycles ♦ SPDT* *For DPDT, Relays 1 & 3 and 2 & 4 work together as separate DPDT trips.
H Series Contact Rating	♦ 5 A (resistive) @ 24 Vdc ♦ 1.0 A @ 120 Vac ♦ 0.5 A @ 220 Vac ♦ SPDT* *For DPDT, Relays 1 & 3 and 2 & 4 work together as separate DPDT trips.
Alarm Set Points	♦ Adjustable, 25-turn cermet potentiometers
Hysteresis	♦ 1% of full-scale frequency
Isolation Transformer	♦ Optional. Isolates the transmitter input from the probe or sensor.

XP Rated Housings (optional)

ENC-6210	XP Cast Housing: 8”H x 10”W x 5” D; 100’s window + P-button UL/CSA Class I, Groups C,D Class II, Groups E,F,G NEMA 3,4
ENC-6311	XP Cast Housing: 8”H x 10”W x 5” D; 100’s window UL/CSA Class I, Groups B,C, D Class II, Groups E,F,G NEMA 3,4
ENC-3000 **ENC-4000**	Sheet Meta:l 6”H x 9”W x 4” D; NEMA 1; No Window Sheet Meta:l 8”H x 10”W x 4” D; NEMA 12; No Window
ENC-5000	XP Cast Housing: 7”H x 9”W x 5”D; No Window UL/CSA Class I, Groups C,D; Class II, Groups E,F,G

Options

Enclosures	XP and NEMA rated enclosures are available.
Open Pickup	Relay 1 switches in the event of an open or disconnected magnetic pickup. Relay 1 will still react when its set point is traversed (field-configurable). NOTE: Not available with signal isolation transformer option.
Pneumatic Trip	Pulses relay 1 for 100 milliseconds Trips Dynalco SPV-200 Solenoid Pneumatic Valve on overspeed (optional)
Underspeed Class "C" Logic	Arms relay 2 as set point 2 is traversed on increasing speed. Pulses relay 2 as set point 2 is traversed on decreasing speed. Use for tripping the pneumatic SPV-200 on underspeed or for general underspeed electrical shutdown.
Expanded Scale Input	Provides full meter output, full proportional output, and full set point range over a limited input range e.g. 0–1 mA and 4–20 mA over 800–1000 Hz input frequency.

Environmental

Temperature Range	–40°F to +160°F (–40°C to +71°C) operating –40°F to + 180°F (–40°C to +82°C) storage
Weight	2.6 lbs (1.17 kg)

Chapter **2**

Installing the SST-2000A/H

Mounting the unit

The SST-2000A/H is installed using standard hand tools. It is generally mounted in a panel or enclosure using standard practices.

About Electrical Connections

Internal Commons, Isolation

WARNING: AVOID DAMAGE WHEN DC-POWERED

Install a current loop isolator between the 4–20mA output and the load if the load does not reference the same common as the SST-2000A/H.

Signal input (low side, terminal 6) is common to the auxiliary output (low side, terminal 7), to the dc supply (terminal 4), and to the main proportional output low side (terminal 9). Relay contacts are always isolated

When powered with ac: all circuitry is isolated from the power line by the built-in supply transformer

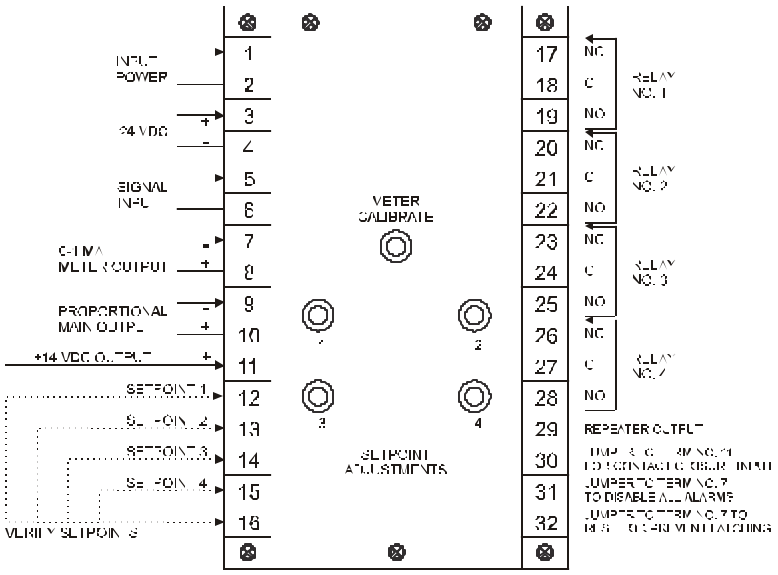
When powered with dc: the transmitter output is *not* isolated from the dc power source. Any load driven by the transmitter (i.e. recorder, controller, etc.) must have the same common as the negative side of the dc supply. Install a current loop isolator between the 4–20mA output and the load if the load does not reference the same common as the SST-2000.

Fig. 2-1 Electrical Connection Drawing.

Use shielded cable: connect ungrounded shield to terminal 4.

Route power line and relay connections separate from signal meter and reset lines to prevent electrical noise interference.

Terminals 4, 6, 7, and 9 are internally tied together to circuit common unless unit has signal isolation transformer. In that case, terminal 6 is isolated.

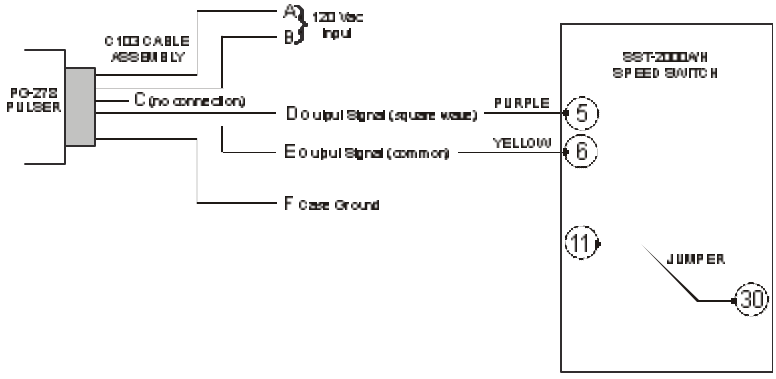


Connecting Signal Inputs

Connecting a PG-278 Pulser

Connect signal source Common to terminal 6 on the SST-2000A/H. Connect signal HI to terminals on the SST-2000A/H.

Fig. 2-2 Connecting a PG-278 Pulser to the SST-2000A/H.



Terminals 11 and 30 on the SST-2000A/H are jumpered to create a one volt threshold.

Chapter **3**

Powering External Devices

Powering an SPD-100, SPD-700, or other frequency instruments

The SST-2000A/H has a repeater output that can be used to power external frequency instruments.

A square wave (14-volt peak-to-peak, zero-based, positive-going) is brought out at terminals 29 and 4 (common) to drive self-powered digital tachometers such as the SPD-100, SPD-700, and MTH-103D, or to use as a conditioned high level signal source into counters or other instruments. The frequency of the signal is equal to that being applied at the signal input: terminals 5 (+) & 6 (–).

This output has an internal resistance of 1 kΩ.

Using DPM-105 meters as external speed indicators

You can use the DPM-105 as an external indicator. You can connect one or more DPM-105 meters to your SST-2000A/H.

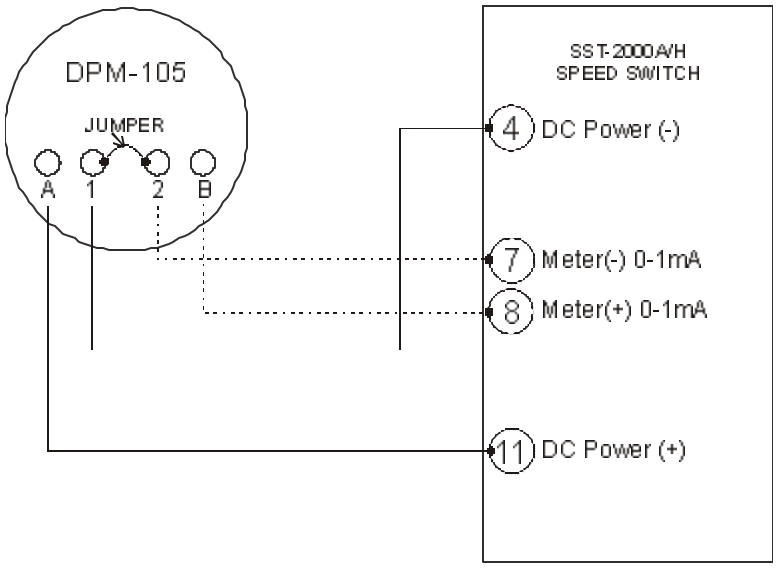
The 0-1 mA meter output of the SST-2000A/H [terminals 7 (–) and 8 (+)] is factory-calibrated into an external load of 40 Ω. The load resistance of the DPM-105 is 95 Ω.

Connecting one DPM-105

1. On the DPM-105, retain the jumper across terminals 1 and 2.
2. Connect the meter as shown in Fig. 3-3.
3. Calibrate the SST-2000A/H.

Fig. 3-3 Connecting one DPM-105 to the SST-2000A/H.

- Keep the jumper between terminal 1 & 2 on the DPM-105



- Confirm the meter is properly connected to the SST-2000A/H.
- Use a frequency generator (e.g. F-16) to apply full-scale frequency to terminal 5 (HI) & 6 (COM) on the SST-2000A/H. Maximum signal input is 50 Vrms for a standard unit.
- Adjust the METER CALIBRATE potentiometer on the SST-2000A/H for the appropriate full-scale reading on each DPM-105.
- Use a DPM-105 data sheet, if necessary, to calibrate the DPM-105 meters.

Connecting more than one DPM-105

1. Remove the jumper across terminals 1 and 2 on each DPM-105.
2. Connect the meters as shown in Fig. 3-4.
3. Calibrate the SST-2000A/H.

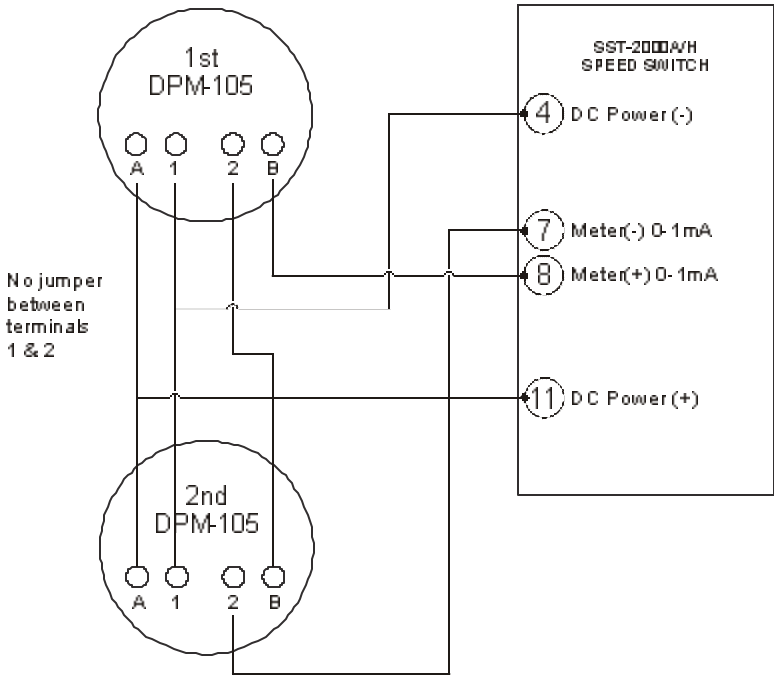


Fig. 3-4 Connecting more than one DPM-105 to the SST-2000A/H.

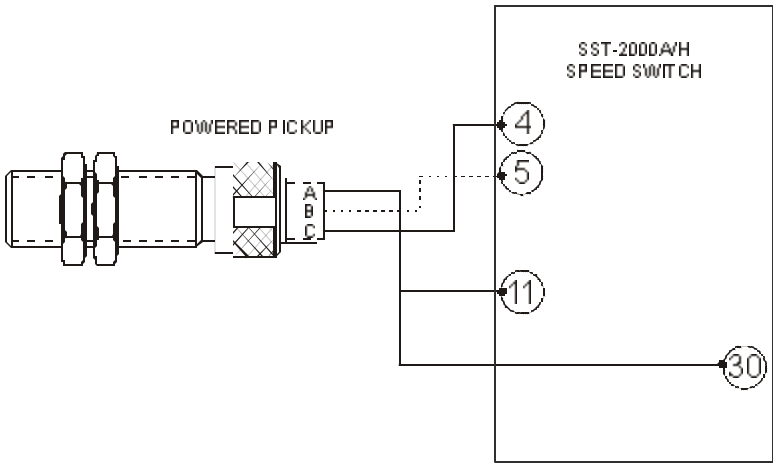
- Confirm the meter is properly connected to the SST-2000A/H.
- Apply full-scale frequency to terminal5 (HI) & 6 (COM) on the SST-2000A/H. Maximum signal input is 50 Vrms for a standard unit.
- Adjust the METER CALIBRATE potentiometer on the SST-2000A/H for the appropriate full-scale reading on each DPM-105.
- Use a DPM-105 data sheet, if necessary, to calibrate the DPM-105 meters.

Powering Zero Velocity Pickups and Other Loads

The regulated 14 Vdc supply brought out at terminals 11 (+) & 4 (–) has a capacity of 40 mA. This output can power zero velocity pickups (e.g. M928) and digital indicators like a DPM-105.

1. Connect the M928 pickup as indicated in Fig. 3-5.
2. Jumper terminals 11 and 30 to desensitize the input signal to a 1.0 V threshold.
3. Adjust signal sensitivity if necessary. See page 27 for instructions on how to adjust input sensitivity.

Fig. 3-5 Jumper terminals 11 and 30 to desensitize the input signal circuit to a one-volt threshold.



Driving an SPV-200 Solenoid Pneumatic Valve

WARNING: TO AVOID SPV-200 COIL DAMAGE

Use a current limiting resistor in series with the dc power source and the transferring relay contacts.

The SPV -200 coil has a resistance of 50 Ω and requires 6 Vdc to trip.

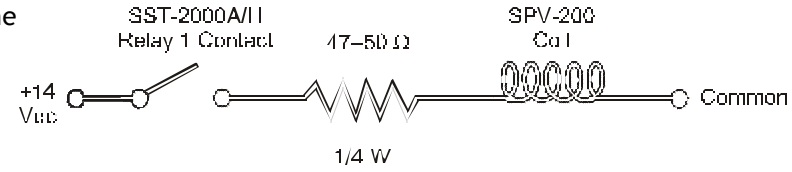
Switching the Regulated 14 Vdc Supply

The regulated 14 Vdc supply at terminals 11 (+) & 4 (–) does not have the capacity to drive the SPV-200 continually.

When the SST-2000A/H speed transmitter is supplied with the Pneumatic Trip Option for Overspeed, Relay 1 transfers for only 100 milliseconds on overspeed; the 14 volt supply can then be used with a series limiting resistor to power the pneumatic trip.

Use a ¼ watt, 47–50 Ω resistor in series with the 14 volt supply.

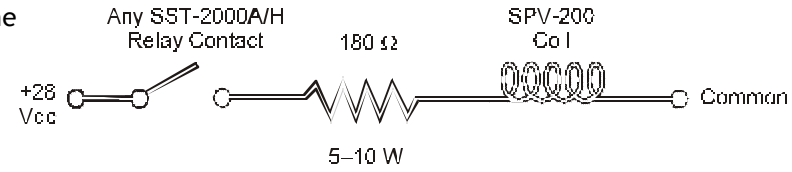
Fig. 3-6 Switching the regulated 14 Vdc supply.



Switching 28 Vdc

When switching 28 Vdc into the coil, use a 5–10 watt, 180 Ω resistor in series with the SPV-200 coil.

Fig. 3-7 Switching the 28 Vdc supply.



Chapter **4**

Calibrating the Speed Switch

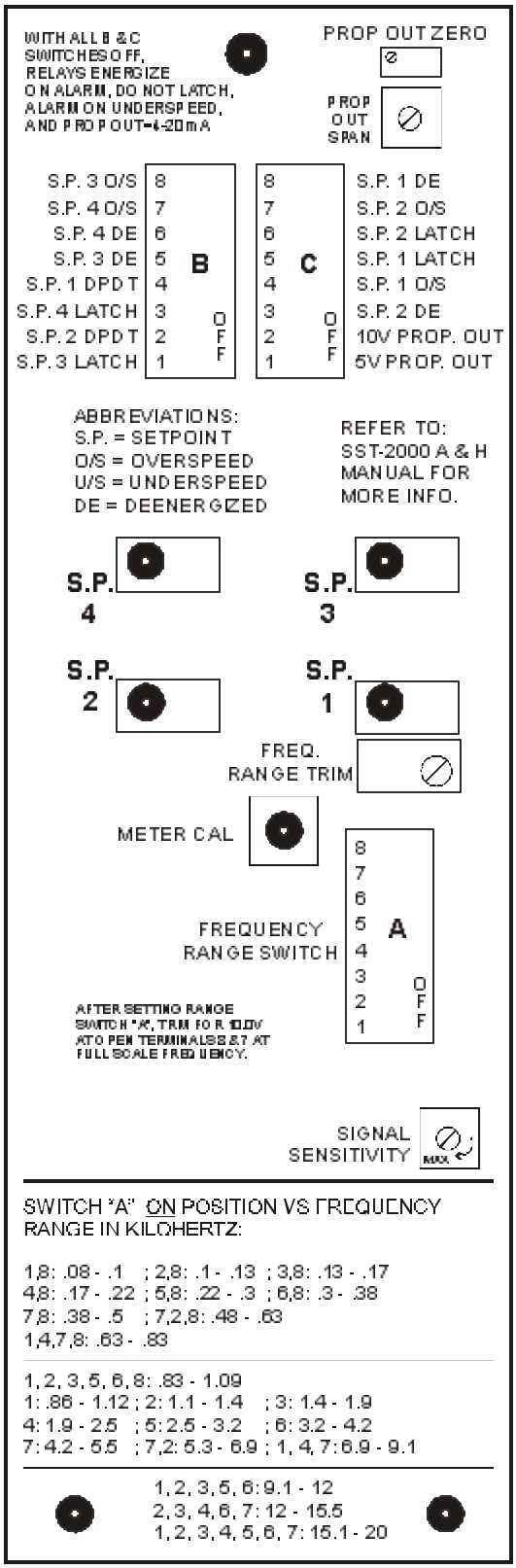
Locating the programming switch instructions

Fig. 4-8 A full description of the programming switches and controls is located under the top plate of the SST-2000A/H.

1 Use a no. 1 or no. 2 Phillips screwdriver to remove the top plate of the switch.

2 The underside of the plate contains instructions for how to:

- ♦ latch set point relays on alarm
- ♦ actuate relays on overspeed
- ♦ actuate 2 relays simultaneously (as DPDT relay)
- ♦ de-energize relays on alarm
- ♦ change proportional output to 0–5 Vdc or 0–10 Vdc
- ♦ recalibrate the full-scale input frequency range (switch A settings)



Changing the full-scale input frequency range

You can set the standard full-scale frequency range from as low as 0–80 Hz to as high as 0–20 kHz.

1. Remove the top plate from the SST-2000A/H to reveal the "A" DIP switches.
2. Use Table 4-1, page 23, or the underside of the top plate (bottom of Fig. 4-9, page 22) to determine the correct DIP switch settings.
3. Calibrate the SST-2000A/H using the procedure on page 22.

Input frequency range *less than* 80 Hz full-scale

The full-scale frequency input range is usually set up at the factory when an SST-2000A/H is ordered.

The SST-2000A/H can easily be field-modified for any standard full scale input frequency range from 0–80 Hz to 0–20,000 Hz using the procedure Recalibration of Full-Scale Input Frequency Range.

Field-changing the SST-2000A/H to accept input frequencies *less than* 0-80 Hz full-scale *is not recommended.* Damage might result that could void the product warranty.

Please contact the Dynalco *Customer Service Department* at (954) 739-4300 for guidance in arranging for a low input frequency range.

Input frequency range *greater than* 20,000 Hz full-scale

The full-scale frequency input range is usually set up at the factory when an SST-2000A/H is ordered.

The SST-2000A/H can easily be field-modified for any standard full scale input frequency range from 0–80 Hz to 0–20,000 Hz using the procedure Recalibration of Full-Scale Input Frequency Range.

Field-changing the SST-2000A/H to accept input frequencies *greater than* 0-20,000 Hz full-scale *is not recommended*. Damage might result that could void the product warranty.

Please contact the Dynalco *Customer Service Department* at (954) 739-4300 for guidance in arranging for a high input frequency range.

Calibrating the SST-2000A/H

WARNING

Calibrate the speed switch:

- immediately after any contact change in Switch A
- before adjusting set points or proportional output

You must calibrate the SST-2000A/H if you have made a change in the full-scale frequency range (changed contacts to DIP switch A).

1. Disconnect any meter connected to terminals 7 & 8. Mark or position the wires so they can be correctly reattached later.
2. Connect a digital voltmeter across terminals 7(–) & 8 (+).
3. Connect a frequency generator (e.g. F-16) at terminals 5 (HI) & 6 (COM). Use the frequency generator to input the new full-scale frequency.
4. Adjust the FREQ RANGE TRIM potentiometer for 10.00 Vdc on the voltmeter. (See Fig. 4-9.)
5. Reattach the meter that is normally connected to terminals 7(–) & 8 (+). *Observe polarity.*

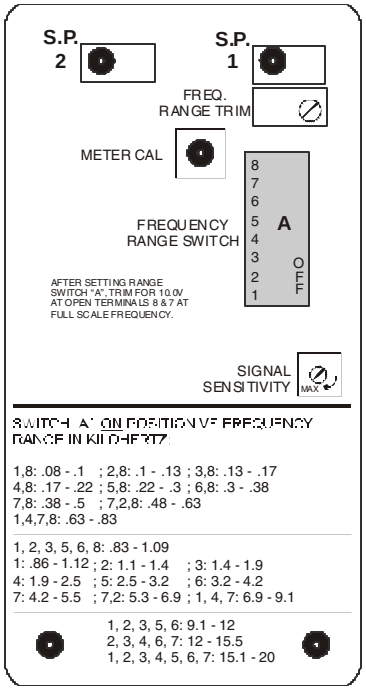


Fig. 4-9 The contact arrangements for the full-scale frequency range switch (A) are on underside of the top plate.

Table 4-1 Table of full-scale frequency and the corresponding switch "A" ON settings.

Freq. Range (in kHz)	Switch A ON Positions	Freq. Range (in Hz)
0.08 - 0.10	1, 8	80 - 100
0.10 - 0.13	2, 8	100 - 130
0.13 - 0.17	3, 8	130 - 170
0.17 - 0.22	4, 8	170 - 220
0.22 – 0.30	5, 8	220 - 300
0.30 - 0.38	6, 8	300 - 380
0.38 – 0.50	7, 8	380 - 500
0.48 – 0.63	7, 2, 8	480 - 630
0.63 – 0.83	1, 4, 7, 8	630 - 830
0.83 – 1.09	1, 2, 3, 5, 6, 8	830 - 1,090
0.86 – 1.12	1	860 - 1,120
1.10 – 1.40	2	1,100 - 1,400
1.40 – 1.90	3	1,400 - 1,900
1.90 – 2.50	4	1,900 - 2,500
2.50 – 3.20	5	2,500 - 3,200
3.20 – 4.20	6	3,200 - 4,200
4.20 – 5.50	7	4,200 - 5,500
5.30 – 6.90	7, 2	5,300 - 6,900
6.90 – 9.10	1, 4, 7	6,900 - 9,100
9.10 – 12.0	1, 2, 3, 5, 6	9,100 - 12,000
12.0 – 15.5	2, 3, 4, 6, 7	12,000 - 15,500
15.1 – 20.0	1, 2, 3, 4, 5, 6, 7	15,100 - 20,000

Calibrating the 4-20 mA Proportional Output

You must calibrate the speed switch if the standard proportional output of 4 to 20 mA is changed to :

- 0–5 Vdc using switch C1, or
- 0–10 Vdc using switch C2

To calibrate the new proportional output

1. Attach a digital voltmeter to terminals 9 (–) & 10 (+).
2. Apply 10% of the full-scale frequency to input terminals 5 (+), 6 (–).
3. Adjust the PROP OUT ZERO adjust potentiometer (See Fig. 4-10, below) to yield 10% of full-scale proportional output on the voltmeter.

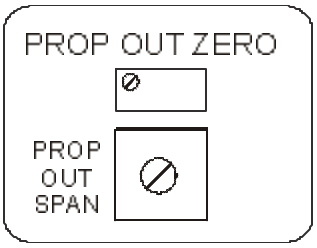


Fig. 4-10 The PROP OUT ZERO and PROP OUT SPAN adjustments are located in the upper right corner under the top plate of the SST-2000A/H.

4. Apply 100% of full-scale frequency to terminals 5 (+) & 6 (–).
5. Turn PROP OUT SPAN adjust potentiometer (See example below) to yield 100% of full-scale proportional output on the voltmeter .
6. Repeat steps 2, 3, 4, and 5 three or four times to assure accuracy.

EXAMPLE: A unit calibrated for 0-500 Hz input is being recalibrated to 0-10 Vdc proportional output (from 4-20 mAdc proportional output).

- Apply 10% of full-scale (50 Hz) to terminals 5 (+) & 6 (-).
- Adjust PROP OUT SPAN adjust potentiometer to yield 1.000 Vdc on the voltmeter.
- Apply full-scale frequency (500 Hz) to terminals 5 (+) & 6 (-).
- Turn PROP OUT ZERO adjust potentiometer to yield 10.00 Vdc.
- Repeat 3 or 4 times for accuracy.

Programming Set Points and Relays

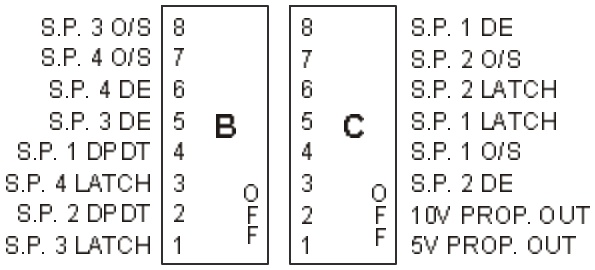
Remove the top plate from the SST-2000A/H to reveal DIP switches B and C.

Use DIP switches B and C to program relay set points to:

- energize (OFF) / de-energize (ON) on alarm
- non-latch (OFF) / latch (ON) on alarm
- actuate SPST (OFF) / DPDT (ON) trip on alarm
- change proportional voltage output

Fig. 4-11 The DIP switch settings available to you depend on the model of speed switch you purchased:

- SST-2400A/H series switches have four set point relay adjustments (DIP switches B and C).
- SST-2200A/H series switches only have relays 1 and 2 (adjustable using DIP switch C).
- SST-2000A/H switches have no set point relays.



The underside of the top plate contains labels for each DIP switch setting.

Resetting a latched relay

To momentarily reset a latched relay, jumper terminals 32 and 7.

Set points 3 & 4 and selecting DPDT trip

WHEN ALL B SWITCHES ARE OFF

- relays 3 and 4 are energized, underspeed
- non-latching
- all relays are SPST

EXAMPLE: To set relays 3 and 4 to actuate, de-energize, and latch on overspeed, turn on B1, B3, B5, B6, B7, and B8.

THE EFFECT OF TURNING B SWITCHES ON	
Turn on B to...	
B1	LATCH set point 3 on alarm
B2	ACTUATE relay 4 simultaneously with relay 2, creating two Form C contacts for set point 2 (DPDT relay).
B3	LATCH set point 4 on alarm
B4	ACTUATE relay 3 simultaneously with relay 1, creating two Form C contacts for set point 1 (DPDT relay).
B5	DE-ENERGIZE relay 3 on alarm
B6	DE-ENERGIZE relay 4 on alarm
B7	ACTUATE set point 4 on overspeed.
B8	ACTUATE set point 3 on overspeed.

Set points 1 & 2: 0-5 & 0-10 Vdc proportional output

WHEN ALL C SWITCHES ARE OFF

- the proportional output is 4-20 mA
- relays 1 and 2 are energized, underspeed
- non-latched

EXAMPLE: To change the proportional output to 0-10 Vdc, and set relay 2 to actuate, energize, and latch on overspeed, turn on C2, C6, and C7.

THE EFFECT OF TURNING C SWITCHES ON	
Turn on C to...	
C1	Change proportional output to 0-5 Vdc*. Confirm C2 is OFF.
C2	Changes proportional output to 0-10 Vdc*. Confirm C1 is OFF.
C3	DE-ENERGIZE relay 2 on alarm.
C4	ACTUATE relay 1 on overspeed, non-latch.
C5	LATCH relay 1 on alarm.
C6	LATCH relay 2 on alarm.
C7	ACTUATE relay 2 on overspeed, non-latch.
C8	DE-ENERGIZE relay 1 on alarm.
* Requires recalibration.	

Adjusting Signal Sensitivity

Desensitizing Standard Inputs

Signal sensitivity is factory set to 25 mVrms (about 35 mV peak or 70 mV peak-to-peak) and satisfies most applications.

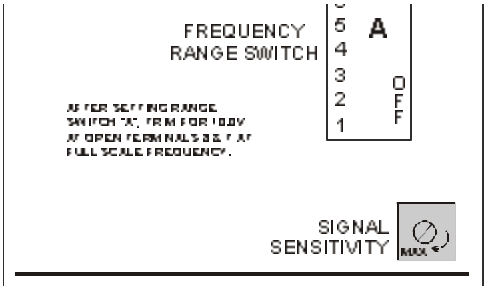


Fig. 4-12 The signal sensitivity control is located under the A DIP switch.

Higher sensitivities can be more vulnerable to noise.

To raise sensitivity Turn the SIGNAL SENSITIVITY potentiometer (Fig. 4-12) clockwise. At full clockwise rotation, sensitivity is approximately 5 mVrms.

To lower sensitivity Turn the SIGNAL SENSITIVITY potentiometer counterclockwise. At full counterclockwise rotation, the sensitivity is approximately 100 mVrms.

Desensitizing Contact Closure

Jumper terminals 30 and 11 to desensitize the unit to about 1 Vrms. Signal Sensitivity pot setting does not affect this procedure.

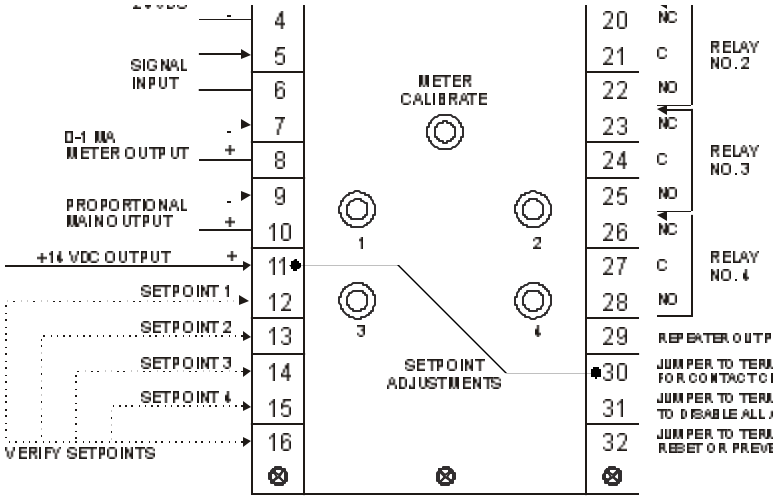


Fig. 4-13 Jumper terminals 11 to 30 to desensitize the SST-2000A/H for contact closure input.

Response Time

Response time is the time required for the proportional outputs to change from 10% to 90% of the maximum calibrated value for an instantaneous step change of the input frequency. Response time affects the transfer speed of the relays.

RELAY RESPONSE

Contact Dynalco if you need a different relay response time.

Standard response time is 150 milliseconds over all standard input frequency ranges: 0-80 Hz full-scale to 0-20,000 Hz full-scale. Response times below 80 Hz full-scale are proportionally slower.

While other response times can be provided, field modification is not recommended since damage might result that could void the product warranty.

Contact Dynalco if you need a different relay response time.

Adjusting Individual Set Points

1. Verify that the SST-2000A/H is calibrated to the correct full-scale frequency range (see page 22).
2. Tools required: Either a very thin-bladed screwdriver or a transformer alignment tool; signal generator (Dynalco's F-16 or equivalent).
3. Provide a signal source. Use an F-16 signal generator or similar zero-crossing signal source, or use the frequency signal generated by the magnetic pickup on the engine.
4. Apply a frequency signal to terminals 5 & 6. This frequency input should equal the target RPM value of the set point being adjusted.

$$Setpoint\ Frequency\ (Hz) = \frac{RPM\ x\ No.\ of\ teeth\ or\ holes\ on\ flywheel}{60}$$

For example: Calculate the set point frequency for a gear with 72 teeth rotating at 800 RPM.

$$Frequency\ (Hz) = \frac{(800) \times (72\ teeth)}{60} = 960\ Hz$$ (to terminals 5 & 6)

Alternate Method 1: Adjusting set points while the engine is not running

Use a signal generator to adjust individual set points when the engine is not operating and if you do not have an analog RPM meter.

1. Disconnect the wires to terminals 5 & 6. Mark or position the wires to assure correct replacement.

2. Apply the calculated set point frequency to terminals 5 (HI) & 6 (COM).
3. Apply operating power to the SST-2000A/H. See lid of your SST-2000A/H or spec sheet for power choices.
4. Select the appropriate set point trim pot.
5. Turn the pot:
   - Counterclockwise to lower the set point value (reduce the speed at which the set point relay will trip).
   - Clockwise to raise the set point value (increase the speed at which the set point relay will trip).
6. Turn the pot slowly so as not to pass the target set point by a large amount. The pot has fine resolution, so a large change in set point value may take several turns.
7. While adjusting the pot, listen for the relay to trip at the set point. You can hear a distinct click when the contacts transfer. If high ambient noise makes it impossible to hear the relay click: use an ohmmeter as described in Alternate Method 2, below.
8. Fine tune the adjustment:
   - After the relay trips, slowly REVERSE the adjustment of the set point pot until the relay again trips.
   - Again, slowly turn the pot FORWARD until the relay trips.
9. Reattach the wires to terminals 5 (HI) & 6 (COM). Observe polarity.
10. Repeat the above procedure for other set points to be changed.

Alternate Method 2: Adjusting Individual Set Points While The Engine Is Operating

A *non-critical* overspeed value is one that will not stress the engine. Use Alternate Method 3 to adjust set points while the engine is operating at a non-critical speed. NOTE: when the set point value is reached the relay will cause an engine shutdown or activate whatever is connected to that relay.

A *critical* overspeed is typically the actual engine shutdown overspeed; running

WARNING: DO NOT RUN AT OVERSPEED

Use Alternate Method 3 to adjust set points while the engine is operating at NON-CRITICAL speed only.

the engine at this speed is generally not desired. Use Alternate Method 1 if you cannot guarantee engine overspeed.

1. Run the engine at the desired speed using:

- an RPM indicator/tachometer operating from one of the proportional outputs of the SST-2000A/H:
- an independent meter mounted elsewhere on or near the engine.

2. Wait for the RPM to stabilize.
3. When RPM is stable, select the appropriate set point trim pot .
4. Follow the procedure in Alternate Method 1: steps 1-10.

Alternate Method 3: Adjusting individual set points in high noise areas

If high ambient noise makes it impossible to hear the relay click:

1. Disconnect the wire from:
   - the center post of the SST-2000A/H set point relay being adjusted.
   - either one of the other two contacts on the same relay.

   [Mark the wires or position them so they can be correctly reattached.]
2. Connect an ohmmeter to the center terminal of this relay and to either one of the other terminals of this relay. [If adjusting Relay 1, connect the ohmmeter to terminals 18 & 17 or 18 & 19.] The ohmmeter will indicate either a short or an open condition depending on which terminals are chosen.
3. Adjust the relay as outlined in Method 1: 1-10. When the relay trips, the ohmmeter will show a short or an open, opposite to the indication it had before the relay tripped.
4. Reattach the wires to the relays.
5. Repeat the above procedure for other set points to be changed.

Verifying Set Point Values

You can view and adjust the set point values without having to run the engine.
NOTE: The SST-2000A/H (no set points) does not have set points.

The temporary jumper does not interfere with the normal operation of any relays.

The 4–20 mA proportional output (terminals 9 & 10) is NOT affected by this procedure.

The 14 Vdc pulsed output is not affected by this procedure.

1. Jumper terminal 16 with the terminal that corresponds with the set point you want to view (for SST02200A/H and SST-2400A/H):
   - Set point 1: jumper 16 to 12
   - Set point 2: jumper 16 to 13
   - Set point 3: jumper 16 to 14
   - Set point 4: jumper 16 to 15
2. When you jumper the two terminals, the 0–1 mA output meter connected to terminals 7 and 8 disconnects and displays the RPM (frequency, rate, etc.) value at that set point.
3. When the jumpers are removed, the meter switches back to its normal operation.

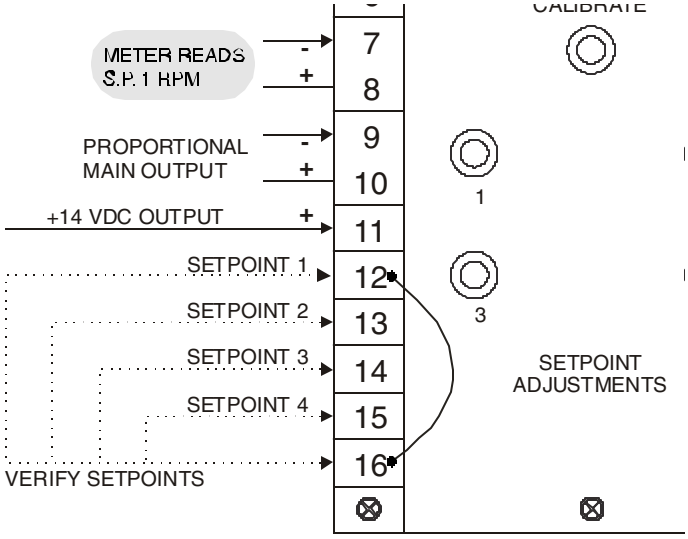


Fig. 4-14 Verify the set point values and view the RPM (frequency, rate, etc.) on the 0–1 mA output meter connected to terminals 7 & 8.

(Shown is the procedure for verifying Set point 1.)

Adjusting Set Point Values

WARNING

You can adjust set points while the engine or other device is operating. However, if you adjust a set point relay to a value lower than the current operating speed, the relay will trip.

You will need a 0–1 mA meter for this procedure. If a meter was supplied with the speed switch, you can use it. Otherwise, you can use a DPM-105 meter, or any 0-1mA ammeter.

The external meter should be calibrated : "0–1 mA = 0 to full-scale input frequency" of the SST-2000A/H.

See the specification sheet or serial number label that accompanied the unit for the full-scale frequency value.

1. Observe polarity. Connect an external 0-1 mA meter to terminals 7 (–) & 8 (+).
2. Depending on the set point to be adjusted, connect a temporary jumper from :
   - Terminal 16 to 12 (for Set point 1) or
   - Terminal 16 to 13 (for Set point 2) or
   - Terminal 16 to 14 (for Set point 3) or
   - Terminal 16 to 15 (for Set point 4)
3. The 0–1 mA meter will now indicate the current value for the chosen set point (see Fig. 4-14, page 31).
4. If necessary, first adjust the selected set point using procedures outlined in Adjusting Individual set points, page 28.
5. Remove the temporary jumper.
6. The output from terminals 7 & 8 will again provided the standard 0–1 mA proportional output.
7. Repeat steps 1–5 for additional set points.

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February 2009

67CF Series Installation Sheet

Introduction

This installation sheet covers the installation and startup of the 67CF Series filter regulators. If maintenance is required, refer to the 67CF Series Instruction Manual, form 5469. Contact your local Sales Office to receive a copy of the instruction manual.

Specifications

- **Maximum Inlet Pressure:**

  250 psig (17,2)

- **Maximum Outlet Pressure:**

  50 psi (3,4 bar) over outlet pressure setting

- **Outlet Pressure Ranges:**

  0 to 35 psig (0 to 2,4 bar)

  0 to 60 psig (0 to 4,1 bar)

  0 to 125 psig (0 to 8,6 bar)

- **Temperature Capabilities with Nitrile (NBR):**

  -40° to 180°F (-40° to 82°C)

Installation

WARNING

Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is overpressured or is installed where service conditions could exceed the limits given in the specifications, or where conditions exceed any ratings of the adjacent piping or piping connections. To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits.

The internal relief valve in the Type 67CFR regulator does not provide full overpressure protection. The internal relief valve is designed for minor seat leakage only. If maximum inlet pressure to the Type 67CFR exceeds the maximum pressure ratings of the downstream equipment or exceeds themaximum allowable outlet pressure of the Type 67CFR, additional overpressure protection is required.

1. Regulator operation within ratings does not preclude the possibility of physical damage from external sources or debris in the lines. Regulators should be inspected for damage periodically and after an overpressure condition.
2. Only personnel qualified through training and experience should install, operate, and maintain a regulator. Make sure there is no damage to or foreign material in the regulator and all tubing or piping is free of debris.
3. Install the regulator so that flow is from the IN to the OUT connection as marked on the regulator body.
4. For best drainage, orient the drain valve (key 2) to the lowest possible point on the dripwell (key 5). This orientation may be improved by rotating the dripwell with respect to the body (key 1).

WARNING

A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air

D102657X012

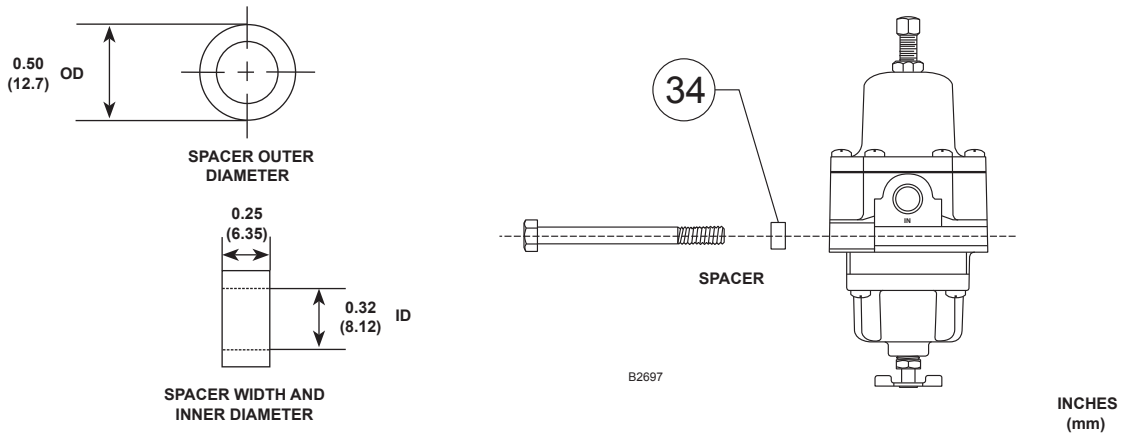


***Figure 1**. Spacer Diameter and Installation*

intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.

5. A clogged spring case vent hole may cause the regulator to function improperly. To keep this vent hole from being plugged (and to keep the spring case from collecting moisture, corrosive chemicals, or other foreign material) orient the vent to the lowest possible point on the spring case or otherwise protect it. Inspect the vent hole regularly to make sure it is not plugged. Spring case vent hole orientation may be changed by rotating the spring case with respect to the body. A 1/4 NPT spring case vent may be remotely vented by installing tubing or piping into the vent.
6. For regulator shutdown, install upstream block and vent valves and downstream block and vent valves (if required), or provide some other suitable means of properly venting the regulator inlet and outlet pressures.
7. Apply a good grade of pipe compound to the male pipe threads before making connections, making sure not to get the pipe compound inside the regulator.
8. Install tubing fitting or piping into the 1/4 NPT inlet connection on the body (key 1) and into the 1/4 NPT body outlet connection.
9. The second 1/4 NPT outlet can be used for a gauge or other use. If not used, it must be plugged.
10. When installing a 67CF Series regulator in an existing installation, it may be necessary to use spacers to adapt the installation. If the mounting bolts are too long, place a spacer on the bolt. To be sure the regulator is secure, the bolts should have at least two full threads of engagement.

Startup and Adjustment

1. With proper installation completed and downstream equipment properly adjusted, slowly open the upstream and downstream shutoff valve (when used) while using pressure gauges to monitor pressure.

WARNING

To avoid personal injury, property damage, or equipment damage caused by bursting of pressure containing parts or explosion of accumulated gas, never adjust the control spring to produce an outlet pressure higher than the upper limit of the outlet pressure range for that particular spring. If the desired outlet pressure is not within the range of the control spring, install a spring of the proper range.

2. If outlet pressure adjustment is necessary, monitor outlet pressure with a gauge during the adjustment procedure. The regulator is adjusted by loosening the locknut (key 19), if used, and turning the adjusting screw or handwheel (key 18) clockwise to increase or counterclockwise to decrease the outlet pressure setting. Tighten the locknut to maintain the adjustment position.

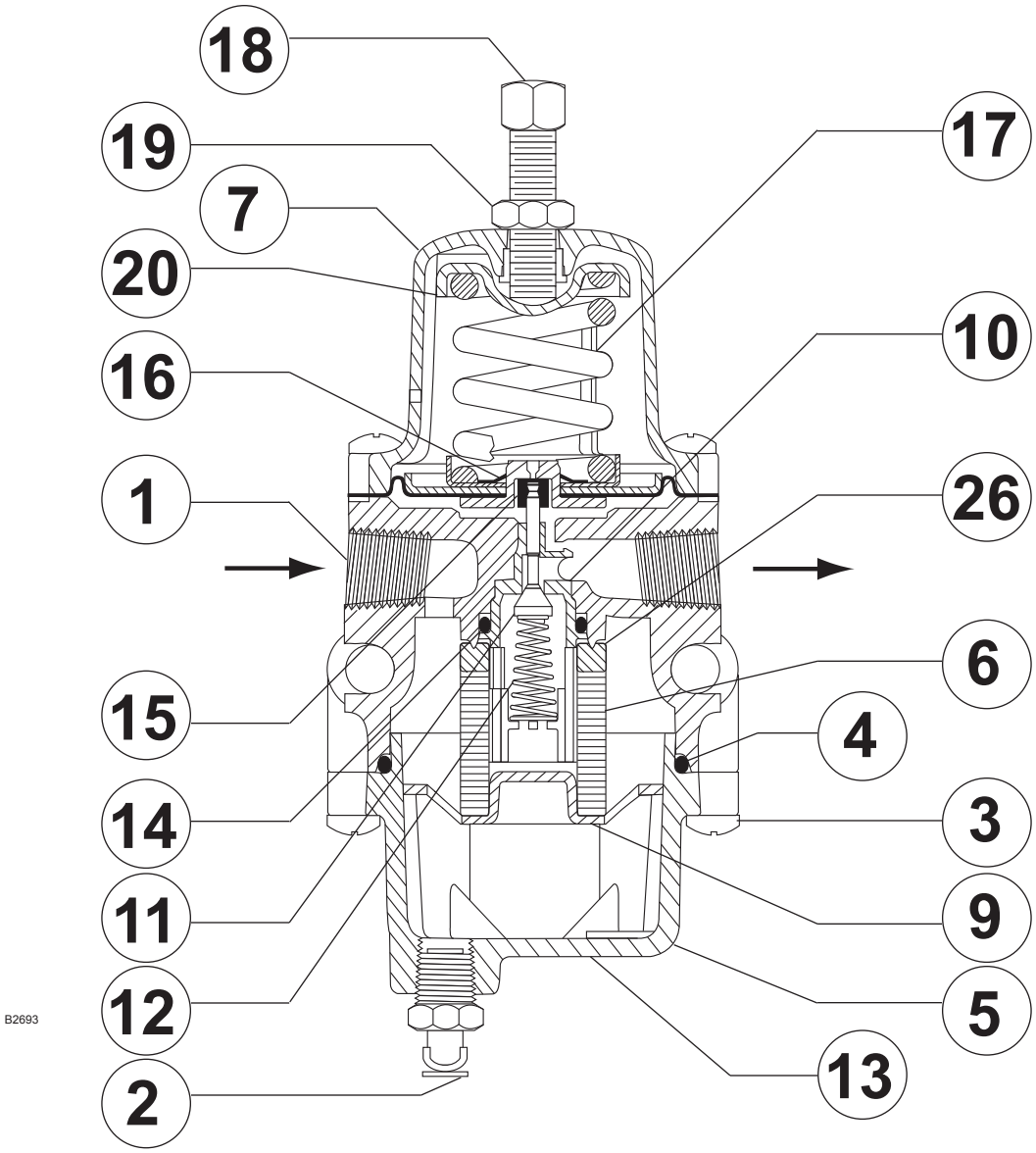


***Figure 2**. 67CF Series Assembly Drawings*

Parts List

Key	Description
1	Body
2	Drain Valve
3	Flange Screw
4*	O-Ring
5	Dripwell
6*	Filter Element
7	Spring Case
9	Filter Retainer
10*(1)	Valve Cartridge
11*(1)	Valve Plug
12*(1)	Valve Spring
13*(1)	Valve Retainer
14*(1)	O-Ring
15*(1)	Soft Seat

Key	Description
16*	Diaphragm Assembly
17	Spring
18	Adjusting Screw
19	Locknut
20	Upper Spring Seat
22	Pressure Gauge
23	1/4-Inch Pipe Plug
24	Tire Valve
26*	Filter Gasket
31	Panel Mounting Nut
32	Wire Seal
33	Closing Cap
34	Spacer

*Recommended Spare Part
1. Valve cartridge assembly includes keys 10, 11, 12, 13, 14, 15.

Industrial Regulators

Emerson Process Management
Regulator Technologies, Inc.

USA - Headquarters
McKinney, Texas 75069-1872 USA
Tel: 1-800-558-5853
Outside U.S. 1-972-548-3574

Asia-Pacific
Shanghai, China 201206
Tel: +86 21 2892 9000

Europe
Bologna, Italy 40013
Tel: +39 051 4190611

Middle East and Africa
Dubai, United Arab Emirates
Tel: +971 4811 8100

Natural Gas Technologies

Emerson Process Management
Regulator Technologies, Inc.

USA - Headquarters
McKinney, Texas 75069-1872 USA
Tel: 1-800-558-5853
Outside U.S. 1-972-548-3574

Asia-Pacific
Singapore, Singapore 128461
Tel: +65 6777 8211

Europe
Bologna, Italy 40013
Tel: +39 051 4190611
Gallardon, France 28320
Tel: +33 (0)2 37 33 47 00

TESCOM

Emerson Process Management
Tescom Corporation

USA - Headquarters
Elk River, Minnesota 55330-2445 USA
Tel: 1-763-241-3238

Europe
Selmsdorf, Germany 23923
Tel: +49 (0) 38823 31 0

For further information visit www.emersonprocess.com/regulators

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Fisher™ 667 Diaphragm Actuator Sizes 30/30i-76/76i and 87

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Figure 1. Fisher 667 Actuator Mounted on easy-e™ Valve



Introduction

Scope of Manual

This instruction manual provides information on installation, adjustment, maintenance, and parts ordering for the Fisher 667 actuator in sizes 30/30i through 76/76i and size 87. The 667-4 actuator in sizes 70/70i and 87 is also covered. Refer to separate instruction manuals for information about the valve positioner and other accessories used with these actuators.

Do not install, operate, or maintain a 667 actuator (see figure 1) without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Table 1. Specifications

SPECIFICATION(1)		ACTUATOR SIZE									
		30/30i	34/34i	40/40i	45/45i	46/46i	50/50i	60/60i	70/70i(1)	76/76i	87(1)
Nominal Effective Area	Sq cm	297	445	445	667	1006	677	1006	1419	1006	1419
	Sq Inch	46	69	69	105	156	105	156	220	156	220
Yoke Boss Diameter	mm	54	54	71	71	71	90	90	90	90	125
	Inch	2-1/8	2-1/8	2-13/16	2-13/16	2-13/16	3-9/16	3-9/16	3-9/16	3-9/16	5
Acceptable Valve Stem Diameter	mm	9.5	9.5	12.7	12.7	12.7	19.1	19.1	19.1	19.1	25.4
	Inch	3/8	3/8	1/2	1/2	1/2	3/4	3/4	3/4	3/4	1
Maximum Allowable Output Thrust(4)	N	10230	10230	12010	25131	33582	25131	30246	39142	30246	39142
	LB	2300	2300	2700	5650	7550	5650	6800	8800	6800	8800
Maximum Travel(2)	mm	19	29	38	51	51	51	51	76(3)	51	76(3)
	Inch	0.75	1.125	1.5	2	2	2	2	3(3)	2	3(3)
Maximum Casing Pressure for Actuator Sizing(4,6)	Bar	3.8	4.8	4.8	4.5	3.8	4.5	3.8	3.4	3.4	3.4
	Psig	55	70	70	65	55	65	55	50	50	50
Maximum Excess Diaphragm Pressure(4,5)	Bar	3.8	1.4	1.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7
	Psig	55	20	20	10	10	10	10	10	10	10
Maximum Diaphragm Casing Pressure(4,6,7)	Bar	7.6	6.2	6.2	5.2	4.5	5.2	4.5	4.1	4.1	4.1
	Psig	110	90	90	75	65	75	65	60	60	60
Approximate Weight	Kg	15/17	22/26	23/26	41/44	55/59	43/48	55/60	115/118	86/89	118
	Pounds	34/37	48/58	50/56	90/98	121/129	94/105	122/133	254/260	190/196	260
Material Temperature Capabilities	Nitrile Elastomers	-40 to 82°C (-40 to 180°F)									
	Silicone Elastomers	-54 to 149°C (-65 to 300°F)									

1. These values also apply to the 667-4 actuator construction.
2. Actuator travel may be less than the value listed after connected to the valve.
3. Maximum actuator travel for 667-4 is 102 mm (4 inches).
4. See also the Specifications portion of the introduction section.
5. Additional pressure may be added when the actuator is at full travel. If the Maximum Excess Diaphragm Pressure is exceeded, damage to the diaphragm or diaphragm casing might result. See the Maximum Pressure Limitation section.
6. Maximum diaphragm casing pressure must not be exceeded and must not produce a force on the actuator stem greater than the maximum allowable actuator output thrust or the maximum allowable stem load. See the Maximum Pressure Limitation section.
7. This maximum casing pressure is not to be used for normal operating pressure. Its purpose is to allow for typical regulator supply settings and/or relief valve tolerances.

Description

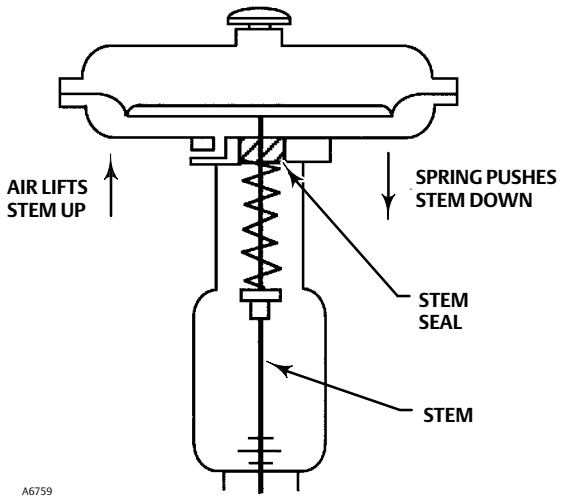
The 667 actuator (figure 1) and the 667-4 actuator are reverse-acting, spring-opposed diaphragm actuators. They provide automatic operation of control valves. The 667 actuator provides 76 mm (3 inches) maximum actuator travel. The 667-4 actuator provides 102 mm (4 inches) maximum actuator travel. Both actuators position the valve plug in response to varying pneumatic loading pressure on the diaphragm. Figure 2 shows the operation of these actuators.

A 667 or 667-4 actuator can be furnished with either a top-mounted or a side-mounted handwheel assembly. A top-mounted handwheel assembly is normally used as an adjustable down travel stop. (A down travel stop limits actuator travel in the down direction [when the stem is traveling out of the actuator]. Travel in the up direction is when the stem is traveling into the actuator.) A side-mounted handwheel assembly is normally used as an auxiliary manual actuator. The side-mounted handwheel can also be used as an adjustable up or down travel stop. Casing-Mounted adjustable up or down travel stops are also available on this actuator.

Note

If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as a manual operator.

Figure 2. Schematic of Fisher 667 and 667-4 Actuators



Specifications

Refer to table 1 for Specifications of the 667 and 667-4 actuators. See the actuator nameplate for specific information for your actuator.

Educational Services

For information on available courses for Fisher 667 diaphragm actuators, as well as a variety of other products, contact:

Emerson Process Management
Educational Services - Registration
Phone: 1-641-754-3771 or 1-800-338-8158
E-mail: education@emerson.com
http://www.emersonprocess.com/education

Instructional Videos

Click here or access the following QR code for a video on mounting a DVC6200 Digital Valve Controller on a 667 actuator.

Click here or access the following QR code for a video on installing a side-mounted handwheel on a 667 actuator.

⚠ WARNING

To avoid personal injury or damage to equipment that may result in the malfunction of the control valve or loss of control of the process caused by excessive pressure, do not exceed the Maximum Pressures listed in table 1. Refer to the Maximum Pressure Limitations section.

Maximum Pressure Limitations

The casing and diaphragm of 667 actuators are pressure operated. This air pressure provides energy to compress the spring, to stroke the actuator, and to seat the valve. The following explanations describe the maximum pressure limits for an actuator. Refer to the nameplate or table 1 for maximum values for your actuator.

- Maximum Casing Pressure for Actuator Sizing: This is the maximum pressure that can be applied at less than full travel of the actuator. If this stroking pressure is exceeded before the upper diaphragm plate contacts the travel stop, damage to the stem or other parts might result.
- Maximum Excess Diaphragm Pressure: Additional pressure may be added when the actuator is at full travel. If the Maximum Excess Diaphragm Pressure is exceeded, damage to the diaphragm or diaphragm casing might result.

Because the actuator has traveled its specified travel, and the diaphragm head is physically stopped from movement, the energy from any additional air pressure is transmitted to the diaphragm and diaphragm casings. The amount of air pressure that can be added once the actuator has traveled to the stops is limited by the resultant adverse effects that may occur. Exceeding this limiting factor could result in leakage or casing fatigue due to the deformation of the upper diaphragm casing.

- Maximum Diaphragm Casing Pressure: If the Maximum Diaphragm Casing Pressure is exceeded, damage to the diaphragm, diaphragm casing, or actuator might result.

Installation

⚠ WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations.

Check with your process or safety engineer for any other hazards that may be present from exposure to process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

Key number locations are shown in figures 6, 7, 8, 9, and 10, unless otherwise noted. Also, refer to figure 3 for location of parts.

CAUTION

To avoid parts damage, do not use an operating pressure that exceeds the Maximum Diaphragm Casing Pressure (table 1) or produces a force on the actuator stem greater than the Maximum Allowable Output Thrust (table 1) or the Maximum Allowable Valve Stem Load.

- Valve/Actuator Assembly: If the actuator and valve are shipped together as a control valve assembly, it has been adjusted at the factory, and may be installed in the pipeline. After installing the valve in the pipeline, refer to the Loading Connection procedures.
- Actuator Mounting: If the actuator is shipped separately or the actuator has been removed from the valve, it is necessary to mount the actuator on the valve before placing the valve in the pipeline. Refer to the following actuator mounting procedures before placing the valve in service. It is recommended that you perform the Bench Set Spring Adjustment procedures in this section to confirm that the actuator is adjusted correctly for the valve travel.
- Positioner: If a positioner is installed, or is to be installed on the actuator, refer to the positioner instruction manual for installation. During the adjustment procedures, it will be necessary to provide a temporary loading pressure to the actuator diaphragm.
- Handwheel Cap: If the handwheel cap (key 247, figures 11, 13, or 21) is not in place, install the cap by pushing it on by hand until it snaps into place.

Mounting the Actuator on the Valve

CAUTION

The 667 actuator spring load pushes the stem down out of the actuator yoke (see figure 2), and it can come in contact with the valve stem during actuator mounting.

If the valve stem is allowed to remain in the up position (towards the actuator) during actuator mounting, it can interfere with the actuator stem during mounting. It is possible to damage valve stem threads or bend the valve stem. Be sure the valve stem is pushed down (into the valve body), away from the actuator while mounting.

It may be necessary to apply a temporary loading pressure to the actuator to move the actuator stem away from the valve during installation.

If it is not possible to provide a temporary loading pressure, be very careful when lowering the actuator over the valve stem to prevent damage to valve stem and threads.

⚠ WARNING

When moving the actuator stem with loading pressure applied, exercise caution to keep hands and tools out of the actuator stem travel path. If the loading pressure is accidently disconnected, personal injury and property damage may result if something is caught between the actuator stem and other control valve parts.

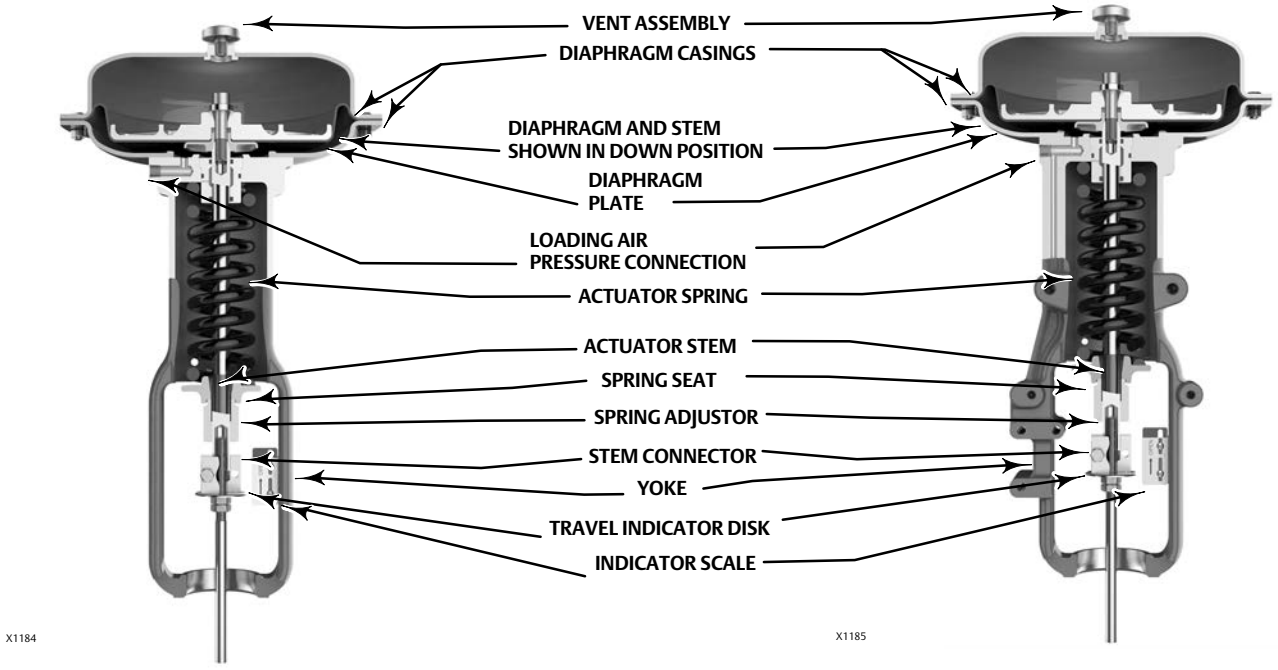
1. Provide a vise or some other method of supporting the valve and the weight of the actuator during assembly. For direct or reverse acting valves, push the valve stem down away from the actuator while mounting the actuator.
2. Screw the stem locknuts all the way onto the valve stem. With the concave side of the travel indicator disk (key 34) facing the valve, install the travel indicator disk on the valve stem. (Note: The travel indicator disk is not used with size 87 actuators.)
3. Lift or hoist the actuator onto the valve bonnet:
   a. For size 87 actuators: Slowly lower the actuator down onto the valve while guiding the valve stem into the opening in the end of the actuator stem (see figure 4). Once the actuator is in place, insert the cap screws and tighten the hex nuts, securing the actuator to the bonnet.

b. For all other size actuators:

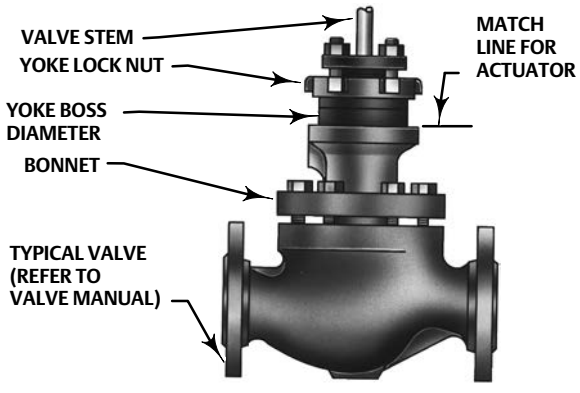
- Slowly lower the actuator down onto the valve. As the yoke passes over the end of the valve stem, place the yoke locknut over the valve stem. (Note: On small size actuators, it may be necessary to remove the indicator disk and re-install it while lowering the actuator onto the valve because the disk will not go through the actuator yoke opening).
- Continue to lower the actuator while guiding the valve stem into the opening in the end of the actuator stem until the actuator is in place (see figure 4).
- Screw the yoke locknut onto the valve bonnet and tighten the locknut.

4. Do not connect the actuator stem to the valve stem at this time. Whenever the actuator is installed on the valve, it is recommended that you perform the Bench Set Spring Adjustment procedures below, to verify that the actuator is still adjusted correctly.

Figure 3. Actuator-Mounting Components for Size 30/30i through 70/70i Actuators



SIZE 30 THROUGH 76 **SIZE 30i THROUGH 76i**



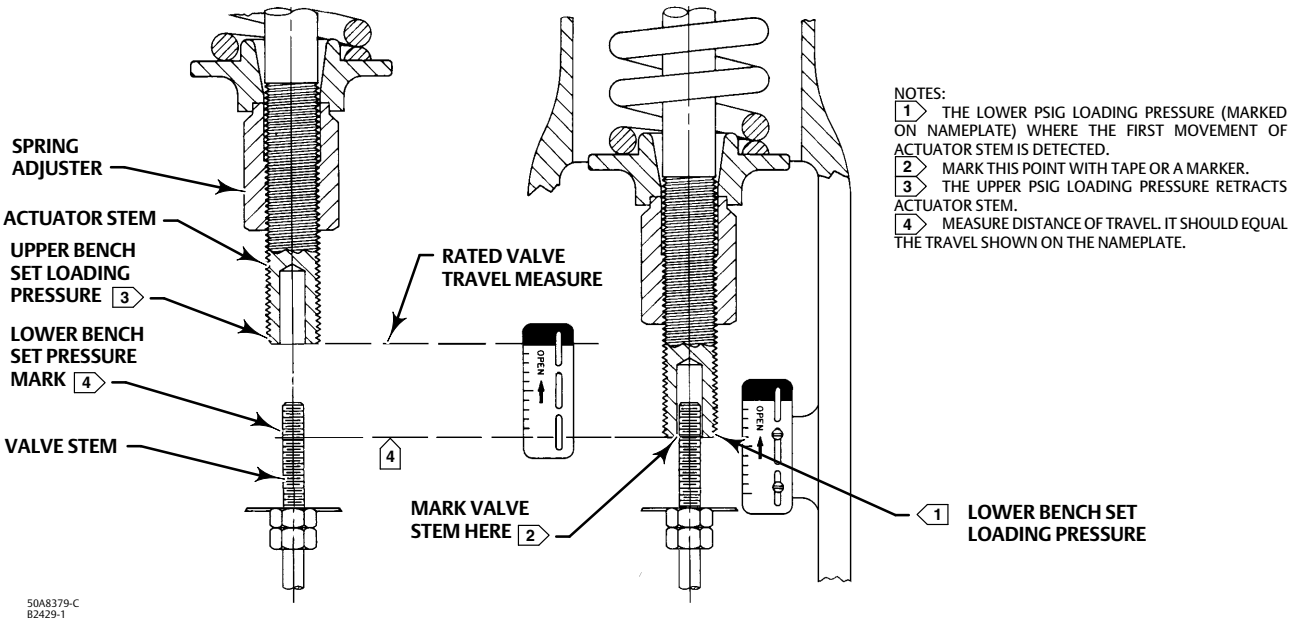
Discussion of Bench Set

The bench set pressure values are used to adjust the initial compression of the actuator spring with the valve-actuator assembly "on the bench." The correct initial compression ensures that the valve-actuator assembly will function properly when it is put into service and the proper actuator diaphragm operating pressure is applied.

The bench set values are established with the assumption that there is no packing friction. When attempting to adjust the spring in the field, it is very difficult to ensure that there is no friction being applied by "loose" packing.

Accurate adjustment to the bench set range can be made during the actuator mounting process by making the adjustment before the actuator is connected to the valve (see the Spring Verification Procedure).

Figure 4. Bench Set Adjustment



Spring Verification

Ensure that the actuator diaphragm is at the bottom of its travel as shown in figure 4 and not connected to the valve. (Note: Some spring compression is required to move the diaphragm to the **bottom** of its travel.)

Also, provide a certified pressure gauge that will accurately read the diaphragm pressure from 0 through 0.3 bar (5 psig) above the upper operating range pressure marked on the nameplate. Apply loading pressure to the diaphragm.

Stroke the actuator a few times to ensure that the pressure gauge is working correctly, and that the actuator is functioning properly.

CAUTION

To prevent actuator damage, it is important to ensure that the actuator stem is stroking smoothly and not exhibiting binding or excessive friction between the actuator stem and the bushing (key 7). Binding or excessive friction could be an indicator of incorrect assembly or damaged parts.

Key numbers are shown in figures 6, 7, 8, 9, and 10.

Note

For 667 actuators installed on push-down-to-close (direct acting) valves with fail-close action, the valve plug seat is the limit for downward travel and the actuator is the limit for upward (away from the valve) movement.

For 667 actuators installed on push-down-to-open (reverse acting) valves with fail-open action, the actuator down stop is the limit for downward movement, and the valve seat is the limit for upward (away from the valve) movement.

Ensure the correct Spring Verification procedure is followed for the type of valve on which the 667 actuator is installed.

For Push Down to Close (Direct Acting) Valves

1. If not already accomplished, push the valve stem down away from the actuator to the closed position.
2. Set the diaphragm loading pressure to 0.3 bar (5 psig) over the upper operating range pressure. The travel stop cap screw (key 12) should be contacting the upper diaphragm casing.
3. Slowly decrease the pressure towards the upper bench set pressure, as indicated on the nameplate, while checking for the **first** linear movement of the actuator stem.

Note

Before turning the spring adjuster on size 70/70i, 76/76i, or 87 actuators, assemble the stem connector around the actuator stem and the anti-rotating lug on the yoke. Mark the actuator stem as a visual reference to verify that stem rotation does not occur. Remove the stem connector before rechecking the bench set.

4. If movement occurs before or after the upper bench set pressure is reached, adjust the spring adjuster (see figure 4). Thread the adjuster up or down on the actuator stem until the actuator stem movement is **first** detected at the upper bench set pressure. (Note: You may need to lower the loading pressure to reduce spring compression, allowing the spring adjuster to turn.)
5. Be sure the spring adjuster is adjusted to meet the requirements of step 4 above.
6. Slowly decrease diaphragm loading pressure to the lower bench set pressure, as indicated on the nameplate. This will extend the actuator stem toward the valve. Mark the end of the actuator stem on a nearby surface using tape or some other method.
7. Slowly increase the diaphragm loading pressure until the upper bench set pressure is reached. Again, the travel stop cap screw (key 12) should be against the upper diaphragm casing.
8. Measure the distance between the mark or tape to the end of the actuator stem. This distance should match the rated travel indicated on the nameplate.
9. If the measured travel matches the nameplate travel, bench set is complete. Proceed to the Installing the Stem Connector Assembly subsection.
10. If the measured travel is not exact, consider the spring free-length and spring rate tolerances may produce a slightly different bench set than specified. Contact your Emerson Process Management sales office for assistance.

For Push Down to Open (Reverse Acting) Valves

1. If not already accomplished, push the valve stem down away from the actuator to the open position. Later, when installing the connector, pull up the valve stem to the closed position.

2. Set the diaphragm loading pressure to a value less than the lower bench set pressure, as indicated on the nameplate, or near zero. The down travel stops (key 77) should be contacting the yoke.
3. Slowly increase the pressure towards the lower bench set pressure while checking for the **first** linear movement of the actuator stem.

Note

Before turning the spring adjuster on size 70/70i, 76/76i, or 87 actuators, assemble the stem connector around the actuator stem and the anti-rotating lug on the yoke. Mark the actuator stem as a visual reference to verify that stem rotation does not occur. Remove the stem connector before rechecking the bench set.

4. If movement occurs before or after the lower pressure is reached, adjust the spring adjuster (see figure 4). Thread the adjuster up or down on the actuator stem until the actuator stem movement is **first** detected at the lower bench set pressure.
5. Apply the upper bench set pressure indicated on the nameplate to the diaphragm. This will retract the actuator stem away from the valve. Mark the end of the actuator stem on a nearby surface using tape or some other method.
6. Slowly decrease the diaphragm pressure until the lower bench set pressure is applied. Again, the down travel stops (key 77) should be against the yoke.
7. Measure the distance between the mark or tape to the end of the actuator stem. This distance should match the rated travel indicated on the nameplate.
8. If the measured travel matches the nameplate travel, bench set is complete. Proceed to the Installing the Stem Connector Assembly subsection.
9. If the measured travel is not exact, consider the spring free-length and spring rate tolerances may produce a slightly different bench set than specified. Contact your Emerson Process Management sales office for assistance.

Installing the Stem Connector Assembly

When installing the stem connector assembly (key 31), the actuator and valve stem threads should engage the threads of the stem connector by a distance equal to the diameter of the stem.

⚠ WARNING

Install the stem connector securely before a positioner is mounted to the actuator and pressurized, using only a regulator-controlled air supply, not the positioner, to move the actuator stem.

To avoid personal injury or property damage, keep hands and tools out of the actuator stem travel path while applying loading pressure to move the actuator stem in the following steps.

CAUTION

To avoid damaging the seating surfaces, do not rotate the valve plug while it is seated. Exercise care while installing the stem connector assembly to avoid damage to the valve plug stem and valve stem threads.

Note

Replacement stem connectors are an assembly of two stem connector halves, cap screws, and a spacer between the connector halves. Remove the spacer and discard it, if present, before clamping the actuator and valve stems together. Use only a mated pair of stem connectors.

1. If necessary, push the valve stem down so that the valve plug is touching the seat ring on direct-acting valves. For reverse-acting valves, pull the stem up to the closed position. Always start with the valve plug on the seat.
2. If necessary, screw the valve stem locknuts down, away from the connector location. For all actuators except size 87, ensure that the travel indicator disk (key 34) is on top of the locknuts.
3. Adjust the diaphragm pressure to the lower bench set pressure (or, the upper bench set pressure for reverse-acting valves.) This should be the same pressure used in the Spring Verification steps, and it is marked on the nameplate.
4. Place the stem connector half with the threaded holes approximately half way between the actuator and valve stems, and align the actuator stem and valve stem with threads from both stems mated root-to-crest with the stem connector. If the threads from one of the stems do not fully align with the stem connector, a slight change to loading pressure may be necessary to align the threads. Refer to figures 6, 7, 8, 9, and 10 to help locate the connector position.

CAUTION

Incomplete engagement of either the valve stem or actuator stem in the stem connector can result in stripped threads or improper operation. Be sure that the length of each stem clamped in the stem connector is equal to or greater than one diameter of that stem. Damage to threads on either stem or in the stem connector can cause the parts to be replaced prematurely. Do not loosen the cap screws when the stem connector has spring or loading pressure force applied.

5. Install the other half of the stem connector and insert the cap screws and tighten them while ensuring even spacing between the stem connector halves on all sides. If installing a positioner, also attach the feedback bracket at the same time.

CAUTION

Over-tightening the valve stem locknuts can make disassembly difficult.

6. Screw the valve stem locknuts up against the stem connector for the size 87 actuator. For all other actuator sizes, screw the valve stem locknuts up until the indicator disk contacts the bottom of the stem connector. Do not overtighten the locknuts.
7. Slowly stroke the valve from fully open to fully closed and verify full rated travel is achieved.

Be sure that the valve is in the closed position. Loosen the screws on the travel indicator scale (key 32), and align it with the travel indicator disk (key 34). Stroke the valve full travel to ensure that the travel matches the rated valve travel on the nameplate. If valve travel is not correct, repeat the stem connector procedure.

Friction Discussion

If you are attempting to adjust the bench set after the actuator is connected to the valve and the packing tightened, you must take friction into account. Make the spring adjustment so full actuator travel occurs at the bench set values (a) plus the friction force divided by the effective diaphragm area with increasing diaphragm pressure or (b) minus the friction force divided by the effective diaphragm area with decreasing diaphragm pressure.

If the stem connector assembly has been installed, the valve friction may be determined by the following procedure:

1. Install a pressure gauge in the actuator loading pressure line that connects to the actuator diaphragm casing.

Note

Steps 2 and 4 require that you read and record the pressure shown on the pressure gauge.

2. Increase the actuator diaphragm pressure and read the diaphragm pressure as the actuator reaches a travel position in the rated travel of the valve that does not contact a travel stop. Make a reference mark on the travel indicator scale using tape or some other method at this point.
3. Increase the actuator diaphragm pressure until the actuator is at a travel position greater than the position referenced in step 2 using the reference point to identify first movement.
4. Decrease the actuator diaphragm pressure and read the diaphragm pressure as the actuator returns to the position referenced in step 2.

The difference between the two diaphragm pressure readings is the change in the diaphragm pressure required to overcome the friction forces in the two directions of travel.

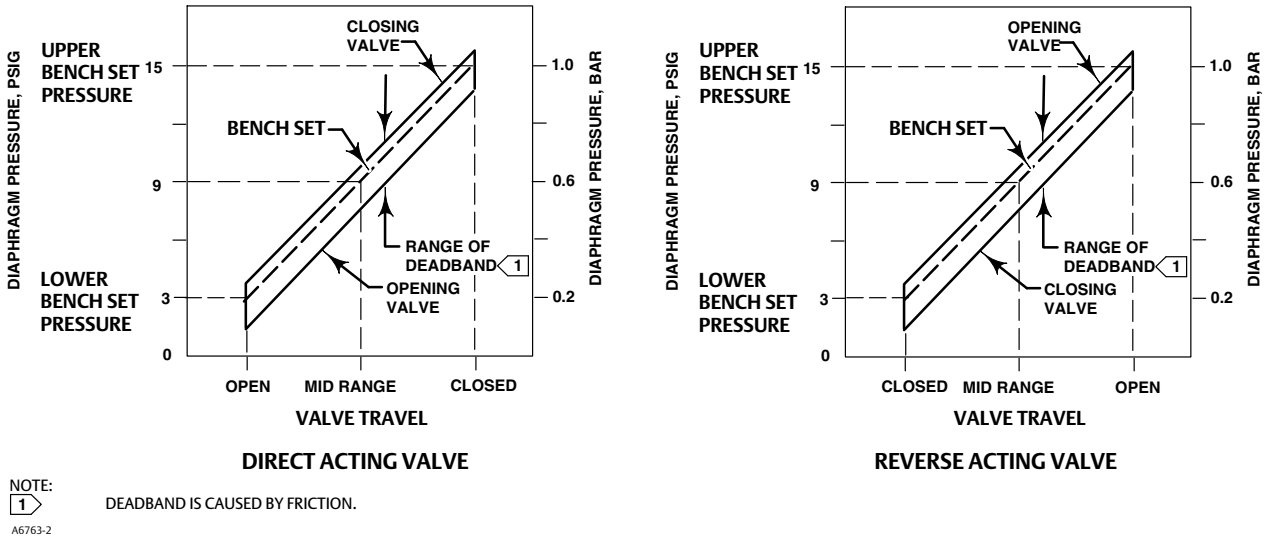
5. Calculate the actual friction force:

$$\text{Friction Force, = pounds} \quad 0.5 \left(\text{Difference in pressure readings, psig} \right) \times \left(\text{Effective diaphragm area, inches}^2 \right)$$

Refer to table 1 for the effective diaphragm area.

It is difficult to rotate the spring adjustor (key 74, figures 6, 7, 8, 9, and 10) when the full actuator loading pressure is applied to the actuator. Release the actuator loading pressure before adjusting. Then re-apply loading pressure to check the adjustment.

Figure 5. Typical Valve Response to Deadband



NOTE:
1 DEADBAND IS CAUSED BY FRICTION.

A6763-2

Deadband Measurement

Deadband is caused by packing friction, unbalanced forces, and other factors in the control valve assembly. Deadband is the range a measured signal can vary without initiating a response from the actuator (see figure 5). Each actuator spring has a fixed spring rate (force divided by compression). You have verified that the right spring was installed in the actuator by completing the Spring Verification steps.

Deadband is one factor that affects the control valve assembly operation during automatic loop control. The control loop tolerance for deadband varies widely depending on the loop response. Some common symptoms of the

deadband being too wide are no movement, a “jump” movement, or oscillating movements of the actuator during automatic loop control. The following steps are provided to determine the span of deadband. The percent of deadband is helpful in troubleshooting problems with the process control loop.

1. Start at a pressure near the lower bench set pressure, slowly increase pressure until the valve is approximately at mid-travel. Note this pressure reading.
2. Slowly decrease pressure until movement of the valve stem is detected, and note this pressure.
3. The difference between these two pressures is deadband, in psi.
4. Calculate the percent of deadband by:

Deadband, psi

$$\text{Deadband} = \frac{\text{Deadband, psi}}{\text{Bench Set Span, psi}} = \text{nn \%}$$

Loading Connection

Key number locations are shown in figures 6, 7, 8, 9, and 10, unless otherwise noted.

The loading pressure connections are made at the factory if the valve, actuator, and positioner come as a unit. Keep the length of tubing or piping as short as possible to avoid transmission lag in the control signal. If a volume booster, valve positioner, or other accessory is used, be sure that it is properly connected to the actuator. Refer to the positioner instruction manual or other manuals as necessary. For actuators shipped separately or whenever the actuator pressure connections are installed, use the following steps:

1. Connect the loading pressure piping to the NPT internal connection in the side of the yoke (key 73).
2. For size 70/70i and 87 actuators, if necessary, remove the 1/4 NPT bushing if a 1/2 NPT internal connection is needed to increase connection size. The connection can be made with either piping or tubing.
3. Cycle the actuator several times to be sure that the valve stem travel is correct when the correct pressure ranges are applied to the diaphragm.
4. If valve stem travel appears to be incorrect, refer to the Bench Set Spring Adjustment procedures at the beginning of this section. Do not place the valve in service if it is not reacting correctly to diaphragm loading pressure changes.

Maintenance

Actuator parts are subject to normal wear and must be inspected regularly and replaced when necessary. The frequency of inspection and replacement depends on the severity of service conditions.

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or uncontrolled movement of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**

- **Vent the power actuator loading pressure and relieve any actuator spring pre-compression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline.* Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

The maintenance instructions are divided into several sections: Actuator, Top-Mounted Handwheel Assembly (Adjustable Down Travel Stop), Side-Mounted Handwheel Assembly for Size 34/34i through 60/60i Actuators (Manual Actuator), Side-Mounted Handwheel Assembly for Size 70, 76 and 87 Actuators (Manual Actuator), and Casing-Mounted Travel Stops.

Actuator

This procedure describes how the actuator can be completely disassembled and assembled. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job; then, start the assembly at the appropriate step.

Key numbers are shown in figures 6, 7, 8, 9, or 10, unless otherwise noted. Figure 6 shows the size 30 through 60 actuators, figure 7 shows the size 30i through 60i actuators, figure 8 shows the size 70 actuator, figure 9 shows the size 70i actuator, and figure 10 shows the size 87 actuator.

Actuator Disassembly

Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Also shut off all pressure lines to the power actuator, release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

1. If equipped, remove the tubing or piping from the connection in the top of the yoke (key 73).
2. Turn the spring adjuster (key 74) counterclockwise (toward the valve body) until all spring compression is relieved.

⚠ WARNING

To avoid personal injury due to the sudden uncontrolled movement of parts, do not loosen the stem connector cap screws when the stem connector has spring force applied to it.

3. If necessary, remove the actuator from the valve body by separating the stem connector (key 31). Loosen the stem locknuts for the size 87 actuator, and remove the stem connector nuts. For all other sizes, separate the stem connector by loosening the stem locknuts (keys 69 and 75) and unscrewing the two stem connector cap screws.
4. Unscrew the spring adjuster (key 74) from the actuator stem (key 144). Also lift the spring seat and spring (key 19 and 18) out of the yoke.
5. Remove the diaphragm casing cap screws and nuts (keys 13 and 14), and lift off the upper diaphragm casing (key 1).

CAUTION

Be careful during disassembly to avoid damaging the O-rings (key 8).

6. Remove the following connected parts: the diaphragm (key 3), upper diaphragm plate (key 4), spacer (key 2), cap screw (key 12), lower diaphragm plate (key 71), and actuator stem (key 144). Be careful when pulling the threads of the actuator stem through the seal bushing (key 7) to avoid damaging the O-rings (key 8).
7. Remove the cap screw (key 12) to separate the parts of this assembly.
8. To remove the seal bushing, remove the snap ring (key 72), and lift out the bushing. Inspect, and if necessary, replace O-rings (keys 8 and 9).
9. Remove cap screws (key 30), and take off the lower diaphragm casing (key 64) and the gasket (key 70, size 30/30i through 60/60i and 76/76i) or O-ring (key 70, size 70/70i or 87). If necessary, the down travel stops (key 77) can be removed.

Table 2. Actuator Assembly Recommended Torque Values

DESCRIPTION, KEY NUMBER	ACTUATOR SIZE	THREAD SIZE, INCH	TORQUE	
			N • m	Lbf • ft
Casing to yoke, key 30(1)	30/30i to 60/60i and 76/76i	3/8-16	41	30
	70/70i and 87	1/2-13	95	70
Travel stop, key 12	30/30i	3/8-24	41	30
	34/34i and 40/40i	1/2-20	68	50
	45/45i to 76/76i and 87	3/4-16	183	135
MO U-bolt nut, key 170	34 and 40	1/2-13	81	60
	45 to 60	5/8-11	163	120
MO U-bolt nut, key 147	34 and 40	3/8-16	41	30
MO U-bolt nut, key 144	45 to 60	3/8-16	41	30
Diaphragm casing, key 14(1)	30/30i to 76/76i and 87	3/8-24	27	20
Hex cap screw,key 256	34i to 40i	1/2-13	92	68
	45i to 60i	5/8-11	163	120
Hex cap screw,key 257	34i to 60i	3/8-16	39	29
Stem connector, key 26(2)	30/30i through 40/40i	5/16-18	23	17
	45/45i through 70/70i	3/8-16	39	29
	87	1/2-13	91	67

1. Observe tightening pattern and procedure described in the appropriate Actuator Assembly section.
2. Torque values when lithium grease is used on the threads.

Actuator Assembly

Refer to table 2 as appropriate.

1. Coat the O-rings (key 70/70i, sizes 70 and 87) with lithium grease (key 237), or, coat the gasket with lithium grease (key 237). Place a new gasket or O-ring (key 70) on the yoke (key 73). Position the lower diaphragm casing (key 64) on the yoke and align the holes. Insert the cap screws (key 30) and tighten evenly in a crisscross pattern to 41 N•m (30 lbf•ft) for size 30/30i-60/60i and 76/76i actuators or 95 N•m (70 lbf•ft) for size 70/70i and 87 actuators. If down travel stops (key 77) were removed, insert and tighten them.
2. Coat the O-rings (keys 8 and 9) with lithium grease (key 237) and place the O-rings in the seal bushing (key 7).
3. Fill the seal bushing with lithium grease (key 237), slide the bushing into the yoke (key 73), and install the snap ring (key 72).

CAUTION

Be careful during assembly to avoid damaging the O-rings (key 8).

4. Assemble the actuator stem (key 144), lower diaphragm plate (key 71), diaphragm (key 3), upper diaphragm plate (key 4), and the travel stop cap screw and spacer (keys 12 and 2). Coat the cap screw threads with lithium grease

(key 237). Tighten the cap screw (key 12) to the appropriate torque as shown in table 2. Place this assembly in the actuator. Take care when pushing the actuator stem through the seal bushing so that the threads do not damage the O-rings.

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing bolts are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 30/30i-76/76i and 87 actuators.

CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

Note

Do not use lubricant on these bolts and nuts. Fasteners must be clean and dry.

5. Install the upper diaphragm casing (key 1), and install the cap screws and nuts (keys 13 and 14). Tighten the diaphragm cap screws and nuts in the following manner.
6. The first four bolts tightened should be diametrically opposed and 90 degrees apart. Tighten these four bolts to 13 N•m (10 lbf•ft).
7. Tighten the remaining bolts in a clockwise, criss-cross pattern to 13 N•m (10 lbf•ft).
8. Repeat this procedure by tightening four bolts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
9. Tighten the remaining bolts in a clockwise, criss-cross pattern to 27 N•m (20 lbf•ft).
10. After the last bolt is tightened to 27 N•m (20 lbf•ft), all of the bolts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
11. Once completed, no more tightening is recommended.
12. Install the actuator spring (key 18) and spring seat (key 19). Apply anti-seize lubricant (key 239) to the threads of the actuator stem and to the surface of the spring adjuster (key 74) that contacts the spring seat. Thread the spring adjuster onto the actuator stem.
13. Mount the actuator onto the valve in accordance with the procedures in the Installation section.

Top-Mounted Handwheel Assembly (Adjustable Down Travel Stop)

Actuator key numbers are shown in figures 6, 7, 8, 9, and 10. And, top-mounted handwheels are shown in figures 11, 12, 13, 14, and 15.

Note

If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as a manual operator.

A top-mounted handwheel assembly (figures 11, 12, 13, 14, and 15) is usually used as an adjustable down travel stop to limit full extension of the actuator stem. Turning the handwheel counterclockwise pulls the extension rod (key 150, figures 11, 13, and 14) up, retracting the actuator stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

Note

For size 70/70i and 87 actuators with handjack bars (figure 15) it is recommended that the handjack bar (key 58) be removed when not in use and the handwheel cap (key 247) be installed for weather protection of the internal components.

Disassembly for Top-Mounted Handwheel

1. Bypass the control valve, reduce loading pressure to atmospheric, and if equipped, remove the tubing or piping from the connection in the top of the yoke (key 73, figures 6, 8, 9, and 10).
2. Turn the handwheel (key 58) clockwise so that the handwheel assembly is not causing any spring compression.
3. Turn the actuator spring adjuster (key 74) to relieve all the compression from the spring (key 18).
4. If servicing just the thrust bearing, races, and handwheel screw (keys 180, 181, and 160), use the following steps:

- Remove the cap and take out the cotter pin. Remove the castle nut, bearing retainer, thrust bearing, and races (keys 247, 167, 166, 180, and 181).
- Use the handwheel to remove the handwheel screw (key 160) from the handwheel body (key 148).
- If necessary, remove the extension rod (key 150) at this time. Most maintenance procedures do not require the rod to be removed.
- Clean and inspect all parts or replace parts as necessary. Upon re-assembly, lubricate handwheel threads, bearings, and races with anti-seize lubricant (key 239).
- Lubricate and re-install the handwheel screw into handwheel body (key 148). Lubricate and replace the races, bearing, and retainer (keys 181, 180, and 182). Replace the castle nut (key 166), tighten it, and insert the cotter pin (key 167). Replace the handwheel cap (key 247).

5. For size 30/30i through 60/60i and 76/76i actuator handwheels (figures 11 and 13):

- Remove the cap screws (key 161). Make sure that the guide plate can turn between the handwheel body and the mounting plate (keys 157, 148 and 158).
- Remove the cap (key 247) and cotter pin (key 167). Remove the castle nut (key 166) and, if necessary, unscrew the extension rod (key 150). Remove the rod, the handwheel body (key 148), and the attached parts.
- Remove the hex nuts and cap screws (keys 14 and 13, figures 6, 7, 8, 9, and 10) from the diaphragm casings. Lift off the upper diaphragm casing (key 1) and the mounting plate (key 158).
- Turn the handwheel (key 58) to remove the handwheel screw (key 160) from the handwheel body (key 148). Remove the retaining ring (key 60) if the handwheel (key 58) must be separated from the handwheel screw.
- If necessary, perform other actuator maintenance before returning to the following assembly steps.

6. For size 70/70i and 87 actuator handwheels (figures 14 and 15):

- Remove the cap (key 247). Take out the cotter pin (key 167) and remove the castle nut, the bearing retainer, and thrust bearing (keys 166, 182, 181, and 180). It is not necessary to remove the extension rod (key 150) at this time.
- Remove the hex nuts and cap screws (keys 14 and 13, figures 6, 7, 8, 9, and 10) from the diaphragm casings. Lift off the upper diaphragm casing (key 1), handwheel body (key 148) and attached parts.
- If travel stops (key 152) are used, note and record their position relative to the cap screws (key 154) for use in assembly. Remove the travel stops and cap screws, and remove either the mounting plate (key 158, figure 14) or the handwheel body (key 148, figure 14) and attached parts.
- Turn the handwheel (key 58) to remove the handwheel screw (key 160) from the handwheel body (key 148). Remove the retaining ring (key 60) if the handwheel (key 58) must be separated from the handwheel screw.
- If necessary, perform other actuator maintenance before returning to the following assembly steps.

Assembly for Top-Mounted Handwheel

For size 30/30i through 60/60i and 76/76i actuator handwheels:

Refer to figures 11, 12, and 13 for top-mounted handwheel assemblies.

1. If it was removed, slide the handwheel (key 58) onto the end of the handwheel screw (key 160), and snap the retaining ring (key 60) into place. Also, install the guide post (key 150) if it was removed.
2. Generously coat the threads of the handwheel screw (key 160) with anti-seize lubricant (key 239). Turn the screw into the handwheel body (key 148).
3. Install the mounting plate (key 158) to the diaphragm casing (key 1, figures 6, 8, 9, and 10) with the cap screws (key 154). Finger tighten the screws.
4. If travel stops were used, install the travel stops to their original positions as recorded in the proceeding Disassembly steps. Tighten the screws and travel stops.

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing bolts are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 30/30i-76/76i and 87 actuators.

CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

Note

Do not use lubricant on these bolts and nuts. Fasteners must be clean and dry.

5. Position the diaphragm casing (key 1, figures 6, 7, 8, 9, and 10), mounting plate (key 158), travel stops (key 152), if used, and cap screws (key 154) on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 6, 7, 8, 9, and 10) and tighten in the following manner.

6. The first four bolts tightened should be diametrically opposed and 90 degrees apart. Tighten these four bolts to 13 N•m (10 lbf•ft).
7. Tighten the remaining bolts in a clockwise, criss-cross pattern to 13 N•m (10 lbf•ft).
8. Repeat this procedure by tightening four bolts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
9. Tighten the remaining bolts in a clockwise, criss-cross pattern to 27 N•m (20 lbf•ft).
10. After the last bolt is tightened to 27 N•m (20 lbf•ft), all of the bolts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
11. Once completed, no more tightening is recommended.
12. If necessary, screw the extension rod (key 150 into the connector (key 27). Slide the guide plate (key 157) onto the extension rod (key 150). For size 45/45i through 76/76i, place the spacer (key 253) on top of the guide plate (key 157). If necessary, replace the extension rod (key 150). Slide the handwheel body (key 148) over the extension rod, position the handwheel body on the spacer (key 253), align the holes, and insert and tighten the cap screws (key 161).
13. Lubricate and install the thrust bearings (keys 181 and 180), install the bearing retainer (key 182), install the castle nut (key 166) on the extension rod. Do not overtighten the castle nut on the bearing. Install the cotter pin (key 167). Replace the cap (key 247).
14. Refer to the Assembly portion of the Actuator maintenance section.

For size 70/70i and 87 actuators handwheels (figures 14 and 15):

Refer to figure 14 for top-mounted handwheel assemblies and figure 15 for handjack bar assemblies.

1. If removed, slide the handwheel (key 58) onto the end of the handwheel screw (key 160), and snap the retaining ring (key 60) into place.
2. Generously coat the threads of the handwheel screw (key 160) with anti-seize lubricant (key 239). Turn the screw into the handwheel body (key 148).
3. If necessary, install the extension rod (key 150) into the connector (key 27) and tighten it. Position the handwheel body (key 148) on the diaphragm casing (key 1, figures 6, 7, 8, 9, and 10), and align the holes. Insert the cap screws (key 154). Finger tighten the screws.
4. If travel stops were used, return the travel stops to their original positions as recorded in the proceeding Disassembly steps. Tighten the screws and travel stops.

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing bolts are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 30/30i-76/76i and 87 actuators.

CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

Note

Do not use lubricant on these bolts and nuts. Fasteners must be clean and dry.

5. Slide the extension rod (key 150) into the handwheel screw (key 160), and position the diaphragm casing (key 1, figures 6, 7, 8, 9, and 10) with the attached parts on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 6, 7, 8, 9, and 10) and tighten in the following manner.
6. The first four bolts tightened should be diametrically opposed and 90 degrees apart. Tighten these four bolts to 13 N•m (10 lbf•ft).
7. Tighten the remaining bolts in a clockwise, criss-cross pattern to 13 N•m (10 lbf•ft).
8. Repeat this procedure by tightening four bolts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
9. Tighten the remaining bolts in a clockwise, criss-cross pattern to 27 N•m (20 lbf•ft).
10. After the last bolt is tightened to 27 N•m (20 lbf•ft), all of the bolts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
11. Once completed, no more tightening is recommended.
12. Lubricate and install the thrust bearings (keys 180 and 181), install the bearing retainer (key 182), install the castle nut (keys 166) on the extension rod. Do not overtighten the castle nut on the bearing. Install the cotter pin (key 167). Replace the cap (key 247).
13. Refer to the Assembly portion of the Actuator maintenance section.

Side-Mounted Handwheel for Sizes 34 through 60 and 34i through 60i Actuators

A side-mounted handwheel assembly is normally used as a manual actuator for sizes 34 through 60 (figures 16 and 18) and 34i through 60i actuators (figures 17 and 19). Turning the handwheel counter-clockwise past the neutral position opens the valve. Two levers (key 146, figures 16, 17, 18, and 19) on a handwheel assembly operate the valve by moving the valve stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then begin the assembly at the appropriate step.

Disassembly for Side-Mounted Handwheel (Sizes 34-60 and 34i-60i)

1. Use **step a. for size 34 through size 60** actuators, and use **step b. for sizes 34i through 60i**.

   a. **For Size 34 through 60:** If desired, the handwheel assembly can be removed from the actuator yoke. To do this, remove the hex nuts (keys 147 and 170) from the U-bolts (key 166 and 143) that hold the assembly to the yoke for the size 30 and size 40. Remove the hex nuts (key 144 and 170) from the U-bolts (key 166 and 143) that hold the assembly to the yoke for the size 45 through size 60.

   b. **For Size 34i through 60i:** If desired, the handwheel assembly can be removed from the actuator yoke. To do this, remove the cap screws (key 256 and 257) and spacers (key 258) that hold the assembly to the yoke for the size 30i through size 60i.

2. Remove the retaining ring (key 154) and drive out the lever pivot pin (key 153).
3. Two screws (key 156) hold the right- and left-hand levers (key 146) together. Remove the screw from the top of the levers so that the levers will drop down out of the assembly. Disassemble further, if necessary, by removing the other screw.
4. Remove the screw (key 161) and pointer mounting bolt (key 159, not shown) located behind the pointer (key 160).
5. Remove the stop nut (key 54), lockwasher (key 150), and washer (key 149). Then remove the handwheel (key 51), being careful not to lose the small ball (key 55) and spring (key 56).
6. Loosen the locking set screw (key 168, figure 19). Then, using a suitable tool, unscrew the bearing retainer (key 136).

7. Pull the handwheel screw assembly (key 145) out of the handwheel body. The operating nut (key 132) will come out with the screw. Also remove the bushing (key 151, figure 16 or 17) on size 34 and 40.
8. If required, remove the two ball bearings (key 152), one from the bearing retainer and the other from the handwheel body.

Assembly for Side-Mounted Handwheel (Sizes 34-60 and 34i-60i)

Click here or access the following QR code for a video on installing a side-mounted handwheel on a 667 actuator.

1. Pack the ball bearings (key 152) with anti-seize lubricant (key 244). Insert one bearing and the bushing (key 151, figure 16 or 17) into the handwheel body (key 142). The bushing is not used in a handwheel assembly for sizes 45/45i through 60/60i actuators.
2. Coat the handwheel screw assembly (key 145) threads with anti-seize lubricant (key244), and thread the operating nut (key 132) onto the screw. Slide the second ball bearing (key 152) onto the screw, and insert the end of the screw into either the bushing (key 151, figure 16 or 17) for sizes 34/34i and 40/40i, or into the bearing for sizes 45/45i through 60/60i.
3. Thread the bearing retainer (key 136) into the body (key 142). Completely tighten the bearing retainer, and then loosen it one-quarter turn. Tighten the set screw (key 168, figure 16 or 17) to hold the bearing retainer in place.
4. Coat the groove in the handwheel body (key 142) with lithium grease (key 241). Insert the spring (key 56) and ball (key 55) into the handwheel (key 51). Holding the ball and spring in the handwheel, put the handwheel, the washer (key 149), the lockwasher (key 150), and the stop nut (key 54) onto the end of the end of the handwheel screw (key 145). Tighten the stop nut.
5. Position the pointer mounting bolt (key 159, not shown) and pointer (key 160). Insert and tighten the screw (key 161).
6. Assemble the two levers (key 146) with the cap screws (key 156) for handwheel assemblies for sizes 45/45i, 50/50i, and 60/60i actuators, or with the machine screws (key 156) for handwheel assemblies on sizes 34/34i and 40/40i actuators.
7. Use **step a. for size 34 through size 60** actuators, and use **step b. for sizes 34i through 60i**.

   a. **For Size 34 through 60:** If the handwheel assembly was removed from the yoke (key 9, figures 6, 8, or 10), remount the handjack assembly to the yoke using the dowel pins for alignment. For the size 34 and size 40, position the U-bolts and J-bolts (keys 166 and 143) on the yoke, and hand-tighten the hex nuts (keys 170 and 147) to hold the handwheel assembly in position. For the size 45 through size 60, position the U-bolts (keys 166 and 143) on the yoke, and hand-tighten the hex nuts (keys 170 and 144) to hold the handwheel assembly in position. Cap screws (key 163) should be tight against the yoke legs to provide stability. Tighten the nuts (key 144 for size 30 and size 40, key 158 for the size 45 through size 60). For the size 34 and size 40 finish tightening the U-bolt nuts to 81 N • m [60lbf • ft] (key170) and 41 N • m [30 lbf • ft] (key 147). For the sizes 45 through 60 finish tightening the U-bolt nuts to 163 N • m [120lbf • ft] (key170) and 41 N • m [30 lbf • ft] (key 144). Be sure the handwheel assembly remains flat against the mounting pad and perpendicular to the yoke.

   b. **For Size 34i through 60i:** If the handwheel assembly was removed from the yoke (key 9, figures 7, 9, or 10), remount the handjack assembly to the yoke using the dowel pins for alignment. Position the upper cap screws (key 256) on the assembly and hand-tighten to hold the handwheel assembly in position. Place the spacers (key 258) between the yoke and handjack assembly, position cap screws (key 257), and hand-tighten. For the size 34i and size 40i finish tightening the cap screws (key 256) to 92 N • m [68 lbf • ft] and (key 257) to 39 N • m [29 lbf • ft]. For the sizes 45i through 60i finish tightening the cap screws (key 256) to 163 N • m [120 lbf • ft] and (key 257)to 39 N • m [29 lbf • ft].

8. Position the levers (key 146) as shown in figures 11 or 12. Insert the lever pivot pin (key 153), and snap the retaining ring (key 154) onto the lever pivot pin.

Side-Mounted Handwheel Assembly for Size 70, 76, and 87 Actuators

A side-mounted handwheel assembly (figure 20) is usually used as a manual actuator. Turning the handwheel clockwise past the neutral position always closes the valve body. A sleeve (key 123, figure 20) on a handwheel assembly for a size 70, 76 or 87 actuator opens the valve body by moving the valve stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; and then begin the assembly at the appropriate step.

Disassembly for Side-Mounted Handwheel (Sizes 70, 76, and 87)

1. Bypass the control valve. Reduce the loading pressure to atmospheric. Disconnect the loading pressure tubing or piping at the yoke.
2. Remove the cover band (key 87), and relieve spring compression by turning the spring adjuster (key 74) counterclockwise.
3. Remove the cap screws and nuts (keys 13 and 14) and lift off the upper diaphragm casing (key 1).
4. Remove the travel stop screw (key 12) and spacer (key 2), and take off the diaphragm plate (key 4), the diaphragm (key 3), and the lower diaphragm plate (key 71).
5. Unscrew the cap screws (key 90) and remove the following connected parts: the lower diaphragm casing (key 64), the O-ring (key 70), spring case adaptor (key 89), the seal bushing, O-rings, and snap ring (keys 7, 8, 9, and 72).
6. Remove the snap ring (key 72), and slide the seal bushing and O-rings (keys 7, 8, and 9) out of the spring case adaptor (key 89).
7. Take out the actuator spring (key 18).
8. Remove the stem connector (key 31) and stem connector cap screws.
9. Pull the actuator stem (key 144) up and out of the yoke. The spring seat (key 19), spring adjuster (key 74), thrust bearing (key 128), and the pinned adjusting screw (key 131) will come out with the actuator stem.
10. Turn the handwheel so that the lower sleeve (key 123) extends out of the bottom of the yoke. DO NOT move the neutral indicator scale (key 125).
11. Loosen two set screws (key 121), and unscrew the bearing retainer flange (key 45). Take out the worm gear and two thrust bearings (key 132), one on each side of the gear.
12. The worm shaft (key 51) and associated parts can be disassembled, if desired, by first removing the handwheel nut (key 127) and the handwheel (key 58). Do not lose the small ball (key 141) and spring (key 142).
13. Loosen the set screw (key 52) for each worm shaft retainer (keys 48 and 49). Unscrew the two worm retainers (keys 48 and 49). The ball bearings (key 50) will come out with the retainers.

Assembly for Side-Mounted Handwheel (Sizes 70, 76, and 87)

1. The front and back worm retainers (keys 48 and 49) each have a slot in their threads for a set screw (key 52). Pack the ball bearings (key 50) with anti-seize lubricant (key 239), and insert one ball bearing in the back worm retainer (key 49) as shown in figure 20.
2. Thread the back bearing retainer and ball bearing (keys 49 and 50) into the yoke. Align the slot in the bearing retainer with the set screw hole in the yoke, insert the set screw (key 52), and tighten it.
3. Coat the worm shaft (key 51) threads with anti-seize lubricant (key 239), and slide the shaft into the yoke so that the end of the shaft fits snugly into the back bearing retainer.
4. Insert the bearing in the front bearing retainer (key 49), and thread the retainer and ball bearing into the yoke. Align the slot in the retainer with the hole in the yoke, insert the set screw (key 52), and tighten it.
5. Put the spring and ball (keys 141 and 142) in the handwheel (key 58). Slide the handwheel onto the worm shaft (key 51). Thread the hex nut (key 127) onto the worm shaft.

6. Pack the two needle bearings (key 132) and coat the worm gear (key 44) threads with anti-seize lubricant (key 239). Insert the key (key 122), the bearings, and the worm gear in the yoke (key 73) as shown in figure 20.
7. Slots are cut in the threads of the bearing retainer flange (key 45). Thread the flange into the yoke so that the slots and the holes for the set screws (key 121) align. Insert the screws, and tighten them.
8. The lower sleeve (key 123) has a milled groove in one end. Coat the sleeve threads with anti-seize lubricant (key 239), slide the end of the lower sleeve with the groove into the bearing retainer flange, turn the handwheel, and feed the sleeve through the worm gear so that the slot in the lower sleeve engages the key (key 122) in the yoke. Continue turning the handwheel until the lower sleeve protrudes 81 mm (3.19 inches) below the surface of the yoke. The bottom of the lower sleeve should be even with the bottom of the extension on the neutral indicator.
9. Pack the thrust bearing (key 128) with anti-seize lubricant (key 239). Slide the actuator stem (key 144) and the attached adjusting screw (key 131), pin (key 130), thrust bearing (key 128), spring seat (key 19), and spring adjuster (key 74) into the yoke. The lower end of the stem slides through the lower sleeve (key 123) and the lower sleeve slides into the adjusting screw (key 131), as shown in figure 20.
10. Position the actuator stem (key 144) against the valve stem. Clamp both stems between the two halves of the stem connector (key 31), and be sure the threads are engaged properly on both stems. The stem connector should not be closer than 3.2 mm (1/8 inches) to the lower sleeve when the actuator stem is in the retracted position. This adjustment will provide approximately 3.2 mm (1/8 inches) of free travel of the lower sleeve in either direction for manual operation. Fasten the halves together with the cap screws.
11. Put the actuator spring (key 18) in the yoke on the spring seat (key 19).
12. Coat the O-rings (keys 8 and 9) with lithium grease (key 237), and insert them in the seal bushing (key 7). Slide the seal bushing and O-rings into the spring case adaptor (key 89).
13. Install the snap ring (key 72).
14. Slide the seal bushing and O-rings (keys 7, 8, and 9) over the actuator stem (key 144), and position the spring case adaptor (key 89), lower diaphragm casing (key 64), and O-ring (key 70) on the yoke.
15. Insert and tighten the cap screws (key 90).
16. Slide the lower diaphragm plate (key 71), the diaphragm (key 3) with the patterned side up, the diaphragm plate (key 4), the spacer (key 2), and the cap screw (key 12) on the actuator stem (key 144). Tighten the cap screw.
17. Put the diaphragm casing (key 1) on the diaphragm. Align the holes in the diaphragm (key 3) and the diaphragm casings (keys 1 and 64).

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing bolts are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 30/30i-76/76i and 87 actuators.

CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

Note

Do not use lubricant on these bolts and nuts. Fasteners must be clean and dry.

18. Install the cap screws and hex nuts (keys 13 and 14) and tighten in the following manner.

19. The first four bolts tightened should be diametrically opposed and 90 degrees apart. Tighten these four bolts to 13 N•m (10 lbf•ft).
20. Tighten the remaining bolts in a clockwise, criss-cross pattern to 13 N•m (10 lbf•ft).
21. Repeat this procedure by tightening four bolts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
22. Tighten the remaining bolts in a clockwise, criss-cross pattern to 27 N•m (20 lbf•ft).
23. After the last bolt is tightened to 27 N•m (20 lbf•ft), all of the bolts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
24. Once completed, no more tightening is recommended.
25. Return the actuator to service after completing the Loading Connection procedure in the Installation section and the procedures in the Adjustments section.

Casing-Mounted Travel Stops

Note

If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as manual operator.

Casing-mounted adjustable travel stops (shown in figures 21 through 25) are available to limit travel in the down direction (extending the actuator stem) or in the up direction (retracting the actuator stem). The travel stop in figure 21 is a down travel stop, the travel stop in figure 22 is an up and down travel stop, and the travel stops in figures 23, 24, and 25 are up travel stops.

Use the locknuts (key 151, figures 21 and 22), stem (key 150, figure 23), handwheel (key 58, figure 24) or cap screw (key 177, figure 25) to set the point at which the travel stop limits travel. Be sure to tighten the locknuts and replace the cap (key 149, figures 21 and 23; key 247, figure 22) after setting the travel stop.

Instructions are given below for disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

Key numbers are shown in figures 21 through 25.

1. Remove the cap (key 149 or 247) if the travel stop uses one. For down travel stops, loosen the locknuts (key 151, figures 21 and 22) so that the stop is not causing any spring compression.
2. Bypass the control valve, reduce loading pressure to atmospheric, and remove the tubing or piping from the connection on top of the yoke (key 73, figures 6, 8, and 10).
3. For down travel stops, turn the spring adjuster (key 74, figures 6, 8, and 10) out of the yoke toward the stem connector (key 31) to relieve all the compression in the spring (key 18).
4. For style 11 travel stops (figure 22), unscrew the cap screws (key 161), and make sure that the guide plate (key 157) can turn between the handwheel body (key 148) and the mounting plate (key 158).
5. Use a wrench on the nuts (key 151) to unscrew the extension rod (key 150). Remove the rod, the handwheel body (key 148), and the attached parts.
6. Unscrew the hex nuts and cap screws (keys 14 and 13, figures 6, 8, and 10) from the diaphragm casings. Lift off the upper diaphragm casing (key 1, figures 6, 8, and 10) and, for the style 11 travel stop, the mounting plate (key 158). For styles 10, 12 and 13, the travel stop assembly will be removed with the casing.
7. Note and record the position of travel stops (key 152) relative to the cap screws (key 154) for use in assembly. Unscrew the travel stops and cap screws, and remove either the mounting plate (key 158) or the handwheel body (key 148) and attached parts.

8. Separate the stem (key 150) and screw (key 160, figure 22) from the handwheel body.
9. Before reassembling, lubricate parts indicated by key 239 in figures 21 through 25. Use anti-seize lubricant (key 239).
10. Reassemble parts in the reverse order of removal.
11. When replacing the cap screws (key 154) and, if used, the travel stops (key 152), be sure to return them to their original position as recorded in step 7.

CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14), figures 6, 7, 8, 9, and 10 can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

12. Install the cap screws and nuts (keys 13 and 14, figures 6, 7, 8, 9, and 10) and finger tighten. Tighten the diaphragm cap screws and nuts to 27 N•m (20 lbf•ft) torque in a crisscross pattern.
13. Return the spring adjuster (key 74, figure 6, 7, 8, 9, and 10) to its original position. Re-adjust the travel stop.

Parts Ordering

Each actuator has a serial number stamped on the nameplate. Always mention this number when corresponding with your Emerson Process Management sales office regarding technical information or replacement parts. Also, reference the complete 11-character part number of each needed part as found in the following Parts Kits and Parts List sections.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

Parts Kits

Actuator Repair Kits

Parts kit includes keys 8, 9, and 70. O-ring material is nitrile, and gasket material is composition.

Key	Description	Part Number
	Size 30/30i	R667X000302
	Sizes 34/34i & 40/40i	R667X000402
	Sizes 45/45i through 60/60i	R667X000502
	Sizes 70/70i & 87	R667X000702
	Size 76/76i	R667X000762

Side-Mounted Handwheels Retrofit Kits

Key	Description	Part Number
Retrofit Kit includes parts to add a Side-Mounted Handwheel.		
	Size 34 Push-Down-To-Close	30A8778X0E2
	Size 34 Push-Down-To-Open	30A8778X0F2
	Size 40 Push-Down-To-Close	30A8778X0G2
	Size 40 Push-Down-To-Open	30A8778X0H2
	Size 45 & 46 Push-Down-To-Close	40A8779X0A2
	Size 45 & 46 Push-Down-To-Open	40A8779X0B2
	Size 50 & 60 Push-Down-To-Close	40A8779X0C2
	Size 50 & 60 Push-Down-To-Open	40A8779X0D2
	Size 34i push down to close	GE71635X0E2
	Size 34i push down to open	GE71635X0F2
	Size 40i push down to close	GE71635X0G2
	Size 40i push down to open	GE71635X0H2
	Size 45i & 46i push down to close	GE71636X0A2
	Size 40i & 60i push down to open	GE71636X0B2
	Size 50i & 60i push down to close	GE71636X0C2
	Size 50i & 60i push down to open	GE71636X0D2

Transition Kits for Side-Mounted Handwheels

Transition kits include fasteners necessary to remount an existing side-mounted handwheel to an actuator where the yoke has been changed to a size i yoke.
Contains key numbers 256, 257, and 258.

Description	Part Number
Size 34i/40i push-down-to-close or push-down-to-open	GE71635X0J2
Size 45i - 60i push-down-to-close or push-down-to-open	GE71636X0E2

Top-Mounted Handwheels Retrofit Kits

Retrofit Kit includes parts to add a Top-Mounted Handwheel. Kit number 1 includes the handwheel assembly only. Kit number 2 includes Kit number 1 and a new diaphragm case that is required to mount the handwheel assembly.

Key	Description	Part Number
	Kit 1	
	Size 30/30i	30B3940X102
	Sizes 34/34i	30B3940X022
	Size 40/40i	30B3940X042
	Sizes 45/45i & 50/50i	33B9224X012
	Sizes 46/46i, 60/60i, & 76/76i	33B9224X012
	Sizes 70/70i & 87	CV8060X0012
	Kit 2	
	Size 30/30i	30B3940X052
	Size 34/34i	30B3940X062
	Size 40/40i	30B3940X092
	Sizes 45/45i & 50/50i	33B9224X022
	Sizes 46/46i, 60/60i, & 76/76i	33B9224X032
	Sizes 70/70i & 87	CV8060X0022

Parts List

Note
Contact your Emerson Process Management sales office for Part Ordering information.

Actuator Assembly

Key	Description
1	Upper Diaphragm Casing
2	Travel Stop Spacer
3*	Diaphragm Molded Nitrile/Nylon Molded Silicone/Polyester
4	Upper Diaphragm Plate
7*	Bushing, Seal Brass S41600 [416 stainless steel (SST)] PTFE w/25% Glass
8*	O-Ring Nitrile Fluorocarbon
9*	O-Ring Nitrile Fluorocarbon
12	Screw, Cap, hex hd
13	Hex hd Cap Screw
14	Hex Nut
17	Vent Assembly
18	Spring
19	Seat, Lower Spring
27	Extension Rod Conn
30	Hex hd Cap Screw
31	Stem Connector Assembly
32	Travel Indicator Scale
33	Screw, Self Tapping
33	Screw, Mach, Fill hd
34	Disk, Travel Indicator
39	Nameplate
40	Screw, Drive
64	Lower Diaphragm Casing
69	Nut, Hex, Jam
70*	Gasket Composition [up to 232°C (450°F)]
70*	O-Ring Nitrile
71	Lower Diaphragm Plate
72	Ring, Snap
73	Yoke
74	Spring Adjuster
75	Nut, Hex
76	Nut, Speed, Twin
77	Stop, Travel
78	Bushing, Pipe, Hex
79	Screw, Mach, Flat Hd
81	Screw, Mach, Rd Hd
82	Indicator, Travel, Adaptor
83	Washer, Plain
89	Spring Case Adaptor
90	Screw, Cap
102	Plug, Pipe, Hex Hd
144	Actuator Stem
227	Washer, Plain
228	Stem Disk Spacer
237	Lubricant, lithium grease not furnished with actuator
239	Lubricant, anti-seize not furnished with actuator
254	Caution Nameplate

*Recommended spare parts

Top-Mounted Handwheel (figures 11, 12, 13, 14, and 15)

Key	Description
58	Handwheel / Handjack Bar
60	Retainer Ring
148	Handwheel Body
150	Extension Rod
152	Up Travel Stop
154	Cap Screw
156	Vent Assembly
157	Guide Plate
158	Mounting Plate
159	Lock Nut
160	Handwheel Screw
161	Cap Screw
166	Castle Nut
167	Cotter Pin
178	Machine Screw
179	Lockwasher
180	Thrust Bearing
181	Thrust Race
182	Bearing Retainer
183	Pipe Nipple
239	Lubricant, anti-seize not furnished with handwheel
247	Handwheel Cap
253	Spacer, Handjack

Figure 6. Fisher 667 Actuator Sizes 30 through 60

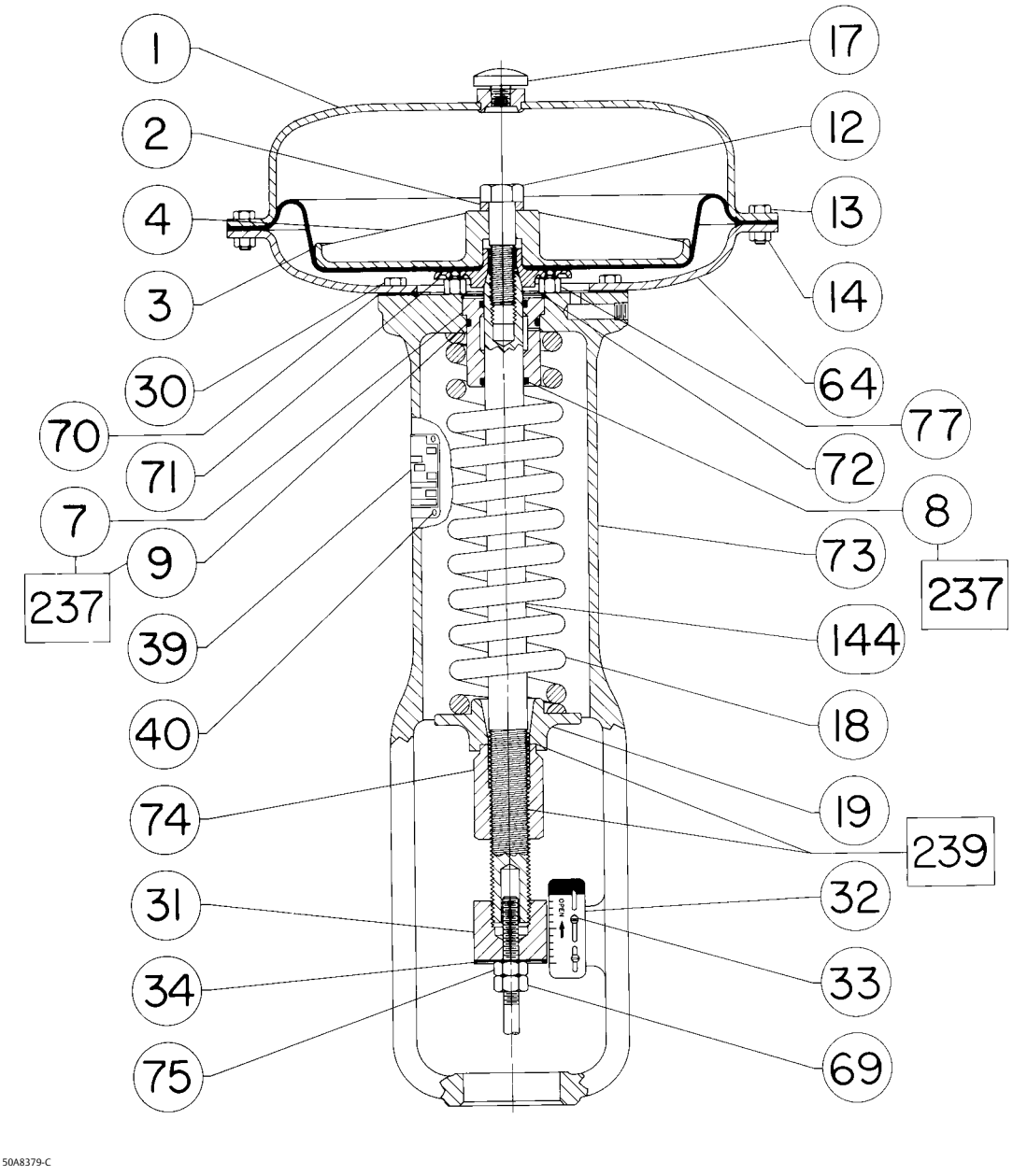
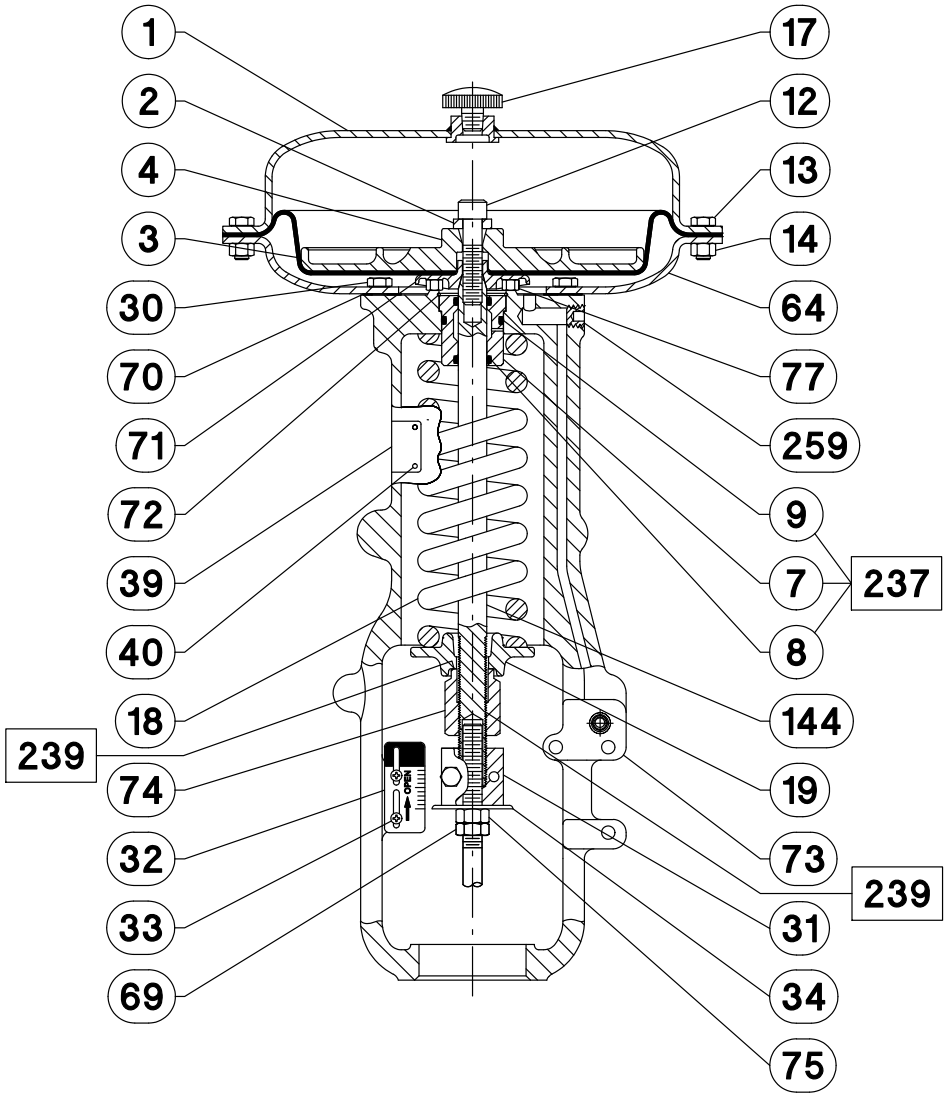


Figure 7. Fisher 667 Actuator Sizes 30i through 60i



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PARTS NOT SHOWN: KEY 76 AND 254

GE71547-A

Figure 8. Fisher 667 Size 70 and 76 Actuator

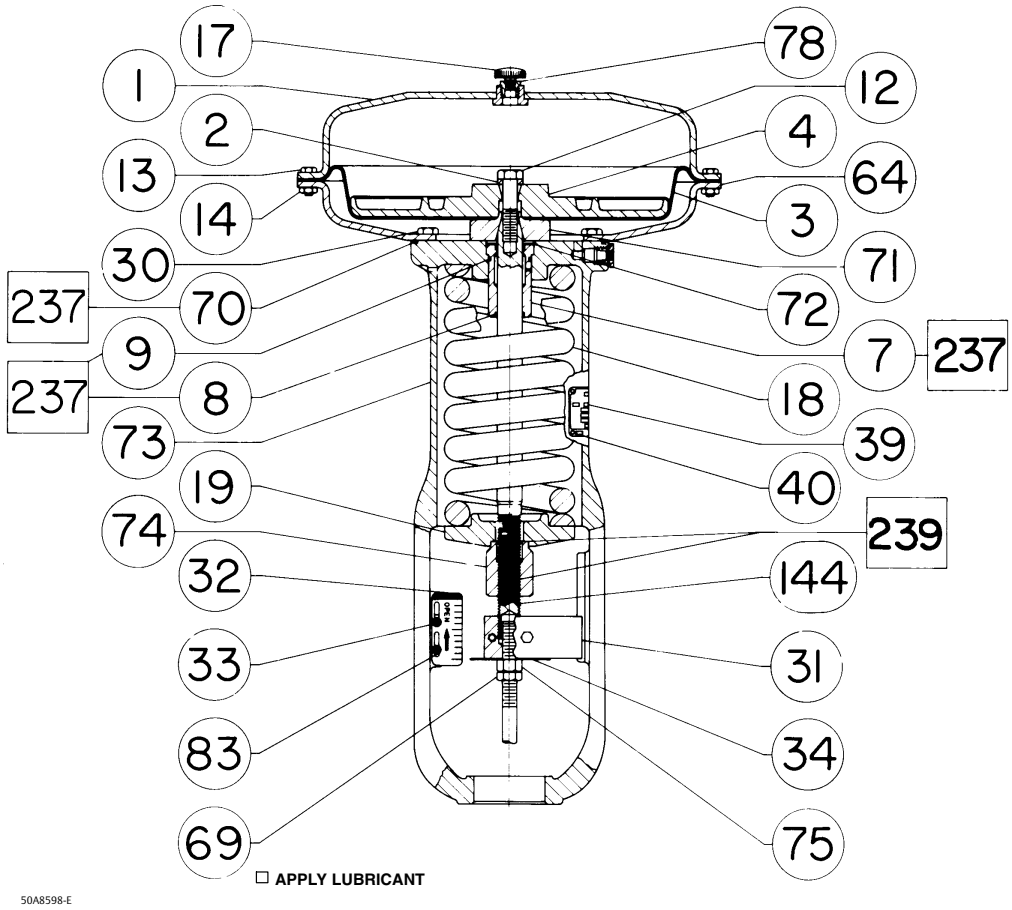
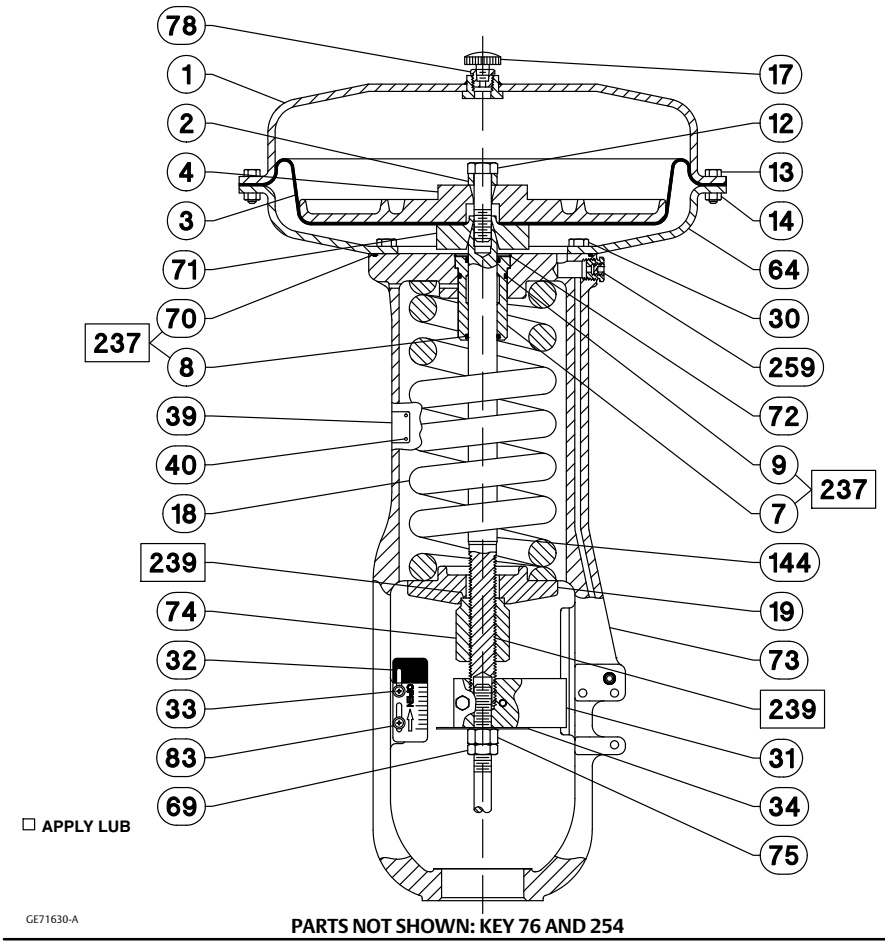


Figure 9. Fisher 667 Size 70i and 76i Actuator



PARTS NOT SHOWN: KEY 76 AND 254

Figure 10. Fisher 667 Size 87 Actuator

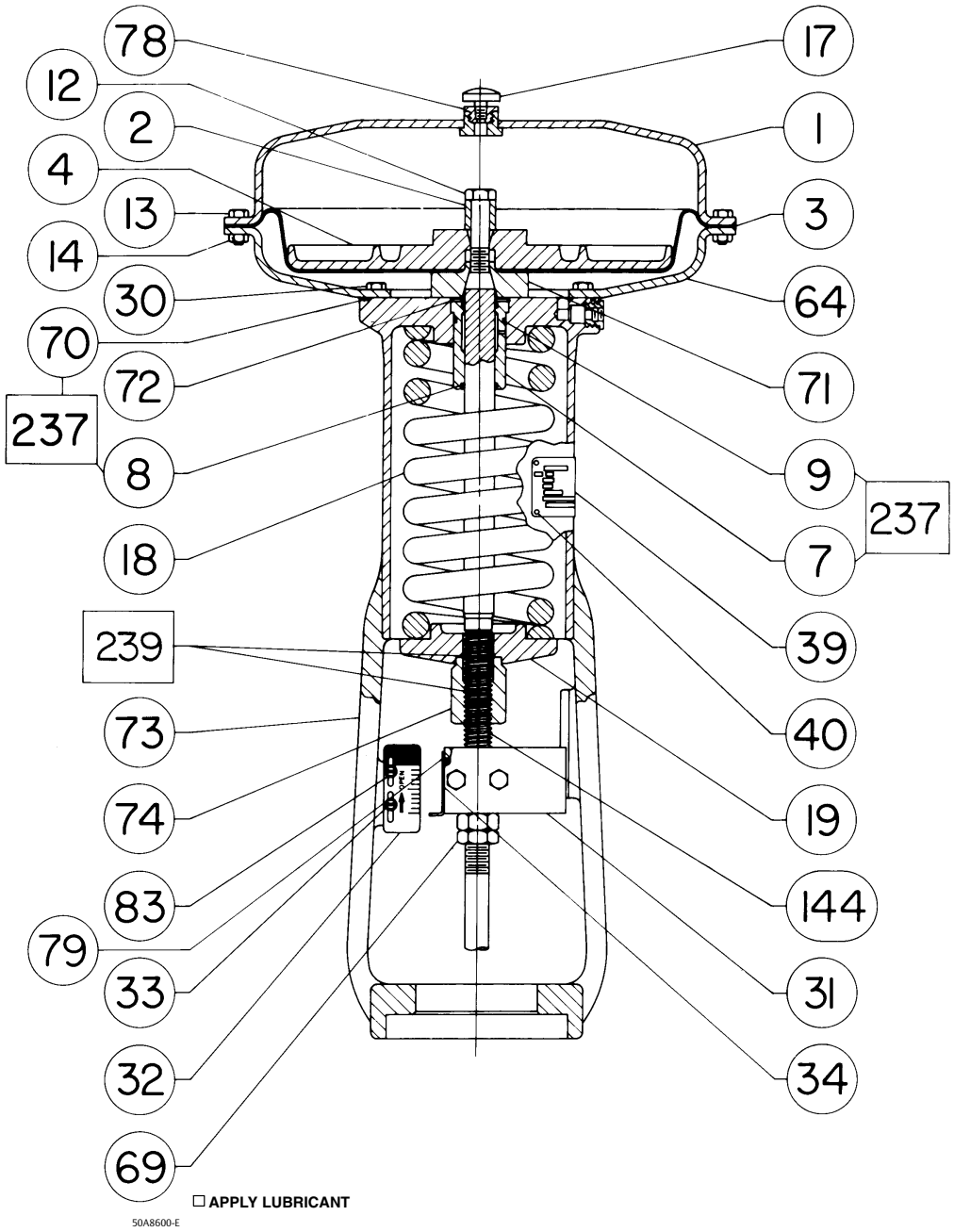


Figure 11. Top-Mounted Handwheel Assembly for Size 30/30i through 40/40i Actuators

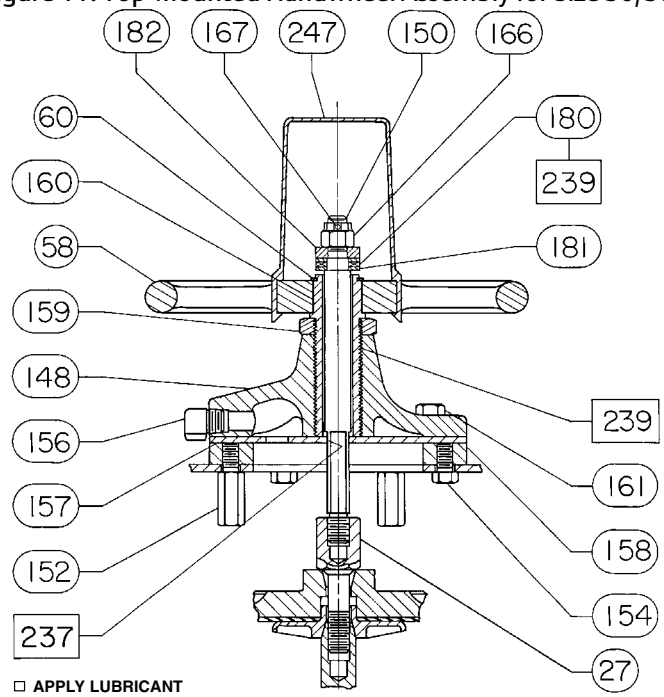


Figure 12. Top-Mounted Handwheel Assembly, Style P2 for Size 45/45i, 50/50i, 60/60i, and 76/76i Actuators

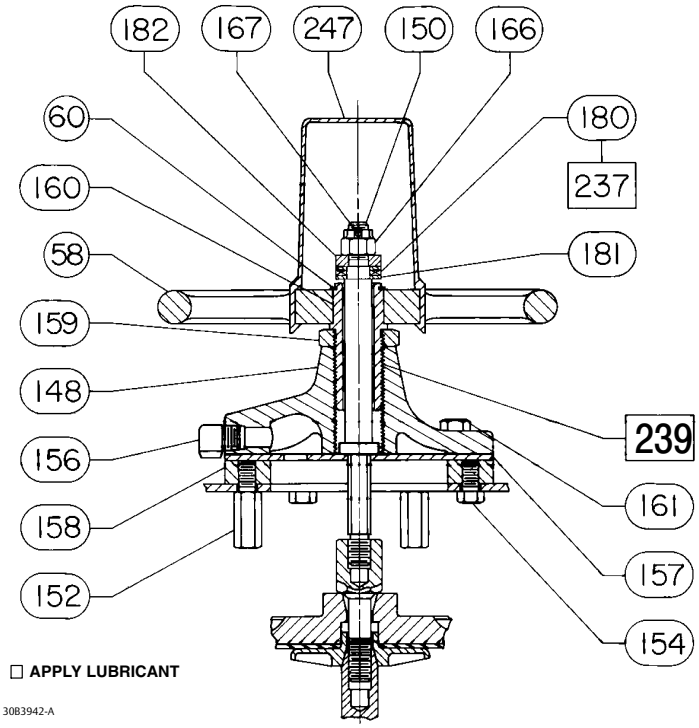


Figure 13. Top-Mounted Handwheel Assembly for Size 45/45i-76/76i Actuators

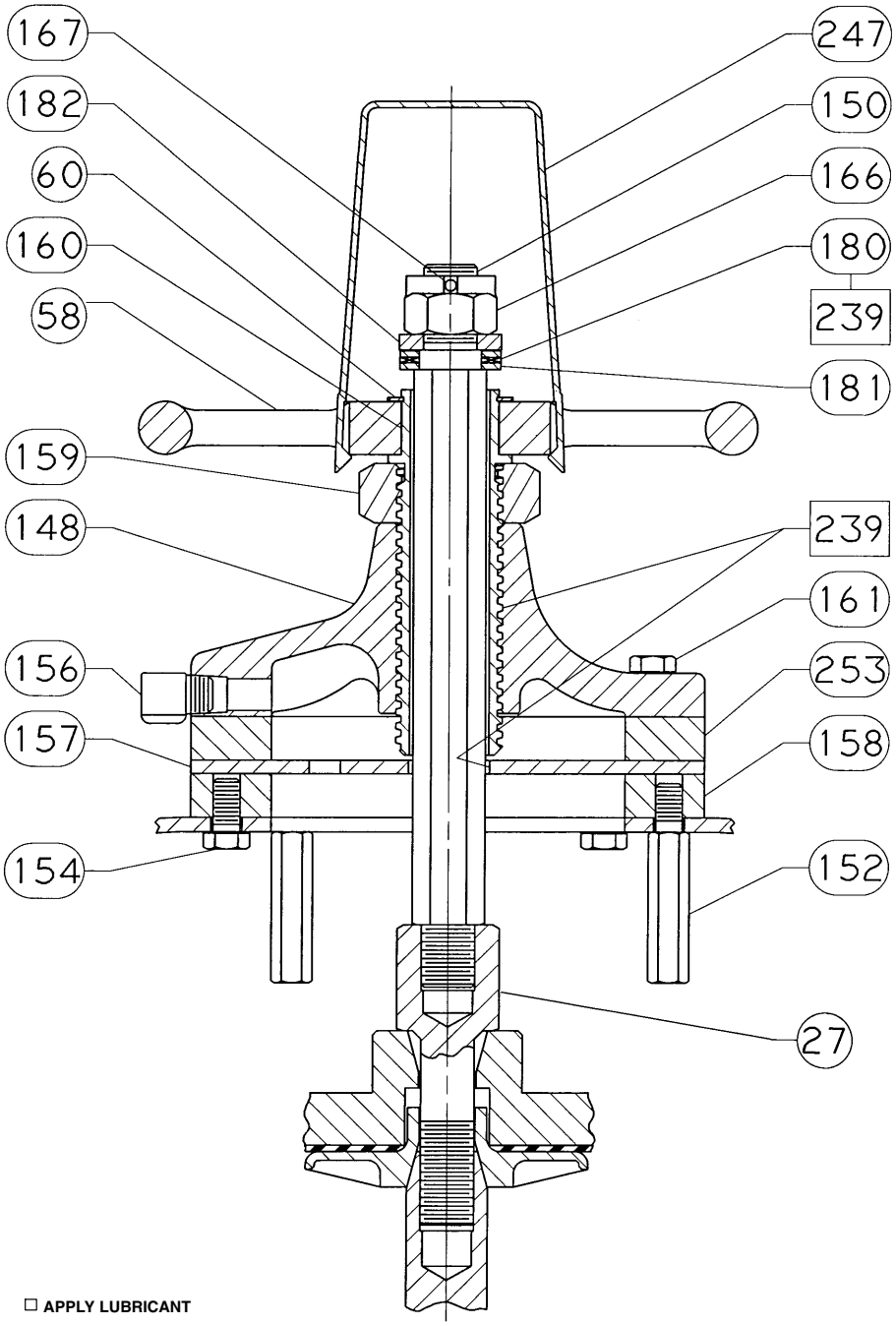


Figure 14. Top-Mounted Handwheel Assembly for Size 70/70i and 87 Actuators

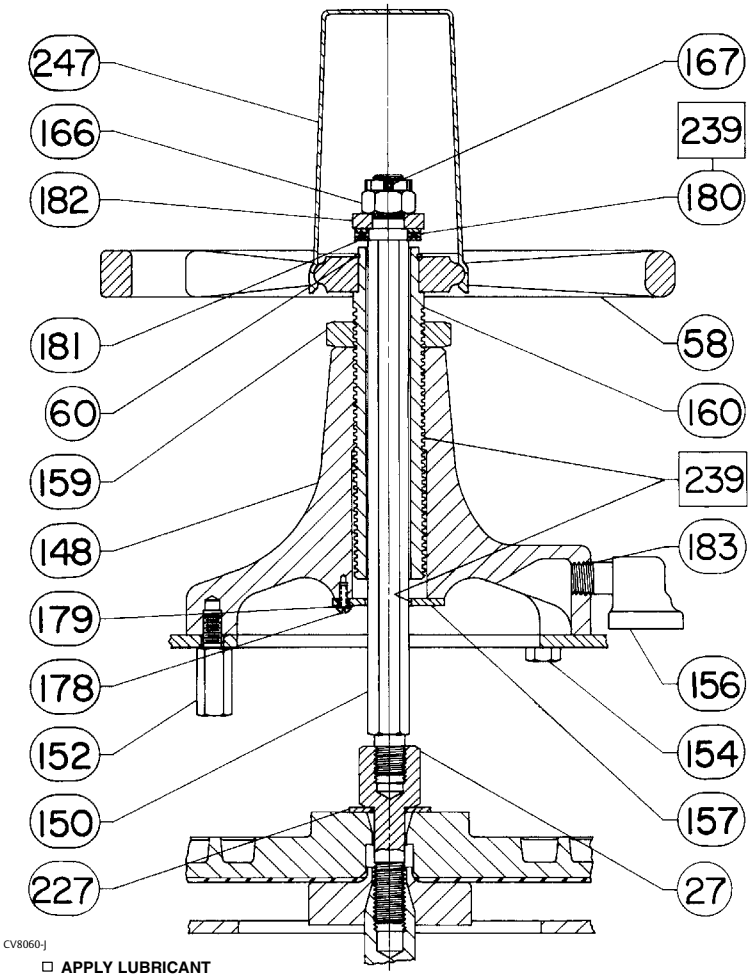
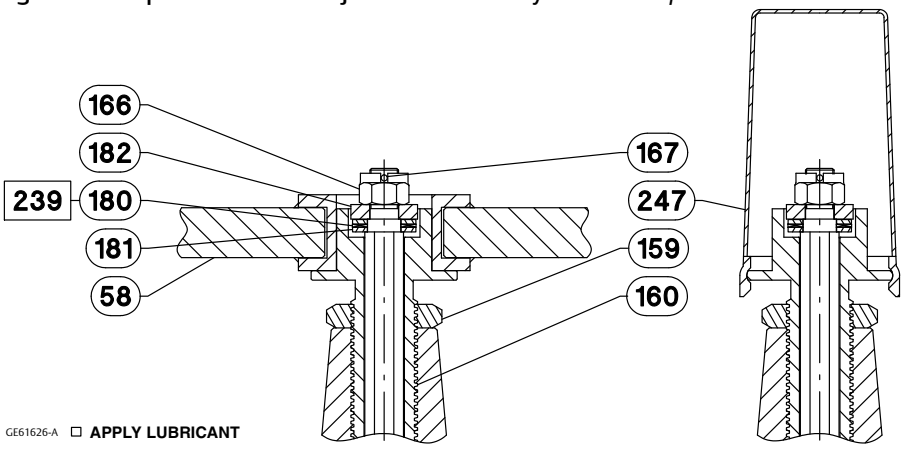


Figure 15. Top-Mounted Handjack Bar Assembly for Size 70/70i and 87 Actuators



NOTE:
THE TOP MOUNTED HANDJACK BAR SHOULD BE REMOVED WHEN NOT IN USE AND THE HANDWHEEL CAP INSTALLED FOR WEATHER PROTECTION OF INTERNAL COMPONENTS.

Figure 16. Side Mounted Handwheel Assembly for Size 34 and 40 Actuators

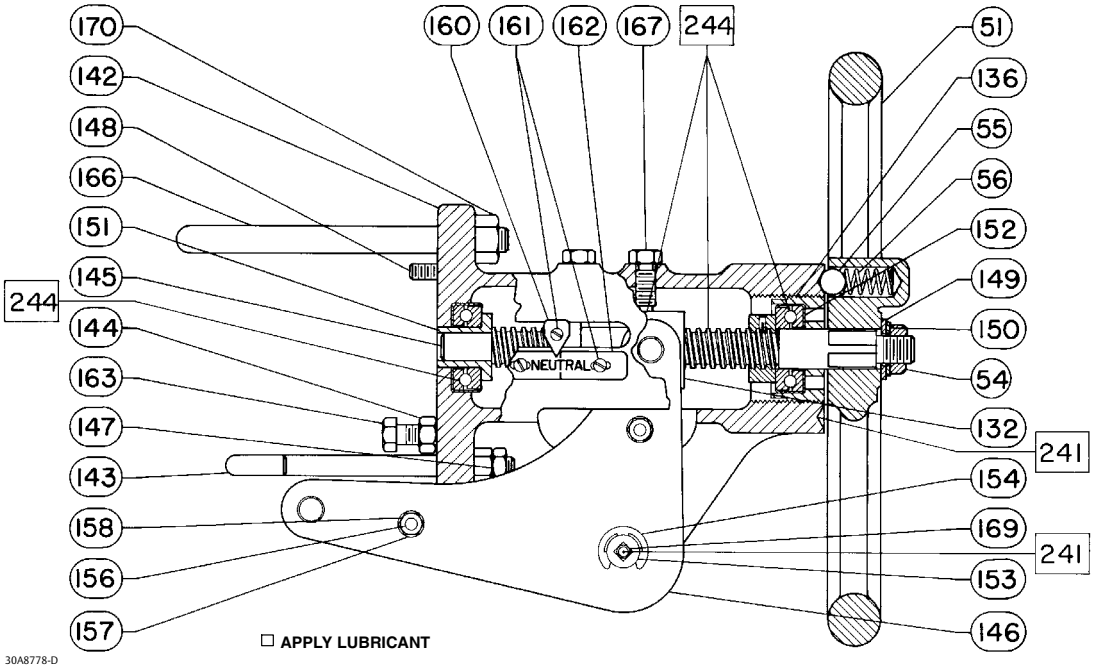


Figure 17. Side Mounted Handwheel Assembly for Size 34i and 40i Actuators

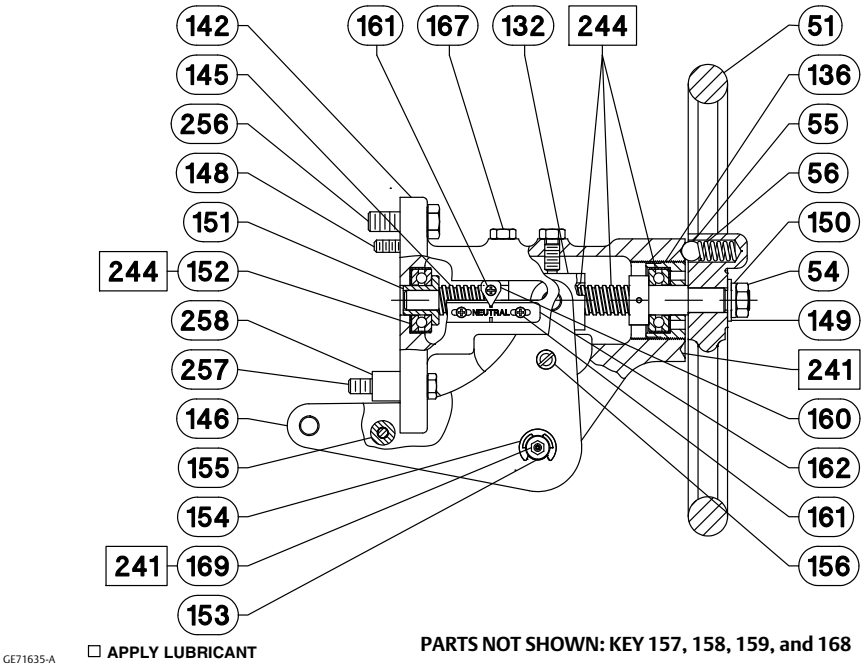


Figure 18. Side-Mounted Handwheel Assembly for Size 45 through 60 Actuators

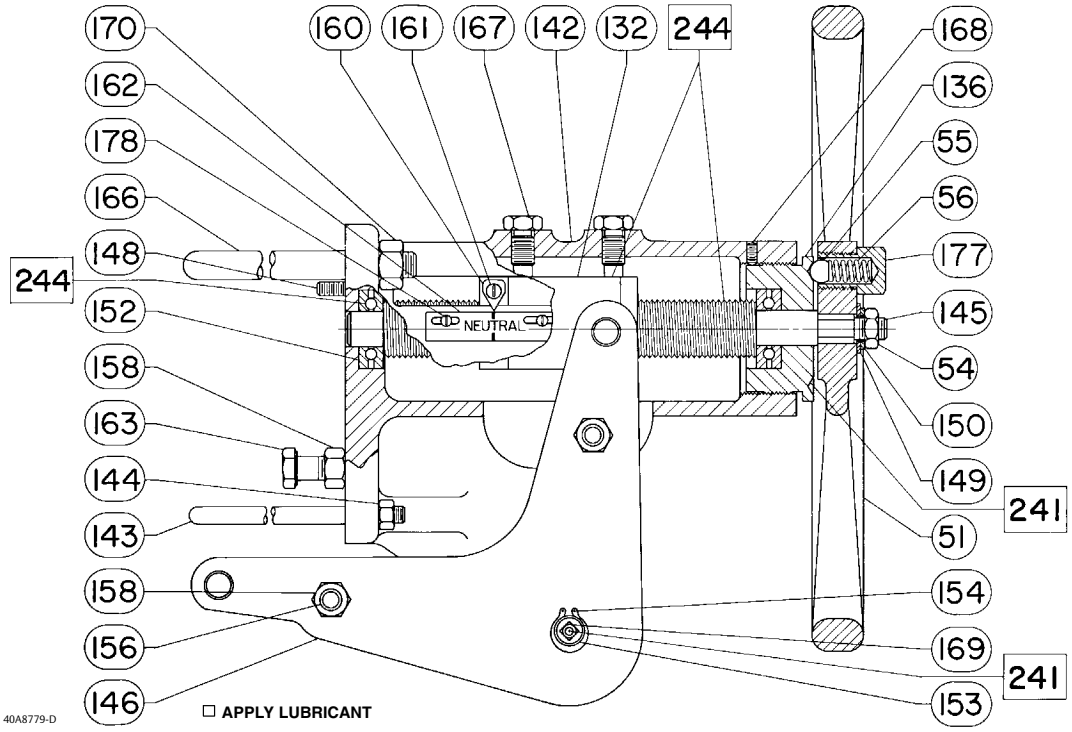
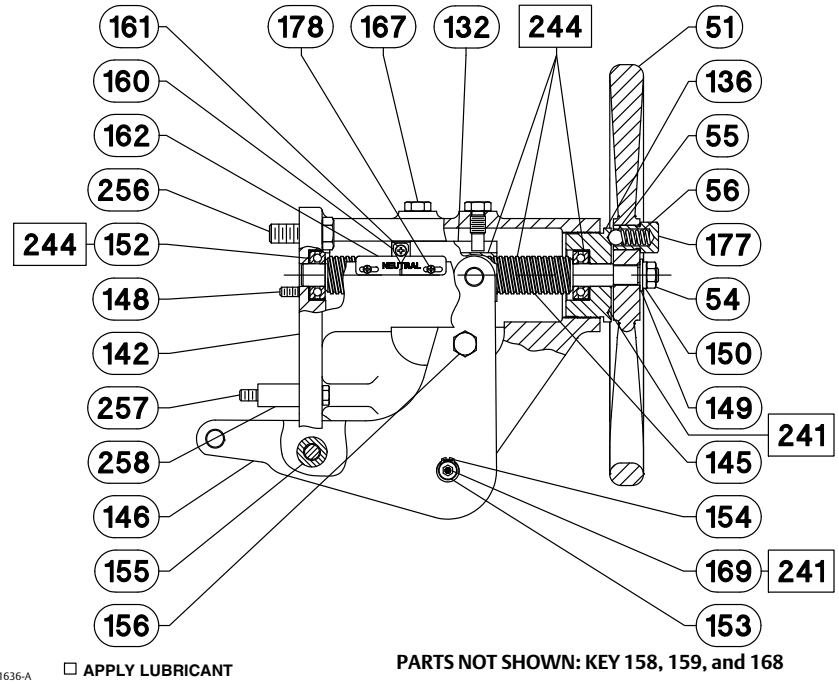


Figure 19. Side Mounted Handwheel Assembly for Size 45i through 60i Actuators



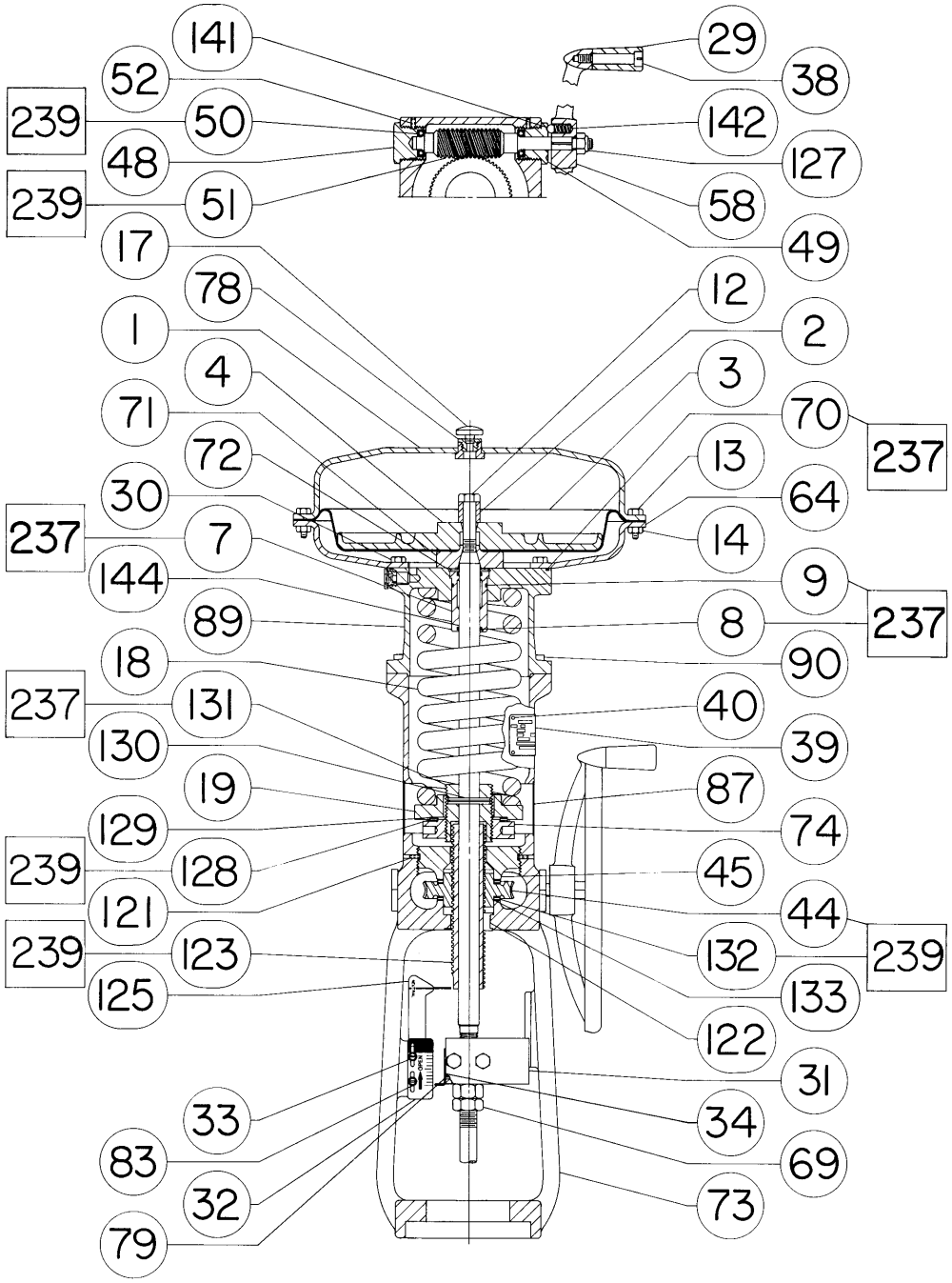
Side-Mounted Handwheel, Size 34-60 and 34i-60i (figures 16 and 18)

Key	Description
51	Handwheel
54	Hex Jam Nut
55	Ball
56	Spring
132	Operating Nut
136	Bearing Retainer
142	Handwheel Body
143	Mounting Bolts
144	Hex Nut
145	Handwheel Screw
146	Lever & Pin Assembly
147	Hex Jam Nut
148	Dowel Pin
149	Washer
150	Lockwasher
151	Bushing
152	Ball Bearing
153	Lever Pivot Pin
154	Retaining Ring
155	Spacer
156	Screw
157	Lockwasher
158	Hex Nut
159	Pointer Mounting Bolt
160	Pointer
161	Machine Screw
162	Indicator Plate (Aluminum)
163	Cap Screw
166	U-Bolt
167	Guide Bolt
168	Set Screw
169	Grease Fitting
170	Hex Nut
177	Spring Cap
178	Machine Screw
241	Lubricant, lithium grease Not furnished with handwheel
244	Lubricant, anti-seize Not furnished with handwheel
256	Cap Screw
257	Cap Screw
258	Spacer

Side-Mounted Handwheel, Size 70, 76 and 87 (figure 20)

Key	Description
29	Handgrip
38	Handgrip Bolt
44	Worm Gear
45	Bearing Retainer Flange
48	Back Worm Retainer
49	Front Worm Retainer
50	Ball Bearing
51	Worm Shaft
52	Set Screw
57	Grease Fitting
58	Handwheel
87	Cover Band Ass'y
89	Spring Case Adaptor
90	Cap Screw
121	Set Screw
122	Key
123	Lower Sleeve
125	Handwheel Indicator
127	Handwheel Cap
128	Needle Bearing
129	Needle Bearing Race
130	Roll Pin
131	Spring Adjusting Screw
132	Needle Bearing
133	Needle Bearing Race
141	Ball
142	Spring
237	Lubricant, lithium grease Not Furnished with Handwheel
239	Lubricant, anti-seize Not Furnished with Handwheel
245	Yoke Extension

Figure 20. Size 70, 76, and 87 Actuator with Side Mounted Handwheel Assembly



PART NOT SHOWN: 57
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Casing-Mounted Travel Stops (figures 21 through 25)

Key	Description
58	Handwheel
102	Plug, Pipe
127	Hex Nut
148	Travel Stop Body
149	Travel Stop Cap
150	Extension Rod
150	Travel Stop Stem
151	Hex Jam Nut
152	Up Travel Stop
153	Nut, Hex
154	Screw, Cap, Hex Hd
155	Washer
156	Vent
157	Guide Plate
158	Mounting Plate
159	Nut, Travel Stop
160	Screw, Handwheel
161	Screw, Cap, Hex Hd
162	Washer
177	Travel Stop Screw
184	Nipple, Pipe, NPT
237	Lubricant, lithium grease
239	Lubricant, anti-seize
247	Travel Stop Cap
248	Mounting Plate

Figure 21. Style 10 Down Travel Stop - For All Sizes (Casing Mounted)

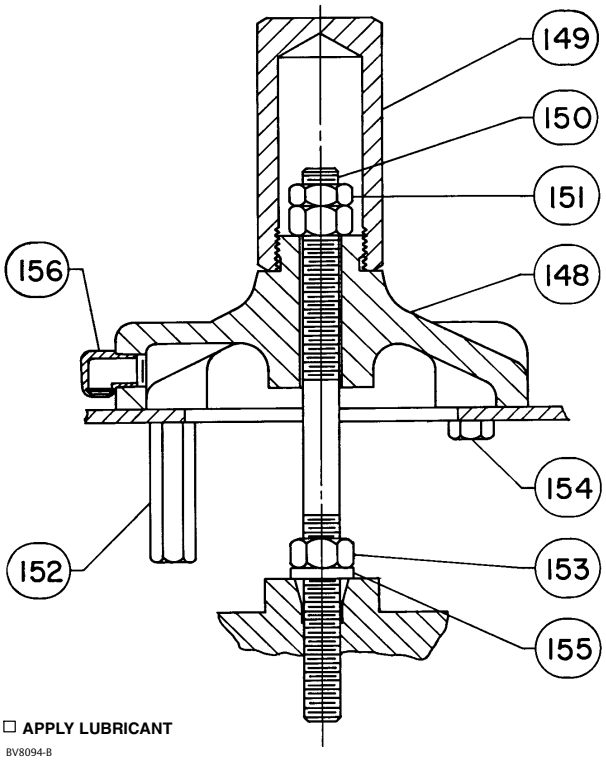


Figure 22. Style 11 Up Or Down Travel Stop - For Sizes 30/30i to 60/60i and 76/76i (Casing Mounted)

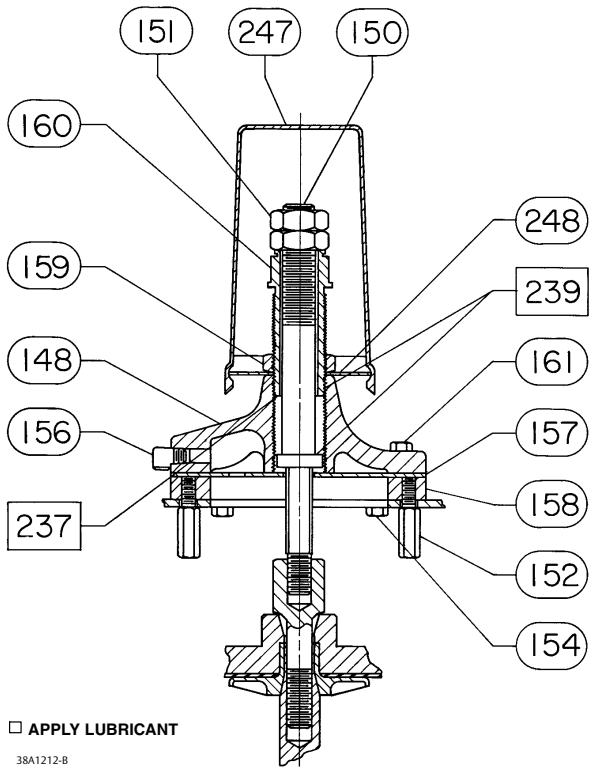


Figure 23. Style 12 Up Travel Stop (Casing Mounted)

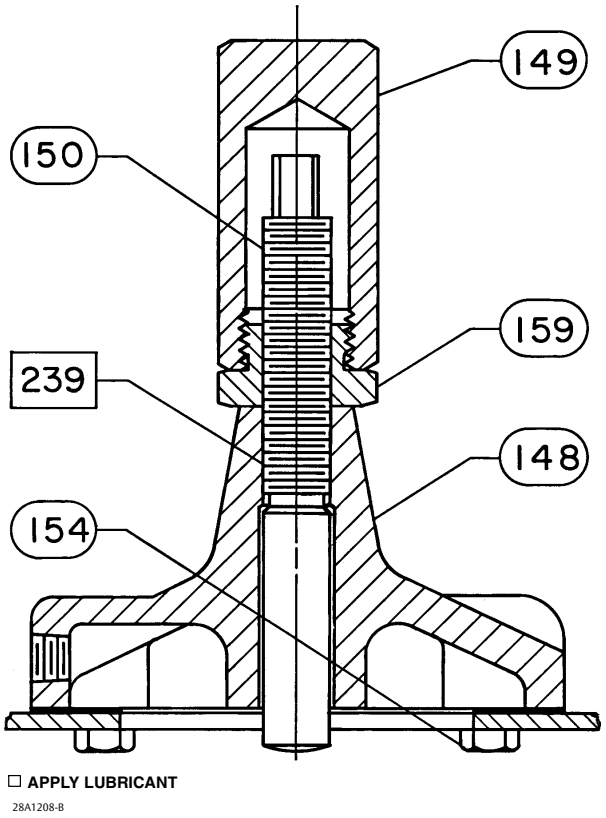


Figure 24. Style 13 Up Travel Stop - For Sizes 30/30i to 60/60i and 76/76i, Size 30/30i Shown (Casing Mounted)

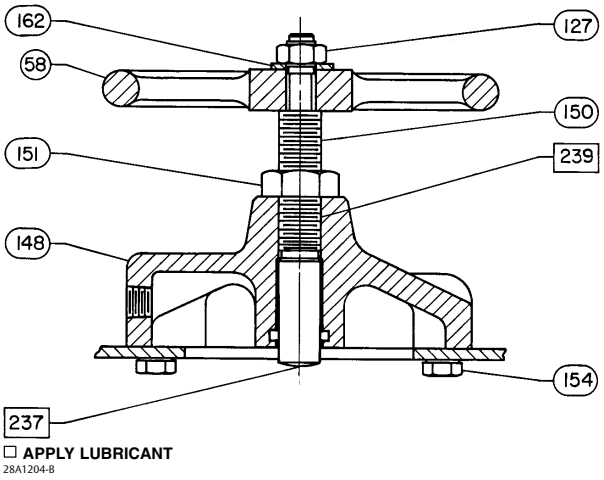
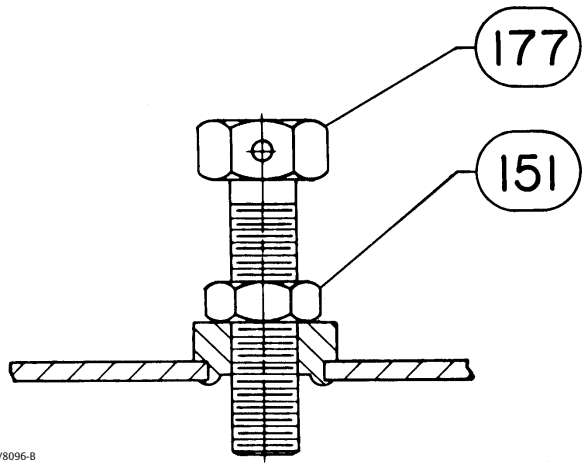


Figure 25. Style 14 Up Travel Stop (Casing Mounted)



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Emerson Process Management
Marshalltown, Iowa 50158 USA
Sorocaba, 18087 Brazil
Cernay, 68700 France
Dubai, United Arab Emirates
Singapore 128461 Singapore

www.Fisher.com

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产品中有害物质名称及含量
Names and Contents of the Hazardous Substances in Product

3800SA DVC2000	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
所有电子组件 （包括液晶显示屏） All Electronic Assemblies (including LCD)	X	O	O	O	O	O
电气转换器 I/P Converter	O	O	O	O	X	X
安装框架 Mounting Frame	O	O	O	O	O	O
放大器 Relay	O	O	O	O	X	X
O 形圈 O-rings	O	O	O	O	X	X
盖子 Cover	O	O	O	X	O	O

本表格依据 SJ/T 11364的规定编制。
This table is prepared in accordance with the provision of SJ/T 11364

O 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下
O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

HF340 HF341 LC340	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	O	O	O
电路板 Circuit Board	X	O	O	O	O	O

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O 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下
O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

DVC6200, DVC6200f DVC6205, DVC6205f DVC6200p DVC6205p	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳/模块底座 Housing /Module Base	X	O	O	X	O	O
电子组件 Electronic Assemblies	X	O	O	O	O	O
电气转换器 I/P Converter	O	O	O	O	X	X
接线盒（包括电路板） Temunal Box (includes circuit board)	X	O	O	X	X	X
放大器 Relay	O	O	O	O	X	X
O 形圈 O-rings	O	O	O	O	X	X
盖子 Cover	O	O	O	O	O	O

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O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

DVC6215	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
电路板 Circuit Board	O	O	O	O	X	X
O 形圈 O-rings	O	O	O	O	X	X
盖子 Cover	O	O	O	X	O	O

本表格依据 SJ/T 11364的规定编制。
This table is prepared in accordance with the provision of SJ/T 11364

O 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下
O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

产品中有害物质名称及含量
Names and Contents of the Hazardous Substances in Product

DVC6200S DVC6000S	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳/模块底座 Housing /Module Base	X	O	O	O	O	O
电子组件 Electronic Assemblies	X	O	O	O	O	O
电气转换器 I/P Converter	O	O	O	O	X	X
接线盒（包括电路板） Terminal Box (includes circuit board)	X	O	O	O	X	X
放大器 Relay	O	O	O	O	X	X
O 形圈 O-rings	O	O	O	O	X	X
盖子 Cover	O	O	O	O	O	O

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O: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下
O: Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X: Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

DVC6000, DVC6000f DVC6005, DVC6005f	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳/模块底座 Housing /Module Base	O	O	O	X	O	O
电子组件 Electronic Assemblies	X	O	O	O	O	O
电气转换器 I/P Converter	O	O	O	O	X	X
接线盒（包括电路板） Terminal Box (includes circuit board)	X	O	O	X	X	X
放大器 Relay	O	O	O	O	X	X
O 形圈 O-rings	O	O	O	O	X	X
盖子 Cover	O	O	O	O	O	O

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O: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下
O: Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X: Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

LCP100	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	O	X	X
电路板 Circuit Board	X	O	O	O	O	O
O 形圈 O-rings	O	O	O	O	X	X
盖子 Cover	O	O	O	O	X	X

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O 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下
O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

DVC6015 DVC6025 DVC6035	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
电位器 Potentiometer	X	O	O	O	X	X
O 形圈 O-rings	O	O	O	O	X	X
盖子 Cover	O	O	O	X	O	O

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O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

产品中有害物质名称及含量
Names and Contents of the Hazardous Substances in Product

546	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr+6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
放大器 Relay	X	O	O	X	O	O
力矩马达 Torque Motor	X	O	O	O	X	X
O 形圈 O-rings	O	O	O	O	X	X
压力表 Gauges	X	O	O	O	O	O

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O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

646 i2P-100	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr+6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
电路板 Circuit Board	X	O	O	O	O	O
放大器 Relay	O	O	O	X	O	O
转换器模块 Converter Module	X	O	O	O	X	X
O 形圈 O-rings	O	O	O	O	X	X
压力表 Gauges	X	O	O	O	O	O

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O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

846	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr+6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	X	O	O	X	O	O
电路板 Circuit Board	X	O	O	O	O	O
指挥器型执行机构 Pilot Actuator	X	O	O	O	O	O
O 形圈 O-rings	O	O	O	O	X	X
压力表 Gauges	X	O	O	O	O	O

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O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

4200	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr+6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	X	O	O	X	X	X
电路板 Circuit Board	X	O	O	O	O	O
O 形圈 O-rings	O	O	O	O	X	X
位置电位器 Position Potentiometer	X	O	O	O	X	X

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O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

产品中有害物质名称及含量

Names and Contents of the Hazardous Substances in Product

2100e	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
开关 Switch	X	O	O	O	X	X
浮筒 Float	O	O	O	O	O	O
阀体 Body	O	O	O	O	O	O

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O: Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

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2016 年 6 月 (June 2016)

DLC3010 DLC3020f DLC3100	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
电路板 Circuit Board	X	O	O	O	O	O
液晶显示屏 LCD	X	O	O	O	O	O
O 形圈 O-rings	O	O	O	O	X	X

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O: Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

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X: Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

4310 4320	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	X	X
电路板 Circuit Board	X	O	O	O	O	O
电源模块 Power Module	X	O	O	O	O	O
O 形圈 O-rings	O	O	O	O	X	X
盖子 Cover	O	O	O	X	O	O

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O: Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

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X: Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

L2e	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
O 形圈 O-rings	O	O	O	O	X	X
盖子 Cover	O	O	O	X	O	O
开关 Switch	X	O	O	O	X	X

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O: Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X: Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

产品中有害物质名称及含量

Names and Contents of the Hazardous Substances in Product

3622 582i 3722	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
电路板 Circuit Board	X	O	O	O	O	O
I/P 模块 I/P Module	X	O	O	O	X	X
O 形圈 O-rings	O	O	O	O	X	X
压力表 Gauges	X	O	O	O	O	O

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O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

3582i	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	X	O	O	X	O	O
电路板 Circuit Board	X	O	O	O	O	O
I/P 模块 I/P Module	X	O	O	O	X	X
放大器 Relay	O	O	O	X	O	O
O 形圈 O-rings	O	O	O	O	X	X
压力表 Gauges	X	O	O	O	O	O

本表格依据 SJ/T 11364的规定编制。
This table is prepared in accordance with the provision of SJ/T 11364

O 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下
O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

3661	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
电路板 Circuit Board	X	O	O	O	O	O
I/P 模块 I/P Module	X	O	O	O	X	X
放大器 Relay	O	O	O	X	O	O
O 形圈 O-rings	O	O	O	O	X	X
压力表 Gauges	X	O	O	O	O	O

本表格依据 SJ/T 11364的规定编制。
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X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

3620J/JP 3720	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
电路板 Circuit Board	X	O	O	O	O	O
I/P 模块 I/P Module	X	O	O	O	X	X
O 形圈 O-rings	O	O	O	O	X	X
压力表 Gauges	X	O	O	O	O	O

本表格依据 SJ/T 11364的规定编制。
This table is prepared in accordance with the provision of SJ/T 11364

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X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

产品中有害物质名称及含量

Names and Contents of the Hazardous Substances in Product

easy-Drive	有害物质 Hazardous Substance					
部件名称 Part Name	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
外壳 Housing	O	O	O	X	O	O
电路板 Circuit Board	X	O	O	O	X	X
电机/齿轮箱 Motor/Gearbox	X	X	X	X	X	X
O 形圈 O-rings	O	O	O	O	X	X
电路板盖 Circuit Board Cover	X	X	X	X	X	X
阀组件 Valve Assembly	O	O	O	O	O	O

本表格依据 SJ/T 11364的规定编制。
This table is prepared in accordance with the provision of SJ/T 11364

O 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下
O Indicate that said hazardous substance contained in all of the homogeneous materials for this part does not exceed the limit requirement of GB/T 26572

X 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求
X Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this parts is above the limit requirement of GB/T 26572

2016 年 6 月 (June 2016)

Fisher™ FIELDVUE™ DVC6200 Digital Valve Controller

This manual applies to

Instrument Level	HC, AD, PD, ODV
Device Type	09
Device Revision	1 & 2
Hardware Revision	2
Firmware Revision	2, 3, 4, 5 & 6
DD Revision	1, 2, 3, 4 & 5



W9713

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Section 1 Introduction

Installation, Pneumatic and Electrical Connections, and Initial Configuration

Refer to the DVC6200 Series Quick Start Guide (D103556X012) for DVC6200 installation, connection and initial configuration information. If a copy of this quick start guide is needed scan or click the QR code at the right, contact your Emerson Automation Solutions sales office, or visit our website at www.Fisher.com.

Scan or click to access field support

Scope of Manual

This instruction manual is a supplement to the DVC6200 Series Quick Start Guide (D103556X012) that ships with every instrument. This instruction manual includes product specifications, reference materials, custom setup information, maintenance procedures, and replacement part details.

This instruction manual describes using the 475 Field Communicator to set up and calibrate the instrument. You can also use Fisher ValveLink software or ValveLink Mobile software to setup, calibrate, and diagnose the valve and instrument. For information on using ValveLink software with the instrument refer to ValveLink software help or documentation.

Do not install, operate, or maintain a DVC6200 digital valve controller without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all of the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Automation Solutions sales office before proceeding.

Conventions Used in this Manual

Navigation paths and fast-key sequences are included for procedures and parameters that can be accessed using the Field Communicator.

For example, to access Device Setup:

Field Communicator	Configure > Guided Setup > Device Setup (2-1-1)

Refer to Appendix B for Field Communicator menu trees.

Description

DVC6200 digital valve controllers (figures 1-1 and 1-2) are communicating, microprocessor-based current-to-pneumatic instruments. In addition to the normal function of converting an input current signal to a pneumatic output pressure, the DVC6200 digital valve controller, using the HART® communications protocol, gives easy access to information critical to process operation. You can gain information from the principal component of the process, the control valve itself, using the Field Communicator at the valve, or at a field junction box, or by using a personal computer or operator's console within the control room.

Figure 1-1. FIELDVUE DVC6200 Digital Valve Controller Mounted on a Fisher Sliding-Stem Valve Actuator



W9643

Figure 1-2. FIELDVUE DVC6200 Digital Valve Controller Integrally Mounted to a Fisher GX Control Valve



W9616

Using a personal computer and ValveLink software or AMS Suite: Intelligent Device Manager, or a Field Communicator, you can perform several operations with the DVC6200 digital valve controller. You can obtain general information concerning software revision level, messages, tag, descriptor, and date.

Diagnostic information is available to aid you when troubleshooting. Input and output configuration parameters can be set, and the digital valve controller can be calibrated. Refer to table 1-1 for details on the capabilities of each diagnostic tier.

Using the HART protocol, information from the field can be integrated into control systems or be received on a single loop basis.

The DVC6200 digital valve controller is designed to directly replace standard pneumatic and electro-pneumatic valve mounted positioners.

Table 1-1. Instrument Level Capabilities

CAPABILITY	DIAGNOSTIC LEVEL(2)			
	HC	AD	PD	ODV
Auto Calibration	X	X	X	X
Custom Characterization	X	X	X	X
Burst Communication	X	X	X	X
Alerts	X	X	X	X
Step Response, Drive Signal Test & Dynamic Error Band		X	X	X
Advanced Diagnostics (Valve Signature)		X	X	X
Performance Tuner		X	X	X
Travel Control - Pressure Fallback		X	X	X
Supply Pressure Sensor		X	X	X
Performance Diagnostics			X	X
Solenoid Valve Testing			X	X
Lead/Lag Set Point Filter(1)				X

1. Refer to brochure part # D351146X012 for information on Fisher optimized digital valves for compressor antisurge applications.
2. HC = HART Communicating ; AD = Advanced Diagnostics ; PD = Performance Diagnostics ; ODV = Optimized Digital Valve.

Specifications

⚠ WARNING

Refer to table 1-2 for specifications. Incorrect configuration of a positioning instrument could result in the malfunction of the product, property damage or personal injury.

Specifications for DVC6200 digital valve controllers are shown in table 1-2. Specifications for the Field Communicator can be found in the product manual for the Field Communicator.

Related Documents

This section lists other documents containing information related to the DVC6200 digital valve controller. These documents include:

- Bulletin 62.1:DVC6200 - Fisher FIELDVUE DVC6200 Digital Valve Controller (D103415X012)
- Bulletin 62.1:DVC6200 HC - Fisher FIELDVUE DVC6200 Digital Valve Controller (D103423X012)
- Bulletin 62.1:DVC6200(S1) Fisher FIELDUVE DVC6200 Digital Valve Controller Dimensions (D103543X012)
- Fisher FIELDVUE DVC6200 Series Digital Valve Controller Quick Start Guide (D103556X012)
- FIELDVUE Digital Valve Controller Split Ranging (D103262X012)
- Using FIELDVUE Instruments with the Smart HART Loop Interface and Monitor (HIM) (D103263X012)
- Using FIELDVUE Instruments with the Smart Wireless THUMt Adapter and a HART Interface Module (HIM) (D103469X012)
- Audio Monitor for HART Communications (D103265X012)
- HART Field Device Specification - Supplement to Fisher FIELDVUE DVC6200 Digital Valve Controller (D103639X012)
- Using the HART Tri-Loop HART-to-Analog Signal Converter with FIELDVUE Digital Valve Controllers (D103267X012)
- Implementation of Lock-in-Last Strategy (D103261X012)
- Fisher HF340 Filter Instruction Manual (D102796X012)
- 475 Field Communicator User's Manual
- ValveLink Software Help or Documentation

All documents are available from your Emerson Automation Solutions sales office. Also visit our website at www.FIELDVUE.com.

Table 1-2. Specifications

Available Mounting

DVC6200 digital valve controller or DVC6215 feedback unit: ■ Integral mounting to the Fisher GX Control Valve and Actuator System ■ Window mounting to Fisher rotary actuators ■ Sliding-stem linear applications ■ Quarter-turn rotary applications

DVC6205 base unit for 2 inch pipestand or wall mounting (for remote-mount)

The DVC6200 digital valve controller or DVC6215 feedback unit can also be mounted on other actuators that comply with IEC 60534-6-1, IEC 60534-6-2, VDI/VDE 3845 and NAMUR mounting standards.

Communication Protocol

■ HART 5 or ■ HART 7

Input Signal

Point-to-Point
Analog Input Signal: 4-20 mA DC, nominal; split ranging available
Minimum Voltage Available at Instrument Terminals must be 9.5 VDC for analog control, 10 VDC for HART communication
Minimum Control Current: 4.0 mA
Minimum Current w/o Microprocessor Restart: 3.5 mA
Maximum Voltage: 30 VDC
Overcurrent protected
Reverse Polarity protected

Multi-drop
Instrument Power: 11 to 30 VDC at 10 mA
Reverse Polarity protected

Supply Pressure(1)

Minimum Recommended: 0.3 bar (5 psig) higher than maximum actuator requirements
Maximum: 10.0 bar (145 psig) or maximum pressure rating of the actuator, whichever is lower

Medium: Air or Natural Gas

Supply medium must be clean, dry and noncorrosive.

Per ISA Standard 7.0.01
A maximum 40 micrometer particle size in the air system is acceptable. Further filtration down to 5 micrometer particle size is recommended. Lubricant content is not to exceed 1 ppm weight (w/w) or volume (v/v) basis. Condensation in the air supply should be minimized.

Per ISO 8573-1
Maximum particle density size: Class 7
Oil content: Class 3
Pressure Dew Point: Class 3 or at least 10 K less than the lowest ambient temperature expected

Output Signal

Pneumatic signal, up to full supply pressure
Minimum Span: 0.4 bar (6 psig)
Maximum Span: 9.5 bar (140 psig)
Action: ■ Double, ■ Single Direct or ■ Reverse

Steady-State Air Consumption(2)(3)

Standard Relay
At 1.4 bar (20 psig) supply pressure:
Less than 0.38 normal m^3/hr (14 scfh)
At 5.5 bar (80 psig) supply pressure:
Less than 1.3 normal m^3/hr (49 scfh)

Low Bleed Relay
At 1.4 bar (20 psig) supply pressure:
Average value 0.056 normal m^3/hr (2.1 scfh)
At 5.5 bar (80 psig) supply pressure:
Average value 0.184 normal m^3/hr (6.9 scfh)

Maximum Output Capacity(2)(3)

At 1.4 bar (20 psig) supply pressure:
10.0 normal m^3/hr (375 scfh)
At 5.5 bar (80 psig) supply pressure:
29.5 normal m^3/hr (1100 scfh)

Operating Ambient Temperature Limits(1)(4)

-40 to 85°C (-40 to 185°F)
-52 to 85°C (-62 to 185°F) for instruments utilizing the Extreme Temperature option (fluorosilicone elastomers)
-52 to 125°C (-62 to 257°F) for remote-mount feedback unit

Independent Linearity(5)

Typical Value: ±0.50% of output span

Electromagnetic Compatibility

Meets EN 61326-1:2013
Immunity—Industrial locations per Table 2 of the EN 61326-1 standard. Performance is shown in table 1-3 below.
Emissions—Class A
ISM equipment rating: Group 1, Class A

-continued-

Table 1-2. Specifications (continued)

Lightning and Surge Protection—The degree of immunity to lightning is specified as Surge immunity in table 1-3. For additional surge protection commercially available transient protection devices can be used.

Vibration Testing Method

Tested per ANSI/ISA-S75.13.01 Section 5.3.5. A resonant frequency search is performed on all three axes. The instrument is subjected to the ISA specified 1/2 hour endurance test at each major resonance.

Input Impedance

An equivalent impedance of 500 ohms may be used. This value corresponds to 10V @ 20 mA.

Humidity Testing Method

Tested per IEC 61514-2

Electrical Classification

Hazardous Area Approvals

CSA— Intrinsically Safe, Explosion-proof, Division 2, Dust Ignition-proof

FM— Intrinsically Safe, Explosion-proof, Dust Ignition-proof, Non-Incendive

ATEX— Intrinsically Safe, Flameproof, Type n Dust by intrinsic safety

IECEx— Intrinsically Safe, Flameproof, Type n Dust by intrinsic safety and enclosure

Electrical Housing

CSA— Type 4X, IP66

FM— Type 4X, IP66

ATEX— IP66

IECEx— IP66

Other Classifications/Certifications

Natural Gas Certified, Single Seal Device— CSA, FM, ATEX, and IECEx (not available with I/O Package)

Lloyds Register— Marine Type Approval

CUTR— Customs Union Technical Regulations (Russia, Kazakhstan and Belarus)

INMETRO— National Institute of Metrology, Quality, and Technology (Brazil)

KGS— Korea Gas Safety Corporation (South Korea)

NEPSI— National Supervision and Inspection Centre for Explosion Protection and Safety of Instrumentation (China)

PESO CCOE— Petroleum and Explosives Safety Organisation - Chief Controller of Explosives (India)

TIIS— Technology Institution of Industrial Safety (Japan)

Contact your Emerson Automation Solutions sales office for classification/certification specific information.

Connections

Supply Pressure: 1/4 NPT internal and integral pad for mounting 67CFR regulator
Output Pressure: 1/4 NPT internal
Tubing: 3/8-inch recommended
Vent: 3/8 NPT internal
Electrical: 1/2 NPT internal or M20(6)

Actuator Compatibility

Stem Travel (Sliding-Stem Linear)
Minimum: 6.5 mm (0.25 inch)
Maximum: 606 mm (23.875 inches)

Shaft Rotation (Quarter-Turn Rotary)
Minimum: 45°
Maximum: 90°

Weight

DVC6200
Aluminum: 3.5 kg (7.7 lbs)
Stainless Steel: 8.6 kg (19 lbs)

DVC6205: 4.1 kg (9 lbs)
DVC6215: 1.4 kg (3.1 lbs)

Construction Materials

Housing, module base and terminal box:
A03600 low copper aluminum alloy (standard)
Stainless steel (optional)
Cover: Thermoplastic polyester
Elastomers: Nitrile (standard)
Fluorosilicone (extreme temperature)

Options

■ Supply and output pressure gauges or ■ Tire valves ■ Integral mounted filter regulator ■ Low-Bleed Relay ■ Extreme Temperature ■ Remote Mount(7) ■ Stainless Steel

■ **Integral 4-20 mA Position Transmitter(8):**
4-20 mA output, isolated
Supply Voltage: 8-30 VDC
Reference Accuracy: 1% of travel span
The position transmitter meets the requirements of NAMUR NE43; selectable to show failure high (> 22.5 mA) or failure low (< 3.6 mA). Fail high only when the positioner is powered.

-continued-

Table 1-2. Specifications (continued)

Options (continued)

■ Integral Switch(8):
One isolated switch, configurable throughout the calibrated travel range or actuated from a device alert
Off State: 0 mA (nominal)
On State: up to 1 A
Supply Voltage: 30 VDC maximum
Reference Accuracy: 2% of travel span

Contact your Emerson Automation Solutions sales office or go to www.FIELDVUE.com for additional information

Declaration of SEP

Fisher Controls International LLC declares this product to be in compliance with Article 4 paragraph 3 of the PED Directive 2014/68/EU. It was designed and manufactured in accordance with Sound Engineering Practice (SEP) and cannot bear the CE marking related to PED compliance.

However, the product *may* bear the CE marking to indicate compliance with *other* applicable European Community Directives.

NOTE: Specialized instrument terms are defined in ANSI/ISA Standard 51.1 - Process Instrument Terminology.
1. The pressure/temperature limits in this document and any other applicable code or standard should not be exceeded.
2. Normal m^3/hour - Normal cubic meters per hour at 0°C and 1.01325 bar, absolute. Scfh - Standard cubic feet per hour at 60°F and 14.7 psia.
3. Values at 1.4 bar (20 psig) based on a single-acting direct relay; values at 5.5 bar (80 psig) based on double-acting relay.
4. Temperature limits vary based on hazardous area approval.
5. Not applicable for travels less than 19 mm (0.75 inch) or for shaft rotation less than 60 degrees. Also not applicable for digital valve controllers in long-stroke applications.
6. M20 electrical connections are only available with ATEX approvals.
7. 4-conductor shielded cable, 18 to 22 AWG minimum wire size, in rigid or flexible metal conduit, is required for connection between base unit and feedback unit. Pneumatic tubing between base unit output connection and actuator has been tested to 91 meters (300 feet). At 15 meters (50 feet) there was no performance degradation. At 91 meters there was minimal pneumatic lag.
8. The electronic output is available with either the position transmitter or the integral switch.

Table 1-3. EMC Summary Results—Immunity

Port	Phenomenon	Basic Standard	Test Level	Performance Criteria(1)
Enclosure	Electrostatic discharge (ESD)	IEC 61000-4-2	4 kV contact 8 kV air	A
	Radiated EM field	IEC 61000-4-3	80 to 1000 MHz @ 10V/m with 1 kHz AM at 80% 1400 to 2000 MHz @ 3V/m with 1 kHz AM at 80% 2000 to 2700 MHz @ 1V/m with 1 kHz AM at 80%	A
	Rated power frequency magnetic field	IEC 61000-4-8	30 A/m at 50/60Hz	A
I/O signal/control	Burst	IEC 61000-4-4	1 kV	A
	Surge	IEC 61000-4-5	1 kV	B
	Conducted RF	IEC 61000-4-6	150 kHz to 80 MHz at 3 Vrms	A

Performance criteria: +/- 1% effect.
1. A = No degradation during testing. B = Temporary degradation during testing, but is self-recovering.

Educational Services

For information on available courses for the DVC6200 digital valve controller, as well as a variety of other products, contact:

Emerson Automation Solutions
Educational Services - Registration
Phone: +1-641-754-3771 or +1-800-338-8158
e-mail: education@emerson.com
http://www.emersonprocess.com/education

Section 2 Wiring Practices

Control System Requirements

There are several parameters that should be checked to ensure the control system is compatible with the DVC6200 digital valve controller.

HART Filter

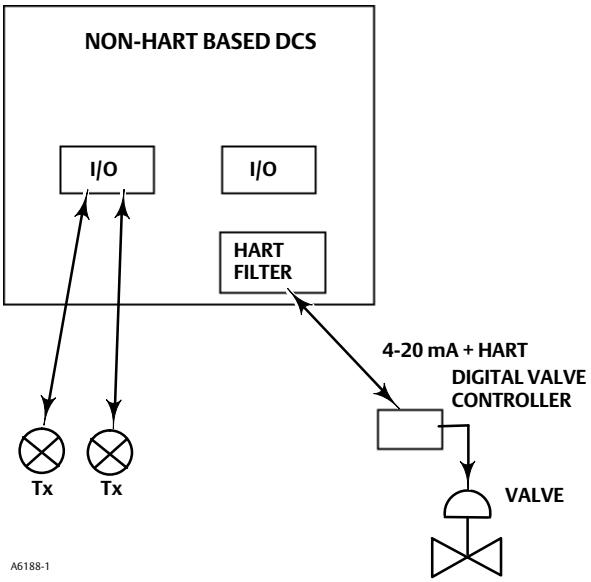
Depending on the control system you are using, a HART filter may be needed to allow HART communication. The HART filter is a passive device that is inserted in field wiring from the HART loop. The filter is normally installed near the field wiring terminals of the control system I/O (see figure 2-1). Its purpose is to effectively isolate the control system output from modulated HART communication signals and raise the impedance of the control system to allow HART communication. For more information on the description and use of the HART filter, refer to the appropriate HART filter instruction manual.

To determine if your system requires a filter contact your Emerson Automation Solutions sales office.

Note

A HART filter is typically NOT required for any of the Emerson Automation Solutions control systems, including PROVOX™, RS3™, and DeltaV™ systems.

Figure 2-1. HART Filter Application



Voltage Available

The voltage available at the DVC6200 digital valve controller must be at least 10 VDC. The voltage available at the instrument is not the actual voltage measured at the instrument when the instrument is connected. The voltage measured at the instrument is limited by the instrument and is typically less than the voltage available.

As shown in figure 2-2, the voltage available at the instrument depends upon:

- the control system compliance voltage
- if a filter, wireless THUM adapter, or intrinsic safety barrier is used, and
- the wire type and length.

The control system compliance voltage is the maximum voltage at the control system output terminals at which the control system can produce maximum loop current.

The voltage available at the instrument may be calculated from the following equation:

Voltage Available = [Control System Compliance Voltage (at maximum current)] - [filter voltage drop (if a HART filter is used)] - [total cable resistance $\times$ maximum current] - [barrier resistance x maximum current].

The calculated voltage available should be greater than or equal to 10 volts DC.

Table 2-1 lists the resistance of some typical cables.

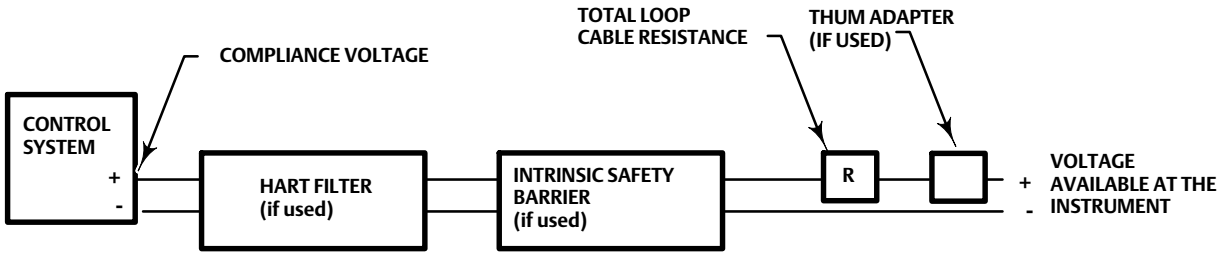
The following example shows how to calculate the voltage available for a Honeywell™ TDC2000 control system with a HF340 HART filter, and 1000 feet of Belden™ 9501 cable:

Voltage available = [18.5 volts (at 21.05 mA)] - [2.3 volts] - [48 ohms $\times$ 0.02105 amps]

Voltage available = [18.5] - [2.3] - [1.01]

Voltage available = 15.19 volts

Figure 2-2. Determining Voltage Available at the Instrument



Calculate Voltage Available at the Instrument as follows:	**Example Calculation**
Control system compliance voltage	**18.5 volts (at 21.05 mA)**
– Filter voltage drop (if used) 1	**– 2.3 volts (for HF300 filter)**
– Intrinsic safety barrier resistance (if used) x maximum loop current	**– 2.55 volts (121 ohms x 0.02105 amps)**
– Smart Wireless THUM adapter voltage drop (if used) 2	
– Total loop cable resistance x maximum loop current	**– 1.01 volts (48 ohms x 0.02105 amps for 1000 feet of Belden 9501 cable)**
= Voltage available at the instrument 3	**= 15.19 volts, available—if safety barrier (2.55 volts) is not used**

NOTES:

1 **Obtain filter voltage drop. The measured drop will be different than this value. The measured filter voltage drop depends upon control system output voltage, the intrinsic safety barrier (if used), and the instrument. See note 3.**

2 **The voltage drop of the THUM adapter is linear from 2.25 volts at 3.5 mA to 1.2 volts at 25 mA.**

3 **The voltage available at the instrument is not the voltage measured at the instrument terminals. Once the instrument is connected, the instrument limits the measured voltage to approximately 8.0 to 9.5 volts.**

Table 2-1. Cable Characteristics

Cable Type	Capacitance(1) pF/Ft	Capacitance(1) pF/m	Resistance(2) Ohms/ft	Resistance(2) Ohms/m
BS5308/1, 0.5 sq mm	61.0	200	0.022	0.074
BS5308/1, 1.0 sq mm	61.0	200	0.012	0.037
BS5308/1, 1.5 sq mm	61.0	200	0.008	0.025
BS5308/2, 0.5 sq mm	121.9	400	0.022	0.074
BS5308/2, 0.75 sq mm	121.9	400	0.016	0.053
BS5308/2, 1.5 sq mm	121.9	400	0.008	0.025
BELDEN 8303, 22 awg	63.0	206.7	0.030	0.098
BELDEN 8441, 22 awg	83.2	273	0.030	0.098
BELDEN 8767, 22 awg	76.8	252	0.030	0.098
BELDEN 8777, 22 awg	54.9	180	0.030	0.098
BELDEN 9501, 24 awg	50.0	164	0.048	0.157
BELDEN 9680, 24 awg	27.5	90.2	0.048	0.157
BELDEN 9729, 24 awg	22.1	72.5	0.048	0.157
BELDEN 9773, 18 awg	54.9	180	0.012	0.042
BELDEN 9829, 24 awg	27.1	88.9	0.048	0.157
BELDEN 9873, 20 awg	54.9	180	0.020	0.069

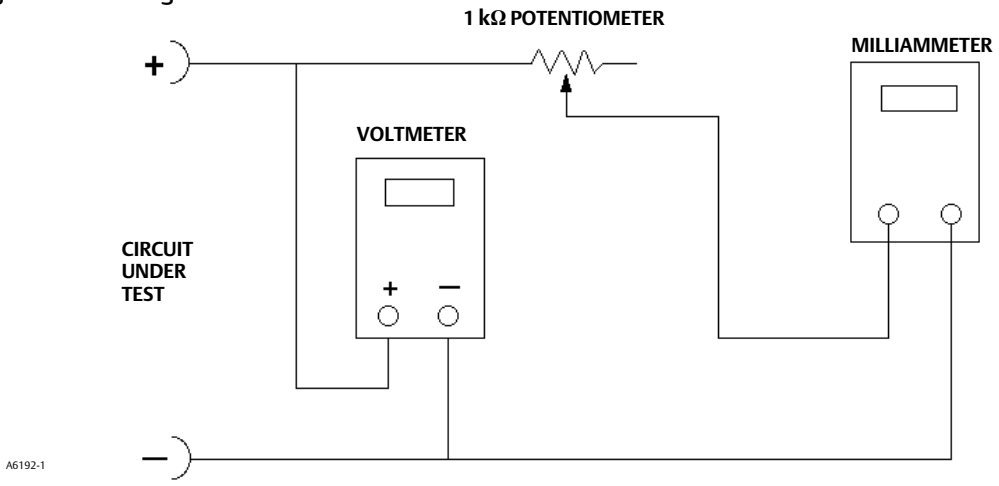
1. The capacitance values represent capacitance from one conductor to all other conductors and shield. This is the appropriate value to use in the cable length calculations.
2. The resistance values include both wires of the twisted pair.

Compliance Voltage

If the compliance voltage of the control system is not known, perform the following compliance voltage test.

1. Disconnect the field wiring from the control system and connect equipment as shown in figure 2-3 to the control system terminals.

Figure 2-3. Voltage Test Schematic



2. Set the control system to provide maximum output current.
3. Increase the resistance of the 1 kΩ potentiometer, shown in figure 2-3, until the current observed on the milliammeter begins to drop quickly.
4. Record the voltage shown on the voltmeter. This is the control system compliance voltage.

For specific parameter information relating to your control system, contact your Emerson Automation Solutions sales office.

Auxiliary Terminal Wiring Length Guidelines

The Auxiliary Input Terminals of a DVC6200 with instrument level ODV can be used with a locally-mounted switch for initiating a partial stroke test. Some applications require that the switch be installed remotely from the DVC6200.

The length for wiring connected to the Auxiliary Input Terminals is limited by capacitance. For proper operation of the Auxiliary Input Terminals capacitance should not exceed 100,000 pF. As with all control signal wiring, good wiring practices should be observed to minimize adverse effect of electrical noise on the Aux Switch function.

Example Calculation: Capacitance per foot or per meter is required to calculate the length of wire that may be connected to the Aux switch input. The wire should not exceed the capacitance limit of 100,000 pF. Typically the wire manufacturer supplies a data sheet which provides all of the electrical properties of the wire. The pertinent parameter is the highest possible capacitance. If shielded wire is used, the appropriate number is the “Conductor to Other Conductor & Shield” value.

Example — 18AWG Unshielded Audio, Control and Instrumentation Cable

Manufacturer's specifications include:

Nom. Capacitance Conductor to Conductor @ 1 KHz: 26 pF/ft
Nom. Conductor DC Resistance @ 20 Deg. C: 5.96 Ohms/1000 ft
Max. Operating Voltage - UL 200 V RMS (PLTC, CMG),150 V RMS (ITC)
Allowable Length with this cable = 100,000pF /(26pF/ft) = 3846 ft

Example — 18AWG Shielded Audio, Control and Instrumentation Cable

Manufacturer's specifications include:

Nom. Characteristic Impedance: 29 Ohms
Nom. Inductance: .15 µH/ft
Nom. Capacitance Conductor to Conductor @ 1 KHz: 51 pF/ft
Nom. Cap. Cond. to other Cond. & Shield @ 1 KHz 97 pF/ft
Allowable Length with this cable = 100,000pF /(97pF/ft) = 1030 ft

The AUX switch input passes less than 1 mA through the switch contacts, and uses less than 5V, therefore, neither the resistance nor the voltage rating of the cable are critical. Ensure that switch contact corrosion is prevented. It is generally advisable that the switch have gold-plated or sealed contacts.

Maximum Cable Capacitance

The maximum cable length for HART communication is limited by the characteristic capacitance of the cable. Maximum length due to capacitance can be calculated using the following formulas:

$\text{Length(ft)} = [160{,}000 - C_{master}(pF)] \div [C_{cable}(pF/ft)]$

$\text{Length(m)} = [160{,}000 - C_{master}(pF)] \div [C_{cable}(pF/m)]$

where:

160,000 = a constant derived for FIELDVUE instruments to ensure that the HART network RC time constant will be no greater than 65 µs (per the HART specification).

C_{master} = the capacitance of the control system or HART filter

C_{cable} = the capacitance of the cable used (see table 2-1)

The following example shows how to calculate the cable length for a Foxboro™ I/A control system (1988) with a C_{master} of 50, 000 pF and a Belden 9501 cable with characteristic capacitance of 50pF/ft.

Length(ft) = [160,000 - 50,000pF] ÷ [50pF/ft]

Length = 2200 ft.

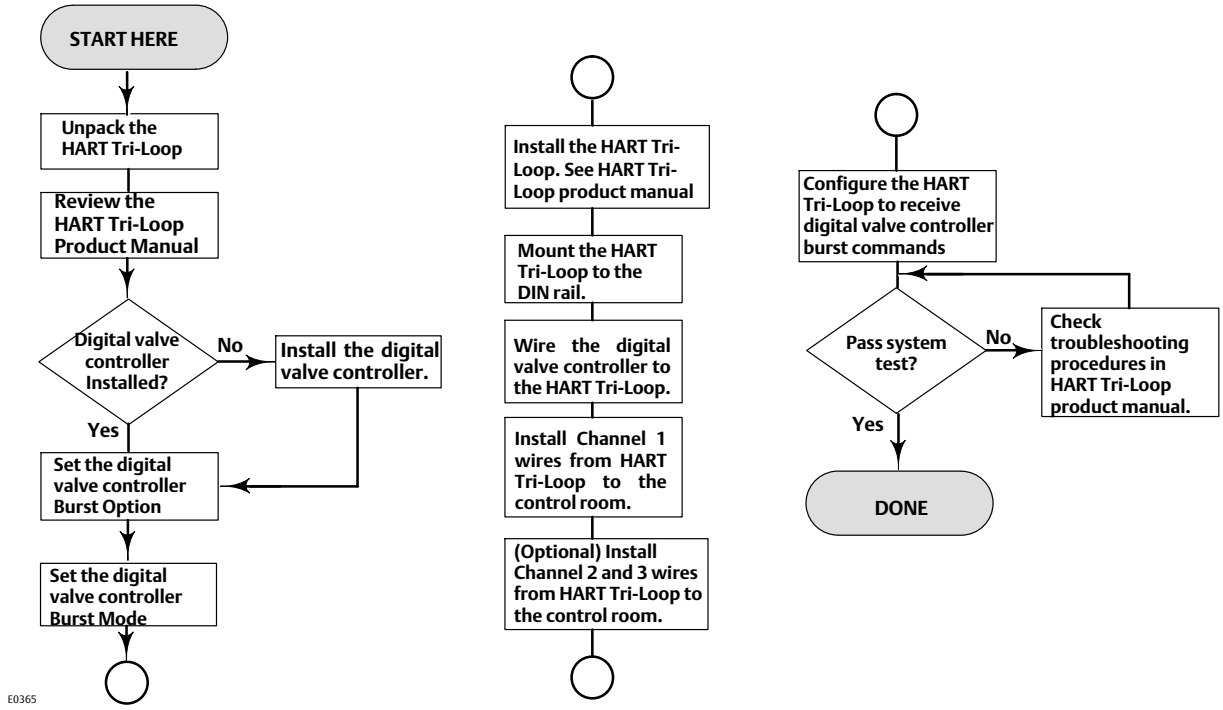
The HART communication cable length is limited by the cable characteristic capacitance. To increase cable length, select a wire with lower capacitance per foot. Contact your Emerson Automation Solutions sales office for specific information relating to your control system.

Installation in Conjunction with a Rosemount 333 HART Tri-Loop HART-to-Analog Signal Converter

Use the DVC6200 digital valve controller in operation with a Rosemount 333 HART Tri-Loop HART-to-Analog Signal Converter to acquire an independent 4-20 mA analog output signal for the analog input, travel target, pressure, or travel. The HART Tri-Loop accepts any three of these digital signals and converts them into three separate 4-20 mA analog channels.

Refer to figure 2-4 for basic installation information. Refer to the 333 HART Tri-Loop HART-to-Analog Signal Converter Product Manual (00809-0100-4754) for complete installation information.

Figure 2-4. HART Tri-Loop Installation Flowchart



Commissioning the Digital Valve Controller for use with the HART Tri-Loop Signal Converter

To prepare the digital valve controller for use with a 333 HART Tri-Loop, you must configure the digital valve controller to burst mode, and select Burst Command 3. In burst mode, the digital valve controller provides digital information to the HART Tri-Loop HART-to-Analog Signal Converter. The HART Tri-Loop converts the digital information to a 4 to 20 mA analog signal. Each burst message contains the latest value of the primary (analog input), secondary (travel target), tertiary (configured output pressure), and quaternary (travel) variables.

To commission a DVC6200 for use with a HART Tri-Loop, perform the following procedures.

Note

The DVC6200 must be in HART 5 compatibility mode to use burst communications.

Enable Burst Operation

Field Communicator	With I/O Package Configure > Manual Setup > Outputs > Burst Mode (2-2-6-5) HC, AD, PD or (2-2-7-5) ODV Without I/O Package Configure > Manual Setup > Outputs > Burst Mode (2-2-6-2) HC, AD, PD or (2-2-7-2) ODV

Select *Burst Enable* and follow the prompts to enable burst mode. Then select *Burst Command* and follow the prompts to configure *Loop Current/PV/SV/TV/QV*.

Select the HART Variable Assignments

Field Communicator	With I/O Package Configure > Manual Setup > Outputs > HART Variable Assignments (2-2-6-4) HC, AD, PD or (2-2-7-4) ODV Without I/O Package Configure > Manual Setup > Outputs > HART Variable Assignments (2-2-6-1) HC, AD, PD or (2-2-7-1) ODV

Configure the *HART Variable Assignments*. The Primary Variable (PV) is always Analog Input. The Secondary Variable (SV), Tertiary Variable (TV) and Quaternary Variable (QV) can be configured to any of the following variables.

- Setpoint
- Travel (see note below)
- Pressure A
- Pressure B
- Pressure A-B
- Supply Pressure
- Drive Signal
- Analog Input

Note

If the instrument is configured to operate in pressure control mode, or detects an invalid travel sensor reading, the Travel variable will report pressure in percent of bench set range.

Section 3 Configuration

Guided Setup

Field Communicator	Configure > Guided Setup (2-1)

To quickly setup the instrument, the following procedures will guide you through the process.

- Device Setup—This procedure is used to configure actuator and valve information, calibrate the valve assembly, and assign the tuning set for the valve assembly.
- Performance Tuner (instrument level AD, PD, ODV)—This procedure executes a simple step response test and then calculates a recommended set of gain values based on the response of the control valve. See page 26 for additional information.
- Stabilize Optimize (instrument level HC)—This procedure permits you to adjust valve response by changing the digital valve controller tuning. See page 26 for additional information.

Manual Setup

Manual Setup allows you to configure the digital valve controller to your application. Table 3-1 lists the default settings for a standard factory configuration. You can adjust actuator response, set the various modes, alerts, ranges, travel cutoffs and limits. You can also restart the instrument and set the protection.

Table 3-1. Default Detailed Setup Parameters

Setup Parameter		Default Setting[1]
Instrument Configuration	Control Mode	Analog
	Restart Control Mode	Resume Last
	Analog In Range Low	4 mA
	Analog In Range High	20 mA
	Analog Input Units	mA
	Local AutoCal Button	Disabled
	Polling Address	0
	Burst Mode Enable	No
	Burst Command	3
	Cmd 3 (Trending) Pressure	A-B
Dynamic Response and Tuning	Input Characterization	Linear
	Travel Limit High	125%
	Travel Limit Low	-25%
	Travel/Pressure Cutoff High	99.46%
	Travel/Pressure Cutoff Low	0.50%
	Set Point Rate Open	0%/sec
	Set Point Rate Close	0%/sec
	Set Point Filter Time (Lag Time)	0 sec
	Integrator Enable	Yes
	Integral Gain	9.4 repeats/minute
	Integral Deadzone	0.26%

-continued on next page-

Table 3-1. Default Detailed Setup Parameters (continued)

Setup Parameter		Default Setting[1]
Deviation & Other Alerts	Travel Deviation Alert Enable	Yes
	Travel Deviation Alert Point	5%
	Travel Deviation Time	9.99 sec
	Pressure Deviation Alert Enable	Yes
	Pressure Deviation Alert Point	5 psi[2]
	Pressure Deviation Alert Time	5.0 sec
	Drive Signal Alert Enable	Yes
	Supply Pressure Alert Enable	Yes

1. The settings listed are for standard factory configuration. DVC6200 instruments can also be ordered with custom configuration settings. Refer to the order requisition for the custom settings.
2. Adjust to bar, kPa, or Kg/cm^2 if necessary

Mode and Protection

Field Communicator	Configure > Manual Setup > Mode and Protection (2-2-1)

Instrument Mode

There are two instrument modes for the DVC6200; In Service or Out of Service. In Service is the normal operating mode such that the instrument follows the 4-20 mA control signal. Out of Service is required in some cases to modify configuration parameters or to run diagnostics.

Note

Some changes that require the instrument to be taken Out Of Service will not take effect until the instrument is placed back In Service or the instrument is restarted.

Write Protection

There are two Write Protection modes for the DVC6200: Not Protected or Protected. Protected prevents configuration and calibration changes to the instrument. The default setting is Not Protected. Write Protection can be changed to Protected remotely. However, to change Write Protection to Not Protected, you must have physical access to the instrument. The procedure will require you to press a button ( ) on the terminal box as a security measure.

Instrument

Field Communicator	Configure > Manual Setup > Instrument (2-2-2)

Follow the prompts on the Field Communicator display to configure the following Instrument parameters:

Identification

- HART Tag—A tag name up to 8 characters is available for the instrument. The HART tag is the easiest way to distinguish between instruments in a multi-instrument environment. Use the HART tag to label instruments electronically according to the requirements of your application. The tag you assign is automatically displayed when the Field Communicator establishes contact with the digital valve controller at power-up.

- HART Long Tag (HART Universal Revision 7 only)—A tag name up to 32 characters is available for the instrument.

- Description—Enter a description for the application with up to 16 characters. The description provides a longer user-defined electronic label to assist with more specific instrument identification than is available with the HART tag.
- Message—Enter any message with up to 32 characters. Message provides the most specific user-defined means for identifying individual instruments in multi-instrument environments.
- Polling Address—If the digital valve controller is used in point-to-point operation, the Polling Address is 0. When several devices are connected in the same loop, such as for split ranging, each device must be assigned a unique polling address. The Polling Address is set to a value between 0 and 63 for HART 7 and 0 and 15 for HART 5. To change the polling address the instrument must be Out Of Service.

  For the Field Communicator to be able to communicate with a device whose polling address is not 0, it must be configured to automatically search for all or specific connected devices.

Serial Numbers

- Instrument Serial Number—Enter the serial number on the instrument nameplate, up to 12 characters.
- Valve Serial Number—Enter the serial number for the valve in the application, up to 12 characters.

Units

- Pressure Units—Defines the output and supply pressure units in either psi, bar, kPa, or kg/cm^2.
- Temperature Units—Degrees Fahrenheit or Celsius. The temperature measured is from a sensor mounted on the digital valve controller's printed wiring board.
- Analog Input Units—Permits defining the Analog Input Units in mA or percent of 4-20 mA range.

Terminal Box

- Calibration (CAL) Button—This button is near the wiring terminals in the terminal box and provides a quick means to autocalibrate the instrument. The button must be pressed for 3 to 10 seconds. Autocalibration will move the valve through the full range of travel whether the Instrument Mode is In Service or Out of Service. However, if the Write Protection is Protected, this button will not be active. To abort, press the button again for 1 second. The calibration button is disabled by default.
- Auxiliary Terminal Action—These wire terminals can be configured to initiate a partial stroke test upon detection of a short across the (+) and (-) terminals. The terminals must be shorted for 3 to 10 seconds.

Note

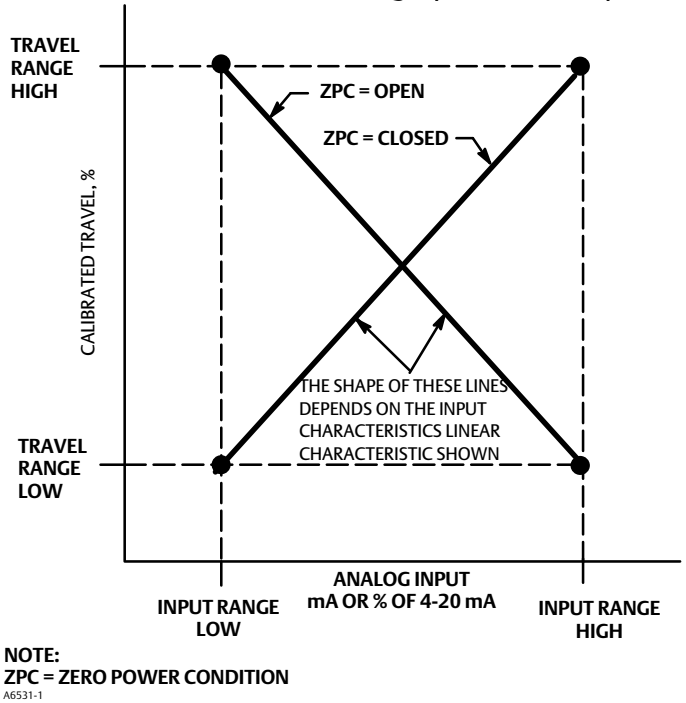
Auxiliary Terminal Action is only available for instrument level ODV.

Analog Input Range

- Input Range Hi—Permits setting the Input Range High value. Input Range High should correspond to Travel Range High, if the Zero Power Condition is configured as closed. If the Zero Power Condition is configured as open, Input Range High corresponds to Travel Range Low. See figure 3-1.

- Input Range Lo—Permits setting the Input Range Low value. Input Range Low should correspond to Travel Range Low, if the Zero Power Condition is configured as closed. If the Zero Power Condition is configured as open, Input Range Low corresponds to Travel Range High. See figure 3-1.

Figure 3-1. Calibrated Travel to Analog Input Relationship



Spec Sheet

The Spec Sheet provides a means to store the entire control valve specifications on board the DVC6200.

Edit Instrument Time

Permits setting the instrument clock. When alerts are stored in the alert record, the record includes the time and date. The instrument clock uses a 24-hour format.

Travel/Pressure Control

Field Communicator	Configure > Manual Setup > Travel/Pressure Control (2-2-3)

Travel/Pressure Select

This defines the operating mode of the instrument as well as the behavior of the instrument should the travel sensor fail. There are four choices.

- Travel Control—The instrument is controlling to a target travel. Fallback is not enabled.
- Pressure Control—The instrument is controlling to a target pressure. Fallback is not enabled.
- Fallback-Sensor Failure—The instrument will fallback to pressure control if a travel sensor failure is detected.

- Fallback-Sensor/Tvl Deviation—The instrument will fallback to pressure control if a travel sensor failure is detected, or if the Tvl Dev Press Fallback setting is exceeded for more than the Tvl Dev Press Fallback Time.

Note

Travel / Pressure Select must be set to Travel for double-acting actuators

Cutoffs and Limits

- Hi Limit/Cutoff Select—When the Hi Cutoff/Limit Select is configured for Cutoff, the Travel Target is set to 123% when the Travel exceeds the Hi Cutoff Point. When the Hi Cutoff/Limit Select is configured for Limit, the Travel Target will not exceed the Hi Limit Point.

- Hi Limit/Cutoff Point—This is the point within the calibrated travel range above which the Limit or Cutoff is in effect. When using cutoffs, a Cutoff Hi of 99.5% is recommended to ensure valve goes fully open. The Hi Cutoff/Limit is deactivated by setting it to 125%.

- Lo Limit/Cutoff Select—When the Lo Cutoff/Limit Select is configured for Cutoff, the Travel Target is set to -23% when the Travel is below the Lo Cutoff Point. When the Hi Cutoff/Limit Select is configured for Limit, the Travel Target will not fall below the Lo Limit Point.

- Lo Limit/Cutoff Point—This is the point within the calibrated travel range below which the Limit or Cutoff is in effect. When using cutoffs, a Cutoff Lo of 0.5% is recommended to help ensure maximum shutoff seat loading. The Lo Limit/Cutoff is deactivated by setting it to -25%.

End Point Pressure Control (EPPC)

Note

End Point Pressure Control is available for instrument level ODV.

- EPPC Enable—Select Yes or No. End Point Pressure Control allows the digital valve controller to pull back from saturation of the pneumatic output after reaching the travel extreme. Rather than having the instrument provide full supply pressure (saturation) continuously at the travel extreme, the digital valve controller switches to an End Point Pressure Control where the output pressure (pressure controller set point) to the actuator is maintained at a certain value. This value is configured through the Upper Operating Pressure feature. Because the digital valve controller is constantly in control and not allowed to reach a dormant or saturated state, it is constantly testing its own pneumatic system. If there is an output pressure deviation, for example, the instrument will issue an alert. To ensure there is an alert when an output pressure deviation occurs, setup the alert as described under Pressure Deviation Alert.

- EPPC Set Point—Used in conjunction with End Point Pressure Control, End Point Pressure Control Set Point allows the user to select a pressure to be delivered by the instrument at the travel extreme. For a fail-closed valve, this pressure must be sufficient to maintain the fully open position. For a fail-open valve, this pressure (which is automatically set to supply pressure) must be sufficient to fully close the valve and maintain its rated shutoff classification. For double-acting spring return actuators, this is the differential pressure required to either maintain the fully open or fully closed position, depending on the valve and actuator configuration. For a double-acting actuator without springs with a fail-close valve, this is 95% of the supply pressure. If the valve is fail-open, the upper operating pressure for all actuator is set to the supply pressure.

- EPPC Saturation Time—End Point Pressure Control Saturation Time is the time the digital valve controller stays in hard cutoff before switching to pressure control. Default is 45 seconds.

Pressure Control

- Pressure Range High—The high end of output pressure range. Enter the pressure that corresponds with 100% valve travel when Zero Power Condition is closed, or 0% valve travel when Zero Power Condition is open. This pressure *must be greater* than the Pressure Range Lo.

- Pressure Range Lo—The low end of the output pressure range. Enter the pressure that corresponds to 0% valve travel when Zero Power Condition is closed, or 100% valve travel when Zero Power Condition is open. This pressure *must be less* than the Pressure Range Hi.

Pressure Fallback

Note

Pressure Fallback is available for instrument level AD, PD, ODV.

- Tvl Dev Press Fallback—When the difference between the travel target and the actual travel exceeds this value for more than the Tvl Dev Press Fallback Time, the instrument will disregard the travel feedback and control based on output pressure.

- Tvl Dev Press Fallback Time—This is the time, in seconds, that the travel target and the actual travel must be exceeded before the instrument falls back into pressure control.

- Fallback Recovery—If the instrument has fallen into pressure control and the feedback problem is resolved, recovery to travel control can occur automatically or with manual intervention. To return to travel control when Manual Recovery is selected, change the Fallback Recovery to Auto Recovery, and then back to Manual Recovery (if desired).

Control Mode

- Control Mode—This displays the current control mode of the instrument. This will show Analog if the instrument is in Point-to-Point mode and is using a 4-20 mA signal for its power and set point. This will show Digital if the instrument is in Multidrop mode and is using 24 VDC for power and a digital set point for control.

Note

Another mode, Test, may be displayed. Normally the instrument should not be in the Test mode. The digital valve controller automatically switches to this mode whenever it needs to stroke the valve during calibration or stroke valve, for example. However, if you abort from a procedure where the instrument is in the test mode, it may remain in this mode. To take the instrument out of the Test mode, select *Change Control Mode* and enter Analog or Digital.

- Change Control Mode—This allows the user to configure the control mode to Analog or Digital.

- Restart Control Mode—This defines the Control Mode of the instrument after a restart (e.g. power cycle). Available choices are Resume Last, Analog and Digital.

Characterization

- Input Characterization

Input Characterization defines the relationship between the travel target and ranged set point. Ranged set point is the input to the characterization function. If the zero power condition equals closed, then a set point of 0% corresponds to a ranged input of 0%. If the zero power condition equals open, a set point of 0% corresponds to a ranged input of 100%. Travel target is the output from the characterization function.

To select an input characterization, select *Input Characterization* from the *Characterization* menu. You can select from the three fixed input characteristics shown in figure 3-2 or you can select a custom characteristic. Figure 3-2 shows the relationship between the travel target and ranged set point for the fixed input characteristics, assuming the Zero Power Condition is configured as closed.

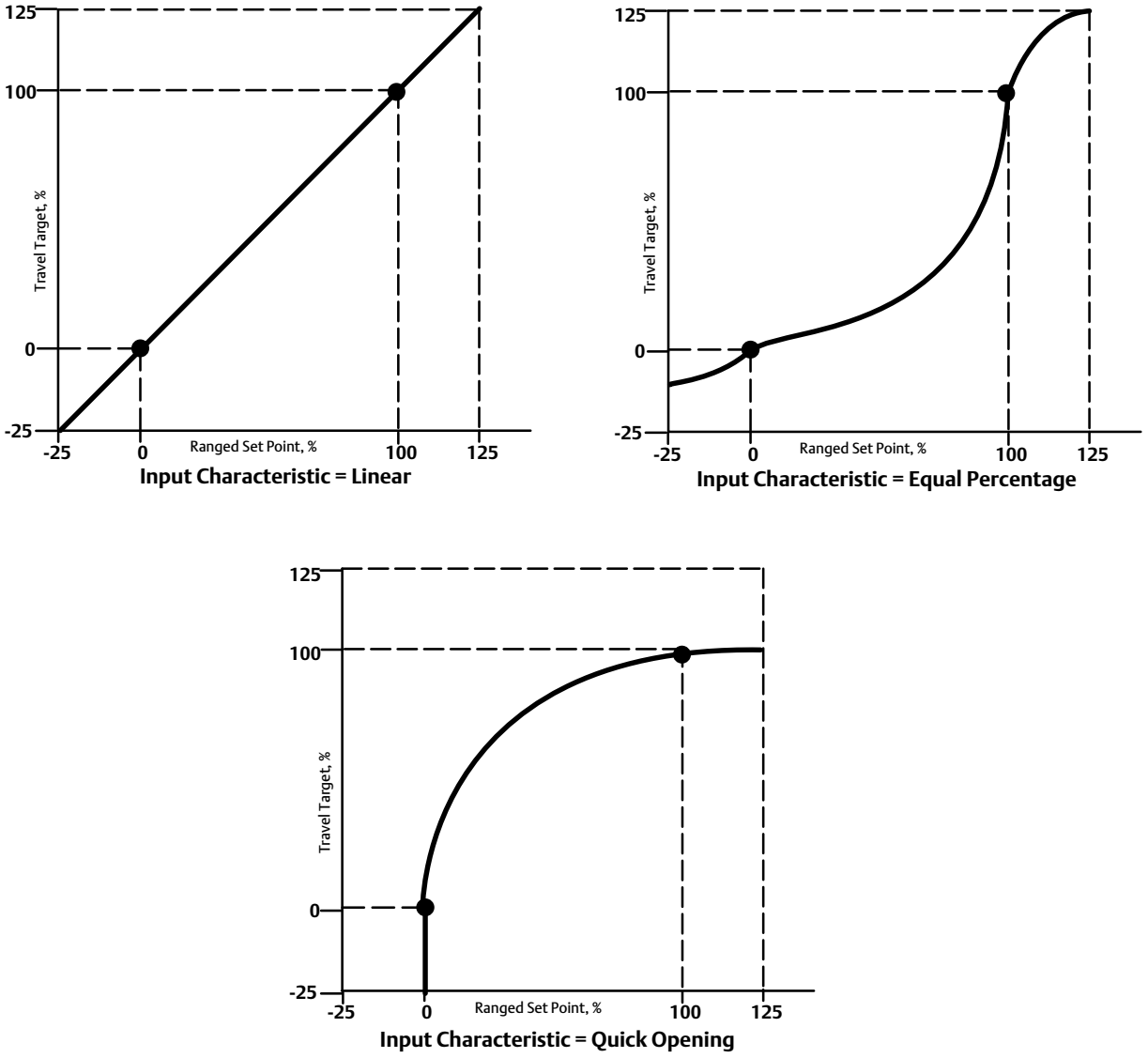
You can specify 21 points on a custom characteristic curve. Each point defines a travel target, in % of ranged travel, for a corresponding set point, in % of ranged set point. Set point values range from -6.25% to 106.25%. Before modification, the custom characteristic is linear.

- Custom Characterization

To define a custom input character, select *Custom Characterization* from the *Characterization* menu. Select the point you wish to define (1 to 21), then enter the desired set point value. Press Enter then enter the desired travel target for the corresponding set point. When finished, select point 0 to return to the *Characterization* menu.

With input characterization you can modify the overall characteristic of the valve and instrument combination. Selecting an equal percentage, quick opening, or custom (other than the default of linear) input characteristic modifies the overall valve and instrument characteristic. However, if you select the linear input characteristic, the overall valve and instrument characteristic is the characteristic of the valve, which is determined by the valve trim (i.e., the plug or cage).

Figure 3-2. Travel Target Versus Ranged Set Point, for Various Input Characteristics (Zero Power Condition = Closed)



A6535-1

Dynamic Response

- SP Rate Open—Maximum rate (% of valve travel per second) at which the digital valve controller will move to the open position regardless of the rate of input current change. A value of 0 will deactivate this feature and allow the valve to stroke open as fast as possible. In firmware 2, 3, and 4 this parameter should be set to 0.

- SP Rate Close—Maximum rate (% of valve travel per second) at which the digital valve controller will move to the close position regardless of the rate of input current change. A value of 0 will deactivate this feature and allow the valve to stroke close as fast as possible. In firmware 2, 3, and 4 this parameter should be set to 0.

- Set Point Filter Time (Lag Time)—The Set Point Filter Time (Lag Time) slows the response of the digital valve controller. A value ranging from 0.2 to 10.0 can be used for noisy or fast processes to improve closed loop process control. Entering a value of 0.0 will deactivate the lag filter. In firmware 2, 3, and 4 this parameter should be set to 0.

Note

Set Point Filter Time (Lag Time) is available for instrument level HC, AD, and PD.

- Lead/Lag Set Point Filter—ODV devices have access to a lead-lag set point filter that can be used to improve a valve's dynamic response. The lead-lag filter is part of the set point processing routine that reshapes the input signal before it becomes travel set point. Lead-lag filters are characterized by lead and lag time constants.

Note

Lead/Lag is only available for instrument level ODV.

When the valve is in its active control region (off the seat), the lead-lag filter improves small amplitude response by momentarily overdriving the travel set point. This is useful when the actuator is large and equipped with accessories. As a result, any volume boosters that are present will be activated. The longer the lag time, the more pronounced the overdrive. Since the lead-lag input filter is used to enhance the dynamic response of a control valve, filter parameters should be set after the tuning parameters have been established.

When the valve is at its seat, the lead-lag filter also has a boost function that sets the initial conditions of the filter artificially low so that small amplitude signal changes appear to be large signal changes to the filter. The boost function introduces a large spike that momentarily overdrives the instrument and activates any external volume boosters that may be present. The lead-lag boost function is normally disabled except for those cases where the valve must respond to small command signals off the seat. By setting the lead/lag ratio in the opening and closing directions to 1.0, the boost function can be enabled without introducing lead-lag dynamics in the active control region. See table 3-2 for typical lead-lag filter settings.

Table 3-2. Typical Lead/Lag Filter Settings for Instrument Level ODV

Parameter	Description	Typical Value
Lag Time	First order time constant. A value of 0.0 will disable the lead-lag filter.	0.2 sec
Opening Lead/Lag Ratio	Initial response to the filter in the opening direction.	2.0
Closing Lead/Lag Ratio	Initial response to the filter in the closing direction.	2.0
Lead-Lag Boost	Initial conditions of the lead-lag filter when the lower travel cutoff is active.	Off

Tuning

Field Communicator	Configure > Manual Setup > Tuning (2-2-4)

Travel Tuning

⚠ WARNING

Changes to the tuning set may cause the valve/actuator assembly to stroke. To avoid personal injury and property damage caused by moving parts, keep hands, tools, and other objects away from the valve/actuator assembly.

- Travel Tuning Set

There are eleven tuning sets to choose from. Each tuning set provides a preselected value for the digital valve controller gain settings. Tuning set C provides the slowest response and M provides the fastest response.

Table 3-3 lists the proportional gain, velocity gain and minor loop feedback gain values for preselected tuning sets.

Table 3-3. Gain Values for Preselected Travel Tuning Sets

Tuning Set	Proportional Gain	Velocity Gain	Minor Loop Feedback Gain
C	4.4	3.0	35
D	4.8	3.0	35
E	5.5	3.0	35
F	6.2	3.1	35
G	7.2	3.6	34
H	8.4	4.2	31
I	9.7	4.85	27
J	11.3	5.65	23
K	13.1	6.0	18
L	15.5	6.0	12
M	18.0	6.0	12
X (Expert)	User Adjusted	User Adjusted	User Adjusted

In addition, you can specify Expert tuning and individually set the proportional gain, velocity gain, and minor loop feedback gain. Individually setting or changing any tuning parameter or running the Performance Tuner or Stabilize Optimize routint will automatically change the tuning set to X (expert).

Note

Use Expert tuning only if standard tuning has not achieved the desired results.

Stabilize/Optimize or Performance Tuner may be used to achieve the desired results more rapidly than manual Expert tuning.

Table 3-4 provides tuning set selection guidelines for Fisher and Baumann actuators. These tuning sets are only recommended starting points. After you finish setting up and calibrating the instrument, you may have to select either a higher or lower tuning set to get the desired response. You can use the Performance Tuner to optimize tuning.

Table 3-4. Actuator Information for Initial Setup

Actuator Manufacturer	Actuator Model	Actuator Size	Actuator Style	Starting Tuning Set	Travel Sensor Motion[2] Relay A or C[3]	
Fisher	585C & 585CR	25 50 60 68, 80 100, 130	Piston Dbl w/ or w/o Spring. See actuator instruction manual and nameplate.	E I J L M	User Specified	
	657	30 34, 40 45, 50 46, 60, 70, 76, & 80-100	Spring & Diaphragm	H K L M	Away from the top of the instrument	
	667	30 34, 40 45, 50 46, 60, 70, 76, & 80-100	Spring & Diaphragm	H K L M	Towards the top of the instrument	
	1051 & 1052	20, 30 33 40 60, 70	Spring & Diaphragm (Window-mount)	H I K M	Away from the top of the instrument	
	1061	30 40 60 68, 80, 100, 130	Piston Dbl w/o Spring	J K L M	Depends upon pneumatic connections. See description for Travel Sensor Motion	
	1066SR	20 27, 75	Piston Sgl w/Spring	G L	Mounting Style	Travel Sensor Motion
					A	Away from the top of the instrument
					B	Towards the top of the instrument
					C	Towards the top of the instrument
					D	Away from the top of the instrument
	2052	1 2 3	Spring & Diaphragm (Window-mount)	H J M	Away from the top of the instrument	
	3024C	30, 30E 34, 34E, 40, 40E 45, 45E	Spring & Diaphragm	E H K	For P_o operating mode (air opens): Towards the top of the instrument For P_s operating mode (air closes): Away from the top of the instrument	
	GX	225	Spring & Diaphragm	X[1]	Air to Open Towards the top of the instrument	Air to Close Away from the top of the instrument
		750		K		
		1200		M		
Baumann	Air to Extend	16 32 54	Spring & Diaphragm	C E H	Towards the top of the instrument	
	Air to Retract				Away from the top of the instrument	
	Rotary	10 25 54		E H J	Specify	

NOTE: Refer to figure table 3-6 for feedback connection (magnet assembly) information.
1. X = Expert Tuning. Proportional Gain = 4.2; Velocity Gain = 3.0; Minor Loop Feedback Gain = 18.0
2. Travel Sensor Motion in this instance refers to the motion of the magnet assembly.
3. Values shown are for Relay A and C. Reverse for Relay B.

- Proportional Gain—the proportional gain for the travel control tuning set. Changing this parameter will also change the tuning set to Expert.

- Velocity Gain—the velocity gain for the travel control tuning set. Changing this parameter will also change the tuning set to Expert.

- MLFB Gain—the minor loop feedback gain for the travel control tuning set. Changing this parameter will also change the tuning set to Expert.
- Integral Enable—Yes or No. Enable the integral setting to improve static performance by correcting for error that exists between the travel target and actual travel. Travel Integral Control is enabled by default.
- Integral Gain—Travel Integral Gain is the ratio of the change in output to the change in input, based on the control action in which the output is proportional to the time integral of the input.
- Performance Tuner

⚠ WARNING

During performance tuning the valve may move, causing process fluid or pressure to be released. To avoid personal injury and property damage caused by the release of process fluid or pressure, isolate the valve from the process and equalize pressure on both sides of the valve or bleed off the process fluid.

Note

The Performance Tuner is available for instrument level AD, PD, and ODV, and can only be run while in Travel control mode.

The Performance Tuner is used to determine digital valve controller tuning. It can be used with digital valve controllers mounted on most sliding-stem and rotary actuators, including Fisher and other manufacturers' products. Moreover, because the performance tuner can detect internal instabilities before they become apparent in the travel response, it can generally optimize tuning more effectively than manual tuning. Typically, the performance tuner takes 3 to 5 minutes to tune an instrument, although tuning instruments mounted on larger actuators may take longer.

- Stabilize/Optimize

⚠ WARNING

During Stabilize/Optimize the valve may move, causing process fluid or pressure to be released. To avoid personal injury and property damage caused by the release of process fluid or pressure, isolate the valve from the process and equalize pressure on both sides of the valve or bleed off the process fluid.

Stabilize/Optimize permits you to adjust valve response by changing the digital valve controller tuning. During this routine the instrument must be out of service, however, the instrument will respond to setpoint changes.

If the valve is unstable, select *Decrease Response* to stabilize valve operation. This selects the next lower tuning set (e.g., F to E). If the valve response is sluggish, select *Increase Response* to make the valve more responsive. This selects the next higher tuning set (e.g., F to G).

If after selecting *Decrease Response* or *Increase Response* the valve travel overshoot is excessive, select *Decrease Damping* to select a damping value that allows more overshoot. Select *Increase Damping* to select a damping value that will decrease the overshoot. When finished, select *done.*

Pressure Tuning

- Pressure Tuning Set

There are twelve Pressure Tuning Sets to choose from. Each tuning set provides a preselected value for the digital valve controller gain settings. Tuning set C provides the slowest response and M provides the fastest response.

Tuning set B is appropriate for controlling a pneumatic positioner. Table 3-5 lists the proportional gain, pressure integrator gain and minor loop feedback gain values for preselected tuning sets.

Table 3-5. Gain Values for Preselected Pressure Tuning Sets

Tuning Set	Proportional Gain	Integrator Gain	Minor Loop Feedback Gain
B	0.5	0.3	35
C	2.2	0.1	35
D	2.4	0.1	35
E	2.8	0.1	35
F	3.1	0.1	35
G	3.6	0.1	34
H	4.2	0.1	31
I	4.8	0.1	27
J	5.6	0.1	23
K	6.6	0.1	18
L	7.8	0.1	12
M	9.0	0.1	12
X (Expert)	User Adjusted	User Adjusted	User Adjusted

In addition, you can specify Expert tuning and individually set the pressure proportional gain, pressure integrator gain, and pressure minor loop feedback gain. Individually setting or changing any tuning parameter will automatically change the tuning set to X (expert).

Note

Use Expert tuning only if standard tuning has not achieved the desired results.

Stabilize/Optimize or Performance Tuner may be used to achieve the desired results more rapidly than Expert tuning.

- Proportional Gain—the proportional gain for the pressure control tuning set. Changing this parameter will also change the tuning set to Expert.
- MLFB Gain—the minor loop feedback gain for the pressure control tuning set. Changing this parameter will also change the tuning set to Expert.
- Integral Enable—Yes or No. Enable the pressure integral setting to improve static performance by correcting for error that exists between the pressure target and actual pressure. Pressure Integral Control is disabled by default.
- Integral Gain—Pressure Integral Gain (also called reset) is the gain factor applied to the time integral of the error signal between desired and actual pressure. Changing this parameter will also change the tuning set to Expert.

Travel/Pressure Integral Settings

- Integral Dead Zone—A window around the Primary Setpoint in which integral action is disabled. This feature is used to eliminate friction induced limit cycles around the Primary Setpoint when the integrator is active. The Dead Zone

is configurable from 0% to 2%, corresponding to a symmetric window from 0% to +/-2% around the Primary Setpoint. Default value is 0.25%.

- Integrator Limit—The Integrator Limit provides an upper limit to the integrator output. The high limit is configurable from 0 to 100% of the I/P drive signal.

Valve and Actuator

Field Communicator	Configure > Manual Setup > Valve and Actuator (2-2-5)

Valve Style—Enter the valve style, rotary or sliding-stem

Actuator Style—Enter the actuator style, spring and diaphragm, piston double-acting without spring, piston single-acting with spring, or piston double-acting with spring.

Feedback Connection—Refer to table 3-6 for Feedback Connection options. Choose the assembly that matches the actuator travel range.

Note

As a general rule, do not use less than 60% of the magnet assembly travel range for full travel measurement. Performance will decrease as the assembly is increasingly subranged.

The linear magnet assemblies have a valid travel range indicated by arrows molded into the piece. This means that the hall sensor (on the back of the DVC6200 housing) has to remain within this range throughout the entire valve travel. The linear magnet assemblies are symmetrical. Either end may be up.

Table 3-6. Feedback Connection Options

Magnet Assembly	Travel Range		
	mm	Inch	Degrees
SStem #7	4.2-7	0.17-0.28	-
SStem #19	8-19	0.32-0.75	-
SStem #25	20-25	0.76-1.00	-
SStem #38	26-38	1.01-1.50	-
SStem #50	39-50	1.51-2.00	-
SStem #110	51-110	2.01-4.125	-
SStem #210	110-210	4.125-8.25	
SStem #1 Roller	> 210	> 8.25	60-90°
RShaft Window #1	-	-	60-90°
RShaft Window #2	-	-	60-90°
RShaft End Mount	-	-	60-90°

Relay Type—There are three categories of relays that result in combinations from which to select.
Relay Type: The relay type is printed on the label affixed to the relay body.
A = double-acting or single-acting
B = single-acting, reverse
C= single-acting, direct
Special App: This is used in single-acting applications where the “unused” output port is configured to read the pressure downstream of a solenoid valve.
Lo Bleed: The label affixed to the relay body indicates whether it is a low bleed version.

Zero Power Condition—The position of the valve (open or closed) when the electrical power to the instrument is removed. Zero Power Condition (ZPC) is determined by relay type, as shown in figure 3-3.

Figure 3-3. Zero Power Condition



Relay Type	Loss of Electrical Power
Single-Acting Direct (Relay A or C)	Port A pressure to zero.
Double-Acting (Relay A)	Port A pressure to zero. Port B pressure to full supply.
Single-Acting Reverse (Relay B)	Port B pressure to full supply.

Travel Sensor Motion

⚠ WARNING

If you answer YES to the prompt for permission to move the valve when determining travel sensor motion, the instrument will move the valve through a significant portion of its travel range. To avoid personal injury and property damage caused by the release of process fluid or pressure, isolate the valve from the process and equalize pressure on both sides of the valve or bleed off the process fluid.

Select Clockwise/Toward Bottom, or Counterclockwise/Toward Top. Travel Sensor Motion establishes the proper travel sensor rotation. For quarter-turn actuators determine rotation by viewing the rotation of the magnet assembly from the back of the instrument.

Note

Travel Sensor Motion in this instance refers to the motion of the magnet assembly. Note that the magnet assembly may be referred to as a magnetic array in user interface tools.

- For instruments with Relay A and C: If increasing air pressure at output A causes the magnet assembly to move down or the rotary shaft to turn clockwise, enter CW/To Bottom Inst. If it causes the magnet assembly to move up, or the rotary shaft to turn counterclockwise, enter CCW/To Top Inst.
- For instruments with Relay B: If decreasing air pressure at output B causes the magnet assembly to down, or the rotary shaft to turn clockwise, enter CW/To Bottom Inst. If it causes the magnet assembly to move up, or the rotary shaft to turn counterclockwise, enter CCW/To Top Inst.

Maximum Supply Pressure

Enter the maximum supply pressure that is required to fully stroke the valve.

Partial Stroke Test (PST) (Instrument Level ODV only)

Field Communicator	Configure > Manual Setup > Partial Stroke (2-2-6)

Note

Partial Stroke is only available for instrument level ODV.

Partial Stroke Test (PST)

- PST Pressure Limit— This defines the actuator pressure at which a partial stroke test will abort. This prevents the DVC6200 from exhausting (or building) excessive pressure to the actuator in an attempt to move a stuck valve. During Device Setup or Auto Travel Calibration, the Partial Stroke Pressure Limit will be set automatically as follows:

  Single Acting Actuators - For those actuators that exhaust pressure from the partial test start point, the Pressure Limit will be a minimum value. For those actuators that build pressure from the partial test start point, the Pressure Limit will be a maximum value.

  Double Acting Actuators - The Pressure Limit will be set to a negative value for actuators where the partial stroke start point is opposite of the Zero Power Condition (e.g., Partial Stroke Start Point = *Open* and Zero Power Condition = *Closed*) and to a positive valve for actuators where the partial stroke start point is the same as the Zero Power Condition.

  The pressure signal used to determine this parameter depends on relay type and is summarized below.

Relay Type	Pressure Signal
A or C	Port A - Port B
B	Port B - Port A
B Special App.	Port B
C Special App.	Port A

To manually set the partial stroke pressure limit, you must examine current partial stroke test results using ValveLink software. The following steps will guide you through the process:

1. Connect the DVC6200 to a system running ValveLink software.
2. Disable the following parameters:
   - Travel Deviation Alert - set to 125%.
   - End Point Pressure Control - disable
   - Partial Stroke Pressure Limit - disable by setting the appropriate value shown in table 3-7.

Table 3-7. Values for Disabling Partial Stroke Pressure Limit

Actuator Type	Relay Type	Zero Power Condition	Partial Stroke Start Point	Partial Stroke Pressure Limit (Disabled)
Single Acting	A or C	Closed	Open	0.0
			Closed	Psupply
		Open	Open	Psupply
			Closed	0.0
	B	Closed	Open	Psupply
			Closed	0.0
		Open	Open	0.0
			Closed	Psupply
Double Acting	A	Closed	Open	-Psupply
			Closed	Psupply
		Open	Open	Psupply
			Closed	-Psupply

3. Run a partial stroke test.
4. Select the Press/Time radio button on the partial stroke graph (refer to the example in figure 3-4, bottom plot). If the actuator pressure starts high and moves low, find the minimum actuator pressure (Pmin). If the actuator pressure starts low and moves high, find the maximum actuator pressure (Pmax). Double-acting actuators will display differential pressure. Use table 3-8 to estimate the partial stroke pressure limit.

Table 3-8. Estimates for Partial Stroke Pressure Limits

Actuator Style	Relay Type	Zero Power Condition	PST Starting Point	Partial Stroke Pressure Limit(1)
Spring and Diaphragm	A or C	Closed	Open	Pmin - 0.25 * (Bench Set High - Bench Set Low)
			Closed	Pmax + 0.25 * (Bench Set High - Bench Set Low)
		Open	Open	Pmax + 0.25 * (Bench Set High - Bench Set Low)
			Closed	Pmin - 0.25 * (Bench Set High - Bench Set Low)
	B	Closed	Open	Pmax + 0.25 * (Bench Set High - Bench Set Low)
			Closed	Pmin - 0.25 * (Bench Set High - Bench Set Low)
		Open	Open	Pmin - 0.25 * (Bench Set High - Bench Set Low)
			Closed	Pmax + 0.25 * (Bench Set High - Bench Set Low)
Single Acting Piston	A or C	Closed	Open	0.5 * Pmin
			Closed	Pmax + 0.5 * (Psupply - Pmax)
		Open	Open	Pmax + 0.5 * (Psupply - Pmax)
			Closed	0.5 * Pmin
	B	Closed	Open	Pmax + 0.5 * (Psupply - Pmax)
			Closed	0.5 * Pmin
		Open	Open	0.5 * Pmin
			Closed	Pmax + 0.5 * (Psupply - Pmax)
Double Acting Piston	A	Closed	Open	Pmin - 0.5 * (Psupply + Pmin)
			Closed	Pmax + 0.5 * (Psupply - Pmax)
		Open	Open	Pmax + 0.5 * (Psupply - Pmax)
			Closed	Pmin - 0.5 * (Psupply + Pmin)

5. Enable the parameters that were previously disabled:
   - Travel Deviation Alert - set to 1.5x the maximum travel deviation between travel set point and travel.
   - End Point Pressure Control - enable
   - Partial Stroke Pressure Limit - calculate the value using table 3-8.

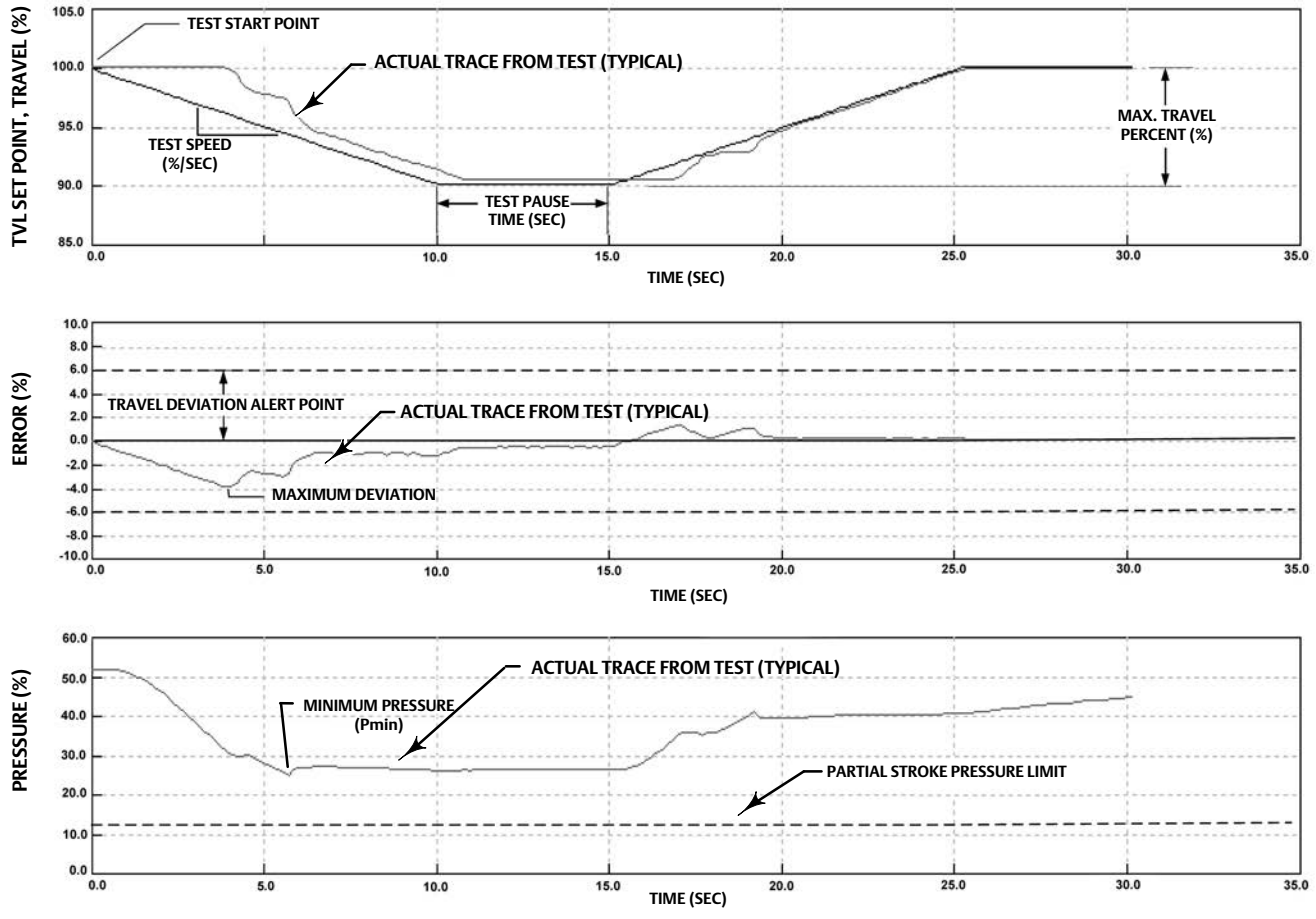
PST Enable—Yes or No. This enables or disables the Partial Stroke Test.

PST Start Point—Valve Open or Valve Closed. This defines the travel stop that the valve needs to be at before a partial stroke test can be initiated. This also defines the travel stop for end point pressure control. Setting this value to Not Configured will disable partial stroke tests and end point pressure control.

PST Variables—Follow the prompts on the Field Communicator display to enter or view information for following PST Variables:

- Max Travel Movement— This is the percentage of total span that the valve moves away from its normal operating state towards its tripped state during the test. The default value is 10%.
- Test Speed—This is the rate at which the valve will move during the test. The default value is 0.25%/second.
- Pause Time—This is the pause time between the up and down strokes of the test. The default value is 5 seconds.

Figure 3-4. Example Time Series Plots of Travel Set Point, Travel, Error, and Actuator Pressure



Outputs

Field Communicator	Configure > Manual Setup > Outputs (2-2-6) HC, AD, PD or (2-2-7) ODV

Output Terminal Configuration

Note

These menu items are only available on units that have the optional 4-20 mA position transmitter or switch hardware installed.

- Output Terminal Enable—If using the optional output terminal for a Position Transmitter or Switch output, this must be Enabled.
- Function—The output terminals can be configured as one of the following:

  Transmitter - 4-20mA output that represents 0-100% of the calibrated valve travel.

  Limit Switch - Discrete switch (1A max) that trips at a configurable point within 0-100% of calibrated valve travel.

  Alert Switch - Discrete switch (1A max) that trips based on a configurable device alert.
- Fail Signal—Should the output circuit fail to operate properly, the output will attempt to drive to a known state. Depending on the nature of the failure, the circuit may or may not be able to achieve this fail state. When configured as a transmitter, the output can be configured to fail low (< 3.6 mA). The output can be configured to fail high (> 22.5 mA) when the positioner is powered. When configured as a switch, the output can be configured to drive Closed or Open.

Note

On loss of positioner power, the switch circuit will always go to the open state.

Switch Configuration

Note

Switch Configuration is only available on units that have the optional 4-20 mA position transmitter or switch hardware installed.

- Limit Switch Trip Point—When the function is configured as a Limit Switch, this defines the threshold for the limit switch in percent of calibrated travel.
- Alert Switch Source—When the function is configured as a Alert Switch, this determines which alert will activate the switch. The alert choices are: Travel Deviation or Pressure Fallback.
- Switch Closed—This configures the action of the switch. The choices are: Below Trip Point / Alert Not Active or Above Trip Point / Alert Active.

HART Variable Assignments

Instrument variables can be reported via four different HART variable assignments. The Primary Variable is always configured as Analog Input. However, the remaining three variables have additional options as listed below.

Primary Variable (PV)	Analog Input
Secondary Variable (SV)	Travel, Travel Setpoint, Pressure A, Pressure B, Pressure A-B, Supply Pressure, Drive Signal, or Analog Input
Tertiary Variable (TV)	Travel, Travel Setpoint, Pressure A, Pressure B, Pressure A-B, Supply Pressure, Drive Signal, or Analog Input
Quaternary Variable (QV)	Travel, Travel Setpoint, Pressure A, Pressure B, Pressure A-B, Supply Pressure, Drive Signal, or Analog Input

Transmitter Output

Note

Transmitter Output is only available on units that have the optional 4-20 mA position transmitter or switch hardware installed.

This configures the relationship between the valve travel and the position transmitter output signal. There are two choices; 4mA = Valve Closed or 4mA = Valve Open.

Burst Mode

Burst mode provides continuous communication from the digital valve controller. Burst mode applies only to the transmission of burst mode data (HART Variable Assignments) and does not affect the way other data is accessed. Burst mode is only available in devices configured as HART Universal Revision 5.

- Burst Enable—This turns on or off the burst mode.
- Burst Command—This defines which HART command is configured for burst reporting. There are three options to choose from. When using a Tri-Loop, select the third option.
  - Analog Input (Command 1)
  - Loop Current / Travel (Command 2)
  - Loop Current / PV / SV / TV / QV (Command 3)

Note

Access to information in the instrument is normally obtained through the poll/response of HART communication. The Field Communicator or the control system may request any of the information that is normally available, even while the instrument is in burst mode. Between each burst mode transmission sent by the instrument, a short pause allows the Field Communicator or control system to initiate a request. The instrument receives the request, processes the response message, and then continues "bursting" the burst mode data.

Burst mode will be automatically disabled during diagnostics tests such as Valve Signature.

Note

If the instrument is configured to operate in pressure control mode, or detects an invalid travel sensor reading, the Travel variable will report pressure in percent of bench set range.

Alert Setup

Field Communicator	Configure > Alert Setup (2-3)

An alert is a notification that the instrument has detected a problem. A shutdown is an action that the instrument takes to drive the air output to the Zero Power Condition as per figure 3-3. Some alerts can be configured to shutdown the instrument. Refer to table 3-9 for default alert and shutdown settings.

Alerts may be enabled or disabled with the instrument In Service, Out of Service, Protected, or Not Protected. However, the instrument must be Not Protected to enable or disable a shutdown. Alerts are not processed when a diagnostic is in progress.

If shutdown is enabled, and the alert is active, the instrument will latch in the shutdown state until power to the instrument is cycled and the alert has cleared. While in the shutdown condition, HART communication will continue if the instrument remains powered.

For a detailed explanation of the alerts and the recommended actions, refer to Section 5.

Table 3-9. Default Alert and Shutdown Settings

ALERT	DEFAULT ALERT SETTING	DEFAULT SHUTDOWN SETTING
Travel Sensor Failure	Enabled	Disabled
Temperature Sensor Failure	Enabled	Disabled
Minor Loop Sensor Failure	Enabled	Disabled
Pressure Sensor Failure	Enabled	Disabled
Drive Current Failure	Enabled	Disabled
Critical NVM Failure	Enabled	Disabled
Non-Critical NVM Failure	Enabled	Disabled
Flash Integrity Failure	Enabled	Disabled
Reference Voltage Failure	Enabled	Disabled
Drive Signal Out of Range	Enabled	Not Available
Supply Pressure Low(1)	Enabled	Not Available
Travel Deviation	Enabled	Not Available
Pressure Fallback Active(1)	Enabled	Not Available
High Travel	Disabled	Not Available
Low Travel	Disabled	Not Available
High-High Travel	Disabled	Not Available
Low-Low Travel	Disabled	Not Available
Travel Limit/Cutoff High	Disabled	Not Available
Travel Limit/Cutoff Low	Disabled	Not Available
Integrator Saturated High	Disabled	Not Available
Integrator Saturated Low	Disabled	Not Available
Cycle Count High	Disabled	Not Available
Travel Accumulator High	Disabled	Not Available
Output Circuit Communication Failure	Disabled	Not Available
Alert Record Not Empty	Disabled	Not Available
Alert Record Full	Disabled	Not Available
Instrument Time is Approximate	Disabled	Not Available

1. Instrument level AD, PD, or ODV only.

Change to HART 5 / Change to HART 7

Field Communicator	Service Tool > Maintenance > Change to HART 5 / Change to HART 7 (3-5-3) HC or (3-5-4) AD, PD or (3-5-5) ODV

Note

This procedure must never be done while the valve is in service and controlling the process. Depending on the control system or asset management system attached, complete system reset may be required to reestablish HART communication. Consult the system documentation for further information.

This procedure changes the instrument from HART Universal Revision 5 to HART Universal Revision 7 (or vice versa). Before proceeding, verify that your systems are prepared to support HART Universal Revision 7 devices. Follow the prompts on the Field Communicator display.

Section 4 Calibration

Calibration Overview

When a DVC6200 digital valve controller is ordered as part of a control valve assembly, the factory mounts the digital valve controller on the actuator and connects the necessary tubing, then sets up and calibrates the controller.

For digital valve controllers that are ordered separately, recalibration of the analog input or pressure sensors generally is unnecessary. However, after mounting on an actuator, perform the initial setup then calibrate travel by selecting *Configure* > *Calibration* > *Travel Calibration* > *Auto Calibration*. For more detailed calibration information, refer to the following calibration procedures.

Field Communicator	Configure > Calibration (2-4)

Auto Travel Calibration - see page 38

Manual Travel Calibration - see page 39

Pushbutton Calibration - see page 40

Pressure Sensor Calibration - see page 41

Analog Input Calibration - see page 42

Relay Adjustment - see page 43

PST Calibration (ODV Instrument Level only) - see page 45

Note

The Instrument Mode must be Out Of Service and the Protection set to None before the instrument can be calibrated.

If you are operating in burst mode, we recommend that you disable burst before continuing with calibration. Once calibration is complete, burst mode may then be turned back on.

⚠ WARNING

During calibration the valve will move full stroke. To avoid personal injury and property damage caused by the release of pressure or process fluid, isolate the valve from the process and equalize pressure on both sides of the valve or bleed off the process fluid.

Travel Calibration

If a double-acting relay is used, you will be prompted to run the relay adjustment when auto or manual calibration is selected. Select Yes to adjust the relay, select No to proceed with calibration. For additional information, refer to Relay Adjustment on page 43.

Auto Calibration

1. The auto calibration procedure is automatic. It is completed when the *Calibration* menu appears.

During calibration, the instrument seeks the high and low end points and the minor loop feedback (MLFB) and output bias. By searching for the end points, the instrument establishes the limits of physical travel, i.e. the actual travel 0 and 100% positions. This also determines how far the relay beam swings to calibrate the sensitivity of the MLFB sensor.

2. Place the instrument In Service and verify that the travel properly tracks the current source.

If the unit does not calibrate, refer to table 4-1 for error messages and possible remedies.

Table 4-1. Auto Calibrate Travel Error Messages

Error Message	Possible Problem and Remedy
Power failure occurred during Auto Calib	The analog input signal to the instrument must be greater than 3.8 mA. Adjust the current output from the control system or the current source to provide at least 4.0 mA.
Auto Calib did not complete within the time limit.	The problem may be one or the other of the following: 1. The tuning set selected is too low and the valve does not reach an end point in the allotted time. Select *Manual Setup* > *Tuning* > *Travel Tuning* > *Stabilize/Optimize* then *Increase Response* (selects next higher tuning set). 2. The tuning set selected is too high, valve operation is unstable and does not stay at an end point for the allotted time. Select *Manual Setup* > *Tuning* > *Travel Tuning* > *Stabilize/Optimize* then *Decrease Response* (selects next lower tuning set).
Insufficient travel	Prior to receiving this message, did the instrument output go from zero to full supply? If not, verify instrument supply pressure by referring to the specifications in the appropriate actuator instruction manual. If supply pressure is correct, check instrument pneumatic components (I/P converter and relay). If the instrument output did go from zero to full supply prior to receiving this message, then verify proper mounting by referring to the appropriate mounting procedure in the Installation section and checking the magnet array for proper alignment.
Drive signal exceed low limit; check supply pressure	1. Check supply pressure (reverse-acting relay) 2. Friction is too high.
Drive signal exceed high limit; check supply pressure	1. Check supply pressure (direct-acting relay) 2. Friction is too high

Manual Calibration

Two procedures are available to manually calibrate travel:

- Analog Adjust— This procedure is used when you can manually change the 4-20 mA current source to move the valve.
- Digital Adjust— This procedure is used when the 4-20 mA current source cannot be manually changed.

Analog Calibration Adjust

Connect a variable current source to the instrument LOOP + and LOOP - terminals. The current source should be capable of generating 4 to 20 mA.

Follow the prompts on the Field Communicator display to calibrate the instrument's travel in percent.

Note
0% Travel = Valve Closed
100% Travel = Valve Open

1. Adjust the input current until the valve is near mid-travel. Press OK.

Note
In steps 2 through 7 the accuracy of the current source adjustment affects the position accuracy.

2. Adjust the current source until the valve is at 0% travel, then press OK.
3. Adjust the current source until the valve is at 100% travel, then press OK.
4. Adjust the current source until the valve is at 0% travel, then press OK.
5. Adjust the current source until the valve is at 100% travel, then press OK.
6. Adjust the current source until the valve is at 5% travel, then press OK.
7. Adjust the current source until the valve is at 95% travel, then press OK.
8. Place the instrument In Service and verify that the travel properly tracks the current source.

Digital Calibration Adjust

Connect a variable current source to the instrument LOOP + and LOOP - terminals. The current source should be set between 4 and 20 mA.

Follow the prompts on the Field Communicator display to calibrate the instrument's travel in percent.

1. Adjust the input current until the valve is near mid-travel. Press OK.

Note
0% Travel = Valve Closed
100% Travel = Valve Open

2. From the adjustment menu, select the direction and size of change required to set the travel at 0%.

Selecting large, medium, and small adjustments causes changes of approximately 10.0%, 1.0%, and 0.1%, respectively. If another adjustment is required, repeat step 2. Otherwise, select Done and go to step 3.

3. From the adjustment menu, select the direction and size of change required to set the travel to 100%.

If another adjustment is required, repeat step 3. Otherwise, select Done and go to step 4.

4. From the adjustment menu, select the direction and size of change required to set the travel at 0%.

If another adjustment is required, repeat step 4. Otherwise, select Done and go to step 5.

5. From the adjustment menu, select the direction and size of change required to set the travel to 100%.

If another adjustment is required, repeat step 5. Otherwise, select Done and go to step 6.

6. From the adjustment menu, select the direction and size of change required to set the travel to 5%.

If another adjustment is required, repeat step 6. Otherwise, select Done and go to step 7.

7. From the adjustment menu, select the direction and size of change required to set the travel to 95%.

If another adjustment is required, repeat step 7. Otherwise, select Done and go to step 8.

8. Place the instrument In Service and verify that the travel properly tracks the current source.

Pushbutton Calibration

A pushbutton near the wiring terminals in the terminal box provides a quick means to autocalibrate the instrument. The button must be pressed for 3 to 10 seconds. Autocalibration will move the valve through the full range of travel whether the Instrument Mode is In Service or Out of Service. However, if the Write Protection is Protected, this button will not be active. To abort, press the button again for 1 second. The calibration button is disabled by default. To enable it, go to *Manual Setup* > *Instrument* > *Calibration Button*.

Note

Pressure range (used for Pressure Fallback) is not recalibrated during this procedure.

This calibration procedure is recommended whenever the I/P converter or pneumatic relay is replaced. Do not use the pushbutton calibration for initial calibration when mounting the instrument on an actuator, or if the printed wiring board assembly was replaced.

If you suspect calibration has changed due to drift, first perform a Valve Signature diagnostic test using ValveLink software to capture the as-found data for future root cause analysis.

Sensor Calibration

Pressure Sensors

Note

The pressure sensor is calibrated at the factory and should not require calibration.

Output Pressure Sensor

To calibrate the output pressure sensor, connect an external reference gauge to the output being calibrated. The gauge should be capable of measuring maximum instrument supply pressure. Depending upon the sensor you wish to calibrate, select either *Output A Sensor* or *Output B Sensor.* Follow the prompts on the Field Communicator display to calibrate the instrument's output pressure sensor.

1. Adjust the supply pressure regulator to the maximum instrument supply pressure. Press OK.
2. The instrument reduces the output pressure to 0. The following message appears.

> Use the Increase and Decrease selections until the displayed pressure matches the output x pressure.

Press OK when you have read the message.

3. The value of the output pressure appears on the display. Press OK to display the adjustment menu.
4. From the adjustment menu, select the direction and size of adjustment to the displayed value.

Selecting large, medium, and small adjustments causes changes of approximately 3.0 psi/0.207 bar/20.7 kPa, 0.30 psi/0.0207 bar/2.07 kPa, and 0.03 psi/0.00207 bar/0.207 kPa, respectively.

If the displayed value does not match the output pressure, press OK, then repeat this step (step 4) to further adjust the displayed value. When the displayed value matches the output pressure, select Done and go to step 5.

5. The instrument sets the output pressure to full supply. The following message appears.

> Use the Increase and Decrease selections until the displayed pressure matches the output x pressure.

Press OK when you have read the message.

6. The value of the output pressure appears on the display. Press OK to display the adjustment menu.
7. From the adjustment menu, select the direction and size of adjustment to the displayed value. If the displayed value does not match the output pressure, press OK, then repeat this step (step 7) to further adjust the displayed value. When the displayed value matches the output pressure, select Done and go to step 8.
8. Place the instrument In Service and verify that the displayed pressure matches the measured output pressure.

Supply Pressure Sensor

Note

Supply Pressure Sensor Calibration is not available for instrument level HC.

To calibrate the supply pressure sensor, connect an external reference gauge to the output side of the supply regulator. The gauge should be capable of measuring maximum instrument supply pressure. Follow the prompts on the Field Communicator display to calibrate the instrument's supply pressure sensor.

1. Select a) Zero Only, or b) Zero and Span (gauge required).

   a. If Zero Only calibration is selected, adjust the supply pressure regulator to remove supply pressure from the instrument. Press OK. Once calibration is complete, go to step 5.

   b. If Zero and Span calibration is selected, adjust the supply pressure regulator to remove supply pressure from the instrument. Press OK. Adjust the supply regulator to the maximum instrument supply pressure. Press OK. Proceed with step 2.

2. The following message appears:

   > Use the Increase and Decrease selections until the displayed pressure matches the supply pressure.

Press OK when you have read this message.

3. The value of the pressure appears on the display.
4. From the adjustment menu, select the direction and size of adjustment to the displayed value.

Selecting large, medium, and small adjustments causes changes of approximately 3.0 psi/0.207 bar/20.7 kPa, 0.30 psi/0.0207 bar/2.07 kPa, and 0.03 psi/0.00207 bar/0.207 kPa, respectively.

Adjust the displayed value until it matches the supply pressure, select Done and go to step 5.

5. Place the instrument In Service and verify that the displayed pressure matches the measured supply pressure.

Analog Input Calibration

To calibrate the analog input sensor, connect a variable current source to the instrument LOOP+ and LOOP- terminals. The current source should be capable of generating an output of 4 to 20 mA. Follow the prompts on the Field Communicator display to calibrate the analog input sensor.

1. Set the current source to the target value shown on the display. The target value is the Input Range Low value. Press OK.
2. The following message appears:

   > Use the Increase and Decrease selections until the displayed current matches the target.

Press OK when you have read this message.

3. The value of the Analog Input appears on the display. Press OK to display the adjustment menu.
4. From the adjustment menu, select the direction and size of adjustment to the displayed value.

Selecting large, medium, and small adjustments causes changes of approximately 0.4 mA, 0.04 mA, and 0.004 mA, respectively.

If the displayed value does not match the current source, press OK, then repeat this step (step 4) to further adjust the displayed value. When the displayed value matches the current source, select Done and go to step 5.

5. Set the current source to the target value shown on the display. The target value is the Input Range High value. Press OK.
6. The following message appears:

> Use the Increase and Decrease selections until the displayed current matches the target.

Press OK when you have read this message.

7. The value of the Analog Input appears on the display. Press OK to display the adjustment menu.
8. From the adjustment menu, select the direction and size of adjustment to the displayed value. If the displayed value does not match the current source, press OK, then repeat this step (step 8) to further adjust the displayed value. When the displayed value matches the current source, select Done and go to step 9.
9. Place the instrument In Service and verify that the analog input displayed matches the current source.

Relay Adjustment

Before beginning travel calibration, check the relay adjustment. Replace the digital valve controller cover when finished.

Note

Relay B and C are not user-adjustable.

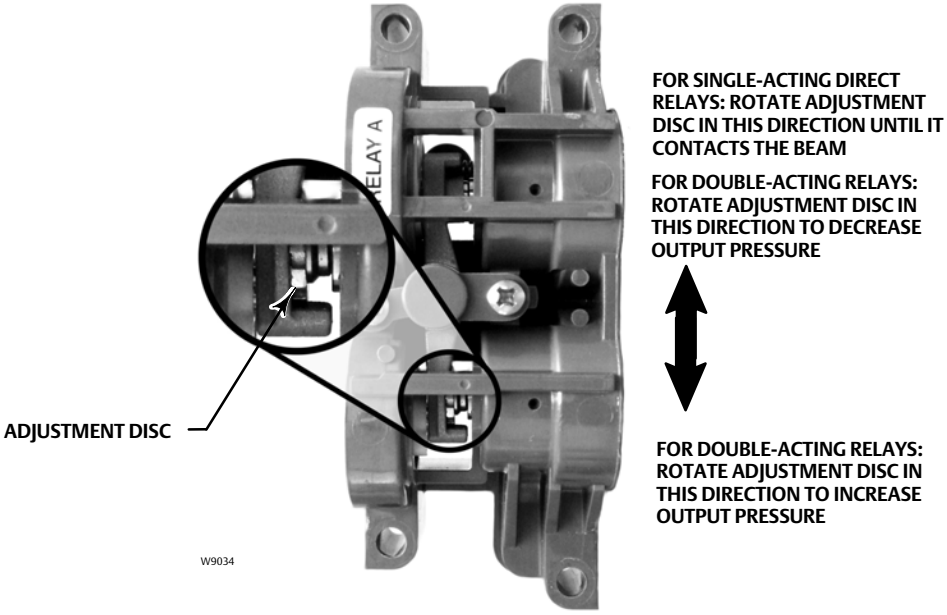
Double-Acting Relay

The double-acting relay is designated by “Relay A” on a label affixed to the relay itself. For double-acting actuators, the valve must be near mid-travel to properly adjust the relay. The Field Communicator will automatically position the valve when *Relay Adjust* is selected.

Rotate the adjustment disc, shown in figure 4-1, until the output pressure displayed on the Field Communicator is between 50 and 70% of supply pressure. This adjustment is very sensitive. Be sure to allow the pressure reading to stabilize before making another adjustment (stabilization may take up to 30 seconds or more for large actuators).

If the low bleed relay option has been ordered stabilization may take approximately two minutes longer than the standard relay.

Figure 4-1. Relay A Adjustment (Shroud Removed for Clarity)



Relay A may also be adjusted for use in single-acting- direct applications. Rotate the adjustment disc as shown in figure 4-1 for single-acting direct operation.

CAUTION

Care should be taken during relay adjustment as the adjustment disc may disengage if rotated too far.

Single-Acting Relays

⚠ WARNING

For Instrument Level ODV only:

If the unused port is monitoring pressure, ensure that the pressure source conforms to ISA Standard 7.0.01 and does not exceed the pressure supplied to the instrument.

Failure to do so could result in personal injury or property damage caused by loss of process control.

Single-Acting Direct Relay

The single-acting direct relay is designated by “Relay C” on a label affixed to the relay itself. Relay C requires no adjustment.

Single-Acting Reverse Relay

The single-acting reverse relay is designated by “Relay B” on a label affixed to the relay itself. Relay B is calibrated at the factory and requires no further adjustment.

PST Calibration (ODV Instrument Level only)

This procedure permits you to run the Partial Stroke Calibration, which enables the Partial Stroke Test. It establishes values for Partial Stroke Pressure Limit, Pressure Set Point and Pressure Saturation Time for End Point Pressure Control, Travel Deviation Alert Point and Travel Deviation Time. The Partial Stroke Calibration also sets default values for max travel movement, test speed, and test pause time.

Note

You must take the instrument out of service before running Partial Stroke Calibration.

Ensure that the instrument is put back in service after the completing the calibration procedure.

Section 5 Device Information, Diagnostics, and Alerts

Overview

Field Communicator	Overview (1)

Status & Primary Purpose Variables

The overview section provides basic information about the current state of the instrument and gives you access to the current values of:

- Alert Status
- Communication Status
- Instrument Mode (In/Out of Service)
- Analog Input
- Setpoint
- Travel
- Supply Pressure (not available in Instrument Level HC)
- Actuator Pressure(s)
- Travel/Pressure Control Configuration

Device Information

Device Information provides details about the instrument construction including:

- Tag Name
- Instrument Model Number
- Instrument Level (see table 5-1)
- Device ID (unique number used to prevent the instrument from accepting commands intended for other instruments)
- Serial Numbers
- Firmware, DD, and Hardware Revisions
- HART Universal Revision
- Write Protection (provides a procedure to enable/disable)

Table 5-1. Functions Available for Instrument Level

Instrument Level	Functions Available
HC	Communicates with the Field Communicator and ValveLink software. In addition, HC provides: travel cutoffs and limits, minimum opening and closing times, input characterization (linear, equal percentage, quick opening, and custom), trending with ValveLink Solo, and the following alerts: travel deviation; travel alert high, low, high high, and low low; drive signal; cycle counter; and travel accumulation.
AD	Includes all functions listed above plus (with ValveLink software) all offline diagnostic tests (dynamic error band, drive signal, step response, and valve signature) plus online trending
PD	Includes all functions listed above plus all Performance Diagnostics online/in-service valve testing (valve friction, electronics, and mechanical condition)
ODV	Includes all functions listed above plus partial stroke test and lead/lag set point filter

Service Tools

Field Communicator	Service Tools (3)

Device Status

Instrument alerts, when enabled, detect many operational and performance issues that may be of interest. If there are no alerts currently active, this display will be empty.

Alert Record

The DVC6200 will store 20 alerts. Once the alert record is full, no additional alerts will be stored until the record is cleared.

Below is a list of the alerts that can be detected by the instrument. To enable or disable the alerts, navigate to *Configure > Alert Setup*.

- Offline/Failed Alert—This alert is active if a shutdown alert has put the device in a failed state and is therefore not controlling the input. Press Enter to view the alert(s) that caused the shutdown.

Electronics

- Drive Current Failure—This alert is active when the drive current to the I/P converter is not flowing as expected. If this alert occurs, check the connection between the I/P converter and the printed wiring board assembly. Try removing the I/P converter and re-installing it. If the alert does not clear, replace the I/P converter or the printed wiring board assembly.

- Drive Signal Alert—This alert monitors the drive signal and calibrated travel. If one of the following conditions exists for more than the Travel Deviation Alert Time, the alert is set.

  For the case where Zero Power Condition is defined as closed:
  Drive Signal < 10% and Calibrated Travel > 3%
  Drive Signal > 90% and Calibrated Travel < 97%

  For the case where Zero Power Condition is defined as open:
  Drive Signal < 10% and Calibrated Travel < 97%
  Drive Signal > 90% and Calibrated Travel > 3%

- Non-Critical NVM Alert—This alert is active if there is a failure associated with NVM (non-volatile memory) that is not critical for instrument operation. If this alert is active, restart the instrument. If the alert persists, replace the printed wiring board assembly.

- Critical NVM Alert—This alert is active if there is a failure associated with NVM that is critical for instrument operation. If this alert is active, restart the instrument. If the alert persists, replace the printed wiring board assembly.

- Flash Integrity Failure—This alert is active if there is a failure associated with flash ROM (read only memory). If this alert is active, restart the instrument. If the alert persists, replace the printed wiring board assembly.

- Reference Voltage Failure—This alert is active if there is a failure associated with the internal voltage reference. If this alert is active, replace the printed wiring board assembly.

- Variable Out of Range—This alert is active if one or more of the measured analog sensor readings (loop current, pressure, temperature, or travel) is saturated or reading out of its configured range. The condition may be due to improper configuration or physical setup and not be due to a sensor malfunction.
- Field Device Malfunction—This alert is active if the pressure, position, or temperature sensors are providing invalid readings.
- Internal Sensor Out of Limits—This alert is active if there is a problem with either the pressure sensor or the printed wiring board assembly.
- Travel Sensor Alert—This alert is active if the sensed travel is outside the range of -25.0 to 125.0% of calibrated travel. If this alert is active, check the instrument mounting. Also, check that the electrical connection from the travel sensor is properly plugged into the printed wiring board assembly. After restarting the instrument, if the alert persists, troubleshoot the printed wiring board assembly or travel sensor.
- Temperature Sensor Alert—This alert is active when the instrument temperature sensor fails, or the sensor reading is outside of the range of -60 to 100°C (-76 to 212°F). The temperature reading is used internally for temperature compensation of inputs. If this alert is active, restart the instrument. If the alert persists, replace the printed wiring board assembly.
- Pressure Sensor Alert—This alert is active if any of the 3 pressure sensor readings are outside the range of -24.0 to 125.0% of the calibrated pressure for more than 60 seconds. If this alert is active, check the instrument supply pressure, ensure the printed wiring board assembly is properly mounted onto the module base assembly, and ensure the pressure sensor o-rings are properly installed. If the alert persists after restarting the instrument, replace the printed wiring board assembly.
- Minor Loop Sensor Alert—This alert is active if the pneumatic relay position reading is outside the valid range. If the alert persists, replace the printed wiring board.
- Loop Current Validation Alert—This alert is active if the loop current is significantly out of range, or if there is a problem with the analog circuit electronics. If this alert is active, restart the instrument with the loop current verified to be in the 4-20 mA range. If the alert persists, replace the printed wiring board.

Note
If the control system is known to output current 24 mA or above, Shutdown on Loop Current Validation should not be enabled.

- Output Circuit Communication Failure—This alert is active if the output circuit is not responding. If configured as a position transmitter output, first make sure the transmitter circuit is powered. If the alert persists, make sure the DIP switch on the main electronics matches the configuration of the OUT terminals. If the alert is still active, replace the main electronics.
- Instrument Time is Approximate Alert—This alert is active if the instrument has been powered down since the last time the instrument clock was set. To clear the alert, reset the instrument time.

Pressure

- Supply Pressure Alert—This alert is active if the supply pressure falls below the supply pressure alert point.

Note
The Supply Pressure Lo alert is available for instrument level AD, PD, and ODV.

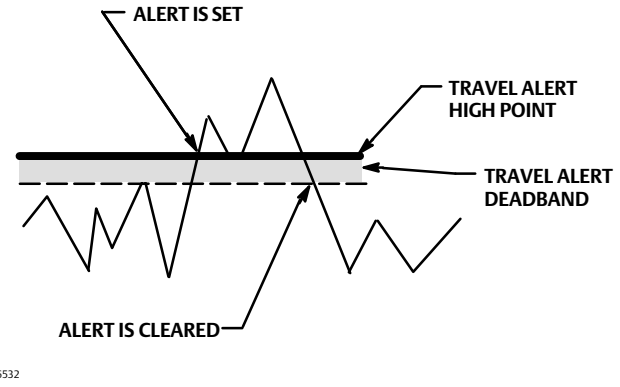
Travel

Note

The Travel Alert Deadband applies to the Travel Deviation Alert as well as the Travel Alert Hi, Lo, Hi Hi, and Lo Lo.

- Travel Deviation Alert—If the difference between the Travel Target and the Travel exceeds the Travel Deviation Alert Point for more than the Travel Deviation Time, the Travel Deviation Alert is active. It remains active until the difference between the travel target and the Travel is less than the Travel Deviation Alert Point minus the Travel Alert Deadband.
- Travel Alert Hi—This alert is active when the Travel exceeds the Travel Alert Hi Point. Once the alert is active, the alert will clear when the Travel falls below the Travel Alert Hi Point minus the Travel Alert Deadband. See figure 5-1.

Figure 5-1. Travel Alert Deadband



- Travel Alert Hi Hi—This alert is active when the Travel exceeds the Travel Alert Hi Hi Point. Once the alert is active, the alert will clear when the Travel falls below the Travel Alert Hi Hi Point minus the Travel Alert Deadband.
- Travel Alert Lo—This alert is active when the Travel is below the Travel Alert Lo Point. Once the alert is active, the alert will clear when the Travel exceeds the Travel Alert Lo Point plus the Travel Alert Deadband.
- Travel Alert Lo Lo—This alert is active when the Travel is below the Travel Alert Lo Lo Point. Once the alert is active, the alert will clear when the Travel exceeds the Travel Alert Lo Lo Point plus the Travel Alert Deadband.
- Travel Limit/Cutoff Hi Alert—This alert is active when the Travel exceeds the Hi Limit/Cutoff Point.
- Travel Limit/Cutoff Lo Alert—This alert is active when the Travel falls below the Lo Limit/Cutoff Point.
- Integrator Saturated High Alert—This alert is active if the instrument integrator is saturated at the high extreme.
- Integrator Saturated Low Alert—This alert is active if the instrument integrator is saturated at the low extreme.
- Pressure Fallback Active Alert—This alert is active when the instrument has detected a problem with the travel feedback and is now controlling the output like an I/P transducer.

Travel History

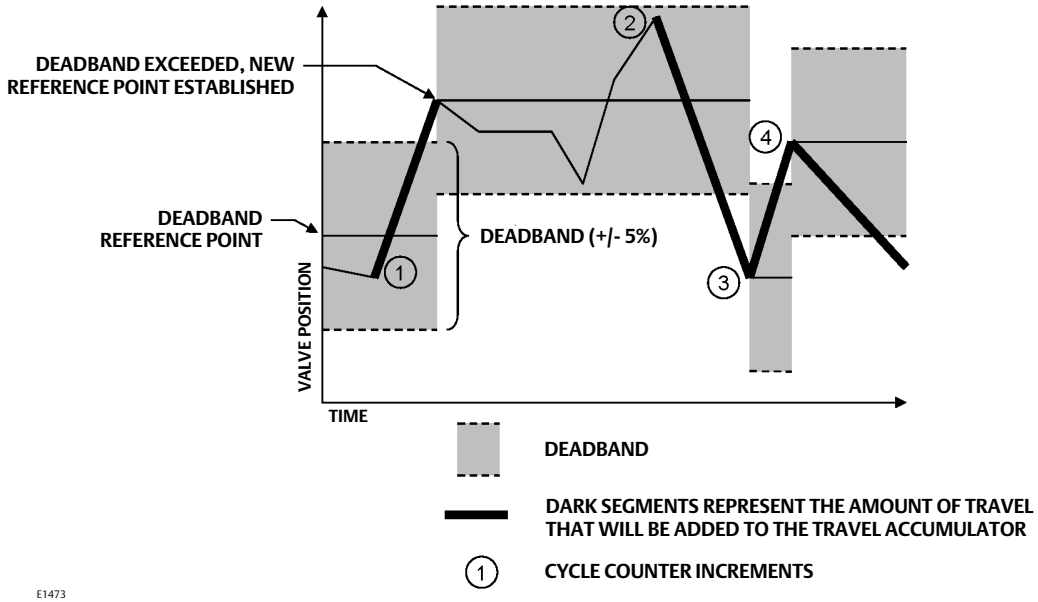
- Cycle Count High Alert—This alert is active if the Cycle Counter exceeds the Cycle Count Alert Point. The Cycle Count records the number of times the travel changes direction when it is outside of the deadband. To clear the alert, set the Cycle Counter to a value less than the alert point.
- Travel Accumulator High Alert—This alert is active if the Travel Accumulator exceeds the Travel Accumulator Alert Point. The Travel Accumulator totalizes the travel of the valve when the deadband is exceeded. To clear the alert, set the Travel Accumulator to a value less than the alert point.

Note

The Cycle Count / Travel Accumulator Deadband applies to both the Cycle Count High Alert and the Travel Accumulator High Alert.

The deadband is the percent (%) of ranged travel around a travel reference point. The travel reference point gets re-established to the point of travel reversal that occurs outside of the deadband. The deadband must be exceeded before a change in travel direction will be counted as a cycle and the accumulated travel (up to the point of travel reversal) is added to the total accumulation. See figure 5-2.

Figure 5-2. Cycle Counter and Travel Accumulator Deadband Example (set at 10%)



Alert Record

- Alert Record Not Empty Alert—This alert is active when there are 1 or more alerts stored in the alert record.
- Alert Record Full Alert—This alert is active when the alert record is full. Additional alerts that are detected will not be saved to the alert record until the alert record is cleared.

Status

- Calibration in Progress Alert—This alert is active when calibration is in progress.
- AutoCal in Progress Alert—This alert is active when auto calibration is in progress.
- Diagnostic in Progress Alert—This alert is active when a diagnostic test is in progress.
- Diagnostic Data Available Alert—This alert is active when diagnostic data has been collected and is being stored in the instrument.
- Pressure Control Active Alert—This alert is active when the instrument is controlling like an I/P transducer (Pressure Control instead of Travel Control).

Diagnostics

Stroke Valve

Follow the prompts on the Field Communicator display to select from the following:

- Done—Select this if you are done. All ramping is stopped when DONE is selected.
- Ramp Open—ramps the travel toward open at the rate of 1.0% per second of the ranged travel.
- Ramp Closed—ramps the travel toward closed at the rate of 1.0% per second of the ranged travel.
- Ramp to Target—ramps the travel to the specified target at the rate of 1.0% per second of the ranged travel.
- Step to Target—steps the travel to the specified target.

Partial Stroke Test

Note
Partial Stroke Test is only available for instrument level ODV.

The Partial Stroke Test allows DVC6200 digital valve controllers with instrument level ODV to perform a Valve Signature type of test while the instrument is in service and operational. In some applications, it is important to be able to exercise and test the valve to verify that it will operate when commanded. This feature allows the user to partially stroke the valve while continually monitoring the input signal. If a demand arises, the test is aborted and the valve moves to its commanded position. The partial stroke valve travel is configurable between 1 and 30% maximum travel, in 0.1% increments. Data from the last partial stroke test is stored in the instrument memory for retrieval by ValveLink software.

The Partial Stroke Test allows you to perform a partial, 10%, stroke test (standard) or a custom stroke test. With the custom stroke test, the stroke may be extended up to 30%. Be sure to check plant guidelines before performing a custom stroke test. The purpose of this test is to ensure that the valve assembly moves upon demand.

A partial stroke test can be initiated when the valve is operating at either 4 or 20 mA (point-to-point mode). In applications where a spurious trip is to be minimized, 4 mA is the normal operating position.

When enabled, a partial stroke test may be initiated by the device (as a scheduled, auto partial stroke test), a remote pushbutton located in the field or at the valve, a Field Communicator, or ValveLink software.

- Automatic (Scheduled)

The Auto Partial Stroke Test allows the partial stroke test to be scheduled by the DVC6200. The test is scheduled in number of hours between tests. Any power cycle will reset the test clock timer.

- Local Pushbutton

A partial stroke test command may be sent to the digital valve controller using a set of contacts wired to the auxiliary +/- terminals. To perform a test, the contacts must be closed for 3 to 5 seconds and then opened. To abort the test, close the contacts for 1 second. The last set of diagnostic data is stored in the instrument memory for later retrieval via ValveLink software.

- Field Communicator

1. Connect the Field Communicator to the LOOP terminals on the digital valve controller.
2. Turn on the Field Communicator.
3. From the *Online* menu, select *Service Tools* > *Diagnostics* > *Partial Stroke Test*.
4. Select either *Standard (10%)* or *Custom*. With the Custom Stroke Test, the stroke may be entered up to 30% with configurable stroking speed and pause time.
5. The currently configured Stroke, Stroking Speed, and Pause Time is displayed. Choose “Yes” to run the test using these values. Choose “No” to modify the values. The default value for Stroke Speed is 0.25%/second.
6. The valve begins to move and the actual travel reported by the digital valve controller is displayed on the Field Communicator.
7. Once the valve has reached the endpoint, check that the valve has reached the desired set point. The valve should return to its original position.

For information on configuring the Partial Stroke Test, see Partial Stroke Variables in the Detailed Setup section.

Variables

Field Communicator	Service Tools > Variables (3-4)

The Variables section provides current values of the instrument variables. Below is a list of the variables available for viewing:

- Write Protection (also provides a procedure to enable/disable)
- Instrument Mode (also provides a procedure to place in/out of service)
- Analog Input
- Setpoint
- Travel
- Drive Signal
- Input Characterization (also provides a procedure to modify)
- Cycle Counter
- Travel Accumulator
- Supply Pressure (not available in Instrument Level HC)

- Actuator Pressure(s)
- Travel/Pressure Control Configuration (also provides a procedure to modify)
- Control Mode (also provides a procedure to modify)
- Instrument Temperature
- Travel Counts (this is the raw travel sensor reading used for advanced adjustments)
- Maximum Recorded Temperature
- Minimum Recorded Temperature
- Number of Power Ups
- Days Powered Up

Section 6 Maintenance and Troubleshooting

The DVC6200 digital valve controller enclosure is rated Type 4X and IP66, therefore periodic cleaning of internal components is not required. If the DVC6200 is installed in an area where the exterior surfaces tend to get heavily coated or layered with industrial or atmospheric contaminants, however, it is recommended that the vent (key 52) be periodically inspected to ensure it is fully open. If the vent appears to be clogged, it can be removed, cleaned and replaced. Lightly brush the exterior of the vent to remove contaminants and run a mild water/detergent solution through the vent to ensure it is fully open. Allow the vent to dry before reinstalling.

⚠ WARNING

Personal injury or property damage can occur from cover failure due to overpressure. Ensure that the housing vent opening is open and free of debris to prevent pressure buildup under the cover.

⚠ WARNING

To avoid static discharge from the plastic cover when flammable gases or dust are present, do not rub or clean the cover with solvents. To do so could result in a spark that may cause the flammable gases or dust to explode, resulting in personal injury or property damage. Clean with a mild detergent and water only.

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance procedures on the DVC6200 digital valve controller:

- **Always wear protective clothing, gloves, and eyewear.**
- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**
- **Vent the pneumatic actuator loading pressure and relieve any actuator spring precompression so the actuator is not applying force to the valve stem; this will allow for the safe removal of the stem connector.**

⚠ WARNING

When using natural gas as the supply medium, or for explosion proof applications, the following warnings also apply:

- **Remove electrical power before removing the housing cap. Personal injury or property damage from fire or explosion may result if power is not disconnected before removing the cap.**
- **Remove electrical power before disconnecting any of the pneumatic connections.**
- **When disconnecting any of the pneumatic connections or any pressure retaining part, natural gas will seep from the unit and any connected equipment into the surrounding atmosphere. Personal injury or property damage may result**

from fire or explosion if natural gas is used as the supply medium and appropriate preventive measures are not taken. Preventive measures may include, but are not limited to, one or more of the following: ensuring adequate ventilation and the removal of any ignition sources.

- **Ensure that the cover is correctly installed before putting this unit back into service. Failure to do so could result in personal injury or property damage from fire or explosion.**

CAUTION

When replacing components, use only components specified by the factory. Always use proper component replacement techniques, as presented in this manual. Improper techniques or component selection may invalidate the approvals and the product specifications, as indicated in table 1-2, and may also impair operations and the intended function of the device.

Because of the diagnostic capability of the DVC6200, predictive maintenance is available through the use of ValveLink software. Using the digital valve controller, valve and instrument maintenance can be enhanced, thus avoiding unnecessary maintenance. For information on using ValveLink software, refer to the ValveLink software online help.

Removing the Magnetic Feedback Assembly

To remove the magnet assembly from the actuator stem, perform the following basic steps.

1. Make sure that the valve is isolated from the process.
2. Remove the instrument terminal box cover.
3. Disconnect the field wiring from the terminal board.
4. Shut off the instrument air supply.
5. Disconnect the pneumatic tubing and remove the DVC6200 or the DVC6215 from the actuator.
6. Remove the screws holding the magnet assembly to the connector arm.

When replacing the instrument, be sure to follow the mounting guidelines in the quick start guide (D103556X012) that shipped with the digital valve controller. Setup and calibrate the instrument prior to returning to service.

Module Base Maintenance

The digital valve controller contains a module base consisting of the I/P converter, printed wiring board assembly, and pneumatic relay. The module base may be easily replaced in the field without disconnecting field wiring or tubing.

Tools Required

Table 6-1 lists the tools required for maintaining the DVC6200 digital valve controller.

Table 6-1. Tools Required

Tool	Size	Component
Phillips Screwdriver		Relay, printed wiring board assembly, and cover screws
Hex key	5 mm	Terminal box screw
Hex key	1.5 mm	Terminal box cover screw
Hex key	2.5 mm	I/P converter screws
Hex key	6 mm	Module base screws

Component Replacement

When replacing any of the components of the DVC6200, the maintenance should be performed in an instrument shop whenever possible. Make sure that the electrical wiring and pneumatic tubing is disconnected prior to disassembling the instrument.

Removing the Module Base

Refer to figure 7-2 or 7-4 for key number locations.

⚠ WARNING

To avoid personal injury or equipment damage from bursting of parts, turn off the supply pressure to the digital valve controller and bleed off any excess supply pressure before attempting to remove the module base assembly from the housing.

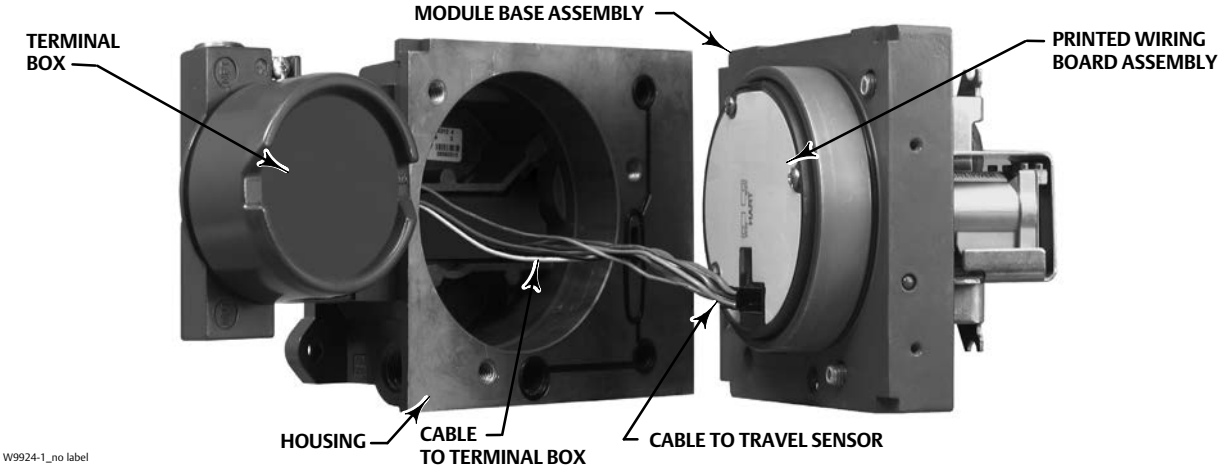
1. Unscrew the four captive screws in the cover (key 43) and remove the cover from the module base (key 2).
2. Using a 6 mm hex socket wrench, loosen the three-socket head screws (key 38). These screws are captive in the module base by retaining rings (key 154).

Note

The module base is linked to the housing by two cable assemblies. Disconnect these cable assemblies after you pull the module base out of the housing.

3. Pull the module base straight out of the housing (key 1). Once clear of the housing, swing the module base to the side of the housing to gain access to the cable assemblies.
4. The digital valve controller/base unit has two cable assemblies, shown in figure 6-1, which connect the module base, via the printed wiring board assembly, travel sensor and the terminal box. Disconnect these cable assemblies from the printed wiring board assembly on the back of the module base.

Figure 6-1. Printed Wiring Board Cable Connections



Replacing the Module Base

Refer to figure 7-2 or 7-4 for key number locations.

CAUTION

To avoid affecting performance of the instrument, take care not to damage the module base seal or guide surface. Do not bump or damage the bare connector pins on the PWB assembly. Damaging either the module base or guide surface may result in material damage, which could compromise the instruments ability to maintain a pressure seal.

Note

To avoid affecting performance of the instrument, inspect the guide surface on the module and the corresponding seating area in the housing before installing the module base assembly. These surfaces must be free of dust, dirt, scratches, and contamination.

Ensure the module base seal is in good condition. Do not reuse a damaged or worn seal.

1. Ensure the module base seal (key 237) is properly installed in the housing (key 1). Ensure the O-ring (key 12) is in place on the module base assembly.
2. Connect the travel sensor and terminal box cable assemblies to the PWB assembly (key 50). Orientation of the connector is required.
3. Insert the module base (key 2) into the housing (key 1).
4. Install three socket head screws (key 38) in the module base into the housing. If not already installed, press three retaining rings (key 154) into the module base. Evenly tighten the screws in a crisscross pattern to a final torque of 16 N•m (138 lbf•in).

⚠ WARNING

Personal injury, property damage, or disruption of process control can result if the cable assemblies/wiring are damaged when attaching the cover to the module base assembly

Ensure that the cable assemblies/wiring are positioned in the cavity of the module base so they do not get compressed or damaged when attaching the cover to the module base assembly in step 5.

5. Attach the cover (key 43) to the module base assembly.

Submodule Maintenance

The module base of the DVC6200 contains the following submodules: I/P converter, PWB assembly, and pneumatic relay. If problems occur, these submodules may be removed from the module base and replaced with new submodules. After replacing a submodule, the module base may be put back into service.

CAUTION

Exercise care when performing maintenance on the module base. Reinstall the cover to protect the I/P converter and gauges when servicing other submodules.

In order to maintain accuracy specifications, do not strike or drop the I/P converter during submodule maintenance.

I/P Converter

Refer to figure 7-2 or 7-4 for key number locations. The I/P converter (key 41) is located on the front of the module base.

Note

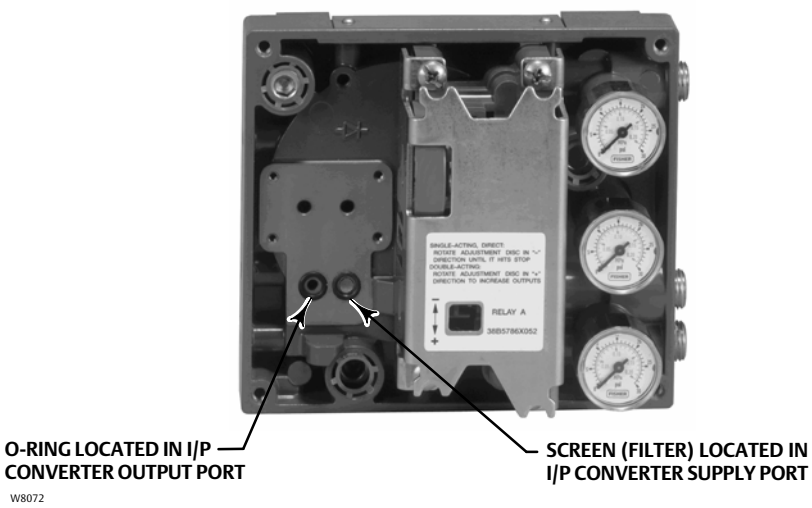
After I/P converter submodule replacement, calibrate the digital valve controller to maintain accuracy specifications.

Replacing the I/P Filter

A screen in the supply port beneath the I/P converter serves as a secondary filter for the supply medium. To replace this filter, perform the following procedure:

1. Remove the I/P converter (key 41) and shroud (key 169) as described in the Removing the I/P Converter procedure.
2. Remove the screen (key 231) from the supply port.
3. Install a new screen in the supply port as shown in figure 6-2.

Figure 6-2. I/P Filter Location



4. Inspect the O-ring (key 39) in the I/P output port. if necessary, replace it.
5. Reinstall the I/P converter (key 41) and shroud (key 169) as described in the Replacing the I/P Converter procedure.

Removing the I/P Converter

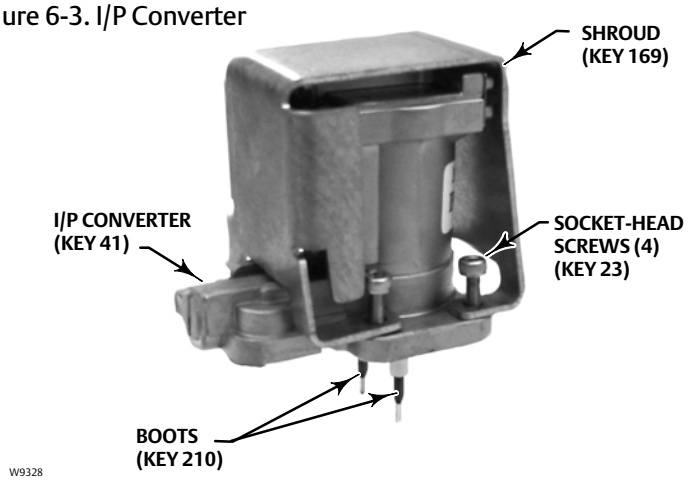
1. Remove the front cover (key 43), if not already removed.
2. Refer to figure 6-3. Using a 2.5 mm hex socket wrench, remove the four socket-head screws (key 23) that attach the shroud (key 169) and I/P converter (key 41) to the module base (key 2).
3. Remove the shroud (key 169); then pull the I/P converter (key 41) straight out of the module base (key 2). Be careful not to damage the two electrical leads that come out of the base of the I/P converter.

4. Ensure that the O-ring (key 39) and screen (key 231) stay in the module base and do not come out with the I/P converter (key 41).

Replacing the I/P Converter

1. Refer to figure 6-2. Inspect the condition of the O-ring (key 39) and screen (key 231) in the module base (key 2). Replace them, if necessary. Apply silicone lubricant to the O-rings.
2. Ensure the two boots (key 210) shown in figure 6-3 are properly installed on the electrical leads.

Figure 6-3. I/P Converter



3. Install the I/P converter (key 41) straight into the module base (key 2), taking care that the two electrical leads feed into the guides in the module base. These guides route the leads to the printed wiring board assembly submodule.
4. Install the shroud (key 169) over the I/P converter (key 41).
5. Install the four socket-head screws (key 23) and evenly tighten them in a crisscross pattern to a final torque of 1.6 N•m (14 lbf•in).
6. After replacing the I/P converter, calibrate travel or perform touch-up calibration to maintain accuracy specifications.

Printed Wiring Board (PWB) Assembly

Refer to figure 7-2 or 7-4 for key number locations. The PWB assembly (key 50) is located on the back of the module base assembly (key 2).

Note

If the PWB assembly submodule is replaced, calibrate and configure the digital valve controller to maintain accuracy specifications.

Removing the Printed Wiring Board Assembly

1. Separate the module base from the housing by performing the Removing the Module Base procedure.
2. Remove three screws (key 33).
3. Lift the PWB assembly (key 50) straight out of the module base (key 2).
4. Ensure that the O-rings (key 40) remain in the pressure sensor bosses on the module base assembly (key 2) after the PWB assembly (key 50) has been removed.

Replacing the Printed Wiring Board Assembly and Setting the DIP Switch

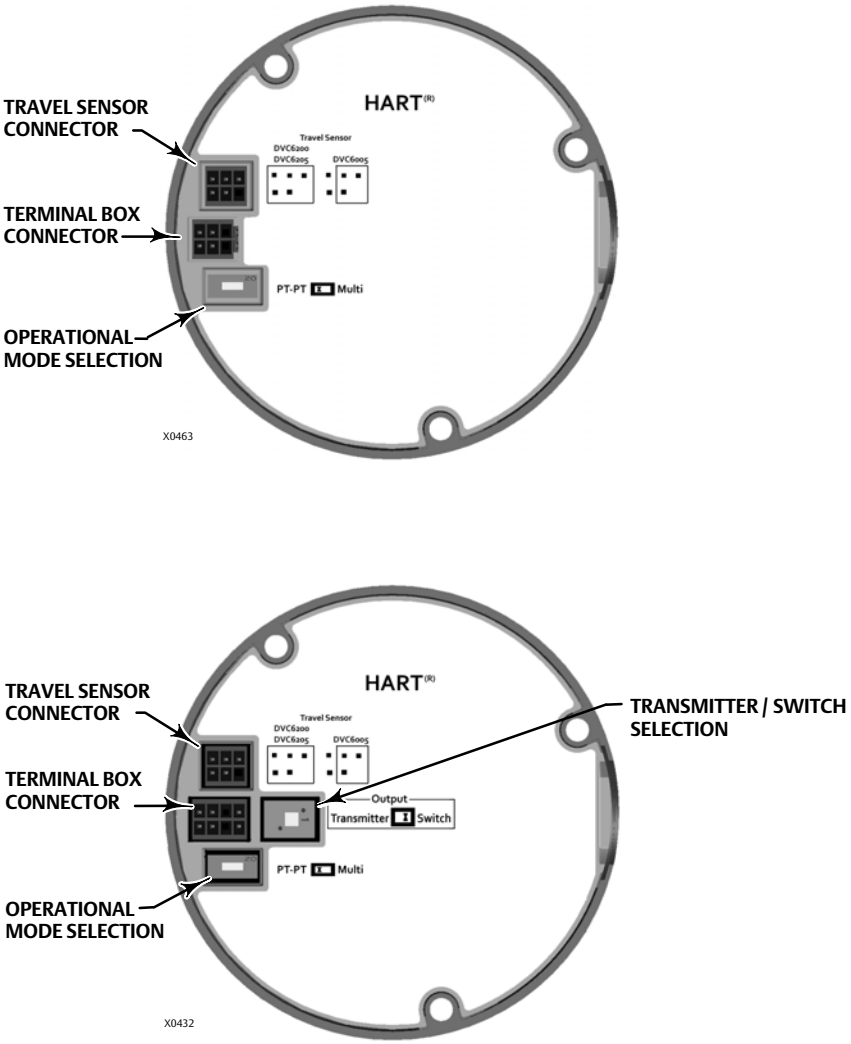
1. Apply silicone lubricant to the pressure sensor O-rings (key 40) and install them on the pressure sensor bosses in the module base assembly.
2. Properly orient the PWB assembly (key 50) as you install it into the module base. The two electrical leads from the I/P converter (key 41) must guide into their receptacles in the PWB assembly and the pressure sensor bosses on the module base must fit into their receptacles in the PWB assembly.
3. Push the PWB assembly (key 50) into its cavity in the module base.
4. Install and tighten three screws (key 33) to a torque of 1 N•m (10.1 lbf•in).
5. Set the DIP switch on the PWB assembly according to table 6-2.

Table 6-2. DIP Switch Configuration(1)

Switch Label	Operational Mode	DIP Switch Position
PT-PT	4-20 mA Point-to-Point Loop	LEFT
Multi	24 VDC Multi-Drop Loop	RIGHT

1. Refer to figure 6-4 for switch location.

Figure 6-4. Printed Wiring Board (PWB) Connections and Settings



Note

For the digital valve controller to operate with a 4 to 20 mA control signal, be sure the DIP switch is in the point-to-point loop position.

6. Reassemble the module base to the housing by performing the Replacing the Module Base procedure.
7. Setup and calibrate the digital valve controller.

Pneumatic Relay

Refer to figure 7-2 or 7-4 for key number locations. The pneumatic relay (key 24) is located on the front of the module base.

Note

After relay submodule replacement, calibrate the digital valve controller to maintain accuracy specifications.

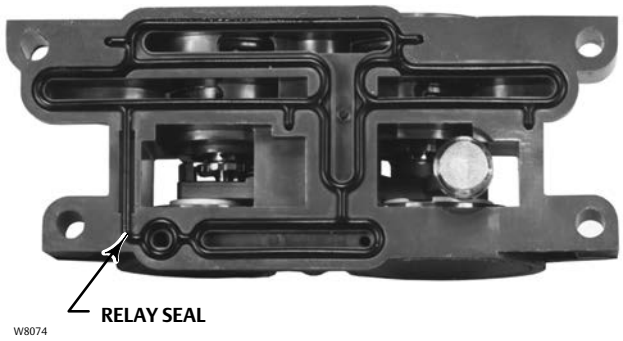
Removing the Pneumatic Relay

1. Loosen the four screws that attach the relay (key 24) to the module base. These screws are captive in the relay.
2. Remove the relay.

Replacing the Pneumatic Relay

1. Visually inspect the holes in the module base to ensure they are clean and free of obstructions. If cleaning is necessary, do not enlarge the holes.
2. Apply silicone lubricant to the relay seal and position it in the grooves on the bottom of the relay as shown in figure 6-5. Press small seal retaining tabs into retaining slots to hold relay seal in place.

Figure 6-5. Pneumatic Relay Assembly



3. Position the relay (with shroud) on the module base. Tighten the four screws, in a crisscross pattern, to a final torque of 2 N•m (20.7 lbf•in).
4. Using the Field Communicator, verify that the value for Relay Type parameter matches the relay type installed.
5. After replacing the relay and verifying the relay type, calibrate travel or perform touch-up calibration to maintain accuracy specifications

Gauges, Pipe Plugs, or Tire Valves

Depending on the options ordered, the DVC6200 or DVC6205 will be equipped with either gauges (key 47), pipe plugs (key 66), or tire valves (key 67). Single-acting direct instruments will also have a screen (key 236, figure 7-3). These are located on the top of the module base next to the relay.

Perform the following procedure to replace the gauges, tire valves, or pipe plugs. Refer to figure 7-2 and 7-3 for key number locations.

1. Remove the front cover (key 43).
2. Remove the gauge, pipe plug, or tire valve as follows:

For gauges (key 47), the flats are on the gauge case. Use a wrench on the flats of the gauge to remove the gauge from the module base. For double-acting instruments, to remove the supply gauge remove one of the output gauges.

For pipe plugs (key 66) and tire valves (key 67), use a wrench to remove these from the module base.

3. Apply pipe thread sealant (key 64) to the threads of the replacement gauges, pipe plugs, or tire valves.
4. Using a wrench, screw the gauges, pipe plugs, or tire valves into the module base.

Terminal Box

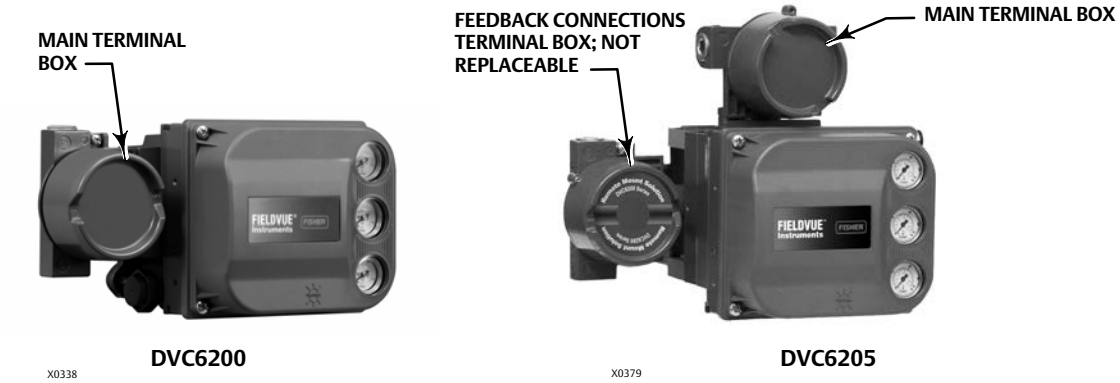
Refer to figure 7-2 or 7-4 for key number locations.

The terminal box is located on the housing and contains the terminal strip assembly for field wiring connections.

Note

The DVC6205 feedback connections terminal box (shown in figure 6-6) is not a replaceable part. Do not remove the tamper proof paint on the screw.

Figure 6-6. Terminal Boxes



Removing the Terminal Box

⚠ WARNING

To avoid personal injury or property damage caused by fire or explosion, remove power to the instrument before removing the terminal box cover in an area which contains a potentially explosive atmosphere or has been classified as hazardous.

1. Loosen the set screw (key 58) in the cap (key 4) so that the cap can be unscrewed from the terminal box.
2. After removing the cap (key 4), note the location of field wiring connections and disconnect the field wiring from the terminal box.

3. Separate the module base from the housing by performing the Removing the Module Base procedure.
4. Disconnect the terminal box wiring connector from the PWB assembly (key 50).
5. Remove the screw (key 72). Pull the terminal box assembly straight out of the housing.

Replacing the Terminal Box

Note
Inspect all O-rings for wear and replace as necessary.

1. Apply lubricant, silicone sealant to the O-ring (key 34) and install the O-ring over the stem of the terminal box.
2. Insert the terminal box assembly stem into the housing until it bottoms out. Position the terminal box assembly so that the hole for the screw (key 72) in the terminal box aligns with the threaded hole in the housing. Install the screw (key 72).
3. Connect the terminal box wiring connector to the PWB assembly (key 50). Orientation of the connector is required.
4. Reassemble the module base to the housing by performing the Replacing the Module Base procedure.
5. Reconnect the field wiring as noted in step 2 in the Removing the Terminal Box procedure.
6. Apply lubricant, silicone sealant to the O-ring (key 36) and install the O-ring over the 2-5/8 inch threads of the terminal box. Use of a tool is recommended to prevent cutting the O-ring while installing it over the threads.
7. Apply lithium grease (key 63) to the 2-5/8 inch threads on the terminal box to prevent seizing or galling when the cap is installed.
8. Screw the cap (key 4) onto the terminal box.
9. Install a set screw (key 58) into the cap (key 4). Loosen the cap (not more than 1 turn) to align the set screw over one of the recesses in the terminal box. Tighten the set screw (key 58).

Troubleshooting

If communication or output difficulties are experienced with the instrument, refer to the troubleshooting chart in table 6-3. Also see the DVC6200 Technical Support Checklist on page 68.

Checking Voltage Available

⚠ WARNING

Personal injury or property damage caused by fire or explosion may occur if this test is attempted in an area which contains a potentially explosive atmosphere or has been classified as hazardous.

To check the Voltage Available at the instrument, perform the following:

1. Connect the equipment in figure 2-3 to the field wiring in place of the FIELDVUE instrument.
2. Set the control system to provide maximum output current.
3. Set the resistance of the 1 kilohm potentiometer shown in figure 2-3 to zero.
4. Record the current shown on the milliammeter.

5. Adjust the resistance of the 1 kilohm potentiometer until the voltage read on the voltmeter is 10.0 volts.
6. Record the current shown on the milliammeter.
7. If the current recorded in step 6 is the same as that recorded in step 4 (± 0.08 mA), the voltage available is adequate.
8. If the voltage available is inadequate, refer to Wiring Practices in the Installation section.

Restart Processor

This is a "soft" reset of the device. This procedure can only be performed while the instrument is out of service. A soft reset will immediately put into effect changes that have been sent to the instrument. Also, if the device is configured to shutdown on an alert, the soft reset will clear the shutdown.

Table 6-3. Instrument Troubleshooting

Symptom	Possible Cause	Action
1. Analog input reading at instrument does not match actual current provided.	1a. Control mode not Analog.	1a. Check the control mode using the Field Communicator. If in the Digital or Test mode, the instrument receives its set point as a digital signal. Control is not based on input current. Change Control Mode to Analog.
	1b. Low control system compliance voltage.	1b. Check system compliance voltage (see Wiring Practices in the Installation section.
	1c. Instrument shutdown due to self test failure.	1c. Check instrument status using the Field Communicator (see Viewing Instrument Status in the Viewing Device Information section).
	1d. Analog input sensor not calibrated.	1d. Calibrate the analog input sensor (see Analog Input Calibration in the Calibration section).
	1e. Current leakage.	1e. Excessive moisture in the terminal box can cause current leakage. Typically the current will vary randomly if this is the case. Allow the inside of the terminal box to dry, then retest.
2. Instrument will not communicate.	2a. Insufficient Voltage Available.	2a. Calculate Voltage Available (see Wiring Practices in the Installation section). Voltage Available should be greater than or equal to 10 VDC.
	2b. Controller output Impedance too low.	2b. Install a HART filter after reviewing Control System Compliance Voltage requirements (see Wiring Practices in the Installation section).
	2c. Cable capacitance too high.	2c. Review maximum cable capacitance limits (see Wiring Practices in the Installation section).
	2d. HART filter improperly adjusted.	2d. Check filter adjustment (see the appropriate HART filter instruction manual).
	2e. Improper field wiring.	2e. Check polarity of wiring and integrity of connections. Make sure cable shield is grounded only at the control system.
	2f. Controller output providing less than 4 mA to loop.	2f. Check control system minimum output setting, which should not be less than 3.8 mA.
	2g. Disconnected loop wiring cable at PWB.	2g. Verify connectors are plugged in correctly.
	2h. PWB DIP switch not set properly.	2h. Check for incorrect setting or broken DIP switch on the back of the PWB. Reset switch or replace PWB, if switch is broken. See table 6-2 for switch setting information

Table 6-3. Instrument Troubleshooting

Symptom	Possible Cause	Action
2. Instrument will not communicate.	2j. PWB failure.	2j. Use a 4-20 mA current source to apply power to the instrument. Terminal voltage across the LOOP+ and LOOP- terminals should be 8.0 to 9.5 VDC. If the terminal voltage is not 8.0 to 9.5 VDC, replace the PWB.
	2k. Polling address incorrect.	2k. Use the Field Communicator to set the polling address (refer to the Detailed Setup section). From the *Utility* menu, select *Configure Communicator* > *Polling* > *Always Poll*. Set the instrument polling address to 0.
	2l. Defective terminal box.	2l. Check continuity from each screw terminal to the corresponding PWB connector pin. If necessary, replace the terminal box assembly.
	2m. Defective Field Communicator or ValveLink modem cable.	2m. If necessary, repair or replace cable.
	2n. ValveLink modem defective or not compatible with PC.	2n. Replace ValveLink modem.
	2p. ValveLink hardlock defective or not programmed.	2p. Replace if defective or return to factory for programming.
3. Instrument will not calibrate, has sluggish performance or oscillates.	3a. Configuration errors.	3a. Verify configuration: If necessary, set protection to None. If Out of Service, place In Service. Check: Travel Sensor Motion Tuning set Zero Power Condition Feedback Connection Control mode (should be Analog) Restart control mode (should be Analog)
	3b. Restricted pneumatic passages in I/P converter.	3b. Check screen in I/P converter supply port of the module base. Replace if necessary. If passages in I/P converter restricted, replace I/P converter.
	3c. O-ring(s) between I/P converter ass'y missing or hard and flattened losing seal.	3c. Replace O-ring(s).
	3d. I/P converter ass'y damaged/corroded/clogged.	3d. Check for bent flapper, open coil (continuity), contamination, staining, or dirty air supply. Coil resistance should be between 1680 - 1860 ohms. Replace I/P assembly if damaged, corroded, clogged, or open coil.
	3e. I/P converter ass'y out of spec.	3e. I/P converter ass'y nozzle may have been adjusted. Verify drive signal (55 to 80% for double-acting; 60 to 85% for single-acting) with the valve off the stops. Replace I/P converter assembly if drive signal is continuously high or low.
	3f. Defective module base seal.	3f. Check module base seal for condition and position. If necessary, replace seal.
	3g. Defective relay.	3g. Depress relay beam at adjustment location in shroud, look for increase in output pressure. Remove relay, inspect relay seal. Replace relay seal or relay if I/P converter assembly is good and air passages not blocked. Check relay adjustment.
	3h. Defective 67CFR regulator, supply pressure gauge jumps around.	3h. Replace 67CFR regulator.
4. ValveLink diagnostic tests provide erroneous results.	4a. Defective pressure sensor.	4a. Replace PWB.
	4b. Pressure sensor O-ring missing.	4b. Replace O-ring.
5. Field Communicator does not turn on.	5a. Battery pack not charged.	5a. Charge battery pack. Note: Battery pack can be charged while attached to the Field communicator or separately. The Field Communicator is fully operable while the battery pack is charging. Do not attempt to charge the battery pack in a hazardous area.

DVC6200 Technical Support Checklist

Have the following information available prior to contacting your Emerson Automation Solutions sales office for support.

1. Instrument serial number as read from nameplate _____
2. Is the digital valve controller responding to the control signal? Yes _____ No _____

   If not, describe _____
3. Measure the voltage across the "Loop -" and Loop +" terminal box screws when the commanded current is 4.0 mA and 20.0 mA: _____V @ 4.0 mA _____V @ 20.0 mA.
   (These values should be around 8.6 V @ 4.0 mA and 8.8 V @ 20 mA).
4. Is it possible to communicate via HART to the digital valve controller? Yes _____ No _____
5. What is the Diagnostic Tier of the digital valve controller? AC ____ HC ____ AD ____ PD ____ ODV____
6. What is the firmware version of the digital valve controller? _____
7. What is the hardware version of the digital valve controller? _____
8. Is the digital valve controller's Instrument Mode "In Service"? Yes _____ No _____
9. Is the digital valve controller's Control Mode set to "Analog"? Yes _____ No _____
10. Is it on Travel or Pressure control?
11. What are the following parameter readings?

    Input Signal _____ Drive Signal _____%

    Supply Pressure _____ Pressure A _____ Pressure B _____

    Travel Target _____% Travel _____%
12. What are the following alert readings?

    Fail alerts _____

    Valve alerts _____

    Operational status _____

    Alert event record entries _____
13. Export ValveLink data (if available) for the device (Status Monitor, Detailed Setup, etc.).

Mounting

1. Which digital valve controller do you have? DVC6200 _____ DVC6205/DVC6215 _____
2. What Make, Brand, Style, Size, etc. actuator is the DVC6200 mounted on? _____
3. What is the full travel of the valve? _____
4. What is the Mounting Kit part number? _____
5. If mounting kits are made by LBP/Customer, please provide pictures of installation.
6. Is the Mounting kit installed per the instructions? Yes _____ No _____
7. What is the safe position of the valve? Fail closed _____ Fail open _____

Section 7 Parts

Parts Ordering

Whenever corresponding with your Emerson Automation Solutions sales office about this equipment, always mention the controller serial number.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Automation Solutions should not, under any circumstances, be used in any Fisher instrument. Use of components not supplied by Emerson Automation Solutions may void your warranty, might adversely affect the performance of the instrument, and could cause personal injury and property damage.

Parts Kits

Kit	Description	Part Number
1*	Elastomer Spare Parts Kit (kit contains parts to service one digital valve controller)	
	Standard	19B5402X012
	Extreme Temperature option (fluorosilicone elastomers)	19B5402X022
2*	Small Hardware Spare Parts Kit (kit contains parts to service one digital valve controller)	19B5403X012
3*	Seal Screen Kit [kit contains 25 seal screens (key 231) and 25 O-rings (key 39)] Standard and Extreme Temperature option (fluorosilicone elastomers)	14B5072X182
4*	Terminal Box Kit (see figure 7-1)	
	Aluminum, without I/O Package	
	Standard	19B5401X142
	Standard, M20	19B5401X342
	Standard, Natural Gas Certified	19B5401X162
	Standard, Natural Gas Certified, M20	19B5401X362
	Extreme Temperature	19B5401X152
	Extreme Temperature, M20	19B5401X352
	Extreme Temperature, Natural Gas Certified	19B5401X172
	Extreme Temperature, Natural Gas Certified, M20	19B5401X372
	Aluminum, with I/O Package	
	Standard	19B5401X182
	Standard, M20	19B5401X392
	Extreme Temperature	19B5401X192
	Extreme Temperature, M20	19B5401X402
	Stainless Steel, without I/O Package	
	Extreme Temperature, Natural Gas Certified	19B5401X312
	Extreme Temperature, Natural Gas Certified, M20	19B5401X382
	Stainless Steel, with I/O Package	
	Extreme Temperature	19B5401X202
	Extreme Temperature, M20	19B5401X412
50	PWB Assembly (HW2) (see figure 7-2 and 7-4) for DVC6200 and DVC6205	
	Hardware Revision 2 (HW2), without I/O Package	
	For instrument level HC	
	For instrument level AD	
	For instrument level PD	
	For instrument level ODV	
	Hardware Revision 2 (HW2), with I/O Package	
	For instrument level HC	
	For instrument level AD	
	For instrument level PD	
	For instrument level ODV	

Note

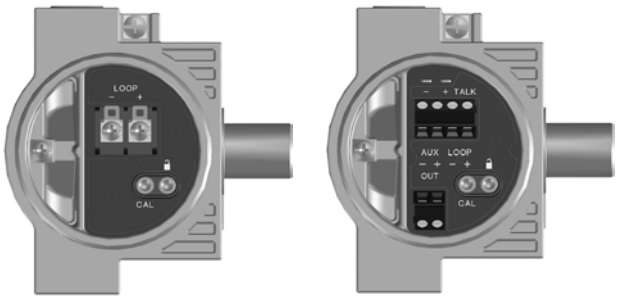
Use only with replace in-kind. The following terminal boxes are compatible only with PWB Assembly electronics hardware revision 2 (HW2).
Standard kits contain nitrile elastomers and extreme temperature kits contains fluorosilicone elastomers.

Note

The following PWB Assemblies are compatible only with the terminal boxes shown in figure 7-1. Contact your Emerson Automation Solutions sales office if a replacement PWB is needed.

*Recommended spare parts

Figure 7-1. Terminal Box



WITHOUT I/O PACKAGE **WITH I/O PACKAGE**

Kit	Description	Part Number
5*	I/P Converter Kit	
	Standard	38B6041X152
	For Extreme Temperature option (fluorosilicone elastomers)	38B6041X132
6*	Spare Module Base Assembly Kit, [kit contains module base (key 2); drive screws, qty. 2, (key 11); shield/label (key 19); hex socket cap screw, qty. 3, (key 38); self tapping screw, qty. 2 (key 49); pipe plug, qty. 3 (key 61); retaining ring, qty. 3 (key 154); screen (key 236); and flame arrestors, qty. 3 (key 243)]	
	Aluminum	GE18654X012
	Stainless Steel	GE18654X022
7*	Spare Housing Assembly Kit [kit contains housing (key 1); vent assembly (key 52); seal (only included in Housing A kits) (key 288); seal (key 237); O-ring (key 34); O-ring (only used with integrally mounted regulator) (key 5)]	
	Aluminum	
	Housing A (used for GX actuator)	
	Standard (nitrile elastomers)	GE48798X032
	Extreme Temperature option (fluorosilicone elastomers)	GE48798X042
	Housing B (used for all actuators except GX)	
	Standard (nitrile elastomers)	GE48798X072
	Extreme Temperature option (fluorosilicone elastomers)	GE48798X082
	Stainless Steel	
	Housing B (used for all actuators except GX)	
	Extreme Temperature option (fluorosilicone elastomers)	GE48798X102
8*	Spare I/P Shroud Kit [kit contains shroud (key 169) and hex socket cap screw, qty. 4 (key 23)]	GE29183X012

Kit	Description	Part Number

Note

The Remote Mount Feedback Unit kit is not orderable by part number due to nameplate/approval requirements. Contact your Emerson Automation Solutions sales office for information on ordering this kit.

9	Remote Mount Feedback Unit Kit (see figure 7-5) [remote housing assembly (key25); hex socket set screw (key 58); 1/2 NPT pipe plug (key 62); wire retainer, qty 2 (key 131); terminal cover (key 255); o-ring (key 256); gasket (Housing A only, used for GX actuator) (key 287); seal (Housing A only, used for GX actuator) (key 288)	
10	Feedback Array Kit	
	Sliding Stem (Linear) [kit contains feedback array and hex socket cap screws, qty. 2, washer, plain, qty. 2, external tooth lock washer, qty. 2 (only with aluminum feedback array kit) and alignment template. 210 mm (8-1/4 inch) kit contains feedback array and hex socket cap screws, qty. 4, washer, plain, qty. 4, external tooth lock washer, qty. 4 (only with aluminum feedback array kit), alignment template and insert]. Stainless steel kits only for use with stainless steel mounting kits.	
	7 mm (1/4-inch)	
	Aluminum	GG20240X012
	19 mm (3/4-inch)	
	Aluminum	GG20240X022
	Stainless steel	GE65853X012
	25 mm (1-inch)	
	Aluminum	GG20240X032
	Stainless steel	GE65853X022
	38 mm (1-1/2 inch)	
	Aluminum	GG20240X042
	Stainless steel	GE65853X032
	50 mm (2-inch)	
	Aluminum	GG20240X052
	Stainless steel	GE65853X042
	110 mm (4-1/8 inch)	
	Aluminum	GG20240X082
	Stainless steel	GE65853X062
	210 mm (8-1/4 inch)	
	Aluminum	GG20243X012
	Stainless steel	GE65853X072
	Rotary [Kit contains feedback assembly, pointer assembly, travel indicator scale and M3 machine pan head screws qty. 2]. Stainless steel kits only for use with stainless steel mounting kits.	
	Aluminum	GE71982X012
	Stainless steel	GE71982X022
11	Mounting Shield Kit [kit contains shield, qty. 3 and machine screws, qty. 6]	GG05242X022
12*	Gasket/Seal Kit, for use with GX actuator [kit contains insulating gasket (key 287) and seal (key 288)]	GE45468X012

*Recommended spare parts

Parts List

Note

Parts with footnote numbers shown are available in parts kits; see footnote information at the bottom of the page.
Contact your Emerson Automation Solutions sales office for Part Ordering information.

Key	Description	Part Number

Housing (see figure 7-2 and 7-4)

DVC6200 and DVC6205

1	Housing(7)	
11	Drive Screw (2 req'd) (DVC6205 only)	
20	Shield (DVC6205 only)	
52	Vent, plastic(2)	
74	Mounting Bracket (DVC6205 only)	
248	Screw, hex head (4 req'd) (DVC6205 only)	
249	Screw, hex head (4 req'd) (DVC6205 only)	
250	Spacer (4 req'd) (DVC6205 only)	
267	Standoff (2 req'd) (DVC6205 only)	
271	Screen(7)	
287	Gasket, Housing A only (used for GX actuator) (DVC6200 only)	
288	Seal, Housing A only (used for GX actuator) (DVC6200 only)	

Common Parts (see figure 7-2, 7-3, and 7-4)

DVC6200 and DVC6205

16*	O-ring(1) (3 req'd)	
29	Warning label, for use only with LCIE hazardous area classifications	
33	Mach Screw, pan head, SST(2) (3 req'd)	
38	Cap Screw, hex socket, SST(2)(6) (3 req'd)	
43*	Cover Assembly (includes cover screws)	
	Standard	38B9580X022
	Extreme temperature option (fluorosilicone elastomers)	38B9580X032
48	Nameplate	
49	Screw, self tapping (2 req'd)(6)	
61	Pipe Plug, hex socket(6)	
	Housing A with relay C (2 req'd) (used for GX actuator)	
	Housing A with relay B (1 req'd) (used for GX actuator)	
	Housing B with relay B and C (1 req'd) (used for all actuators except GX)	
	Not required for relay A	

*Recommended spare parts
1. Available in the Elastomer Spare Parts Kit
2. Available in the Small Hardware Spare Parts Kit
3. Available in the Seal Screen Kit
5. Available in the I/P Converter Kit
6. Available in the Spare Module Base Assembly Kit
7. Available in the Spare Housing Assembly Kit
8. Available in the Spare Shroud Kit

Kit	Description	Part Number
63	Lithium grease (not furnished with the instrument)	
64	Pipe thread sealant (not furnished with the instrument)	
65	Lubricant, silicone sealant (not furnished with the instrument)	
154	Retaining Ring(2) (3 req'd)	
236	Screen (required for relay B and C only)(7)	
237	Module Base Seal(1)	

Module Base (see figure 7-2 and 7-4)

DVC6200 and DVC6205

2	Module Base(6)	
11	Drive Screw(6) (2 req'd)	
12	O-ring(1)	
19	Shield(6)	
61	Pipe Plug, hex socket(6) (3 req'd)	
243	Slotted Pin (flame arrestor)(6) (3 req'd)	

I/P Converter Assembly (see figure 7-2 and 7-4)

DVC6200 and DVC6205

23	Cap Screw, hex socket, SST(2)(8) (4 req'd)	
39*	O-ring(1)(3)(5)	
41	I/P Converter(5)	
169	Shroud(5)(8) (see figure 6-3)	
210*	Boot, nitrile(1)(5) (2 req'd) (see figure 6-3)	
231*	Seal Screen(1)(3)(5)	

Relay (see figure 7-2 and 7-4)

DVC6200 and DVC6205

24*	Relay Assembly, (includes shroud, relay seal, mounting screws)	
	Standard (nitrile elastomers)	
	Standard Bleed	
	Housing A (used for GX actuator)	
	Single-acting direct (relay C)	38B5786X182
	Single-acting reverse (relay B)	38B5786X172
	Housing B (used for all actuators except GX)	
	Single-acting direct (relay C)	38B5786X132
	Double-acting (relay A)	38B5786X052
	Single-acting reverse (relay B)	38B5786X092
	Low Bleed	
	Housing A (used for GX actuator)	
	Single-acting direct (relay C)	38B5786X202
	Single-acting reverse (relay B)	38B5786X192
	Housing B (used for all actuators except G)	
	Single-acting direct (relay C)	38B5786X152
	Double-acting (relay A)	38B5786X072
	Single-acting reverse (relay B)	38B5786X112

Key	Description	Part Number
24*	Relay Assembly, (includes shroud, relay seal, mounting screws) (continued)	
	Extreme Temperature option (fluorosilicone elastomers)	
	Standard Bleed	
	Single-acting direct (relay C)	38B5786X142
	Double-acting (relay A)	38B5786X032
	Single-acting reverse (relay B)	38B5786X102
	Low Bleed	
	Single-acting direct (relay C)	38B5786X162
	Double-acting (relay A)	38B5786X082
	Single-acting reverse (relay B)	38B5786X122

Loop Connections Terminal Box (see figure 7-2 and 7-4)

DVC6200 and DVC6205

4	Terminal Box Cap
34*	O-ring(1)(4)
36*	O-ring(1)(4)
58	Set Screw, hex socket, SST(2)
72	Cap Screw, hex socket, SST(2)
164	Terminal Box Assembly

Feedback Connections Terminal Box (see figure 7-4)

DVC6205

4	Terminal Box Cap
34*	O-ring(1)(4)
36*	O-ring(1)(4)
58	Set Screw, hex socket, SST(2)
62	Pipe Plug, hex hd, SST
262	Adapter
263*	O-ring
	Standard or Extreme temperature option

Key	Description	Part Number

Pressure Gauges, Pipe Plugs, or Tire Valve Assemblies (see figure 7-3)

DVC6200 and DVC6205

47* Pressure Gauge, nickel-plated brass case, brass connection
Double-acting (3 req'd); Single-acting (2 req'd)
PSI/MPA Gauge Scale
To 60 PSI, 0.4 MPa
To 160 PSI, 1.1 MPa
PSI/bar Gauge Scale
To 60 PSI, 4 bar
To 160 PSI, 11 bar
PSI/KG/CM^2 Gauge Scale
To 60 PSI, 4 KG/CM^2
To 160 PSI, 11 KG/CM^2

66 Pipe Plug, hex head
For double-acting and single-acting direct w/gauges (none req'd)
For single-acting reverse w/gauges (1 req'd)
For all units w/o gauges (3 req'd)

67 Tire Valve, used with Tire Valve Option only
Double-acting (3 req'd); Single-acting (2 req'd)

DVC6215 Feedback Unit (see figure 7-5)

65	Lubricant, silicone sealant (not furnished with the instrument)
256*	O-Ring, fluorosilicone

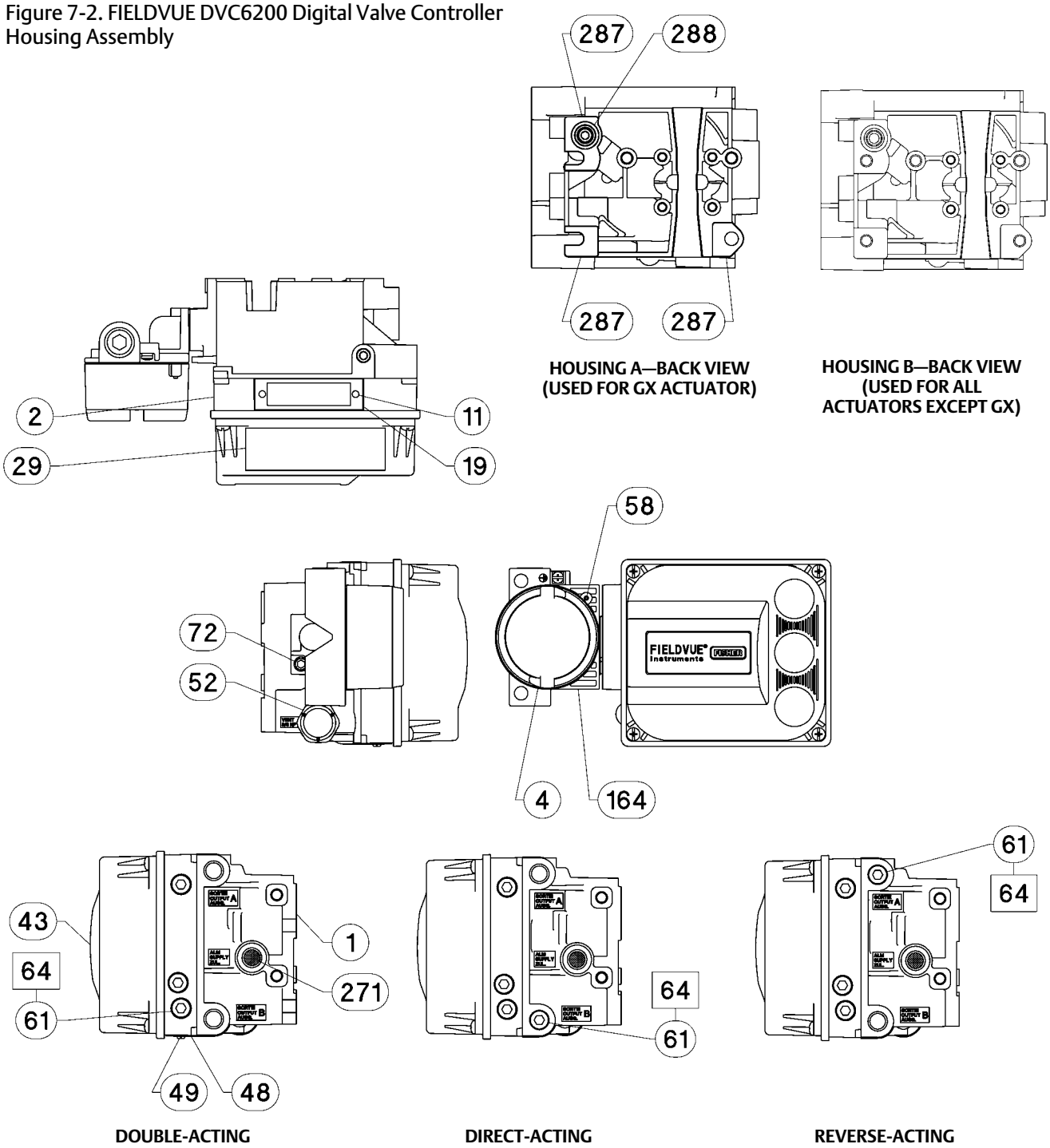
HART Filters

HF340, DIN rail mount	39B5411X022
HF341, DIN rail Mount, pass through (no filter)	39B5412X012

*Recommended spare parts

1. Available in the Elastomer Spare Parts Kit
2. Available in the Small Hardware Spare Parts Kit
4. Available in the Terminal Box Kit

Figure 7-2. FIELDVUE DVC6200 Digital Valve Controller Housing Assembly

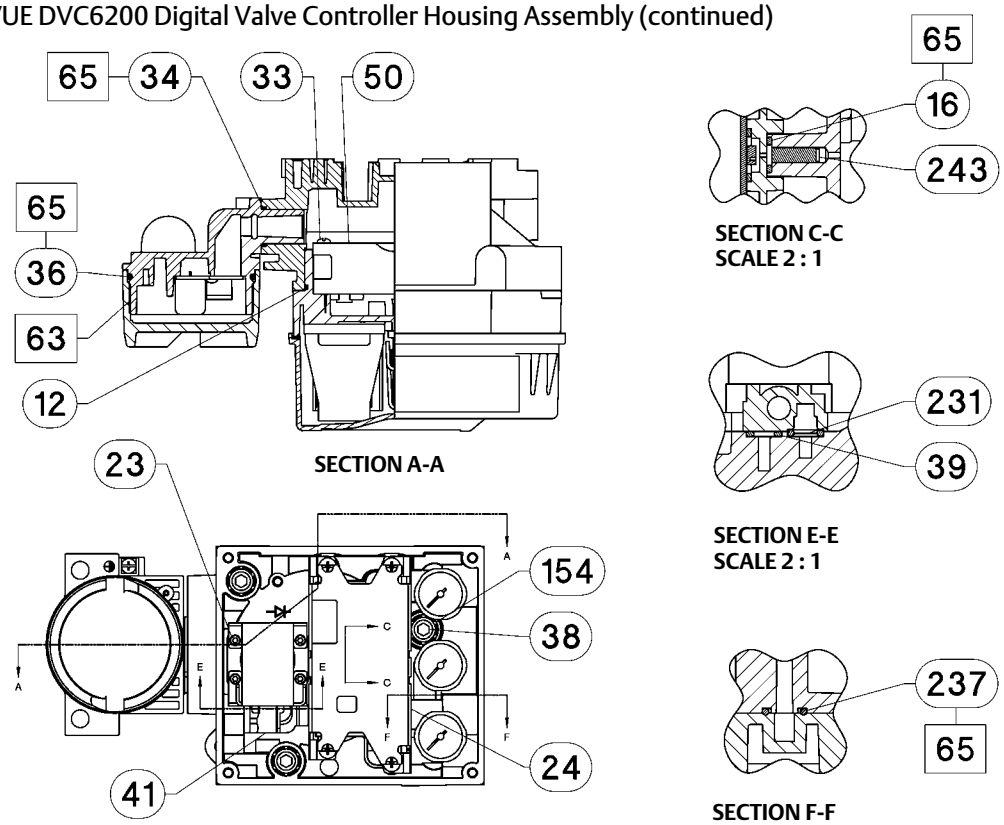


APPLY LUBRICANT, SEALANT, OR THREAD LOCK

65 APPLY LUBRICANT ON ALL O-RINGS UNLESS OTHERWISE SPECIFIED

GE40185 sheet 1 of 3

Figure 7-2. FIELDVUE DVC6200 Digital Valve Controller Housing Assembly (continued)

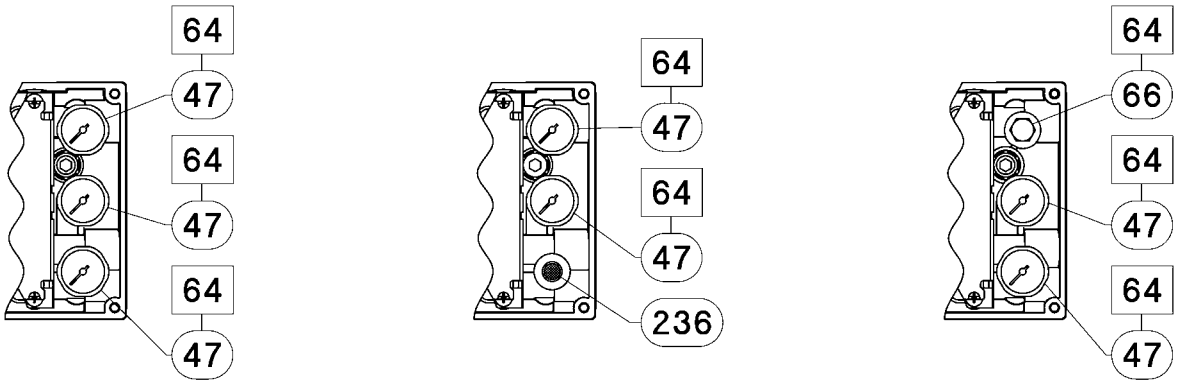


☐ APPLY LUBRICANT, SEALANT, OR THREAD LOCK

65 APPLY LUBRICANT ON ALL O-RINGS UNLESS OTHERWISE SPECIFIED

GE40185 sheet 2 of 3

Figure 7-3. Gauge Configuration



FOR PIPE PLUG OPTION REPLACE (47) WITH (66)
FOR TIRE VALVE OPTION REPLACE (47) WITH (67)

☐ APPLY LUBRICANT, SEALANT, OR THREAD LOCK

65 APPLY LUBRICANT ON ALL O-RINGS UNLESS OTHERWISE SPECIFIED

GE40185 sheet 3 of 3

Figure 7-4. FIELDVUE DVC6205 Base Unit Housing Assembly

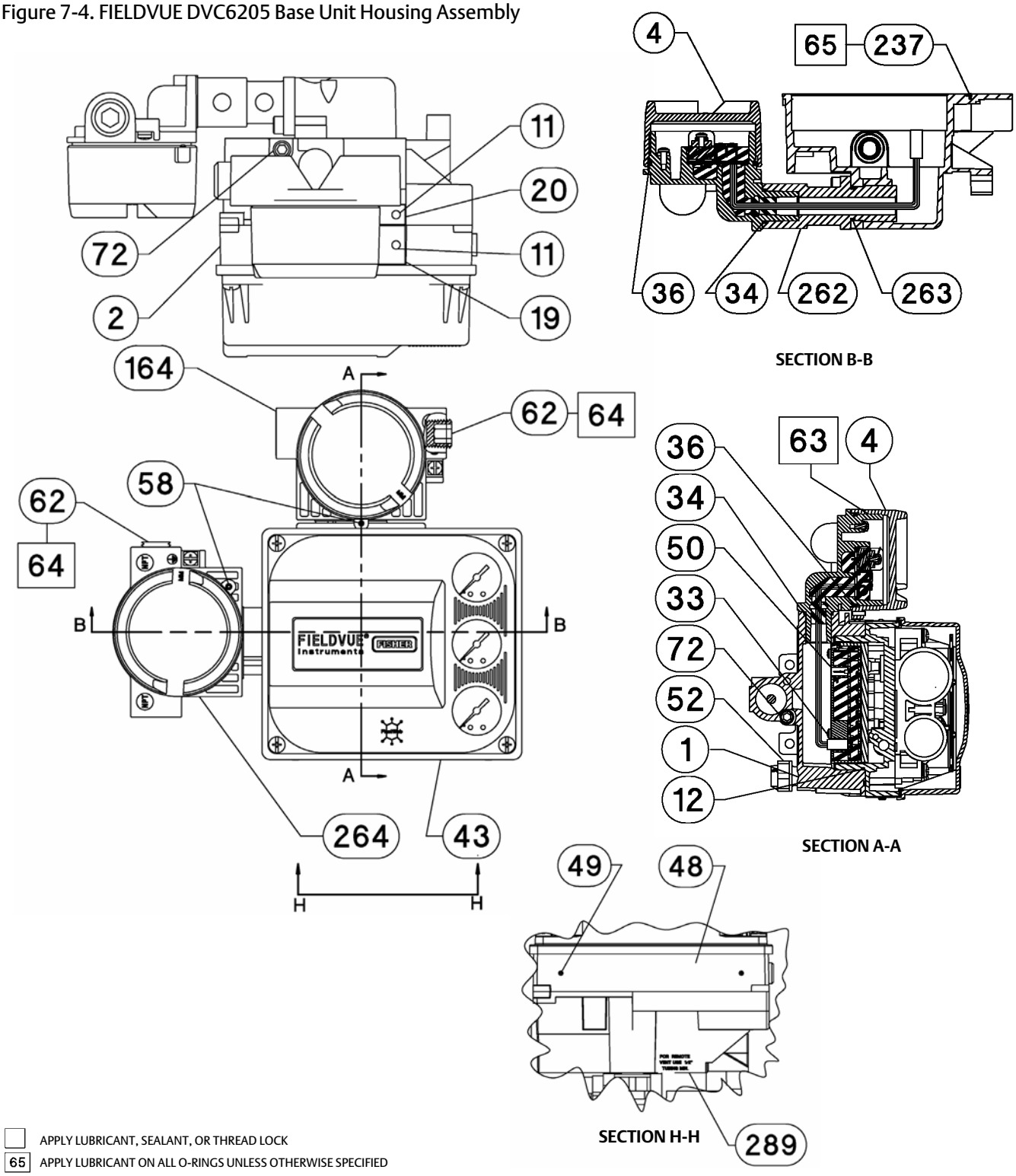
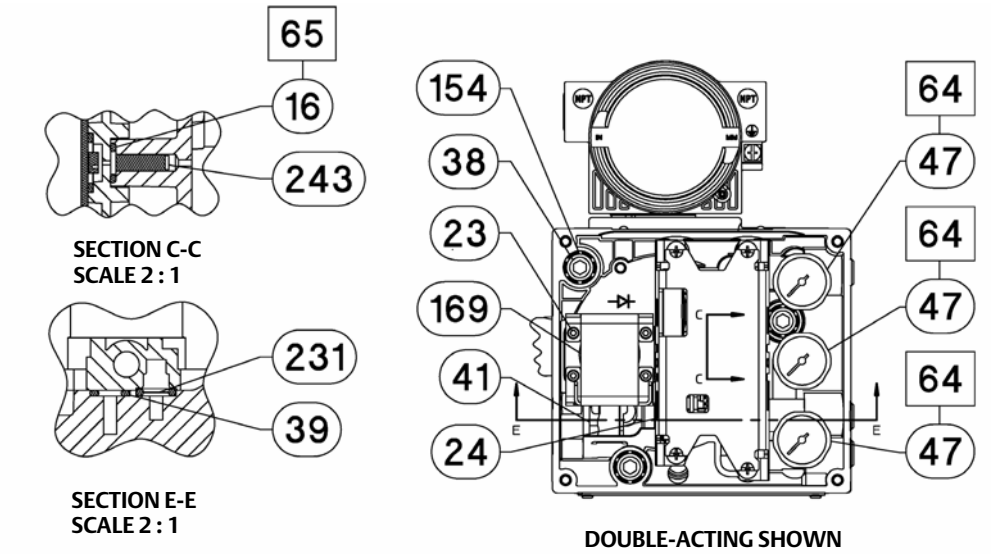
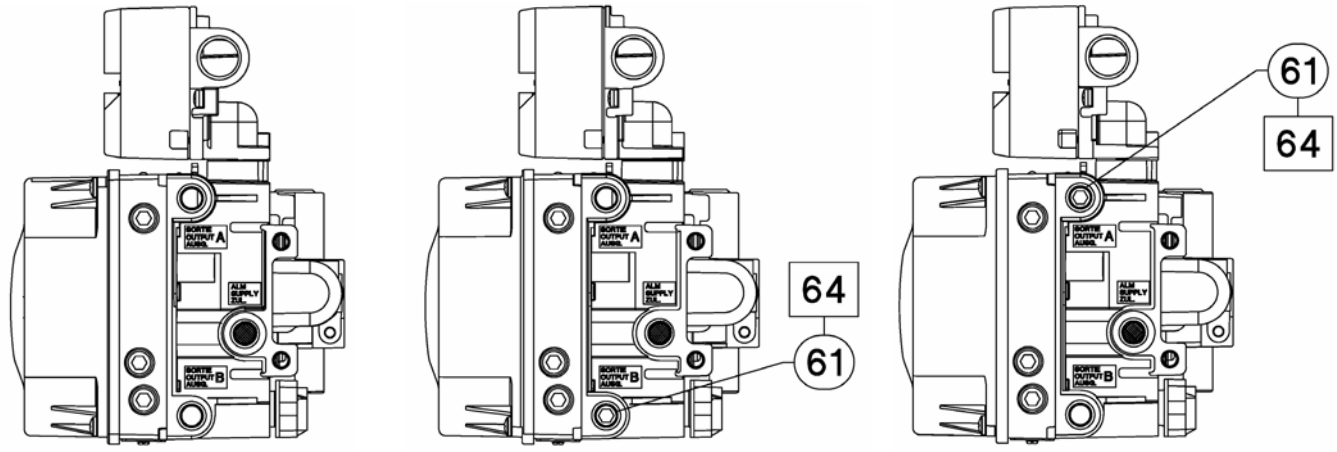


Figure 7-4. FIELDVUE DVC6205 Base Unit Housing Assembly (continued)





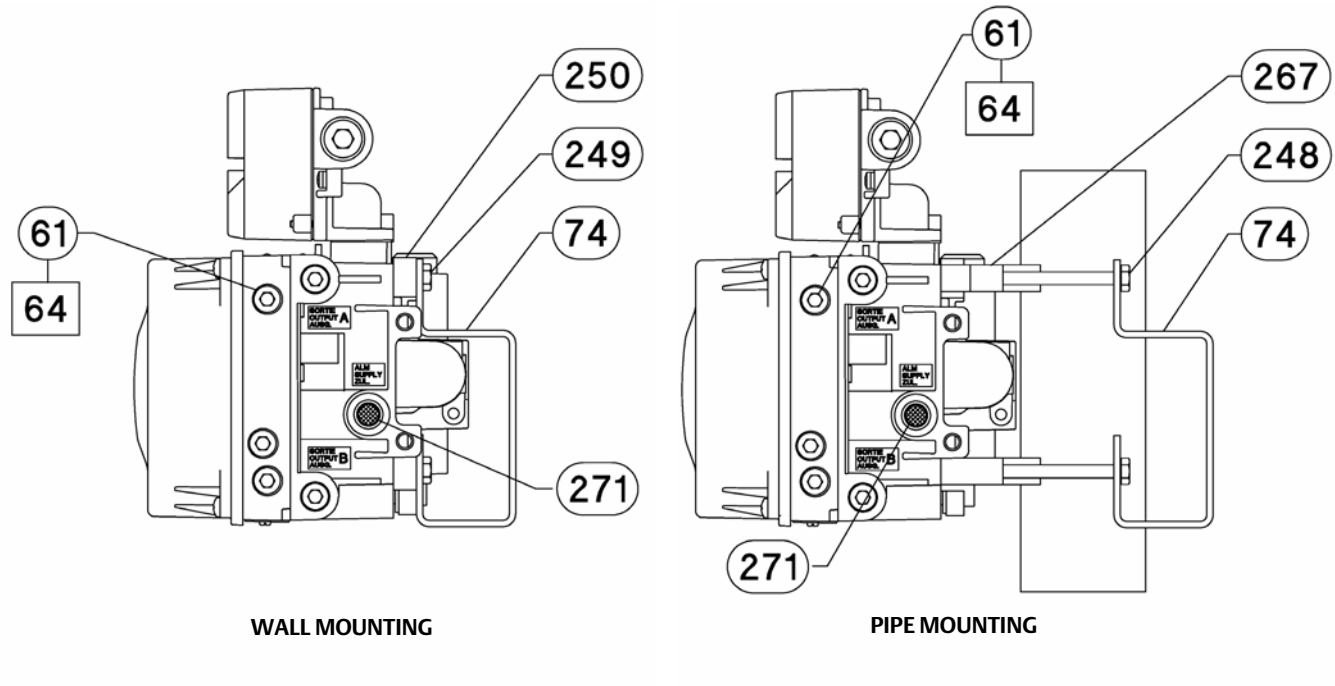
DOUBLE-ACTING **DIRECT-ACTING** **REVERSE-ACTING**

APPLY LUBRICANT, SEALANT, OR THREAD LOCK

65 APPLY LUBRICANT ON ALL O-RINGS UNLESS OTHERWISE SPECIFIED

GE40181

Figure 7-4. FIELDVUE DVC6205 Base Unit Housing Assembly (continued)

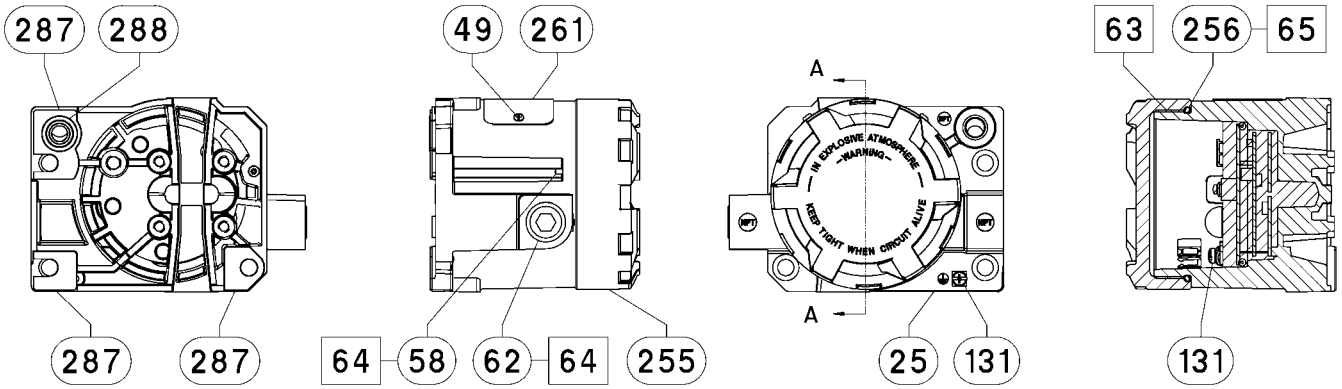


APPLY LUBRICANT, SEALANT, OR THREAD LOCK

65 APPLY LUBRICANT ON ALL O-RINGS UNLESS OTHERWISE SPECIFIED

GE40181

Figure 7-5. FIELDVUE DVC6215 Remote Feedback Assembly



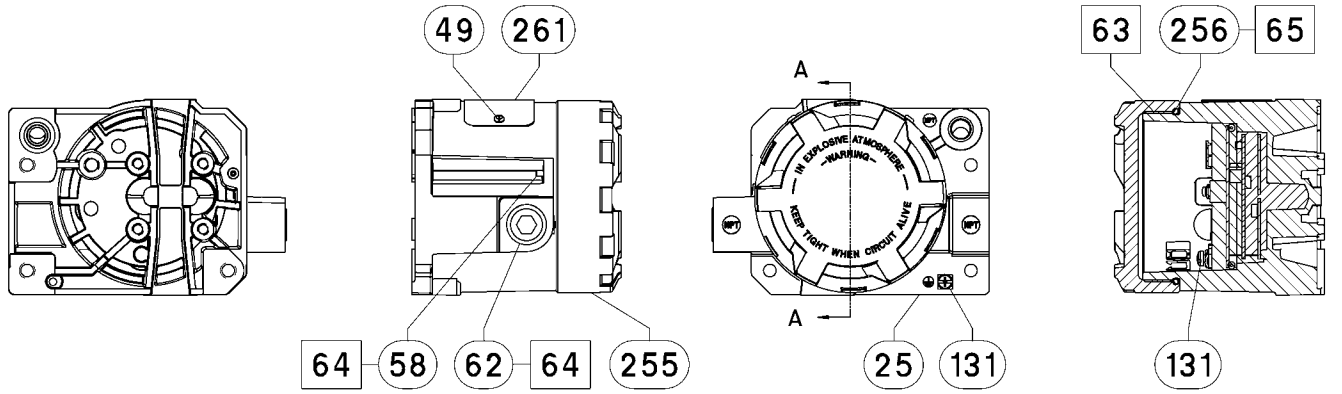
PARTS NOT SHOWN: 158

APPLY LUBRICANT/SEALANT

GE46670-B

SECTION A-A

HOUSING A
(USED FOR GX ACTUATOR)



PARTS NOT SHOWN: 158

APPLY LUBRICANT/SEALANT

GE40178-B

SECTION A-A

HOUSING B
(USED FOR ALL ACTUATORS EXCEPT GX)

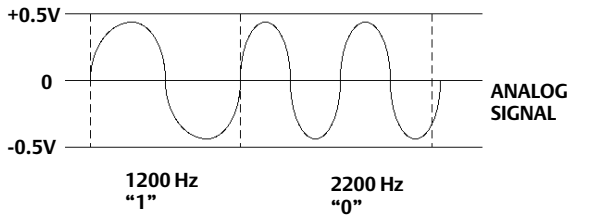
Appendix A Principle of Operation

HART Communication

The HART (Highway Addressable Remote Transducer) protocol gives field devices the capability of communicating instrument and process data digitally. This digital communication occurs over the same two-wire loop that provides the 4-20 mA process control signal, without disrupting the process signal. In this way, the analog process signal, with its faster update rate, can be used for control. At the same time, the HART protocol allows access to digital diagnostic, maintenance, and additional process data. The protocol provides total system integration via a host device.

The HART protocol uses frequency shift keying (FSK). Two individual frequencies of 1200 and 2200 Hz are superimposed over the 4-20 mA current signal. These frequencies represent the digits 1 and 0 (see figure A-1). By superimposing a frequency signal over the 4-20 mA current, digital communication is attained. The average value of the HART signal is zero, therefore no DC value is added to the 4-20 mA signal. Thus, true simultaneous communication is achieved without interrupting the process signal.

Figure A-1. HART Frequency Shift Keying Technique

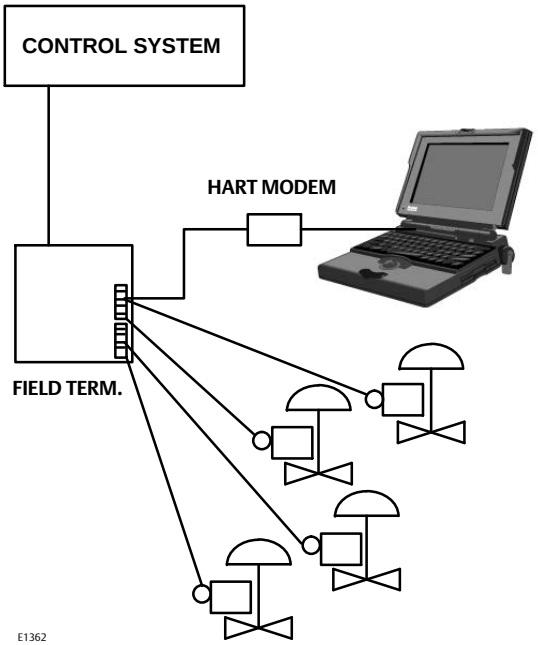


The HART protocol allows the capability of multidropping, i.e., networking several devices to a single communications line. This process is well suited for monitoring remote applications such as pipelines, custody transfer sites, and tank farms. See table 6-2 for instructions on changing the printed wiring board DIP switch configuration to multidrop.

DVC6200 Digital Valve Controller

The DVC6200 digital valve controller housing contains the travel sensor, terminal box, pneumatic input and output connections and a module base that may be easily replaced in the field without disconnecting field wiring or tubing. The module base contains the following submodules: I/P converter, printed wiring board (pwb) assembly, and pneumatic relay. The relay position is detected by sensing the magnet on the relay beam via a detector on the printed wiring board. This sensor is used for the minor loop feedback (MLFB) reading. The module base can be rebuilt by replacing the submodules. See figures A-3 and A-4.

Figure A-2. Typical FIELDVUE Instrument to Personal Computer Connections for ValveLink Software



DVC6200 digital valve controllers are loop-powered instruments that provide a control valve position proportional to an input signal from the control room. The following describes a double-acting digital valve controller mounted on a piston actuator.

The input signal is routed into the terminal box through a single twisted pair of wires and then to the printed wiring board assembly submodule where it is read by the microprocessor, processed by a digital algorithm, and converted into an analog I/P drive signal.

As the input signal increases, the drive signal to the I/P converter increases, increasing the I/P output pressure. The I/P output pressure is routed to the pneumatic relay submodule. The relay is also connected to supply pressure and amplifies the small pneumatic signal from the I/P converter. The relay accepts the amplified pneumatic signal and provides two output pressures. With increasing input (4 to 20 mA signal), the output A pressure always increases and the output B pressure decreases. The output A pressure is used for double-acting and single-acting direct applications. The output B pressure is used for double-acting and single-acting reverse applications. As shown in figure A-3 the increased output A pressure causes the actuator stem to move downward. Stem position is sensed by the non-contact travel feedback sensor. The stem continues to move downward until the correct stem position is attained. At this point the printed wiring board assembly stabilizes the I/P drive signal. This positions the flapper to prevent any further increase in nozzle pressure.

As the input signal decreases, the drive signal to the I/P converter submodule decreases, decreasing the I/P output pressure. The pneumatic relay decreases the output A pressure and increases the output B pressure. The stem moves upward until the correct position is attained. At this point the printed wiring board assembly stabilizes the I/P drive signal. This positions the flapper to prevent any further decrease in nozzle pressure.

Figure A-3. FIELDVUE DVC6200 Digital Valve Controller Block Diagram

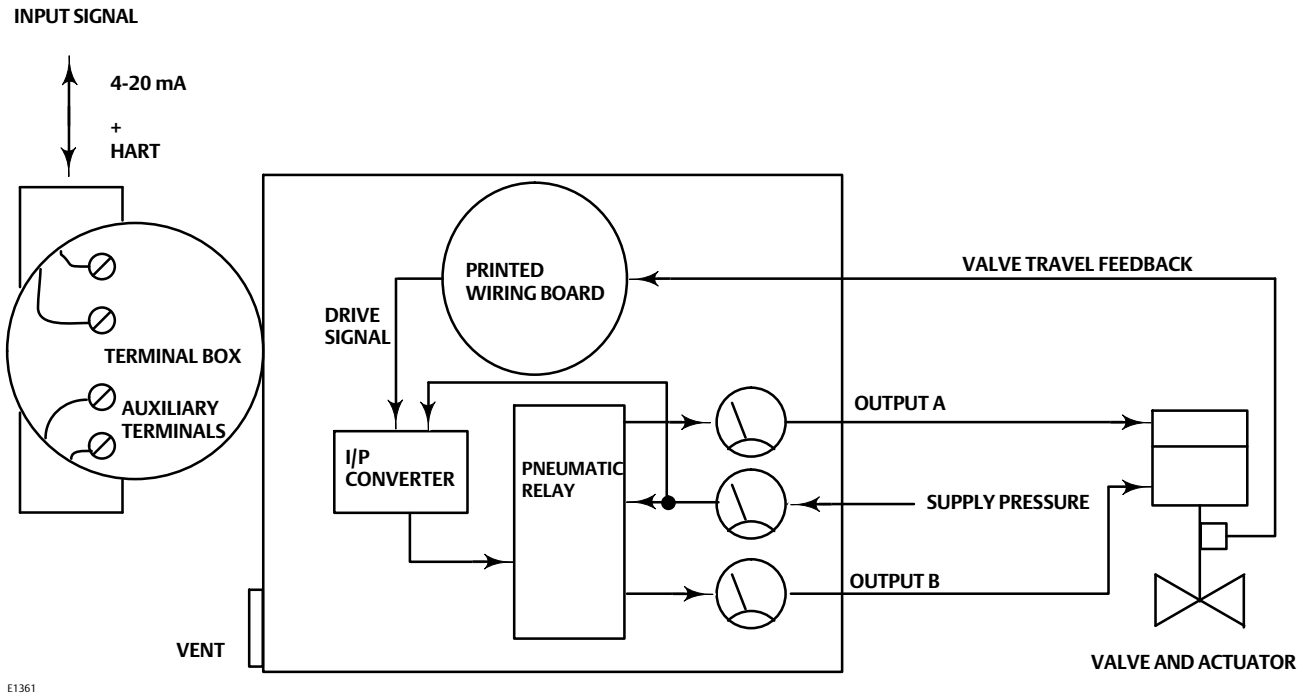
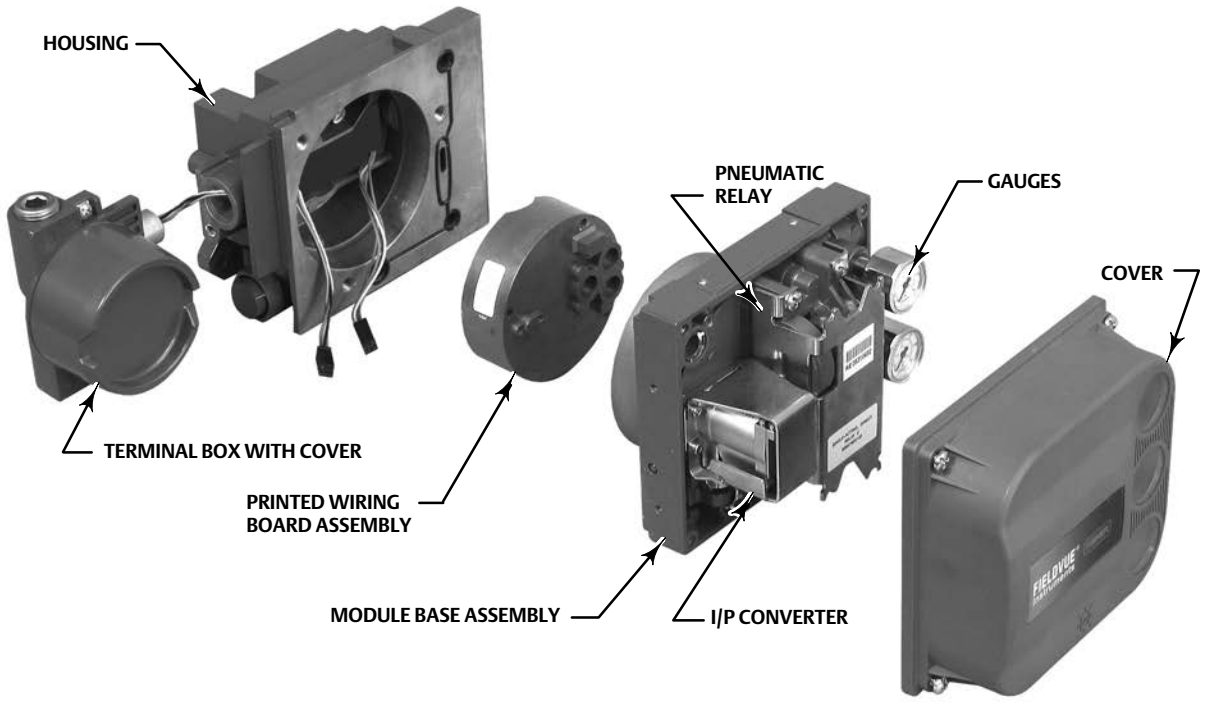


Figure A-4. FIELDVUE DVC6200 Digital Valve Controller Assembly



Appendix B Field Communicator Menu Trees

This section contains the Field Communicator menu trees for instrument level HC, AD, PD, and ODV. It also contains an alphabetized function/variable list to help locate the function/variable on the appropriate menu tree. All Fast Key Sequences referenced in the menu trees assume the Online menu (see figure B-2) as the starting point.

Instrument Level HC, AD, PD, and ODV

Function/Variable	See Figure
Actual Travel	B-5
Actuator Manufacturer	B-5
Actuator Model	B-5
Actuator Selection	B-5
Actuator Size	B-5
Actuator Style	B-7
Air	B-5
Alert Record Full Enable	B-8
Alert Record Not Empty Enable	B-8
Alert Switch Source	B-7
Analog Input	B-3, B-10
Analog Input (Calibration)	B-9
Analog Input Units	B-5
Area Units	B-5
Auto Calibration	B-9
Auxiliary Terminal Action	B-5
Auxiliary Terminal Action, Edit	B-5
Breakout Torque	B-5
Burst Mode	B-7
Calibration Button	B-5
Calibration Record	B-9
Calibration Time	B-9
Calibration Type	B-9
Calibrator	B-9
Change Control Mode	B-6, B-10
Change Instrument Mode	B-1, B-5
Change to HART 5	B-10
Change to HART 7	B-10
Change Write Protection	B-1, B-3, B-5
Clear Records	B-8, B-10
Control Mode	B-6, B-10
Critical NVM Failure Shutdown	B-8
Custom Characterization	B-6, B-10
Cycle Count Alert Enable	B-8
Cycle Count Alert Point	B-8
Cycle Counter	B-10
Cycle Count/Travel Accum Deadband	B-8
Days Powered Up	B-10
DD Information	B-3
Description	B-3, B-5
Device ID	B-3
Device Revision	B-3
Device Setup	B-4
Device Status	B-3, B-10
Drive Current Failure Shutdown	B-8
Drive Signal	B-10

Function/Variable	See Figure
Drive Signal Alert Enable	B-8
Dynamic Torque	B-5
Edit Cycle Counts	B-8
Edit Instrument Time	B-5, B-8
Edit Travel Accumulator	B-8
Effective Area (Acutator)	B-5
End Point Pressure Control (EPPC)	B-6
EPPC Deviation (Alert Setup)	B-8
Fail Signal	B-7
Fallback Recovery	B-6, B-8, B-10
Feedback Connection	B-7
Firmware Revision	B-3
Flash Integrity Failure Shutdown	B-8
Flow Direction	B-5
Flow Tends to	B-5
Function	B-7
Hardware Revision (Device)	B-3
HART Long Tag	B-3, B-5
HART Tag	B-3, B-5
HART Universal Revision	B-3
Hi Limit/Cutoff Point	B-6, B-8
Hi Limit/Cutoff Select	B-6, B-8
HART Variable Assignments	B-7
Inlet Pressure	B-5
Input Characterization	B-6, B-10
Input Range Hi	B-5
Input Range Lo	B-5
Instrument Alert Record	B-8
Instrument Level	B-3
Instrument Mode	B-1, B-5
Instrument Serial Number	B-3, B-5
Instrument Time is Approximate Enable	B-8
Integral Enable	B-7
Integral Gain	B-7
Integrator Saturated High Enable	B-8
Integrator Saturated Lo Enable	B-8
Integrator Limit	B-7
Intgegral Dead Zone	B-7
Last AutoCal Status	B-9
Leak Class (Trim)	B-5
Length Units	B-5
Lever Arm Length	B-5
Lever Style	B-5
Limit Switch Trip Point	B-7
Limit Switch Valve Close	B-5
Limit Switch Valve Open	B-5

Function/Variable	See Figure
Lo Limit/Cutoff Point	B-6, B-8
Lo Limit/Cutoff Select	B-6, B-8
Manual Calibration	B-9
Manufacturer (Device)	B-3
Maximum Recorded Temperature	B-10
Maximum Supply Pressure	B-7
Message	B-3, B-5
Mininum Recorded Temperature	B-10
Minor Loop Sensor Failure Shutdown	B-8
MLFB Gain	B-7
Model (Device)	B-3
Non-Critical NVM Failure Shutdown	B-8
Number of Power Ups	B-10
Outlet Pressure	B-5
Output Circuit Comm Failure Enable	B-8
Output Terminal Enable	B-7
Packing Type	B-5
Partial Stroke Test	B-10
Partial Stroke Test (PST)	B-7
Performance Tuner	B-4, B-7, B-10
Polling Address	B-5
Port Diameter (Trim)	B-5
Port Type (Trim)	B-5
Position Transmitter	B-5
Pressure A	B-3, B-10
Pressure A-B	B-3, B-10
Pressure B	B-3, B-10
Pressure Fallback Active Enable	B-8
Pressure Range Hi	B-6
Pressure Range Lo	B-6
Pressure Sensor Failure Shutdown	B-8
Pressure Sensors (Calibration)	B-9
Pressure Tuning Set	B-7
Pressure Units	B-5
Proportional Gain	B-7
PST Enable	B-7
PST Calibration	B-9
PST Pressure Limit	B-7
PST Start Point	B-7
PST Variables	B-7
Push Down To (Trim)	B-5
PWB Serial Number	B-3
Quick Release	B-5
Rated Travel	B-5
Relay Adjust	B-9
Relay Type	B-7
Reference Voltage Failure Shutdown	B-8
Reset Valve Stuck Alert	B-10
Restart Control Mode	B-10
Restart Processor	B-10
Seat Type (Trim)	B-5
Setpoint	B-3, B-10
Shutdown on Alert	B-8
Solenoid Valve	B-5
SP Rate Close	B-6

Function/Variable	See Figure
SP Rate Open	B-6
Spring Rate	B-5
Spring Rate Units	B-5
Stabilize/Optimize	B-4, B-7, B-10
Stem Diameter	B-5
Stroke Valve	B-10
Supply Pressure	B-3, B-10
Supply Pressure Lo Alert	B-8
Switch Closed	B-7
Temperature	B-10
Temperature Units	B-5
Temp Sensor Failure Shutdown	B-8
Torque Units	B-5
Transmitter Output	B-7
Travel	B-3, B-10
Travel Accumulator	B-10
Travel Accumulator Alert Enable	B-8
Travel Accumulator Alert Point	B-8
Travel Alert Deadband	B-8
Tavel Alert Hi Enable	B-8
Travel Alert Hi Hi Enable	B-8
Travel Alert Hi Hi Point	B-8
Travel Alert Hi Point	B-8
Travel Alert Lo Enable	B-8
Travel Alert Lo Lo Enable	B-8
Travel Alert Lo Lo Point	B-8
Travel Alert Lo Point	B-8
Travel Counts	B-10
Travel Deviation (Alert Setup)	B-8
Travel Deviation Pressure Fallback	B-6
Travel Deviation Pressure Fallback Time	B-6
Travel Limit/Cutoff High Enable	B-8
Travel Limit/Cutoff Lo Enable	B-8
Travel/Pressure Select (Alert Setup)	B-8
Travel Sensor Failure Shutdown	B-8
Travel Sensor Motion	B-7
Travel Tuning Set	B-7
Travel Units	B-5
Travel/Pressure Select	B-6, B-10
Unbalanced Area (Trim)	B-5
Valve Class	B-5
Valve Manufacturer	B-5
Valve Model	B-5
Valve Serial Number	B-3, B-5
Valve Size	B-5
Valve Style	B-7
Velocity Gain	B-7
View Alert Records	B-10
View Edit Lag Time	B-6
View Edit Lead/Lag	B-6
Volume Booster	B-5
Write Protection	B-1, B-3, B-5
Zero Power Condition	B-7

Figure B-1. Hot Key

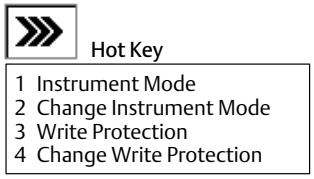


Figure B-2. Online

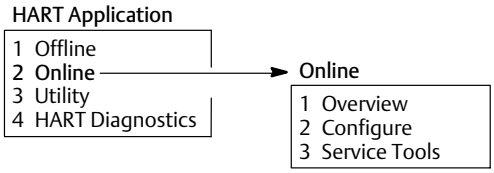
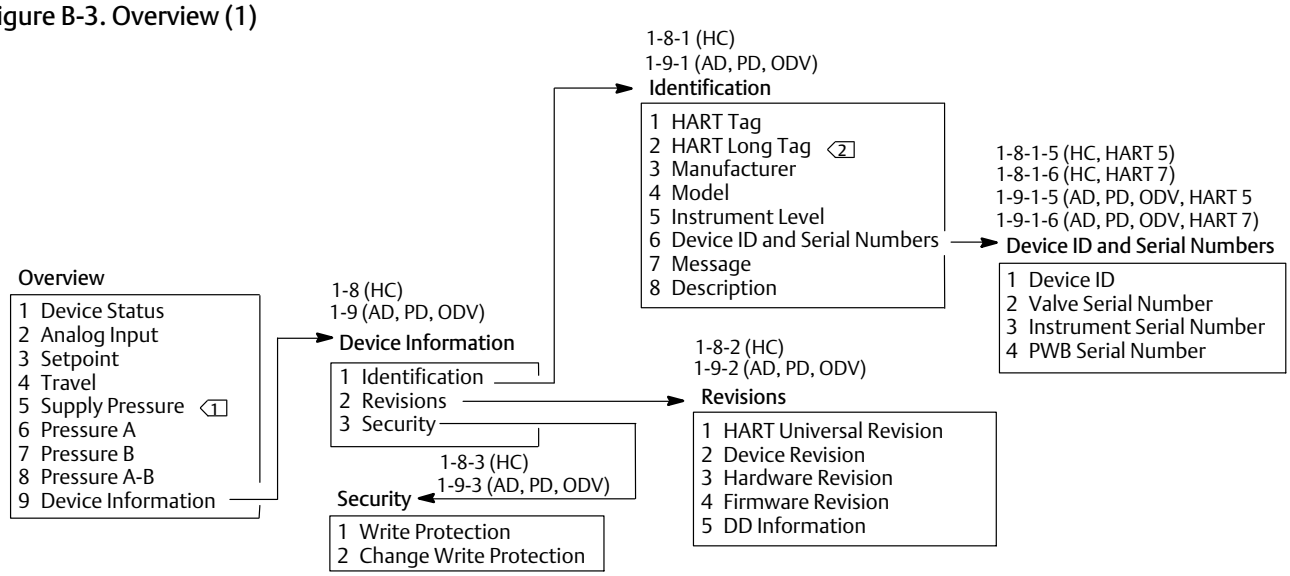


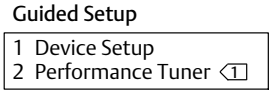
Figure B-3. Overview (1)



NOTES:

1 SUPPLY PRESSURE IS AVAILABLE FOR INSTRUMENT LEVEL AD, PD, AND ODV.
2 HART LONG TAG IS AVAILABLE WITH HART 7.

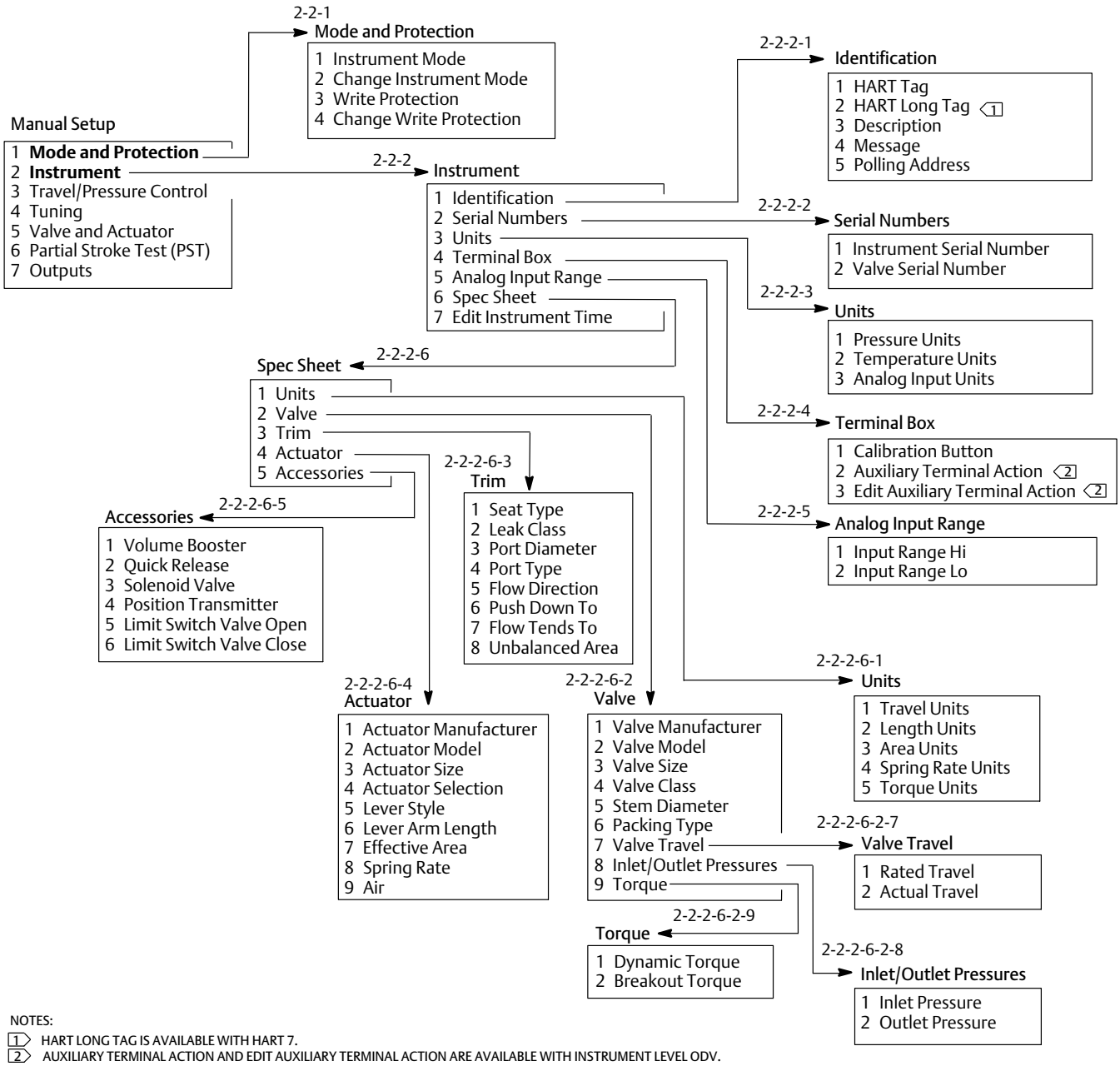
Figure B-4. Guided Setup (2-1)



NOTES:

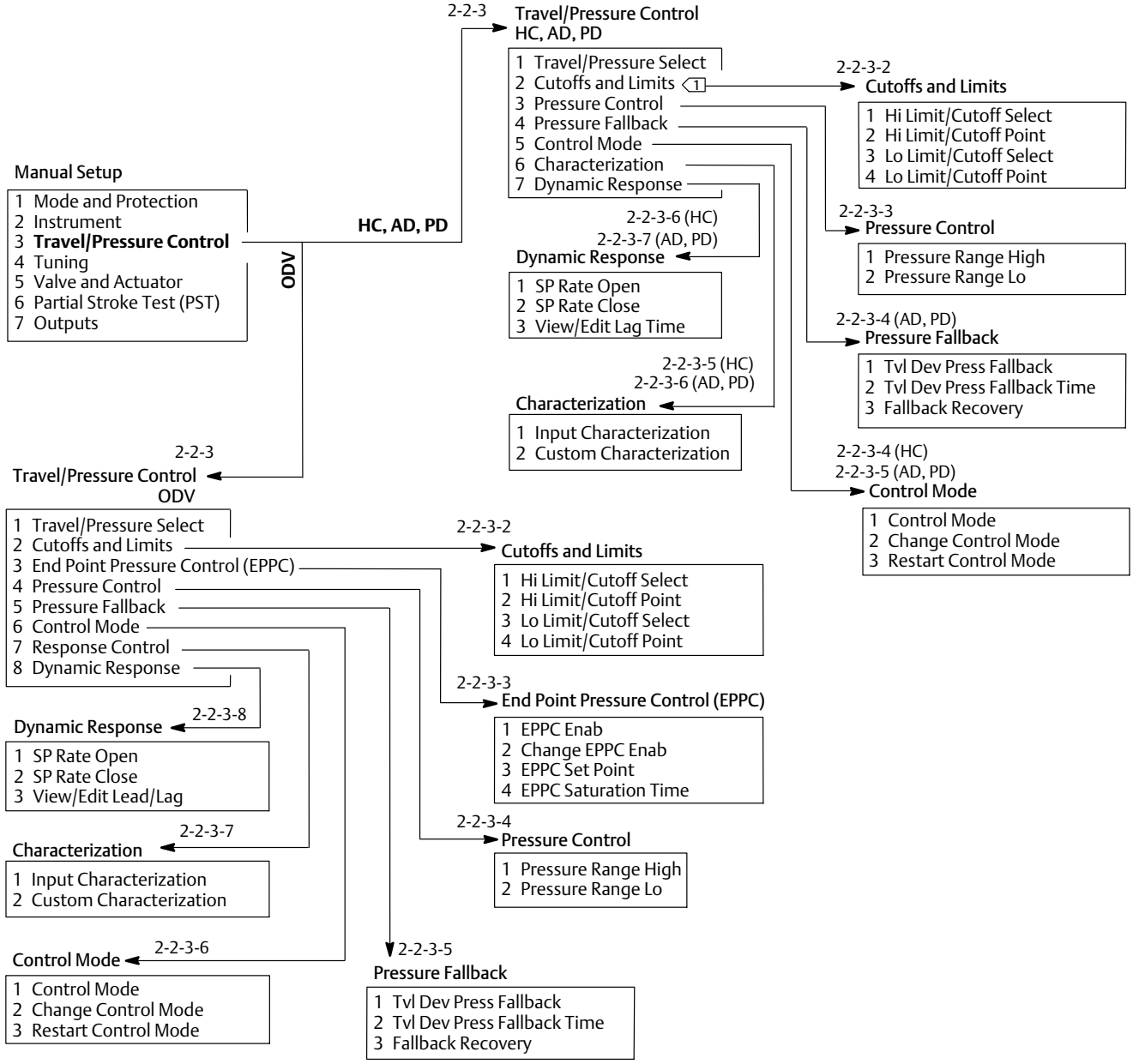
1 THIS MENU ITEM IS STABILIZE/OPTIMIZE FOR INSTRUMENT LEVEL HC.

Figure B-5. Manual Setup > Mode Protection (2-2-1) and Manual Setup > Instrument (2-2-2)



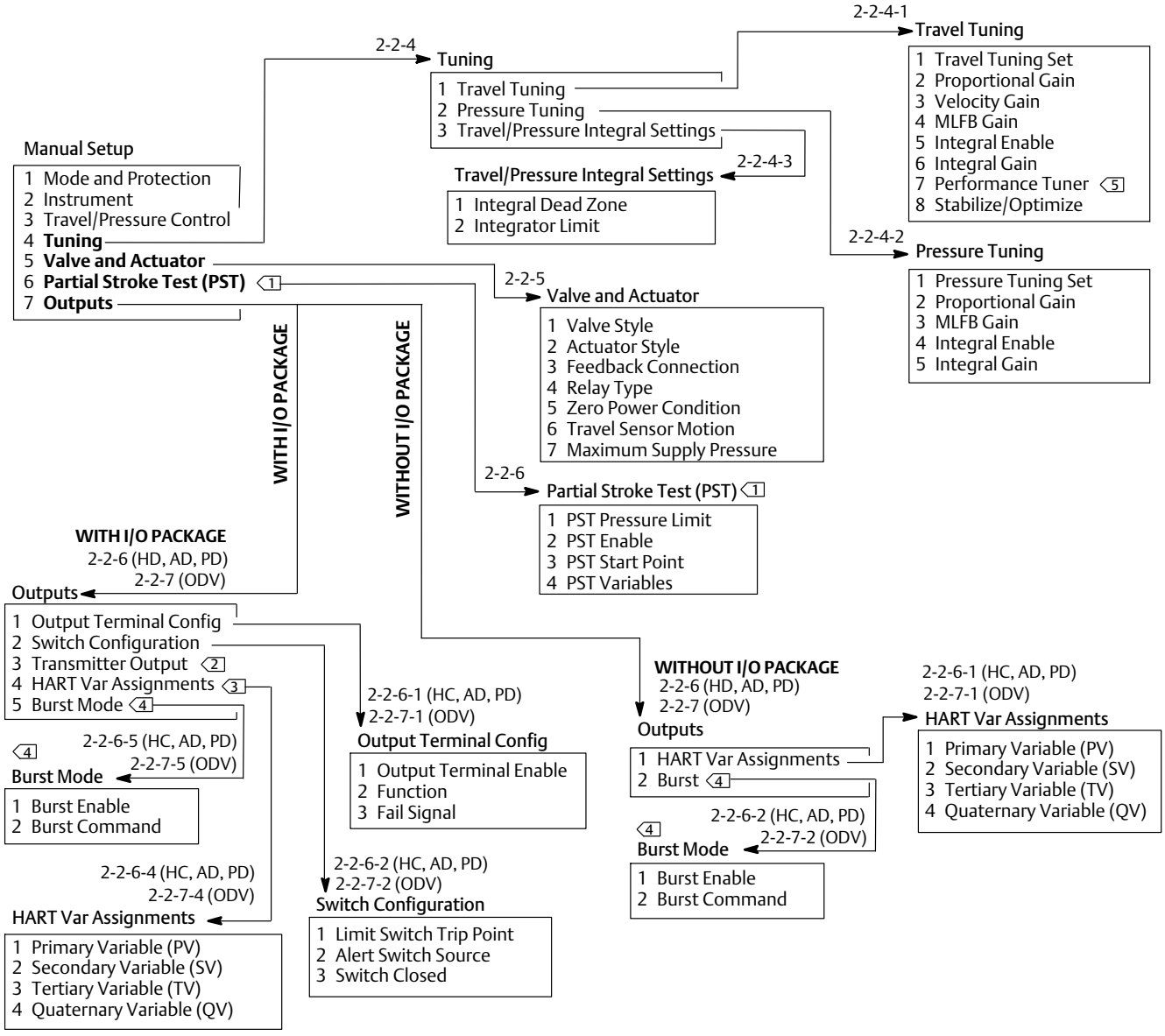
NOTES:
1 HART LONG TAG IS AVAILABLE WITH HART 7.
2 AUXILIARY TERMINAL ACTION AND EDIT AUXILIARY TERMINAL ACTION ARE AVAILABLE WITH INSTRUMENT LEVEL ODV.

Figure B-6. Manual Setup > Travel/Pressure Control (2-2-3)



NOTE:
1 PRESSURE FALLBACK IS AVAILABLE FOR INSTRUMENT LEVEL AD, PD, AND ODV.

Figure B-7. Manual Setup > Tuning (2-2-4) through Manual Setup > Outputs (2-2-7)



NOTES:

1 PARTIAL STROKE TEST (PST) IS AVAILABLE FOR INSTRUMENT LEVEL ODV.

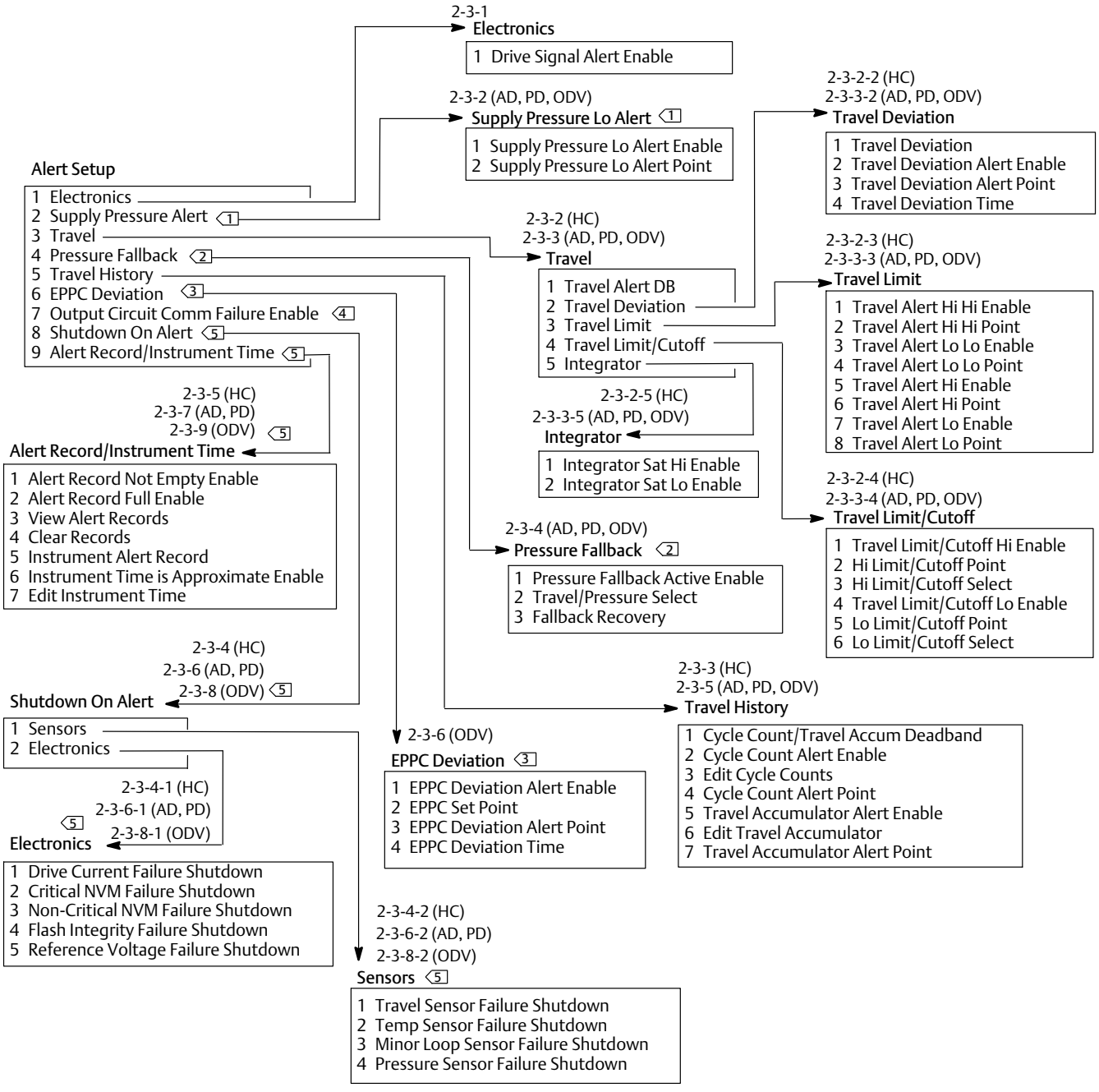
2 THIS MENU ITEM IS HART VAR ASSIGNMENTS WITH HART 5.

3 THIS MENU ITEM IS TRANSMITTER OUTPUT WITH HART 5.

4 BURST MODE IS AVAILABLE WITH HART 5.

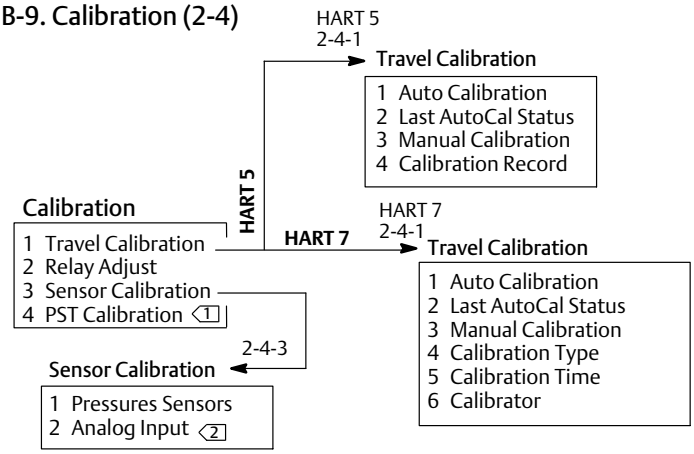
5 PERFORMANCE TUNER IS AVAILABLE FOR INSTRUMENT LEVEL AD, PD, AND ODV.

Figure B-8. Alert Setup (2-3)



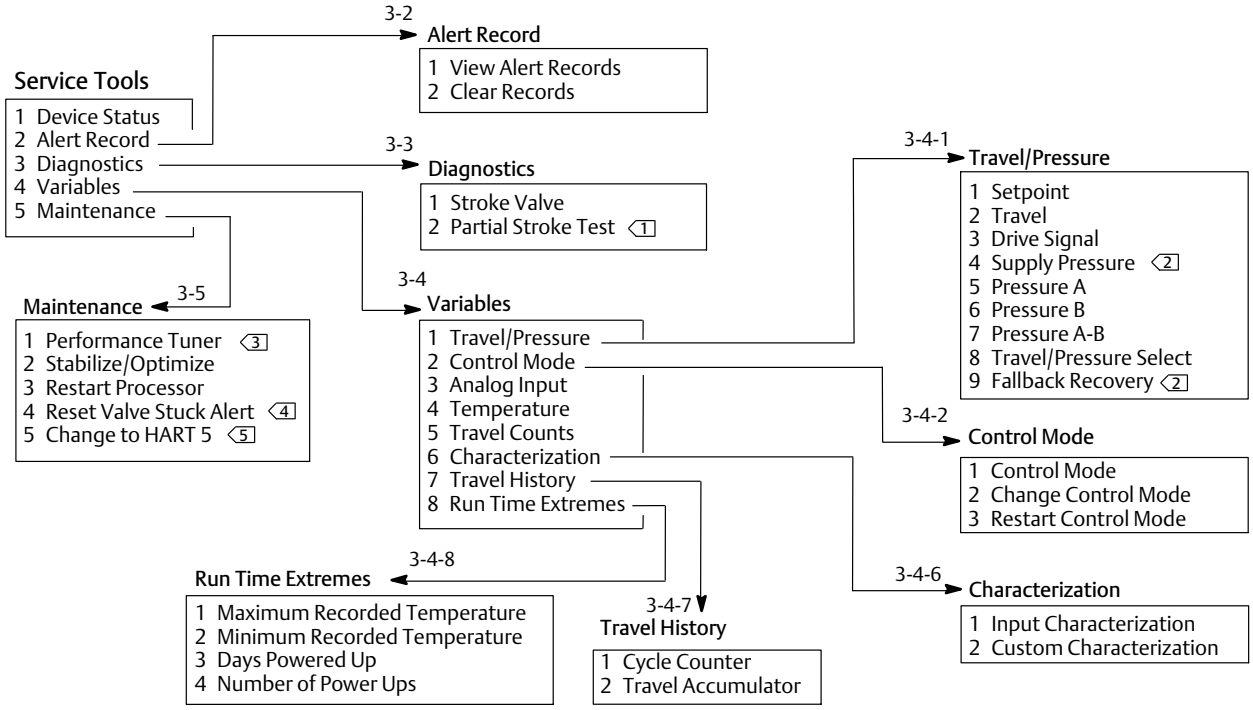
NOTES:
1. SUPPLY PRESSURE LO ALERT IS AVAILABLE FOR INSTRUMENT LEVEL AD, PD, AND ODV.
2. PRESSURE FALLBACK IS AVAILABLE FOR INSTRUMENT LEVEL AD, PD, AND ODV.
3. EPPC DEVIATION IS AVAILABLE FOR INSTRUMENT LEVEL ODV.
4. OUTPUT CIRCUIT COMM FAILURE ENABLE IS AVAILABLE WHEN THE TRANSMITTER FUNCTION IS CONFIGURED.
5. FAST KEY SEQUENCES FOR THESE MENUS DROP ONE MENU SEQUENCE WHEN THE TRANSMITTER FUNCTION IS NOT CONFIGURED.

Figure B-9. Calibration (2-4)



NOTE:
1 PST CALIBRATION IS AVAILABLE FOR INSTRUMENT LEVEL ODV.
2 ANALOG INPUT IS NOT AVAILABLE WHEN THE DIP SWITCH IS SET TO MULTI-DROP.

Figure B-10. Service Tools (3)



NOTES:
1 PARTIAL STROKE TEST IS AVAILALBE IN INSTRUMENT LEVEL ODV.
2 SUPPLY PRESSURE AND FALLBACK RECOVERY ARE AVAILABLE FOR AD, PD, ODV.
3 PERFORMANCE TUNER IS AVAILABLE FOR INSTRUMENT LEVEL AD, PD, AND ODV.
4 RESET VALVE STUCK ALERT IS AVAILABLE IN INSTRUMENT LEVEL OD V.
5 THIS MENU ITEM READS CHANGE TO HART 7 WITH HART 5.

Glossary

Alert Point
An adjustable value that, when exceeded, activates an alert.

Algorithm
A set of logical steps to solve a problem or accomplish a task. A computer program contains one or more algorithms.

Alphanumeric
Consisting of letters and numbers.

Analog Input Units
Units in which the analog input is displayed and maintained in the instrument.

ANSI (acronym)
The acronym ANSI stands for the American National Standards Institute

ANSI Class
Valve pressure/temperature rating.

Bench Set
Pressure, supplied to an actuator, required to drive the actuator through rated valve travel. Expressed in pounds per square inch.

Byte
A unit of binary digits (bits). A byte consists of eight bits.

Calibration Location
Where the instrument was last calibrated; either in the factory or in the field.

Configuration
Stored instructions and operating parameters for a FIELDVUE Instrument.

Control Loop
An arrangement of physical and electronic components for process control. The electronic components of the loop continuously measure one or more aspects of the process, then alter those aspects as necessary to achieve a desired process condition. A simple control loop measures only one variable. More sophisticated control loops measure many variables and maintain specified relationships among those variables.

Control Mode
Defines where the instrument reads its set point. The following control modes are available for a FIELDVUE Instrument:
Analog The instrument receives its travel set point over the 4-20 mA loop.
Digital The instrument receives its set point digitally, via the HART communications link.
Test This is not a user-selectable mode. The Field Communicator or ValveLink software places the instrument in this mode whenever it needs to move the valve, such as for calibration or diagnostic tests.

Control Mode, Restart
Determines the instrument control mode after a restart. See Control Mode for the available restart control modes.

Controller
A device that operates automatically to regulate a controlled variable.

Current-to-Pressure (I/P) Converter
An electronic component or device that converts a milliamp signal to a proportional pneumatic pressure output signal.

Cycle Counter
The capability of a FIELDVUE instrument to record the number of times the travel changes direction. The change in direction must occur after the deadband has been exceeded before it can be counted as a cycle.

Cycle Counter Alert

Checks the difference between the Cycle Counter and the Cycle Counter Alert Point. Cycle Counter Alert is active when the cycle counter value exceeds the Cycle Counter Alert Point. It clears after you reset the Cycle Counter to a value less than the alert point.

Cycle Counter Alert Point

An adjustable value which, when exceeded, activates the Cycle Counter Alert. Valid entries are 0 to 4 billion cycles.

Cycle Counter Deadband

Region around the travel reference point, in percent of ranged travel, established at the last increment of the Cycle Counter. The deadband must be exceeded before a change in travel can be counted as a cycle. Valid entries are 0% to 100%. Typical value is between 2% and 5%.

Deviation

Usually, the difference between set point and process variable. More generally, any departure from a desired or expected value or pattern.

Device ID

Unique identifier embedded in the instrument at the factory.

Device Revision

Revision number of the interface software that permits communication between the Field Communicator and the instrument.

Drive Signal

The signal to the I/P converter from the printed wiring board. It is the percentage of the total microprocessor effort needed to drive the valve fully open.

Drive Signal Alert

Checks the drive signal and calibrated travel. If one of the following conditions exists for more than 20 seconds, the Drive Signal Alert is active. If none of the conditions exist, the alert is cleared.
If Zero Power Condition = Closed

The alert is active when:

drive signal <10% and calibrated travel >3%

drive signal >90% and calibrated travel <97%

If Zero Power Condition = Open

The alert is active when:

drive signal <10% and calibrated travel <97%

drive signal >90% and calibrated travel >3%

Equal Percentage

A valve flow characteristic where equal increments of valve stem travel produce equal percentage changes in existing flow. One of the input characteristics available for a FIELDVUE Instrument. See also, Linear and Quick Opening.

Feedback Signal

Indicates to the instrument the actual position of the valve. The travel sensor provides the feedback signal to the instrument printed wiring board assembly.

Firmware Revision

The revision number of the instrument firmware. Firmware is a program that is entered into the instrument at time of manufacture and cannot be changed by the user.

Free Time

Percent of time that the microprocessor is idle. A typical value is 25%. The actual value depends on the number of functions in the instrument that are enabled and on the amount of communication currently in progress.

Full Ranged Travel

Current, in mA, that corresponds with the point where ranged travel is maximum, i.e., limited by the mechanical travel stops.

Gain

The ratio of output change to input change.

Hardware Revision

Revision number of the Fisher instrument hardware. The physical components of the instrument are defined as the hardware.

HART (acronym)
The acronym HART stands for Highway Addressable Remote Transducer.

HART Universal Revision
Revision number of the HART Universal Commands which are the communications protocol for the instrument.

Input Characteristic
The relationship between the ranged travel and ranged input. Possible values include: linear, equal percentage, and quick opening.

Input Current
The current signal from the control system that serves as the analog input to the instrument. See also Input Signal.

Input Range
The analog input signal range that corresponds to the travel range.

Input Signal
The current signal from the control system. The input signal can be displayed in milliamperes or in percent of ranged input.

Instrument Level
Determines the functions available for the instrument. See table 5-1.

Instrument Mode
Determines if the instrument responds to its analog input signal. There are two instrument modes:
In Service: For a fully functioning instrument, the instrument output changes in response to analog input changes. Typically changes to setup or calibration cannot be made when the instrument mode is In Service.
Out of Service: The instrument output does not change in response to analog input changes when the instrument mode is Out of Service. Some setup parameters can be changed only when the instrument mode is Out of Service.

Instrument Protection
Determines if commands from a HART device can calibrate and/or configure certain parameters in the instrument. There are two types of instrument protection:
Configuration and Calibration: Prohibits changing protected setup parameters; prohibits calibration.
None: Permits both configuration and calibration. The instrument is "unprotected."

Instrument Serial Number
The serial number assigned to the printed wiring board by the factory but can be changed during setup. The instrument serial number should match the serial number on the instrument nameplate.

Leak Class
Defines the allowable leakage by a valve when it is closed. Leak class numbers are listed in two standards: ANSI/FCI 70-2 and IEC 534-4.

Linear
A valve flow characteristic where changes in flow rate are directly proportional to changes in valve stem travel. One of the input characteristics available for a FIELDVUE Instrument. See also, Equal Percentage and Quick Opening.

Linearity, dynamic
Linearity (independent) is the maximum deviation from a straight line best fit to the opening and closing curves and a line representing the average value of those curves.

Memory
A type of semiconductor used for storing programs or data. FIELDVUE instruments use three types of memory: Random Access Memory (RAM), Read Only Memory (ROM), and Non-Volatile Memory (NVM). See also these listings in this glossary.

Menu
A list of programs, commands, or other activities that you select by using the arrow keys to highlight the item then pressing ENTER, or by entering the numeric value of the menu item.

Minimum Closing Time

Minimum time, in seconds, for the travel to decrease through the entire ranged travel. This rate is applied to any travel decrease. Valid entries are 0 to 400 seconds. Deactivate by entering a value of 0 seconds.

Minimum Opening Time

Minimum time, in seconds, for the travel to increase through the entire ranged travel. This rate is applied to any travel increase. Because of friction, actual valve travel may not respond in exactly the same time frame. Valid entries are 0 to 400 seconds. Deactivate by entering a value of 0 seconds.

Non-Volatile Memory (NVM)

A type of semiconductor memory that retains its contents even though power is disconnected. NVM contents can be changed during configuration unlike ROM which can be changed only at time of instrument manufacture. NVM stores configuration restart data.

Parallel

Simultaneous: said of data transmission on two or more channels at the same time.

Polling Address

Address of the instrument. If the digital valve controller is used in a point-to-point configuration, set the polling address to 0. If it is used in a multidrop configuration, or split range application, set the polling address to a value from 0 to 15.

Pressure Sensor

A FIELDVUE instrument internal device that senses pneumatic pressure. The DVC6200 has three pressure sensors: one to sense supply pressure and two to sense the output pressures.

Primary Master

Masters are communicating devices. A primary master is a communicating device permanently wired to a field instrument. Typically, a HART-compatible control system or a computer running ValveLink software is the primary master.

In contrast, a secondary master is not often permanently wired to a field instrument. The Field Communicator or a computer running ValveLink software communicating through a HART modem could be considered a secondary master.

Note: If one type of master takes an instrument Out Of Service, the same type must put it In Service. For example, if a device set up as a primary master takes an instrument Out Of Service, a device set up as a primary master must be used to place the instrument In Service.

Quick Opening

A valve flow characteristic where most of the change in flow rate takes place for small amounts of stem travel from the closed position. The flow characteristic curve is basically linear through the first 40 percent of stem travel. One of the input characteristics available for a FIELDVUE Instrument. See also, Equal Percentage and Linear.

Random Access Memory (RAM)

A type of semiconductor memory that is normally used by the microprocessor during normal operation that permits rapid retrieval and storage of programs and data. See also Read Only Memory (ROM) and Non-Volatile Memory (NVM).

Rate

Amount of change in output proportional to the rate of change in input.

Read-Only Memory (ROM)

A memory in which information is stored at the time of instrument manufacture. You can examine but not change ROM contents.

Seat Load

Force exerted on the valve seat, typically expressed in pounds force per lineal inch of port circumference. Seat load is determined by shutoff requirements.

Set Point Filter Time (Lag Time)

The time constant, in seconds, for the first-order input filter. The default of 0 seconds will bypass the filter.

Software

Microprocessor or computer programs and routines that reside in alterable memory (usually RAM), as opposed to firmware, which consists of programs and routines that are programmed into memory (usually ROM) when the instrument is manufactured. Software can be manipulated during normal operation, firmware cannot.

Stroking Time

The time, in seconds, required to move the valve from its fully open position to fully closed, or vice versa.

Temperature Sensor

A device within the FIELDVUE instrument that measures the instrument's internal temperature.

Travel

Movement of the valve stem or shaft which changes the amount the valve is open or closed.

Travel Accumulator

The capability of a FIELDVUE instrument to record total change in travel. The value of the Travel Accumulator increments when the magnitude of the change exceeds the Travel Accumulator Deadband. To reset the Travel Accumulator, set it to zero.

Travel Accumulator Alert

Checks the difference between the Travel Accumulator value and the Travel Accumulator Alert Point. The Travel Accumulator Alert is active when the Travel Accumulator value exceeds the Travel Accumulator Alert Point. It clears after you reset the Travel Accumulator to a value less than the alert point.

Travel Accumulator Alert Point

An adjustable value which, when exceeded, activates the Travel Accumulator Alert. Valid entries are 0% to 4 billion %.

Travel Accumulator Deadband

Region around the travel reference point established at the last increment of the accumulator. This region must be exceeded before a change in travel can be accumulated. Valid entries are 0% to 100%.

Travel Alert

Checks the ranged travel against the travel high and low alert points. The travel alert is active if either the high or low point is exceeded. Once a high or low point is exceeded, the ranged travel must clear that point by the Travel Alert Deadband before the alert clears. Four travel alerts are available: Travel Alert Hi, Travel Alert Lo, Travel Alert Hi Hi, and Travel Alert Lo Lo.

Travel Alert Deadband

Travel, in percent of ranged travel, required to clear a travel alert, once it is active. Valid entries are -25% to 125%.

Travel Alert High Point

Value of the travel, in percent of ranged travel, which, when exceeded, sets the Travel Alert Hi alert. Valid entries are -25% to 125%.

Travel Alert High High Point

Value of the travel, in percent of ranged travel, which, when exceeded, sets the Travel Alert Hi Hi alert. Valid entries are -25% to 125%.

Travel Alert Low Point

Value of the travel, in percent of ranged travel, which, when exceeded, sets the Travel Alert Lo alert. Valid entries are -25% to 125%.

Travel Alert Low Low Point

Value of the travel, in percent of ranged travel, which, when exceeded, sets the Travel Alert Lo Lo alert. Valid entries are -25% to 125%.

Travel Cutoff

Defines the cutoff point for the travel, in percent of ranged travel. There are two travel cutoffs: high and low. Once travel exceeds the cutoff, the drive signal is set to either maximum or minimum, depending on the Zero Control Signal and if the cutoff is high or low. Minimum opening time or minimum closing time are not in effect while the travel is beyond the cutoff. Use the travel cutoff to obtain the desired seat load or to be sure the valve is fully open.

Travel Deviation
The difference between the analog input signal (in percent of ranged input), the “target” travel, and the actual “ranged” travel.

Travel Deviation Alert
Checks the difference between the target and the ranged travel. If the difference exceeds the Travel Deviation Alert Point for more than the Travel Deviation Time, the Travel Deviation Alert is active. It remains active until the difference is less than the Travel Deviation Alert Point.

Travel Deviation Alert Point
An adjustable value for the target travel and the ranged travel difference, expressed in percent, When this value is exceeded by the travel deviation for more than the Travel Deviation Time, the Travel Deviation Alert is active. Valid entries are 0% to 100%. Typically this is set to 5%.

Travel Deviation Time
The time, in seconds. that the travel deviation must exceed the Travel Deviation Alert Point before the alert is active. Valid entries are 1 to 60 seconds.

Travel Limit
A setup parameter that defines the maximum allowable travel (in percent of ranged travel) for the valve. During operation, the travel target will not exceed this limit. There are two travel limits: high and low. Typically the travel limit low will be used to keep the valve from going completely closed.

Travel Range
Travel, in percent of calibrated travel, that corresponds to the input range.

Travel Sensor
A device within the FIELDVUE instrument that senses valve stem or shaft movement. The travel sensor in the DVC6200 is the Hall Effect sensor that measures the position of the magnetic assembly.

Travel Sensor Motion
Increasing or decreasing air pressure causes the magnet assembly to move up or down or the rotary shaft to turn clockwise or counterclockwise. The Setup Wizard asks if it can move the valve to determine travel.

Tuning
The adjustment of control terms or parameter values to produce a desired control effect.

Tuning Set
Preset values that identify gain settings for a FIELDVUE instrument. The tuning set and supply pressure together determine an instrument's response to input signal changes.

Watch Dog Timer
A timer that the microprocessor must rearm periodically. If the microprocessor is unable to rearm the timer, the instrument goes through reset.

Zero Power Condition
The position of the valve (open or closed) when the electrical power to the instrument is removed. Zero Power Condition (ZPC) is determined by relay and actuator action as follows:

Single Acting Direct (Relay C) Upon loss of electrical power instrument goes to zero air output at port A.

Double Acting (Relay A) Upon loss of electrical power instrument goes to full supply air output at port B. A goes to zero air output.

Single Acting Reverse (Relay B) Upon loss of electrical power instrument goes to full supply air output at Port B.

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Emerson Automation Solutions
Marshalltown, Iowa 50158 USA
Sorocaba, 18087 Brazil
Cernay, 68700 France
Dubai, United Arab Emirates
Singapore 128461 Singapore

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Fisher® EZ easy-e™ Control Valve

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Figure 1. Fisher EZ Valve with 657 Actuator and DVC6000 Digital Valve Controller



W8120A-1

Introduction

Scope of Manual

This instruction manual includes installation, maintenance, and parts information for NPS 1/2 through 4 Fisher EZ valves through CL600 ratings. Refer to separate manuals for instructions covering the actuator and accessories.

Do not install, operate, or maintain an EZ valve without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Description

EZ valves (figure 1) are globe-style with integral end connections, post guiding, and quick-change trim. These valves are used in chemical or hydrocarbon processing applications or in applications that require control of nonlubricating, viscous, or other hard-to-handle fluids.

Table 1. Specifications

End Connection Styles

Cast Iron Valves
Flanged: CL125 flat-face or 250 raised-face flanges per ASME B16.1
Steel and Stainless Steel Valves
Flanged: CL150, 300, and 600 raised-face or ring-type joint flanges per ASME B16.5
Screwed or Socket Welding: Consistent with ASME B16.11
Buttwelding: All available ASME B16.25 schedules that are consistent with ASME B16.34

Maximum Inlet Pressure(1)

Cast Iron Valves
Flanged: Consistent with CL125B or 250B per ASME B16.1
Steel and Stainless Steel Valves
Flanged: Consistent with CL150, 300, or 600 per ASME B16.34
Screwed or Welding: Consistent with CL600 per ASME B16.34

Shutoff Classifications per ANSI/FCI 70-2 and IEC 60534-4

Metal Seats: Class IV is standard, Class V is optional
PTFE Composition Seats: Class VI

Flow Characteristics

■ Equal percentage, ■ quick opening, and ■ linear

Flow Direction

Up through the seat ring

Approximate Weights

NPS 1/2 and 3/4 Valves: 9.1 kg (20 pounds)
NPS 1 Valve: 11 kg (25 pounds)
NPS 1-1/2 Valve: 18 kg (40 pounds)
NPS 2 Valve: 36 kg (80 pounds)
NPS 3 Valve: 54 kg (120 pounds)
NPS 4 Valve: 75 kg (165 pounds)

1. The pressure/temperature limits in this manual and any applicable standard or code limitation for valve should not be exceeded.

Specifications

Typical specifications for these valves are shown in table 1.

Educational Services

For information on available courses for the Fisher EZ valve, as well as a variety of other products, contact:

Emerson Process Management
Educational Services - Registration
Phone: 1-641-754-3771 or 1-800-338-8158
E-mail: education@emerson.com
http://www.emersonprocess.com/education

Installation

⚠ WARNING

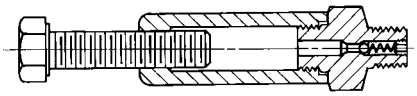
Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

Personal injury or equipment damage caused by sudden release of pressure may result if the valve assembly is installed where service conditions could exceed the limits given in table 1 or on the appropriate nameplates. To avoid such injury or damage, provide a relief valve for overpressure protection as required by government or accepted industry codes and good engineering practices.

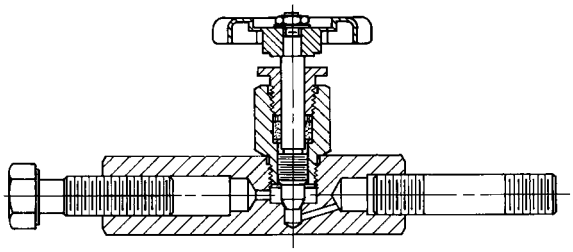
Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

Figure 2. Optional Packing Lubricator and Lubricator/Isolating Valve



LUBRICATOR



10A9421-A
AJ5428-D
A0832-2

LUBRICATOR/ISOLATING VALVE

CAUTION

When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions. Responsibility for the safety of process media and compatibility of valve materials with process media rests solely with the purchaser and end-user. Since some body/trim material combinations are limited in their pressure drop and temperature ranges, do not apply any other conditions to the valve without first contacting your Emerson Process Management sales office.

1. Before installing the valve, inspect it and any associated equipment for damage and any foreign material. Make certain the valve interior is clean, that pipelines are free of foreign material, and that the valve is oriented so that pipeline flow is in the same direction as the arrow on the side of the valve.
2. The control valve assembly may be installed in any orientation unless limited by seismic criteria. However, the normal method is with the actuator vertical above the valve. Other positions may result in uneven valve plug and seat ring retainer wear, and improper operation. With some valves, the actuator may also need to be supported when it is not vertical. For more information, consult your Emerson Process Management sales office.
3. Use accepted piping and welding practices when installing the valve in the line. Internal elastomeric parts may stay in place during the welding procedure. For flanged valves, use a suitable gasket between the valve body flange and pipeline flanges.

CAUTION

Depending on valve body materials used, post weld heat treating may be required. If so, damage to internal elastomeric and plastic parts, as well as internal metal parts is possible. Shrunk-fit pieces and threaded connections may also loosen. In general, if post weld heat treating is to be performed, all trim parts should be removed. Contact your Emerson Process Management sales office for additional information.

4. With a leak-off bonnet construction, remove the pipe plugs (key 14) to hook up the leak-off piping. If continuous operation is required during inspection or maintenance, install a three-valve bypass around the control valve assembly.
5. If the actuator and valve are shipped separately, refer to the actuator mounting procedure in the appropriate actuator instruction manual.

⚠ WARNING

Personal injury could result from packing leakage. Valve packing was tightened before shipment; however, the packing might require some readjustment to meet specific service conditions. Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

Valves with ENVIRO-SEAL live-loaded packing or HIGH-SEAL Heavy-Duty live-loaded packing will not require this initial re-adjustment. See the Fisher instruction manuals titled ENVIRO-SEAL Packing System for Sliding-Stem Valves or Heavy-Duty Live-Loaded Packing System (as appropriate) for packing instructions. If you wish to convert your present packing arrangement to ENVIRO-SEAL packing, refer to the retrofit kits listed in the Parts Kits sub-section near the end of this manual.

Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing lubrication, packing maintenance, trim maintenance, and ENVIRO-SEAL bellows seal replacement. All maintenance operations may be performed with the valve in the line.

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the pneumatic actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline.* Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

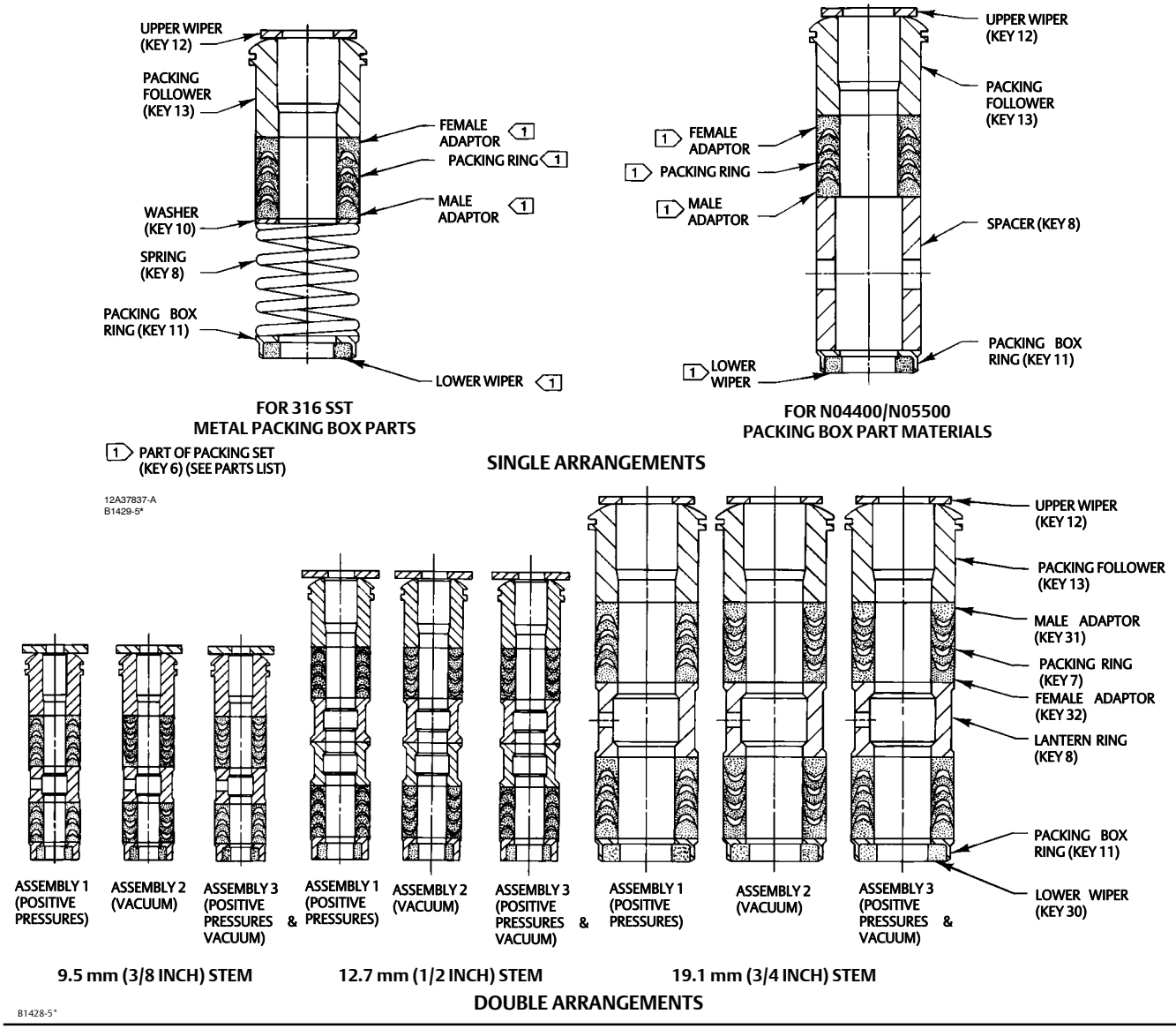
Note

Whenever a gasket seal is disturbed by removing or shifting gasketed parts, a new gasket should be installed upon reassembly. This is necessary to ensure a good gasket seal since the used gasket may not seal properly.

Note

If the valve has ENVIRO-SEAL or HIGH-SEAL live-loaded packing installed, refer to instruction manuals ENVIRO-SEAL Packing System for Sliding Stem Valves, D101642X012, or HIGH-SEAL Live Loaded Packing System, D101453X012, for packing instructions. Figure 6 shows a typical HIGH-SEAL packing system. Figures 7 and 8 show typical ENVIRO-SEAL systems.

Figure 3. PTFE V-Ring Packing Arrangements for Plain and Extension Bonnets

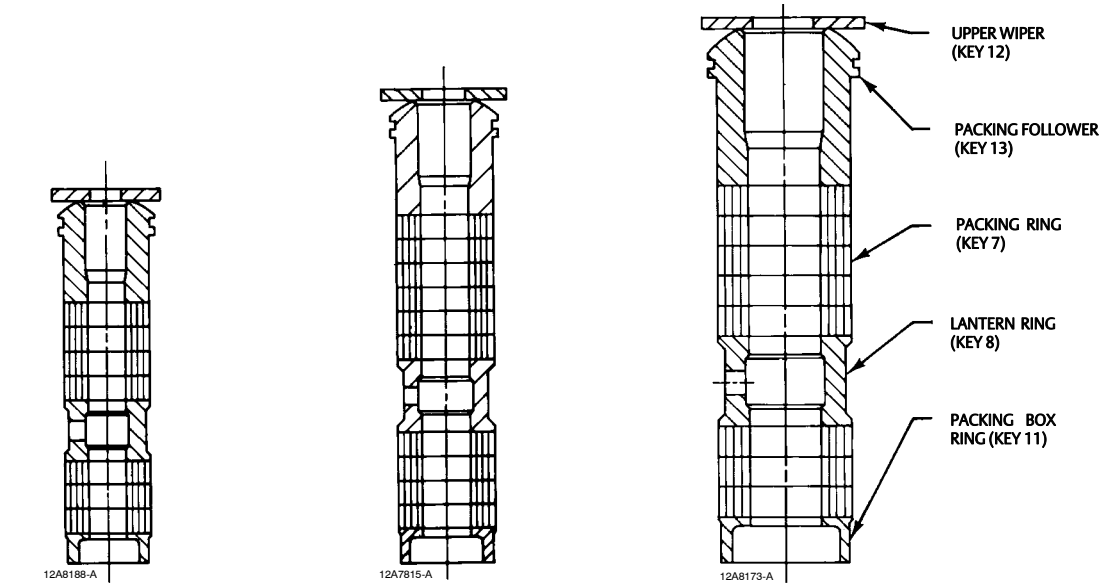


Packing Lubrication

Note
ENVIRO-SEAL or HIGH-SEAL packing does not require lubrication.

If an optional lubricator or lubricator/isolating valve (figure 2) is provided for PTFE/composition or other packings that require lubrication, it will be installed in an optional tapped hole in the bonnet. Use a good quality silicon-base lubricant. Packing used in oxygen service or in processes with temperatures over 260°C (500°F) should not be lubricated. To operate the lubricator, simply turn the cap screw clockwise to force the lubricant into the packing box. The lubricator/isolating valve must first be opened and then closed after lubrication is completed.

Figure 4. PTFE/Composition Packing Arrangements for Plain and Extension Bonnets



Packing Maintenance

This section covers PTFE V-ring, PTFE/composition, and graphite/ribbon packing as used in plain and extension bonnets. Unless otherwise indicated, key numbers refer to figure 3 for PTFE V-ring packing, figure 4 for PTFE/composition packing, and figure 5 for graphite ribbon/filament packing.

For spring-loaded single PTFE V-ring packing, the spring (key 8, figure 3) maintains a sealing force on the packing. If leakage is noted around the packing follower (key 13, figure 3), check to be sure the shoulder on the packing follower is touching the bonnet. If the shoulder is not touching the bonnet, tighten the packing flange nuts (key 5, figure 11), until the shoulder is against the bonnet. If leakage cannot be stopped in this manner, proceed to the Replacing Packing procedure.

If there is unacceptable packing leakage with other than spring-loaded packing, first try to limit the leakage and establish a stem seal by tightening the packing flange nuts.

If the packing is relatively new and tight on the stem, and if tightening the packing flange nuts does not stop the leakage, the valve stem may be worn or nicked so that a seal cannot be made. The surface finish of a valve stem is critical for making a good packing seal. If the leakage comes from the outside diameter of the packing, the leakage may be caused by nicks or scratches around the packing box wall. If performing any of the following procedures, inspect the valve stem and packing box wall for nicks and scratches.

An illustration of a HIGH-SEAL live-loaded packing system is shown in figure 6. Illustrations of ENVIRO-SEAL live-loaded packing systems are shown in figures 7, 8, and 9.

Figure 5. Graphite Ribbon/Filament Packing Arrangements for Plain and Extension Bonnets

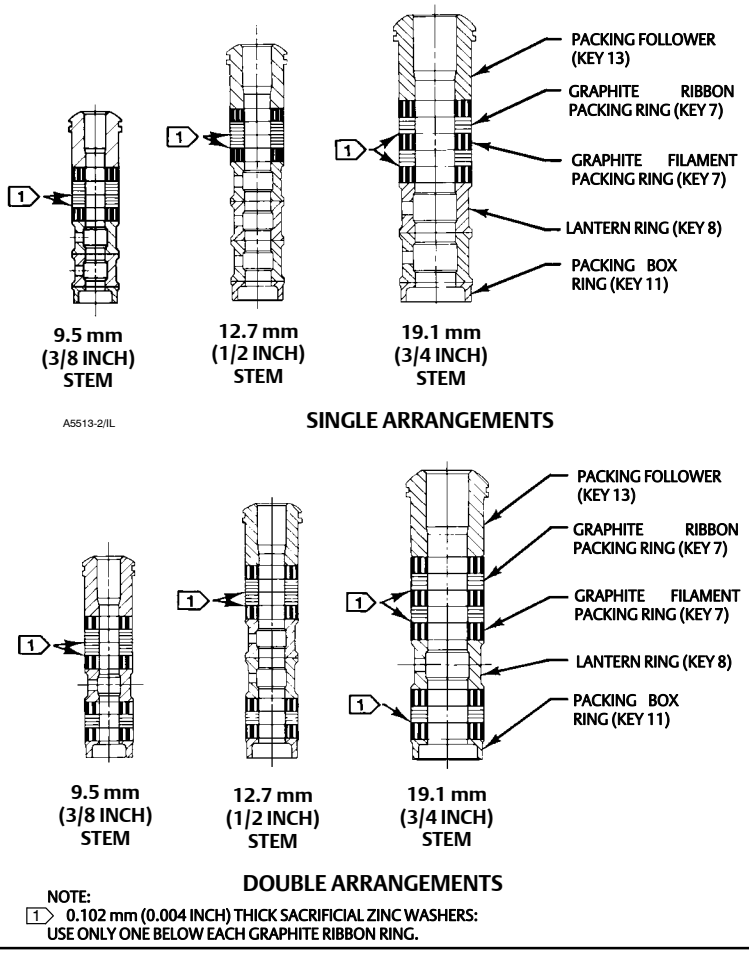
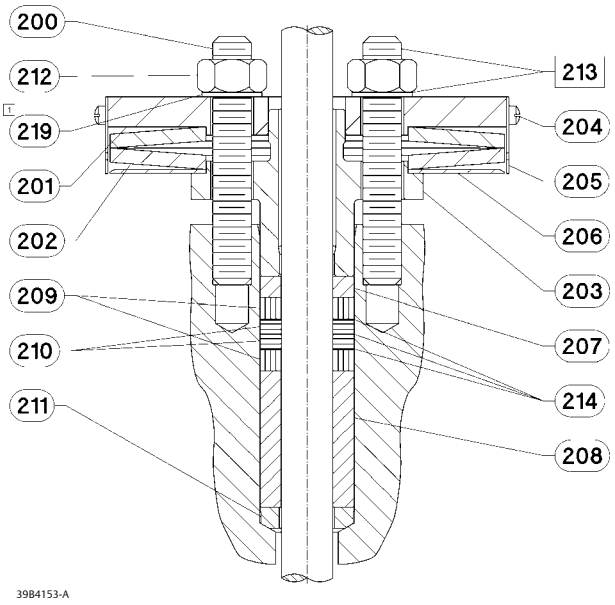


Table 2. Body-to-Bonnet Torque Guidelines

VALVE SIZE, NPS	TORQUES(1, 3)			
EZ	Bolt Material			
	SA193-B7		SA193-B8M(2)	
	N•m	Lbf•ft	N•m	Lbf•ft
1 or smaller	129	95	64	47
1-1/2 or 2	96	71	45	33
3	169	125	88	65
4	271	200	156	115

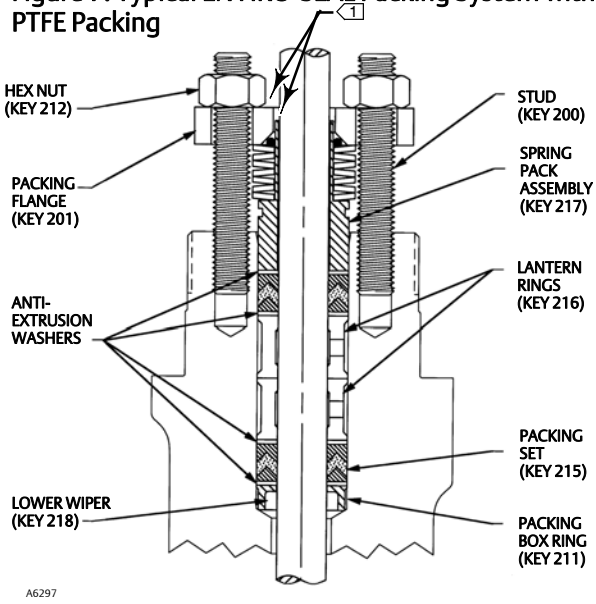
1. Determined from laboratory tests.
2. SA193-B8M annealed.
3. For other materials, contact your Emerson Process Management sales office for torques.

Figure 6. Typical HIGH-SEAL Graphite ULF Packing System



1. Find number 219 not required with 3/8-inch stem

Figure 7. Typical ENVIRO-SEAL Packing System with PTFE Packing



Note:
1 For PTFE packing, tighten the packing box hex nuts until the top of the flange is even with the top of the sleeve on the follower (spring pack assembly).

Figure 8. Typical ENVIRO-SEAL Packing System with Graphite ULF Packing

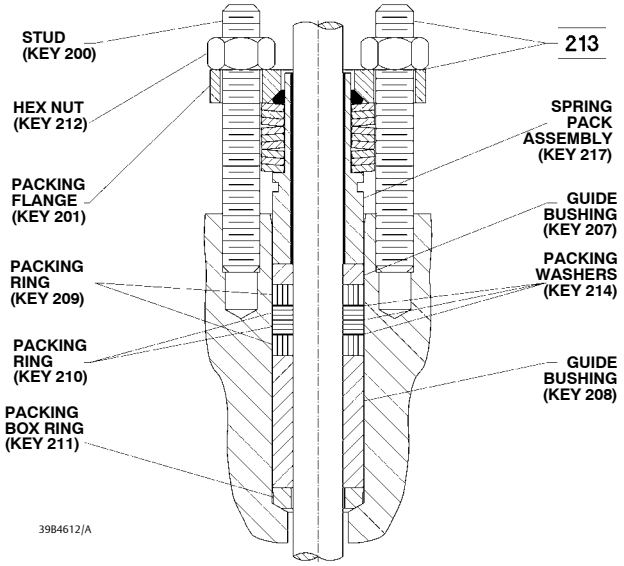
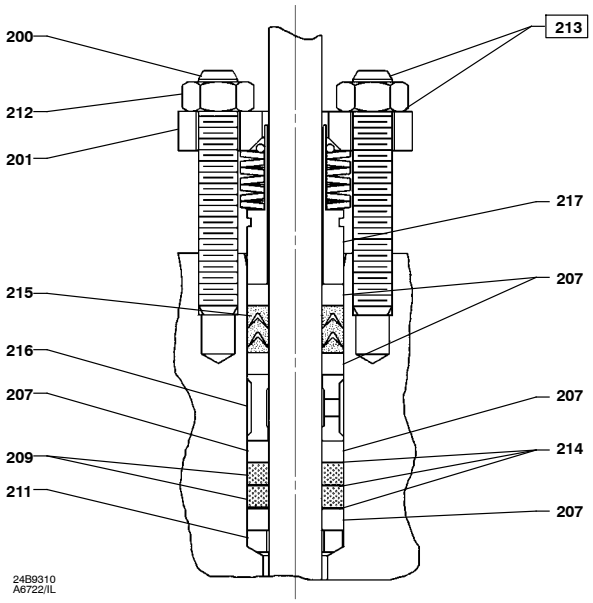


Figure 9. Typical ENVIRO-SEAL Packing System with Duplex Packing



Replacing Packing

⚠ WARNING

Observe the warning at the start of the Maintenance section.

This section covers replacing packing used in plain and extension bonnets. PTFE V-ring packing is shown in figure 3, PTFE/composition packing is shown in figure 4, and graphite/ribbon packing is shown in figure 5.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. If using a power actuator, also shut off all pressure lines to the power actuator, and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
2. Disconnect the operating lines from the actuator and any leak-off piping from the bonnet. Disconnect the stem connector and then remove the actuator from the valve by unscrewing the yoke locknut (key 15, figure 11).

⚠ WARNING

To avoid personal injury or property damage caused by uncontrolled movement of the bonnet, loosen the bonnet by following the instructions in the next step. Do not remove a stuck bonnet by pulling on it with equipment that can stretch or store energy in any other manner. The sudden release of stored energy can cause uncontrolled movement of the bonnet. If the seat ring retainer sticks to the bonnet, proceed carefully with bonnet removal.

Note

The following step also provides additional assurance that the valve body fluid pressure has been relieved.

3. Hex nuts (key 16, figure 11) attach the bonnet to the valve. Loosen these nuts or cap screws approximately 3 mm (1/8-inch). Then loosen the body-to-bonnet gasketed joint by either rocking the bonnet or prying between the bonnet and valve body. Work the prying tool around the bonnet until the bonnet loosens.
4. Loosen the packing flange nuts (key 5, figure 11) so that the packing is not tight on the valve stem. Remove any travel indicator parts and stem locknuts from the valve stem threads.

CAUTION

Avoid damaging the seating surface caused by the valve plug and stem assembly dropping from the bonnet after being lifted part way out. When lifting the bonnet, temporarily install a valve stem locknut on the valve stem. This locknut will prevent the valve plug and stem assembly from dropping out of the bonnet.

5. Completely remove the cap screws (not shown) or hex nuts (key 16, figure 12) that bolt the bonnet and valve body together and carefully lift the bonnet off.
6. Remove the locknut and separate the valve plug and stem from the bonnet. Set the parts on a protective surface to prevent damage to gasket or seating surfaces.
7. Remove the bonnet gasket (key 10, figure 12) and cover the opening in the valve to protect the gasket surface and to prevent foreign material from getting into the valve body cavity.
8. Remove the packing flange nuts, packing flange, upper wiper, and packing follower (keys 5, 3, 12, and 13, figure 11). Carefully push out all the remaining packing parts from the valve side of the bonnet using a rounded rod or other tool that will not scratch the packing box wall. Clean the packing box and the metal packing parts.
9. Inspect the valve stem threads and the packing box surfaces for any sharp edges which might cut the packing. Scratches or burrs could cause packing box leakage or damage to the new packing. If the surface condition cannot be improved by light sanding, replace the damaged parts.
10. Remove the covering protecting the valve cavity and install a new bonnet gasket (key 10, figure 12), making sure the gasket seating surfaces are clean and smooth. Then slide the bonnet over the stem and onto the stud bolts (key 15, figure 12), or onto the valve cavity if cap screws (not shown) are used instead.

Note

Proper performance of the tightening procedures in step 11 compresses the spiral wound gasket (key 12, figure 12) enough to both load and seal the seat ring gasket (key 13, figure 12). The tightening procedures also compresses the outer edge of the bonnet gasket (key 10, figure 12) enough to seal the body-to-bonnet joint.

The accepted bolting procedures referred to in step 11 include--but are not limited to--ensuring that bolting threads are clean, and evenly tightening the cap screws, or the nuts onto the studs, in a crisscross pattern. Because of the boltup characteristics of spiral wound gaskets, tightening one cap screw or nut may loosen an adjacent cap screw or nut. Repeat the crisscross tightening pattern several times until each cap screw or nut is tight and the body-to-bonnet seal is made. When the operating temperature has been reached, perform this torquing procedure once again.

Note

Stud(s) and nut(s) should be installed such that the manufacturer's trademark and material grade marking is visible, allowing easy comparison to the materials selected and documented in the Emerson/Fisher serial card provided with this product.

⚠ WARNING

Personal injury or damage to equipment could occur if improper stud and nut materials or parts are used. Do not operate or assemble this product with stud(s) and nut(s) that are not approved by Emerson/Fisher engineering and/or listed on the

serial card provided with this product. Use of unapproved materials and parts could lead to stresses exceeding the design or code limits intended for this particular service. Install studs with the material grade and manufacturer's identification mark visible. Contact your Emerson Process Management representative immediately if a discrepancy between actual parts and approved parts is suspected.

11. Install bolting, using accepted bolting procedures during tightening so that the body-to-bonnet joint can withstand test pressures and application service conditions. The bolt torques in table 2 may be used as guidelines unless accepted bolting procedures dictate otherwise.
12. Install new packing and the metal packing box parts according to the appropriate arrangement in figure 3, 4, or 5. If split-ring packing is being added, alternate the position of the splits to avoid a leak path. Place a smooth-edged pipe over the valve stem and gently tap each soft packing part into the packing box, being sure that air is not trapped between adjacent soft parts.

Installation of graphite ribbon packing requires special care to avoid trapping air between the rings. Start with only one ring at a time without forcing the top of the packing ring below the bottom of the entrance chamfer of the packing box. Thus, when a ring is added, the stack should not be pushed into the cavity more than the thickness of the added ring.

13. Slide the packing follower, upper wiper, and packing flange (keys 13, 12, and 3, figure 11) into position. Lubricate the packing flange studs (key 4, figure 11) and the faces of the packing flange nuts (key 5, figure 11). Install the packing flange nuts.

Note

The torque values discussed in step 14 and shown in table 3 are recommended guidelines only and are presented as a starting point for this procedure. Tightening the packing flange nuts to a torque value that exceeds the table guidelines, in order to obtain a seal, may indicate other problems.

14. **For spring-loaded PTFE V-ring packing,** tighten the packing flange nuts until the shoulder on the packing follower (key 13, figure 11) contacts the bonnet.

For graphite packing, tighten the packing flange nuts to the maximum recommended torque shown in table 3. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 3.

For other packing types, tighten the packing flange nuts alternately in small equal increments until one of the nuts reaches the minimum recommended torque shown in table 3. Then, tighten the remaining flange nuts until the packing flange is level and at a 90-degree angle to the valve stem.

For ENVIRO-SEAL or HIGH-SEAL live-loaded packing, refer to the note at the beginning of the Maintenance section on page 5 of this manual.

15. Mount the actuator on the valve body and reconnect the actuator and valve stem according to the procedure in the appropriate actuator instruction manual.

Table 3. Recommended Torque for Packing Flange Nuts (Not for Spring-Loaded Packing)

VALVE STEM DIAMETER		PRESSURE RATING	GRAPHITE TYPE PACKING				PTFE TYPE PACKING			
			Minimum Torque		Maximum Torque		Minimum Torque		Maximum Torque	
mm	Inches		N•m	Lbf•in	N•m	Lbf•in	N•m	Lbf•in	N•m	Lbf•in
9.5	3/8	CL125, CL150	3	27	5	40	1	13	2	19
		CL250 CL300	4	36	6	53	2	17	3	26
		CL600	6	49	8	73	3	23	4	35
12.7	1/2	CL125, CL150	5	44	8	66	2	21	4	31
		CL250 CL300	7	59	10	88	3	28	5	42
		CL600	9	81	14	122	4	39	7	58
19.1	3/4	CL125, CL150	11	99	17	149	5	47	8	70
		CL250 CL300	15	133	23	199	7	64	11	95
		CL600	21	182	31	274	10	87	15	131

Trim Maintenance

⚠ WARNING

Observe the warning at the start of the Maintenance section.

This procedure describes how the valve trim can be completely disassembled. When inspection or repairs are required, perform only those steps necessary to accomplish the task.

Disassembly

Except where indicated, key numbers referenced in the following steps are found in figure 12.

1. Remove the actuator and the bonnet according to steps 1 through 6 of the Replacing Packing procedure of the Maintenance section.

⚠ WARNING

Avoid personal injury or property damage from valve or packing leakage.

Any damage to the gasket sealing surfaces could cause the valve to leak.

The surface finish of the valve stem (key 7) is critical for making a good packing seal. The inside surface of the seat ring retainer is critical for smooth operation of the valve plug.

The seating surfaces of the valve plug and seat ring (keys 2 and 9) are critical for proper shutoff.

Protect these parts accordingly while disassembling the trim. Gasket selection criteria is provided on page 38 of this instruction manual.

2. Packing parts can be removed if desired. Replace these parts as described in the Replacing Packing procedure.

Valves with Plain or Extension Bonnets

Perform the following steps to remove the valve trim.

1. Lift the valve plug and stem assembly [or the plug guide, disk retainer, and disk (keys 27, 28, and 29, figure 13) if used], out of the valve body and set it on a protective surface.

Note

With some valve plug sizes and configurations, the seat ring retainer and bushing assembly (keys 3 and 26, figures 12 and 13) will come out of the valve body with the valve plug and stem assembly, and in other valve plug sizes and configurations, the valve plug or tip will slide through the seat ring retainer and bushing assembly, leaving the retainer and bushing assembly in the valve body.

2. With the valve plug and stem assembly out of the valve, either slide the seat ring retainer and bushing assembly (keys 3 and 26), and gaskets and shim (keys 10, 12, and 25) up over the valve plug and stem or lift the seat ring retainer and bushing assembly and associated gaskets and shim out of the valve body. If the valve plug is to be reused, protect the valve plug seating surface to prevent scratches.
3. **For valves with metal seats,** drive out the pin (key 8) and unscrew the valve stem (key 7) from the valve plug (key 2).
4. **For valves with 0.25 and 0.375-inch ports and composition seats,** refer to figure 13. Drive out the pin (key 8) and unscrew the valve stem (key 7) from the valve plug guide (key 27). Unscrew the disk retainer (key 28) from the valve plug guide. Remove the disk (key 29) from the valve plug tip (key 30).

For valves with 0.5 through 2-inch ports and composition seats, refer to figure 13. Drive out the pin (key 8) and unscrew the valve stem (key 7) from the valve plug guide (key 27). Drive out pin (key 31) and unscrew the tip (key 30) from the valve plug guide. Remove the disk (key 29) from the valve plug guide.

For valves with 3 and 4-inch ports and composition seats, refer to figure 13. Drive out the pin (key 8) and unscrew the valve stem from the valve plug guide (key 27). Remove the cap screw (key 32) to remove the tip (key 30) from the valve plug guide. Remove the disk (key 29).

5. Remove the seat ring and seat ring gasket (keys 9 and 13).
6. Inspect parts for wear or damage that would prevent proper operation of the valve. Replace or repair trim parts according to the following Lapping Metal Seats or Assembly procedure as appropriate.

Valves with Overtravel (EZ-OVT) Trim

Perform the following steps to remove the valve trim.

1. Lift the bonnet flat sheet gasket, gasket shim, and spiral wound gasket (keys 10, 25, and 12) from the valve body. Discard the old gaskets.
2. Lift the valve plug and stem assembly (key 30, figure 13) out of the valve body and set it on a protective surface.

Note

The seat ring retainer and bushing assembly (keys 3 and 26) will come out of the valve body with the valve plug and stem assembly.

3. Lift the seat ring (key 9) out of the valve body. There will be a flat sheet gasket located between the seat ring and valve body shelf (key 13). If the gasket does not come out of the valve body with the seat ring, be sure to remove the gasket from the valve body. Discard the gasket and tape or otherwise protect the seating surface of the seat ring to prevent damage.
4. Inspect all parts for wear and damage which would prevent proper operation of the valve. All gasket surfaces on the trim parts and in the valve body must be cleaned of any graphite residue and must be free from nicks and scratches.

The seating surfaces of the valve plug post and seat ring must be free from nicks, scratches, or any other damage which could affect the proper shutoff. Replace or repair trim parts as appropriate.

Note

If the soft seat disk is damaged, the entire plug assembly must be replaced.

Valves with ENVIRO-SEAL Bellows Seal Bonnets

Perform the following steps to remove the valve trim.

1. Lift the stem/bellows assembly with valve plug attached [or the plug guide, disk retainer, and disk (keys 27, 28, and 29, figure 13) if used], seat ring retainer and gaskets out of the valve body and set them on a protective surface.

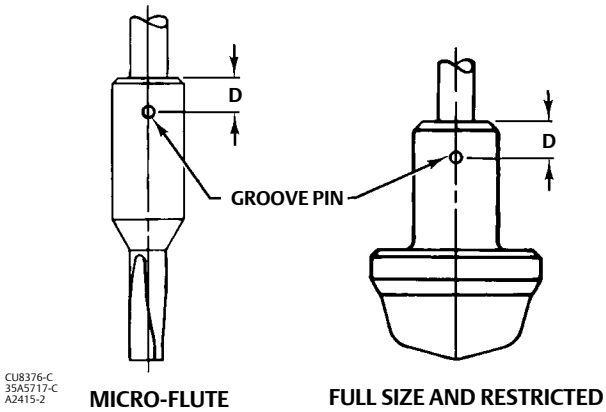
Note

With some valve plug sizes and configurations, the seat ring retainer and bushing assembly (keys 3 and 26, figures 12 and 13) will come out of the valve body with the stem/bellows, and in other valve plug sizes and configurations, the valve plug or tip will slide through the seat ring retainer and bushing assembly, leaving the retainer and bushing assembly in the valve body.

2. If the seat ring retainer and bushing assembly (keys 3 and 26) stayed in the valve, lift them out along with gaskets and shim (keys 10, 12, and 25).
3. If the seat ring retainer and bushing assembly (keys 3 and 26) came out of the valve with the stem/bellows assembly, move the seat ring retainer and bushing assembly against the shoulder of the valve plug (key 2) or valve plug guide (key 27, figure 13) to provide access to the pin (key 36, figure 11).

VALVE STEM		BOLT TORQUE		DRILL SIZE, INCH	D DIMENSION	
mm	Inch	N•m	Lbf•ft		mm	Inch
9.5	3/8	40-47	25-35	3/32	16	0.625
12.7	1/2	81-115	60-85	1/8	19	0.75
19.0	3/4	237-339	175-250	3/16	25	1

Figure 10. Bolt Torque for Plug/Stem Connection and Plug/Adaptor Connection and Pin Replacement



4. Place the stem/bellows assembly and valve plug or valve plug guide in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug or valve plug guide that is not a seating or guiding surface. Drive out the pin (key 36, figure 11).

5. Remove the stem/bellows assembly from the soft-jaw chuck or vise. Place a wrench on the flat areas on the valve stem just below the threads for the actuator/stem connection to keep the stem from turning. Then, unscrew the adaptor (key 24, figure 11), which also includes the valve plug (key 2) or valve plug guide (key 27, figure 13), from the stem/bellows assembly (key 20, figure 11).
6. Remove the seat ring retainer and bushing assembly (keys 3 and 26) by sliding it over the adaptor. If the valve plug is to be reused, protect the valve plug seating surface to prevent scratches.
7. **For valves with metal seats,** drive out the pin (key 8) and unscrew the adaptor (key 24, figure 11) from the valve plug (key 2).
8. **For valves with 0.25 and 0.375-inch ports and composition seats, refer to figure 13.** Drive out the pin (key 8) and unscrew the adaptor (key 24, figure 11) from the valve plug guide (key 27). Unscrew the disk retainer (key 28) from the valve plug guide. Remove the disk (key 29) from the valve plug tip (key 30).

For valves with 0.5 through 2-inch ports and composition seats, refer to figure 13. Drive out the pin (key 8) and unscrew the adaptor (key 24, figure 11) from the valve plug guide (key 27). Drive out the pin (key 31) and unscrew the tip (key 30) from the valve plug guide. Remove the disk (key 29) from the valve plug guide.

For valves with 3 and 4-inch ports and composition seats, refer to figure 13. Drive out the pin (key 8) and unscrew the adaptor (key 24, figure 11) from the valve plug guide (key 27). Remove the cap screw (key 32) to remove the tip (key 30) from the valve plug guide. Remove the disk (key 29).

9. Remove the seat ring and seat ring gasket (keys 9 and 13).
10. Inspect parts for wear or damage that would prevent proper operation of the valve. Replace or repair trim parts according to the following Assembly procedure as appropriate.

Lapping Metal Seats on Valves with Plain and Extension Bonnets

CAUTION

To avoid damaging the ENVIRO-SEAL Bellows Seal Bonnet assembly, do not attempt to lap the metal seating surfaces on valves with ENVIRO-SEAL bellows seal bonnets. The design of the bonnet assembly prevents rotation of the stem and any forced lapping rotation will damage internal components of the ENVIRO-SEAL Bellows Seal bonnet.

With metal-seat constructions, seating surfaces of the valve plug and seat ring (key 2, figure 12) can be lapped for improved shutoff. (Deep nicks should be machined out rather than ground out.) Use a good quality lapping compound of a mixture of 280 to 600-grit. Apply the compound to the bottom of the valve plug.

Assemble the valve to the extent that the seat ring retainer is in place and the bonnet is bolted to the valve body. A simple handle can be made from a piece of strap iron locked to the valve plug stem with nuts. Rotate the handle alternately in each direction to lap the seats. After lapping, remove the bonnet and clean the seat surfaces. Completely assemble as described in the assembly portion of the Trim Maintenance procedure and test the valve for shutoff. Repeat the lapping procedure if leakage is still excessive.

Note

EZ valves with Overtravel (EZ-OVT) trim should not be lapped.

Assembly

This procedure assumes that all the trim and associated gaskets were removed from the valve body. If these parts were not all removed, start the assembly procedure at the appropriate step. Except where indicated, key numbers referenced in the following steps are found in figure 12.

Valves with Plain or Extension Bonnets

Perform the following steps to assemble and install the trim.

CAUTION

To avoid weakening the stem that may cause failure in service, never reuse an old stem with a new valve plug. Using an old stem with a new plug requires drilling a new pin hole in the stem,which will weaken the stem. However, a used valve plug may be reused with a new stem.

1. For valves with metal seats, screw the valve stem (key 7) into the valve plug (key 2). Tighten to the torque value given in figure 10. Refer to figure 10 to select the proper drill size. Drill through the stem using the hole in the valve plug as a guide. Remove any chips or burrs and drive in a new pin (key 8) to lock the assembly.
2. For valves with 0.25 and 0.375-inch ports and composition seats, refer to figure 13. Place the disk (key 29) on the valve plug tip (key 30). Place the disk retainer (key 28) over the disk, and then thread the disk retainer onto the valve plug guide (key 27).

CAUTION

To avoid failure in service for valves with 0.5 through 1-inch ports and composition seats, never reuse an old valve plug guide with a new valve plug tip. Using an old valve plug guide with a new plug tip requires drilling a new pin hole in the valve plug guide, which will weaken the guide. However, a used valve plug tip may be reused with a new valve plug guide.

For valves with 0.5 through 1-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Screw the tip (key 30) onto the valve plug guide to clamp the disk in place. Using a 3/32-inch bit, drill through the valve plug guide using the hole in the tip as a drilling guide. Remove any chips or burrs and drive in a new pin (key 31).

CAUTION

To avoid failure in service for valves with 1.5 and 2-inch ports and composition seats, never reuse an old valve plug tip with a new valve plug guide. Using an old valve plug tip with a new valve plug guide requires drilling a new pin hole in the valve plug tip which will weaken the tip. However, a used valve plug guide may be reused with a new valve plug tip.

For valves with 1.5 and 2-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Screw the tip (key 30) into the valve plug guide to clamp the disk in place. Using a 3/32-inch bit, drill through the valve plug tip using the hole in the valve plug guide as a drilling guide. Remove any chips or burrs and drive in a new pin (key 31).

For valves with 3 and 4-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Place the tip (key 30) against the valve plug guide to clamp the disk in place. Insert the cap screw (key 32) through the tip and thread it into valve plug guide to secure the tip to the valve plug guide.

CAUTION

To avoid failure in service, never reuse an old stem with a new valve plug guide. Using an old stem with a new valve plug guide requires drilling a new pin hole in the stem, which will weaken the stem. However, a used valve plug guide may be

reused with a new stem except for valves with 0.5 through 1-inch ports and composition seats (see to figure 13). For these constructions, a used valve plug guide should only be used if the tip is reused.

3. **For all valves with composition seats,** screw the valve stem (key 7) into the valve plug guide (key 27, figure 13). Tighten to the torque value given in figure 10. Refer to figure 10 to select the proper drill size. Drill through the stem, using the hole in the valve plug guide as a drilling guide. Remove any chips or burrs and drive in a new pin (key 8) to lock the assembly.
4. Install the seat ring gasket (key 13), and replace the seat ring (key 9).

Note

With some valve plug sizes and configurations, the valve plug or tip will slide through the seat ring retainer and bushing assembly (keys 3 and 26), and in other configurations it won't.

5. If the valve plug (key 2) or valve plug tip (key 30, figure 13) will not slide through the seat ring retainer and bushing assembly (keys 3 and 26), proceed as follows:
   a. Place the seat ring retainer and bushing assembly (keys 3 and 26) over the stem of valve plug and stem assembly or over the stem of the valve plug guide and stem assembly.
   b. Install the seat ring retainer and bushing assembly, which also includes the valve plug and stem assembly or valve plug guide and stem assembly, on the top of the seat ring, ensuring that the seat ring retainer slips onto the seat ring properly. Any rotation orientation of the seat ring retainer with respect to the valve body is acceptable.
   c. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10) on the shoulder of the seat ring retainer.
6. If the valve plug (key 2) or the valve plug tip (key 30, figure 13) will slide through the seat ring retainer and bushing assembly (keys 3 and 26), proceed as follows:
   a. Install the seat ring retainer and bushing assembly on the top of the seat ring, ensuring that the seat ring retainer slips onto the seat ring properly. Any rotation orientation of the seat ring retainer with respect to the valve body is acceptable.
   b. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10) on the shoulder of the seat ring retainer.
   c. Slide the valve plug and stem assembly or the valve plug guide and stem assembly into the seat ring retainer and bushing assembly (keys 3 and 26).
7. Mount the bonnet on the valve body and complete the assembly according to steps 10 through 15 of the Replacing Packing procedure, omitting steps 12 and 13 if new packing is not being installed, and being sure to observe the note prior to step 11.

Valves with Overtravel (EZ-OVT) Trim

Perform the following steps to assemble and install the trim

1. Install the seat ring gasket (key 13) and replace the seat ring (key 9).
2. Place the seat ring retainer and bushing assembly (key 3) over the stem of the valve plug and stem assembly (key 30, figure 13).
3. Install the seat ring retainer and bushing assembly, which also includes the valve plug and stem assembly, on top of the seat ring. Ensure that the seat ring retainer slips onto the seat ring properly. Any rotation orientation of the seat ring retainer with respect to the valve body is acceptable.

4. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, 10) on the shoulder of the seat ring retainer.
5. Mount the bonnet on the valve body and complete the assembly according to steps 10 through 15 of the Replacing Packing procedure, omitting steps 12 and 13 if new packing is not being installed. Be sure to observe the note prior to step 11.

Note

When connecting the valve stem to the stem connecting block on the actuator, extra stem force is required on the valve plug to ensure proper seating of the plug to the seat ring. This is required to deform the soft seat disk ensuring a backup metal-to-metal mating surface between the valve plug guide post and the seat ring.

Valves with ENVIRO-SEAL Bellows Seal Bonnets

Perform the following steps to assemble and install the trim.

1. **For valves with 0.25 and 0.375-inch ports and composition seats, refer to figure 13.** Place the disk (key 29) on the valve plug tip (key 30). Place the disk retainer (key 28) over the disk, and then thread the disk retainer onto the valve plug guide (key 27).

CAUTION

To avoid failure in service of valves with 0.5 through 1-inch ports and composition seats, never reuse an old valve plug guide with a new valve plug tip. Using an old valve plug guide with a new plug tip requires drilling a new pin hole in the valve plug guide, which will weaken the guide. However, a used valve plug tip may be reused with a new valve plug guide.

For valves with 0.5 through 1-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Screw the tip (key 30) onto the valve plug guide to clamp the disk in place. Using a 3/32-inch bit, drill through the valve plug guide using the hole in the tip as a drilling guide. Remove any chips or burrs and drive in a new pin (key 31).

CAUTION

To avoid failure in service of valves with 1.5 and 2-inch ports and composition seats, never reuse an old valve plug tip with a new valve plug guide. Using an old valve plug tip with a new valve plug guide requires drilling a new pin hole in the valve plug tip, which will weaken the tip. However, a used valve plug guide may be reused with a new valve plug tip.

For valves with 1.5 and 2-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Screw the tip (key 30) into the valve plug guide to clamp the disk in place. Using a 3/32-inch bit, drill through the valve plug tip using the hole in the valve plug guide as a drilling guide. Remove any chips or burrs and drive in a new pin (key 31).

For valves with 3 and 4-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Place the tip (key 30) against the valve plug guide to clamp the disk in place. Insert the cap screw (key 32) through the tip and thread it into valve plug guide to secure the tip to the valve plug guide.

CAUTION

To avoid weakening the adaptor that may cause failure in service, never reuse an old adaptor with a new valve plug or valve plug guide. Using an old adaptor with a new valve plug or valve plug guide requires drilling a new pin hole in the adaptor, which will weaken the adaptor. However, a used valve plug or valve plug guide may be reused with a new adaptor.

2. Thread the valve plug (key 2) or, the valve plug guide (key 27, figure 13) if the valve has composition seats, onto the adaptor (key 24, figure 11). Tighten to the torque valve given in figure 10.

Note

Valve plugs may not be pre-drilled. Follow the procedure in the following step.

3. If the valve plug is not pre-drilled, drill a hole according to figure 10. Otherwise, select the proper drill size (figure 10) and drill through the adaptor using the hole in the valve plug as a guide. Remove any chips or burrs and drive in a new pin (key 8) to lock the assembly.

Note

With some valve plug sizes and configurations, the valve plug or tip will slide through the seat ring retainer and bushing assembly, and in other configurations it won't.

4. If the valve plug (key 2) or valve plug tip (key 30, figure 13) will not slide through the seat ring retainer and bushing assembly (keys 3 and 26), proceed as follows:

   a. Slide the seat ring retainer and bushing assembly (keys 3 and 26) over the adaptor (key 24, figure 11) so that the bushing rests on the shoulder of the valve plug or valve plug guide.

   b. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10) on the shoulder of the seat ring retainer.

   c. Place a wrench on the flat areas of the stem just below the threads for the actuator/stem connection to keep the stem from turning.

   d. Screw the adaptor (key 24, figure 11), which also includes the valve plug or valve plug guide and seat ring retainer and bushing assembly and gaskets, onto the stem/bellows assembly (key 20, figure 11). Tighten the adaptor until it is snug. Then, turn the adaptor until the valve stem hole lines up with the next adaptor pin hole. Drive in a new pin (key 36) to lock the assembly.

   e. Install the seat ring gasket (key 13), and replace the seat ring (key 9).

   f. Install the seat ring retainer and bushing assembly, which also contains the valve plug/adaptor assembly or valve plug guide/adaptor assembly, on the top of the seat ring, ensuring that the seat ring retainer slips onto the seat ring properly. Any rotation orientation of the seat ring retainer with respect to the valve body is acceptable.

   g. Place a new gasket (key 22, figure 11) over the stem and bellows assembly.

5. If the valve plug (key 2) or the valve plug tip (key 30, figure 13) will slide through the seat ring retainer and bushing assembly (keys 3 and 26), proceed as follows:

   a. Place a wrench on the flat areas of the stem just below the threads for the actuator/stem connection to keep the stem from turning.

   b. Screw the adaptor (key 24, figure 11), which also includes the valve plug or valve plug guide onto the stem/bellows assembly (key 20, figure 11). Tighten the adaptor until it is snug. Then, turn the adaptor until the valve stem hole lines up with the next adaptor pin hole. Drive in a new pin (key 36) to lock the assembly.

   c. Install the seat ring gasket (key 13), and replace the seat ring (key 9).

d. Install the seat ring retainer and bushing assembly on the top of the seat ring, ensuring that the seat ring retainer slips onto the seat ring properly. Any rotation orientation of the seat ring retainer with respect to the valve body is acceptable.

e. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10) on the shoulder of the seat ring retainer.

f. Slide the valve plug/adaptor assembly or the valve plug guide/adaptor assembly and the connected stem and bellows assembly into the seat ring retainer and bushing assembly (keys 3 and 26).

g. Place a new gasket (key 22, figure 11) over the stem and bellows assembly.

6. Mount the bonnet on the valve body and complete the assembly according to steps 10 through 15 of the Replacing Packing procedure, omitting steps 12 and 13 if new packing is not being installed, and being sure to observe the note prior to step 11.

ENVIRO-SEAL Bellows Seal and Bonnet

Replacing a Plain or Extension Bonnet with an ENVIRO-SEAL Bellows Seal (Stem/Bellows Assembly) and Bonnet

Instructions are provided for replacing a plain or extension bonnet with an ENVIRO-SEAL bellows seal bonnet when the existing valve has a metal seat. If the valve has a composition seat, refer to figure 13 and to composition seat information in the Valves with ENVIRO-SEAL Bellows Seal Bonnet procedure of the Trim Maintenance section.

1. Remove the actuator and bonnet according to steps 1 through 6 of the Replacing Packing procedure of the Maintenance section.

Note

With some valve plug sizes and configurations, the valve plug will slide through the seat ring retainer and bushing assembly, and in other configurations it won't. If the valve plug will not slide through the seat ring retainer and bushing assembly, then the valve plug and stem assembly and the seat ring retainer and bushing assembly must be removed together.

2. Using care, remove the valve plug and stem assembly, and, if necessary, the seat ring retainer and bushing assembly from the valve body.
3. Remove and discard the existing bonnet gasket (key 10, figure 12). Cover the valve body opening to protect sealing surfaces and to prevent foreign material from entering the valve body cavity.

Note

The ENVIRO-SEAL stem/bellows assembly for easy-e valves is available only with a threaded and drilled plug/adaptor connection. The existing valve plug can be reused with the new stem/bellows assembly or a new plug can be installed.

4. Inspect the existing valve plug. If the plug is in good condition, it can be reused with the new ENVIRO-SEAL stem/bellows assembly. To remove the existing valve plug from the stem, first, place the existing plug stem assembly in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out or drill out the pin (key 8, figure 12).
5. Place a wrench on the flat areas on the existing valve stem just below the threads for the actuator/stem connection. Then, unscrew the stem from the valve plug (key 2, figure 12).

CAUTION

When installing a valve plug on the ENVIRO-SEAL stem/bellows assembly, the valve stem must not be rotated. Damage to the bellows may result.

Do not grip the bellows shroud or other parts of the stem/bellows assembly. Grip only the flat areas on the stem where it extends out of the top of the bellows shroud.

Note

The ENVIRO-SEAL stem/bellows assembly has a one-piece stem.

Table 4. Recommended Torque for ENVIRO-SEAL Bellows Seal Packing Flange Nuts

VALVE SIZE, NPS	VALVE STEM DIAMETER THROUGH PACKING	MINIMUM TORQUE		MAXIMUM TORQUE	
		N•m	Lbf•in	N•m	Lbf•in
1/2 - 2	1/2	2	22	4	33
3 -4	1	5	44	8	67

6. To attach the valve plug to the stem of the new ENVIRO-SEAL stem/bellows assembly, it is necessary to first attach the valve plug to the adaptor (key 24, figure 11). Locate the adaptor. Notice that a hole has not been drilled in the adaptor threads where the valve plug screws onto the adaptor.

Secure the valve plug in a soft-jaw chuck or other type of vise. Do not grip the plug on any seating surface. Position the plug in the chuck or vise for easy threading of the adaptor. Thread the adaptor into the valve plug and tighten to the torque value given in figure 10.

Note

Valve plugs may not be pre-drilled. Follow the procedure in the following step.

7. If the valve plug is not pre-drilled, drill a hole according to figure 10. Otherwise, select the proper size of drill bit (figure 10) and drill through the adaptor using the hole in the valve plug as a guide. Remove any metal chips or burrs and drive in a new pin (key 8, figure 12) to lock the valve plug/adaptor assembly together.

Note

For some valve plug configurations, you must place the valve plug/adaptor assembly inside the seat ring retainer and bushing assembly before attaching the adaptor to the stem extending from the bottom of the ENVIRO-SEAL stem/bellows assembly. If this task is necessary, then place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10, figure 12) on the shoulder of the seat ring retainer. Check the existing seat ring retainer and bushing assembly for clearances. If necessary, use appropriate procedures to support the seat ring retainer while screwing the valve plug/adaptor assembly onto the valve stem extending from the ENVIRO-SEAL stem/bellows assembly.

8. Place a wrench on the flat areas of the valve stem just below the threads for the actuator/stem connection to keep the stem from turning.
9. Screw the adaptor (key 24, figure 11), which also includes the valve plug or valve plug guide and may include the seat ring retainer and bushing assembly and gaskets, onto the valve stem. Tighten the adaptor until it is

finger-tight. Then, tighten the adaptor with a wrench until the valve stem hole lines up with the next adaptor pin hole. Drive in a new pin (key 36, figure 11) to lock the assembly. Make certain the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10, figure 12) are located on the shoulder of the seat ring retainer.

10. Inspect the seat ring. Replace, if necessary.
11. Install the new stem/bellows assembly with valve plug/adaptor by placing it into the valve body.
12. Place a new gasket (key 22, figure 11) over the stem/bellows assembly. Place the new ENVIRO-SEAL bonnet over the stem/bellows assembly.

Note

Stud(s) and nut(s) should be installed such that the manufacturer's trademark and material grade marking is visible, allowing easy comparison to the materials selected and documented in the Emerson/Fisher serial card provided with this product.

⚠ WARNING

Personal injury or damage to equipment could occur if improper stud and nut materials or parts are used. Do not operate or assemble this product with stud(s) and nut(s) that are not approved by Emerson/Fisher engineering and/or listed on the serial card provided with this product. Use of unapproved materials and parts could lead to stresses exceeding the design or code limits intended for this particular service. Install studs with the material grade and manufacturer's identification mark visible. Contact your Emerson Process Management representative immediately if a discrepancy between actual parts and approved parts is suspected.

13. Properly lubricate the bonnet stud bolts. Install and tighten the bonnet hex nuts to the proper torque.
14. Install new packing and the metal packing box parts according to the appropriate arrangement in figure 14 or 15.
15. Install the packing flange. Properly lubricate the packing flange stud bolts and the faces of the packing flange nuts.

For graphite packing, tighten the packing flange nuts to the maximum recommended torque shown in table 4. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 4.

For other packing types, tighten the packing flange nuts alternately in small equal increments until one of the nuts reaches the minimum recommended torque shown in table 4. Then, tighten the remaining flange nuts until the packing flange is level and at a 90-degree angle to the valve stem.

16. Install travel indicator parts, stem locknuts, and mount the actuator on the valve body according to the procedure in the appropriate actuator instruction manual.

Replacing an Installed ENVIRO-SEAL Bellows Seal (Stem/Bellows Assembly)

Instructions are provided for replacing an ENVIRO-SEAL bellows seal (stem/bellows assembly) when the existing valve has a metal seat. If the valve has a composition seat, refer to figure 13 and to composition seat information in the Valves with ENVIRO-SEAL Bellows Seal Bonnet procedure of the Trim Maintenance section.

1. Remove the actuator and bonnet according to steps 1 through 5 of the Replacing Packing procedure of the Maintenance section.

Note

With some valve plug sizes and configurations, the valve plug will slide through the seat ring retainer and bushing assembly, and in other configurations it won't. If the valve plug will not slide through the seat ring retainer and bushing assembly, then the valve plug and stem assembly and the seat ring retainer and bushing assembly must be removed together.

2. Using care, remove the valve plug and stem assembly, and, if necessary, the seat ring retainer and bushing assembly from the valve body. Remove and discard the existing bonnet gasket (key 10, figure 12) and gasket (key 22, figure 11). Cover the valve body opening to protect sealing surfaces and to prevent foreign material from entering the valve body cavity.

CAUTION

The ENVIRO-SEAL stem/bellows assembly for easy-e valves is available only with a threaded and pinned adaptor/stem connection. The existing valve plug can be reused with the new stem/bellows assembly or a new plug can be installed. If the existing valve plug is reused, and the adaptor is in good condition, it may be reused also. However, to avoid weakening the adaptor that may cause failure in service, never reuse an old adaptor with a new valve plug. Using an old adaptor with a new plug requires drilling a new pin hole in the adaptor, which will weaken the adaptor. However, a used valve plug may be reused with a new adaptor.

3. Inspect the existing valve plug and adaptor. If they are in good condition, they can be reused with the new stem/bellows assembly, and they do not need to be separated.

CAUTION

When removing/installing a valve plug on the ENVIRO-SEAL stem/bellows assembly, the valve stem must not be rotated. Damage to the bellows may result.

Do not grip the bellows shroud or other parts of the stem/bellows assembly. Grip only the flat areas on the stem where it extends out of the top of the bellows shroud.

Note

The ENVIRO-SEAL stem/bellows assembly has a one-piece stem.

4. If the existing valve plug and adaptor are not in good condition and must be replaced, first, place the existing stem/bellows assembly and valve plug and adaptor assembly in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out or drill out pin (key 8, figure 12). Drive out pin (key 36, figure 11).
5. Use a wrench on the flat areas on the valve stem just below the threads for the actuator/stem connection in a soft-jaw chuck or vice to keep the stem from turning. Then, unscrew the valve plug from the adaptor and the adaptor from the stem/bellows assembly.
6. To attach either the existing valve plug or a new one to the stem of the new ENVIRO-SEAL stem/bellows assembly, it is necessary to first attach the valve plug to the adaptor (key 24, figure 11), if the valve plug was removed from the adaptor. Locate the adaptor. Notice that a hole has not been drilled in the new adaptor threads where the valve plug screws onto the adaptor.

If installing either a new valve plug and/or a new adaptor, secure the valve plug in a soft-jaw chuck or other type of vise. Do not grip the plug on any seating surface. Position the plug in the chuck or vise for easy threading of the adaptor. Thread the adaptor into the valve plug and tighten to the torque values given in figure 10.

7. Complete the installation by following steps 7 through 16 of the Replacing a Plain or Extension Bonnet with an ENVIRO-SEAL Bellows Seal and Bonnet procedure provided in the previous section.

Purging the ENVIRO-SEAL Bellows Seal Bonnet

The ENVIRO-SEAL bellows seal bonnet has been designed so that it can be purged or leak tested. Refer to figure 11 for an illustration of an ENVIRO-SEAL bellows seal bonnet, and perform the following steps for purging or leak testing.

1. Remove the two diametrically opposed pipe plugs (key 16).
2. Connect a purging fluid to one of the pipe plug connections.
3. Install appropriate piping or tubing in the other pipe plug connection to pipe away the purging fluid or to make a connection to an analyzer for leak testing.
4. When purging or leak testing has been completed, remove the piping or tubing and reinstall the pipe plugs (key 16).

Parts Ordering

Each valve is assigned a serial number which can be found on the valve body. This same number also appears on the actuator nameplate when the valve is shipped from the factory as part of a control valve assembly. Refer to the serial number when contacting your Emerson Process Management sales office for technical assistance. When ordering replacement parts, refer to the serial number and to the 11-character part number for each part required from the following parts list.

Parts Kits

Gasket parts kits are in key 10 table.

Packing Kits (non-live-loaded)

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)
PTFE (Contains keys 6, 8, 10, 11, and 12)	RPACKX00012	RPACKX00022	RPACKX00032
Double PTFE (Contains keys 6, 8, 11, and 12)	RPACKX00042(1)(2)	RPACKX00052(1)	RPACKX00062(1)
PTFE/Composition (Contains keys 7, 8, 11, and 12)	RPACKX00072	RPACKX00082	RPACKX00092
Single Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], 8, and 11)	RPACKX00102	RPACKX00112	RPACKX00122
Double Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], 8, and 11)	RPACKX00162	RPACKX00172	RPACKX00182

1. These parts kits contain one extra lower wiper (key 30). Discard this extra part upon assembly.
2. This parts kit contains one extra packing ring (key 7). Discard this extra part upon assembly.

Packing Kits (ENVIRO-SEAL) Repair

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)
Double PTFE (Contains keys 214, 215, and 218)	RPACKX00192	RPACKX00202	RPACKX00212
Graphite ULF (Contains keys 207, 208, 209, 210, and 214)	RPACKX00592	RPACKX00602	RPACKX00612
Duplex (Contains keys 207, 209, 214, and 215)	RPACKX00292	RPACKX00302	RPACKX00312

Packing Kits (ENVIRO-SEAL) Retrofit

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)
Double PTFE (Contains keys 200, 201, 211, 212, 214, 215, 216, 217, and 218)	RPACKXRT012	RPACKXRT022	RPACKXRT032
Graphite ULF (Contains keys 200, 201, 207, 208, 209, 210, 211, 212, 214, and 217)	RPACKXRT262	RPACKXRT272	RPACKXRT282
Duplex (Contains keys 200, 201, 207, 209, 211, 212, 214, 215, 216, and 217)	RPACKXRT212	RPACKXRT222	RPACKXRT232

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

Parts List

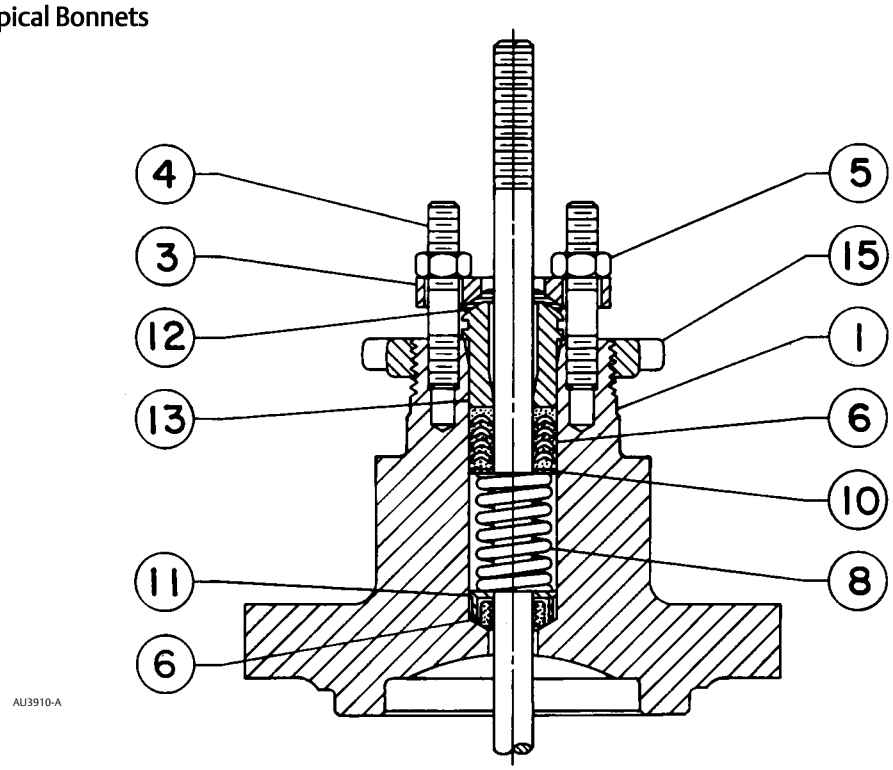
Bonnet

Note
Part numbers are shown for recommended spares only. For part numbers not shown, contact your Emerson Process Management sales office.

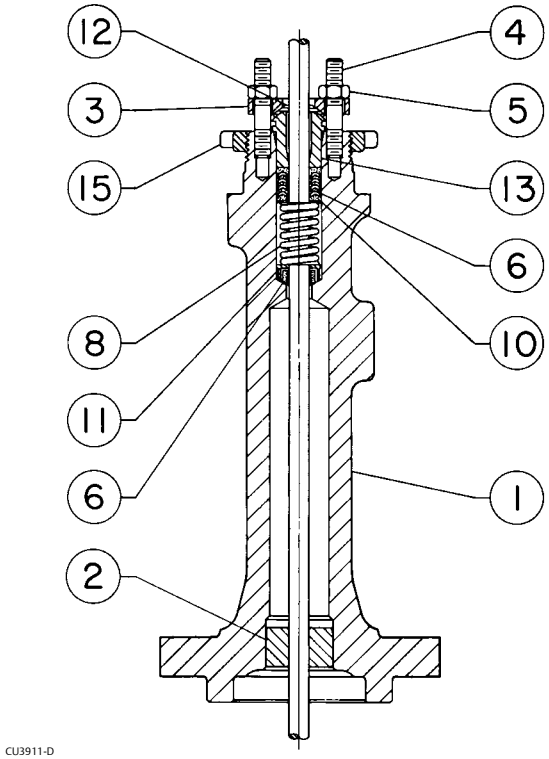
Key	Description	Part Number
1	Bonnet/ENVIRO-SEAL bellows seal bonnet	
	If you need a bonnet or an ENVIRO-SEAL bellows seal bonnet as a replacement part, order by valve size and stem diameter, serial number, and desired material.	
2	Baffle,(for extension bonnets only)	
3	Packing Flange, S31600 (316 SST)	
3	ENVIRO-SEAL Bellows Seal Packing Flange	
4	Packing Flange Stud, S31600 (2 req'd)	
4	ENVIRO-SEAL Bellows Seal Stud Bolt	
5	Packing Flange Nut, S31600 (2 req'd)	
5	ENVIRO-SEAL Bellows Seal Hex Nut	
6*	Packing Set, PTFE (2 req'd for double packing)	
	9.5 mm (3/8-inch) stem	1R290001012
	12.7 mm (1/2-inch) stem	1R290201012
	19.1 mm (3/4-inch) stem	1R290401012
6*	ENVIRO-SEAL Bellows Seal Packing Set	
	PTFE for 9.5 mm (3/8-inch) stem (1 req'd for single packing, 2 req'd for double packing)	12A9016X012
	PTFE for size 2 with 12.7 mm (1/2 inch) stem (2 req'd for double packing)	12A9016X012
	PTFE for size 3 and 4 with 12.7 mm (1/2 inch) stem (2 req'd for double packing)	12A8832X012
7*	Packing Ring, PTFE/comp (for double packing)	
	9.5 mm (3/8-inch) stem PTFE/comp (7 req'd)	1F3370X0012
	12.7 mm (1/2-inch) stem PTFE/comp (10 req'd)	1E319001042
	19.1 mm (3/4-inch) stem PTFE/comp (8 req'd)	1E319101042
7*	Packing Ring, graphite ribbon ring (2 req'd for single packing, 3 req'd for double packing)	
	9.5 mm (3/8-inch) stem	1V3160X0022
	12.7 mm (1/2-inch) stem	1V3802X0022
	19.1 mm (3/4-inch) stem	1V2396X0022
7*	Packing Ring, graphite filament ring	
	9.5 mm (3/8-inch) stem (2 req'd for single packing, 4 req'd for double packing)	1F3370X0322
	12.7 mm (1/2-inch) stem (3 req'd for single packing, 5 req'd for double packing)	1E3190X0222
	19.1 mm (3/4-inch) stem (2 req'd for single packing, 4 req'd for double packing)	1E3191X0282
7*	ENVIRO-SEAL Bellows Seal Packing Ring for low chloride graphite ribbon/filament packing arrangement	
	Ribbon packing ring for 9.5 mm (3/8 inch) and size 2 with 12.7 mm (1/2 inch) stem (4 req'd)	18A0908X012
	Filament packing ring for 9.5 mm (3/8 inch) and size 2 with 12.7 mm (1/2 inch) stem (4 req'd)	1P3905X0172
	Ribbon packing ring for size 3 and 4 with 12.7 mm (1/2 inch) stem (4 req'd)	18A0918X012
	Filament packing ring for size 3 and 4 with 12.7 mm (1/2 inch) stem (4 req'd)	14A0915X042
8	Spring, S31600 (for single PTFE packing only)	
8	Spacer, N04400 (for single PTFE packing only)	
8	Lantern Ring (for double PTFE packing)	
8	ENVIRO-SEAL Bellows Seal Spring	
8	ENVIRO-SEAL Bellows Seal Spacer	
10	Special Washer, S31600 (for single PTFE packing)	
11*	Packing Box Ring	
	Single PTFE packing	
	9.5 mm (3/8-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873135072
	N05500 (std for N05500 trim)	1J873146222
	12.7 mm (1/2-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873235072
	N05500 (std for N05500 trim)	1J873246222
	19.1 mm (3/4-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873335072
	N05500 (std for N05500 trim)	1J873346222
	Double PTFE packing	
	9.5 mm (3/8-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873135072
	Glass-filled PTFE (std for N05500 trim)	17A6872X012
	12.7 mm (1/2-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873235072
	Glass-filled PTFE (std for N05500 trim)	17A6873X012
	Double PTFE packing (cont'd)	
	19.1 mm (3/4-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873335072
	Glass-filled PTFE (std for N05500 trim)	17A6874X012
	PTFE/composition packing	
	9.5 mm (3/8-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873135072
	Glass-filled PTFE (std for N05500 trim)	17A6872X012
	12.7 mm (1/2-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873235072
	N05500 (std for N05500 trim)	1J873246222
	19.1 mm (3/4-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873335072
	Glass-filled PTFE (std for N05500 trim)	17A6874X012
12*	Upper Wiper, felt	
	9.5 mm (3/8-inch) stem	1J872606332
	12.7 mm (1/2-inch) stem	1J872706332
	19.1 mm (3/4-inch) stem	1J872806332
12*	ENVIRO-SEAL Bellows Seal Upper Wiper	
	For 9.5 mm (3/8 inch) and size 2 with 12.7 mm (1/2 inch) stem	18A0868X012
	For size 3 & 4 with 12.7 mm (1/2 inch) stem	18A0870X012
13	Packing Follower	

*Recommended spare parts

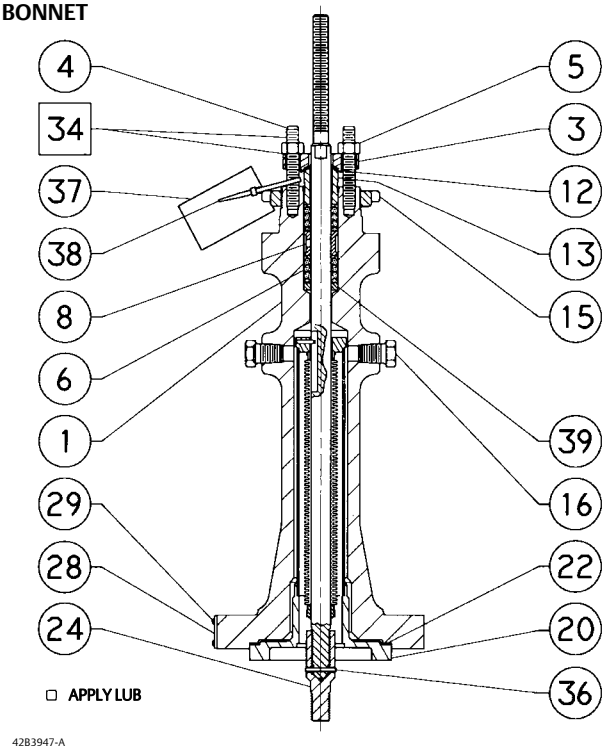
Figure 11. Typical Bonnets



PLAIN BONNET



EXTENSION BONNET



ENVIRO-SEAL BELLOWS SEAL BONNET

Key	Description	Part Number
13*	ENVIRO-SEAL Bellows Seal Bushing	
	For 9.5 mm (3/8 inch) stem (1 req'd),	
	for size 2 with 12.7 mm (1/2 inch) stem, (2 req'd)	
	S31600/PTFE	18A0820X012
	R30006	18A0819X012
	S31600/Cr Ct	11B1155X012
	For size 3 and 4 with 12.7 mm (1/2 inch)	
	stem (1 req'd)	
	S31600/PTFE	18A0824X012
	R30006	18A0823X012
	S31600/Cr Ct	11B1157X012
13*	ENVIRO-SEAL Bellows Seal Bushing/Liner	
	For 9.5 mm (3/8 inch) stem (1 req'd),	
	for size 2 with 12.7 mm (1/2 inch) stem (2 req'd)	
	N10276 bushing, PTFE/glass liner	12B2713X012
	N10276 bushing, PTFE/carbon liner	12B2713X042
	For size 3 and 4 with 12.7 mm (1/2 inch)	
	stem (1 req'd)	
	N10276 bushing, PTFE/glass liner	12B2715X012
	N10276 bushing, PTFE/carbon liner	12B2715X042
14	Pipe Plug (not shown)	
14	Lubricator	
14	Lubricator/Isolating Valve	
15	Yoke Locknut	
15	ENVIRO-SEAL Bellows Seal Yoke Locknut	
16	Pipe Plug (not shown)	
16	ENVIRO-SEAL Bellows Seal Pipe Plug (2 req'd)	
20*	ENVIRO-SEAL Bellows Seal Stem/Bellows	
	Assembly	
	1 Ply Bellows	
	S31603 trim mat'l, N06625 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X012
	Size 1-1/2 w/ 9.5 mm (0.375 inch) stem	32B4225X012
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X012
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X012
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X012
	N06022 trim mat'l, N06022 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X022
	Size 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X022
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X022
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X022
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X022
	2 Ply Bellows	
	S31603 trim mat'l, N06625 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X032
	Size 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X032
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X032
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X032
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X032
	N06022 trim mat'l, N06022 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X042
	Size 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X042
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X042
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X042
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X042
22*	ENVIRO-SEAL Bellows Seal Bonnet Gasket	
	(graphite/S31600)	
	Size 1/2 through 1-1/4	12B6316X022
	Size 1-1/2	12B6317X022
	Size 2	12B6318X022
	Size 3	12B6319X022
	Size 4	12B6320X022
24	ENVIRO-SEAL Bellows Seal Adaptor	
27	Pipe Nipple, for lub/isolating valve,steel	
28	ENVIRO-SEAL Bellows Seal Nameplate, Warning	
29	ENVIRO-SEAL Bellows Seal Drive Screw (2 req'd)	
34	Lubricant, anti-seize (not furnished with valve)	
36*	ENVIRO-SEAL Bellows Seal Pin	12B3951X012
37	ENVIRO-SEAL Bellows Seal Warning Tag	
38	ENVIRO-SEAL Bellows Seal Tie	
39	ENVIRO-SEAL Bellows Seal Thrust Ring	
200	Stud (2 req'd)	
201	Packing Flange	
202	Spring, (2 req'd)	
203	Spring guide packing follower	
204	Screw, 18-8 SST (4 req'd)	
205	Load Scale, 18-8 SST (2 req'd)	
206	Indicator Disk, 18-8 SST	
207*	Guide Bushing, white (2 req'd)	
	For ENVIRO-SEAL and HIGH-SEAL	
	packing	
	Carbon-graphite	
	for graphite packing	
	9.5 mm (3/8-inch) stem	12B5780X012
	12.7 mm (1/2-inch) stem	12B5782X012
	19.1 mm (3/4-inch) stem	12B5784X012
208*	Guide Bushing, no color	
	For ENVIRO-SEAL and HIGH-SEAL packing	
	Carbon-Graphite for graphite packing	
	9.5 mm (3/8-inch) stem	12B5781X012
	12.7 mm (1/2-inch) stem	12B5783X012
	19.1 mm (3/4-inch) stem	12B5785X012
209*	Packing Ring[1] (3 req'd)	
	For ENVIRO-SEAL and HIGH-SEAL	
	packing	
	Graphite Composite	
	for graphite packing	
	9.5 mm (3/8-inch) stem	12B5798X012
	12.7 mm (1/2-inch) stem	12B5799X012
	19.1 mm (3/4-inch) stem	12B5800X012
210*	Packing Ring (2 req'd)	
	For ENVIRO-SEAL and HIGH-SEAL	
	packing	
	Graphite Ribbon	
	for graphite packing	
	9.5 mm (3/8-inch) stem	1V3160X0022
	12.7 mm (1/2-inch) stem	1V3802X0022
	19.1 mm (3/4-inch) stem	1V2396X0022
211*	Packing Box Ring	
	For ENVIRO-SEAL packing	
	S31600	
	For PTFE Packing	
	9.5 mm (3/8-inch) stem	1J873135072
	12.7 mm (1/2-inch) stem	1J873235072
	19.1 mm (3/4-inch) stem	1J873335072
	For ENVIRO-SEAL and HIGH-SEAL	
	packing	
	S31600	
	For Graphite packing and Duplex packing	
	9.5 mm (3/8-inch) stem	12B5774X012
	12.7 mm (1/2-inch) stem	12B5775X012
	19.1 mm (3/4-inch) stem	12B5776X012
212	Hex Nut (2 req'd)	

*Recommended spare parts
1. Part number is stamped on part.

Key	Description	Part Number
213	Lubricant, anti-seize	
214*	Anti-Extrusion washer (4 req'd)	
	For ENVIRO-SEAL packing	
	PTFE filled (off-white)	
	For PTFE packing	
	9.5 mm (3/8-inch) stem	12B6336X022
	12.7 mm (1/2-inch) stem	12B6335X022
	19.1 mm (3/4-inch) stem	12B6660X012
214*	Packing Washer (5 req'd)	
	For ENVIRO-SEAL packing	
	PTFE	
	For Graphite packing and Duplex packing	
	9.5 mm (3/8-inch) stem	12B6936X012
	12.7 mm (1/2-inch) stem	12B6937X012
	19.1 mm (3/4-inch) stem	12B6938X012
215*	Packing Set (2 req'd)	
	For ENVIRO-SEAL packing	
	PTFE-carbon/PTFE	
	9.5 mm (3/8-inch) stem	12B6663X012
	12.7 mm (1/2-inch) stem	12B6667X012
	19.1 mm (3/4-inch) stem	12B6671X012
216	Lantern Ring	
217	Spring Pack Assembly	
218*	Lower wiper	
	For ENVIRO-SEAL packing	
	PTFE	
	For PTFE packing	
	9.5 mm (3/8-inch) stem	1J872106992
	12.7 mm (1/2-inch) stem	1J872206992
	19.1 mm (3/4-inch) stem	1J872306992

Valve Body

Key	Description	Part Number
1	Valve Body	
	If you need a valve body as a replacement part, order by valve size, serial number, and desired material.	
2*	Valve Plug	See following table
3*	Seat Ring Retainer (part numbers for the seat ring retainer/bushing assy are provided in a following table)	
	NPS 1/2, 3/4, & 1 valve	
	CB7Cu-1 (17-4PH SST)	25A6683X012
	CF8M (316 SST)	25A6683X022
	M35-1	25A6683X052
	NPS 1-1/2 valve	
	CB7Cu-1	25A6685X012
	NPS 1-1/2 valve	
	CF8M	25A6685X022
	M35-1	25A6685X052
	NPS 2 valve	
	CB7Cu-1	25A6687X012
	CF8M	25A6687X022
	M35-1	25A6687X052
	NPS 3 valve	
	CB7Cu-1	25A6689X012
	CF8M	25A6689X022
	M35-1	25A6689X052
	NPS 4 valve	
	CB7Cu-1	35A6691X012
	CF8M	35A6691X022
	M35-1	35A6691X052
7*	Stem	See following table
8*	Pin	See following table
9*	Seat Ring	See following table
10*	Bonnet Gasket	See following table
12*	Spiral Wound Gasket	See following table
13*	Seat Ring Gasket	See following table
15	Cap Screw or Stud Bolt	
16	Nut	
17	Pipe Plug, for use in valve bodies with drain tapping only	
18	Flow Arrow, SST	
19	Drive Screw, SST (4 req'd)	
25*	Shim	See following table
26*	Bushing	See following table
	(See additional table for part numbers of assemblies that include both the seat ring retainer and the bushing)	
27*	Valve Plug Guide (for composition seats only)	See following table
28*	Disk Retainer, (composition seats only)	
	6.4 mm (0.25-inch) port diameter	
	S31600	16A3441X012
	N05500	16A3441X042
	S41600	16A3441X052
	9.5 mm (0.375-inch) port diameter	
	S31600	16A5706X012
	N05500	16A5706X042
	S41600	16A5706X052
29*	Disk, PTFE (composition seats only)	
	6.4 mm (0.25-inch) port diameter	13A1226X062
	9.5 mm (0.375-inch) port diameter	13A5125X042
	12.7 mm (0.5-inch) port diameter	1P696806242
	19.1 mm (0.75-inch) port diameter	1P696106242
	25.4 mm (1-inch) port diameter	1P696906242
	38.1 mm (1.5 inch) port diameter	1U279606242
	50.8 mm (2-inch) port diameter	1U279906242
	76.2 mm (3-inch) port diameter	1F5653X0012
	101.6 mm (4-inch) port diameter	16A3462X012
30*	Tip (composition seats only)	See following table
31*	Pin (composition seats only)	
	12.7 mm (0.5-inch) port diameter	
	S31600 and S41600	1B599038992
	N05500	1B5990X0032
	19.1 mm (0.75-inch) port diameter	
	S31600 and S41600	1P730438992
	N05500	1P7304X0032
	25.4 mm (1-inch) and 38.1 mm (1.5 inch) port diameter	
	S31600 and S41600	1B599335072
	N05500	1B5993X00B2
	50.8 mm (2-inch) port diameter	
	S31600 and S41600	1B599538992
	N05500	1B599540032
32	Cap Screw (composition seat only)	
33	Nameplate, stainless steel	
34	Wire, lead	

*Recommended spare parts

Figure 12. Fisher EZ Valve with Optional Drain Plug

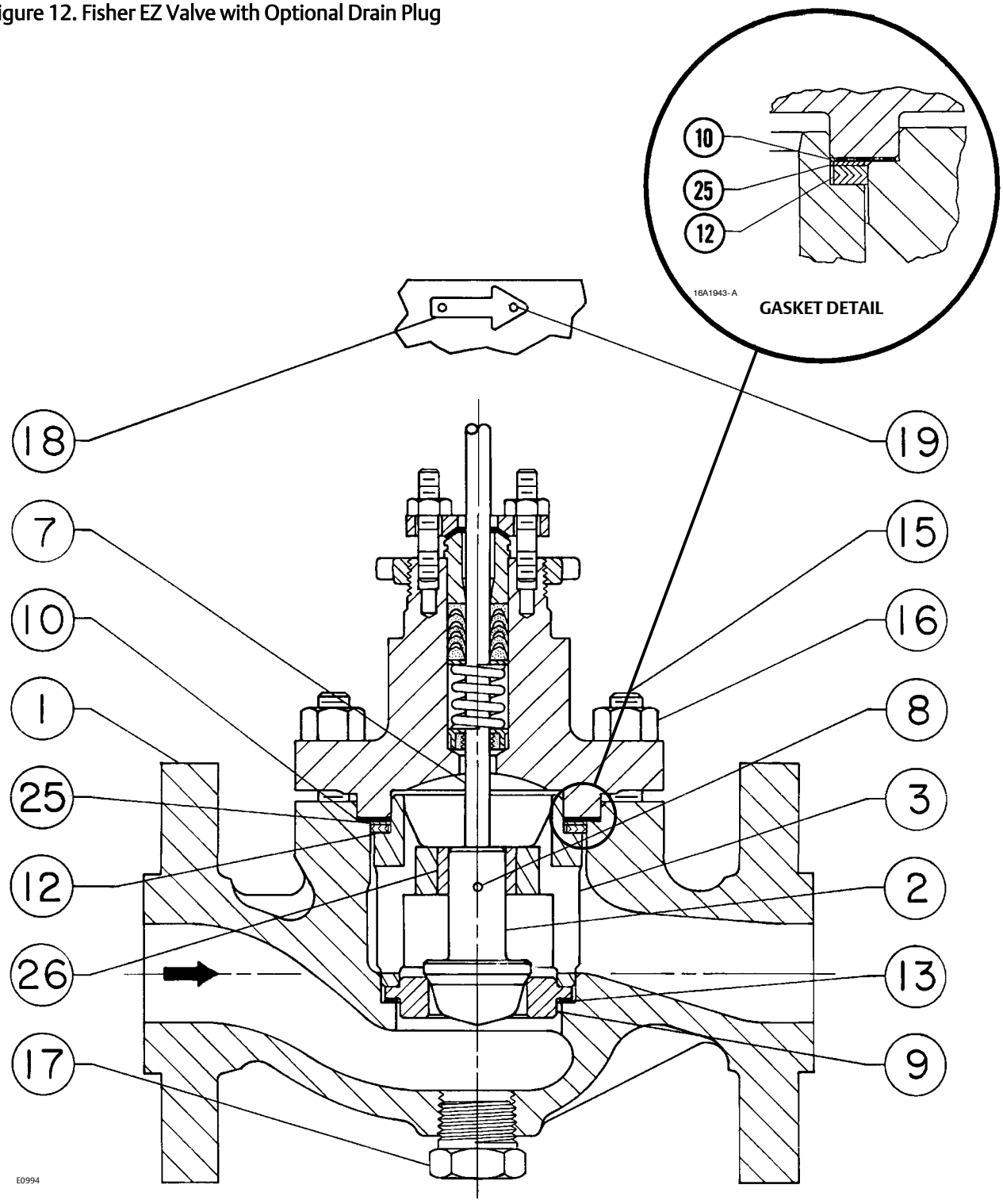
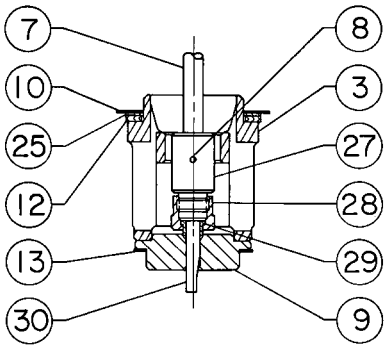
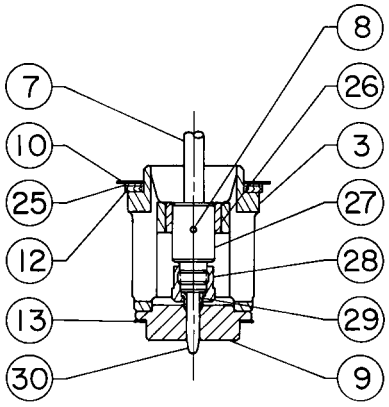


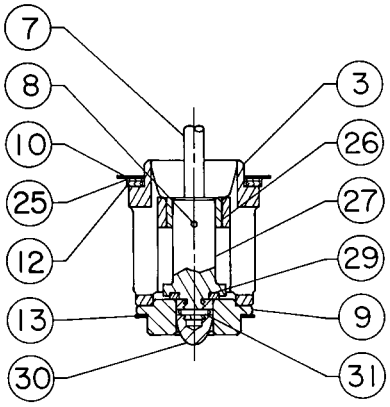
Figure 13. Composition Seats for Fisher EZ Valve



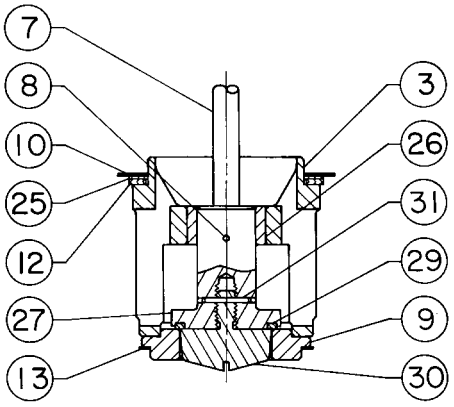
MICRO-FLUTE VALVE PLUG
6.4 mm (0.25 INCH) PORT DIAMETER



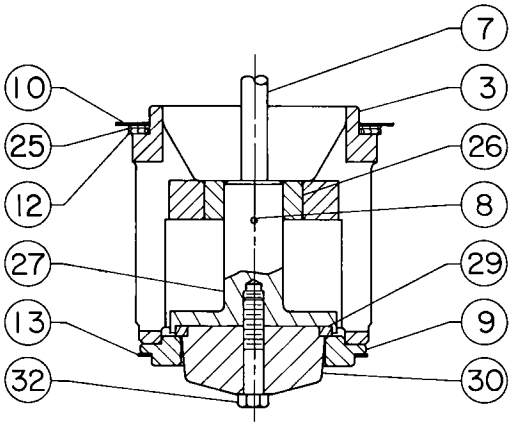
MICRO-FORM VALVE PLUG
6.4 AND 9.5 mm (0.25 AND 0.375 INCH) PORT DIAMETERS



MICRO-FORM VALVE PLUG
12.7 mm THROUGH 25.4 mm (0.5 INCH THROUGH 1 INCH) PORT DIAMETER

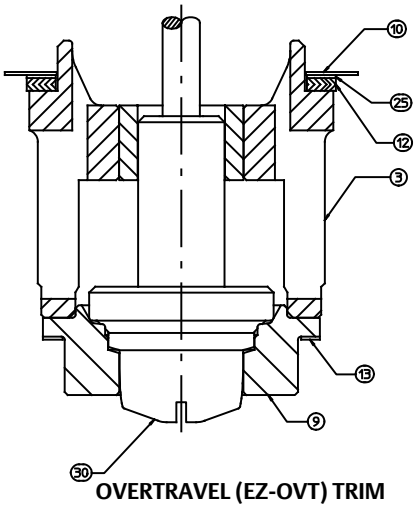


EQUAL PERCENTAGE VALVE PLUG
38.1 mm AND 50.8 mm (1.5 INCH AND 2 INCH) PORT DIAMETER



EQUAL PERCENTAGE VALVE PLUG
76.2 mm AND 101.6 mm (3 INCH AND 4 INCH) PORT DIAMETER

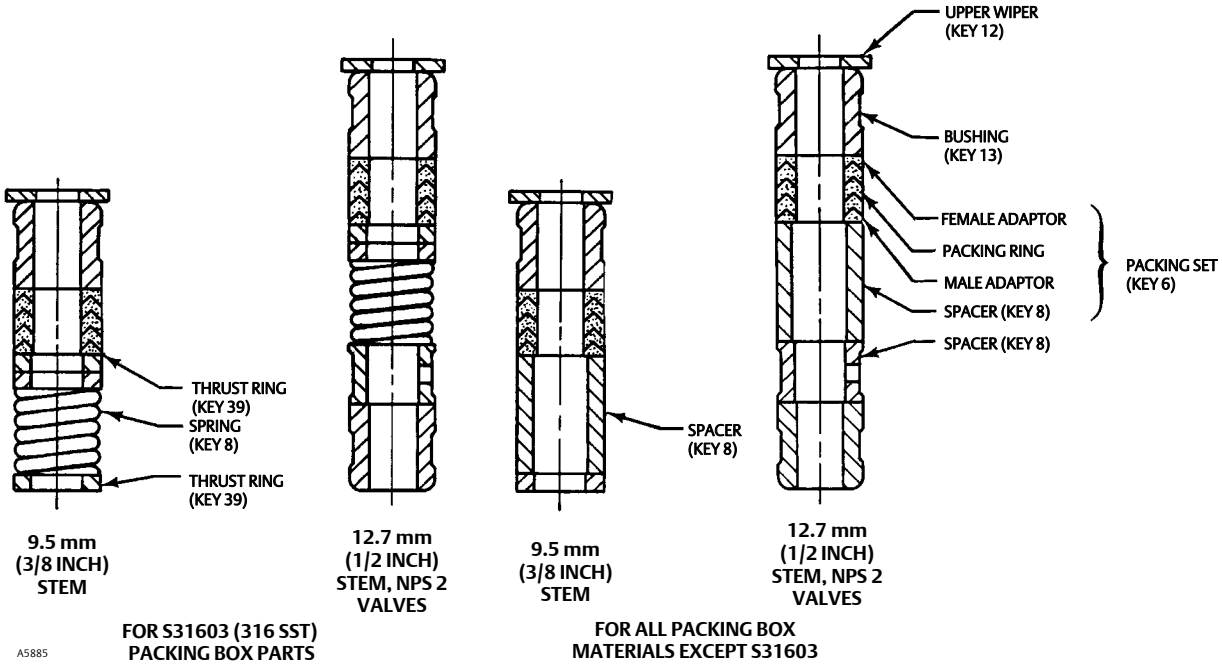
46A1842-B



GE70358-A

OVERTRAVEL (EZ-OVT) TRIM VALVE PLUG
ALL SIZES

Figure 14. PTFE Packing Arrangements for ENVIRO-SEAL Bellows Seal Bonnets



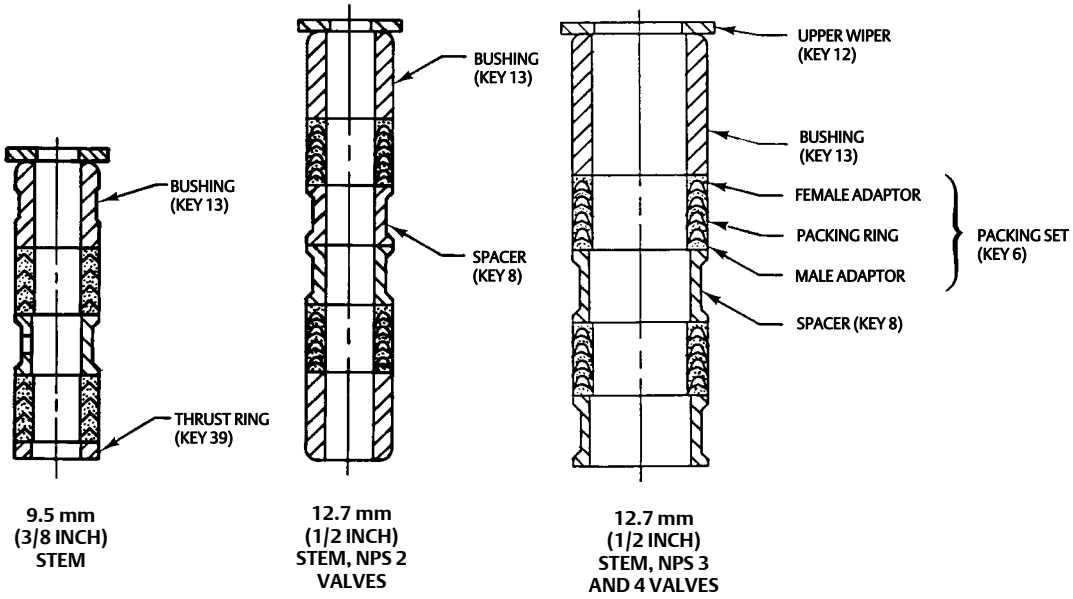
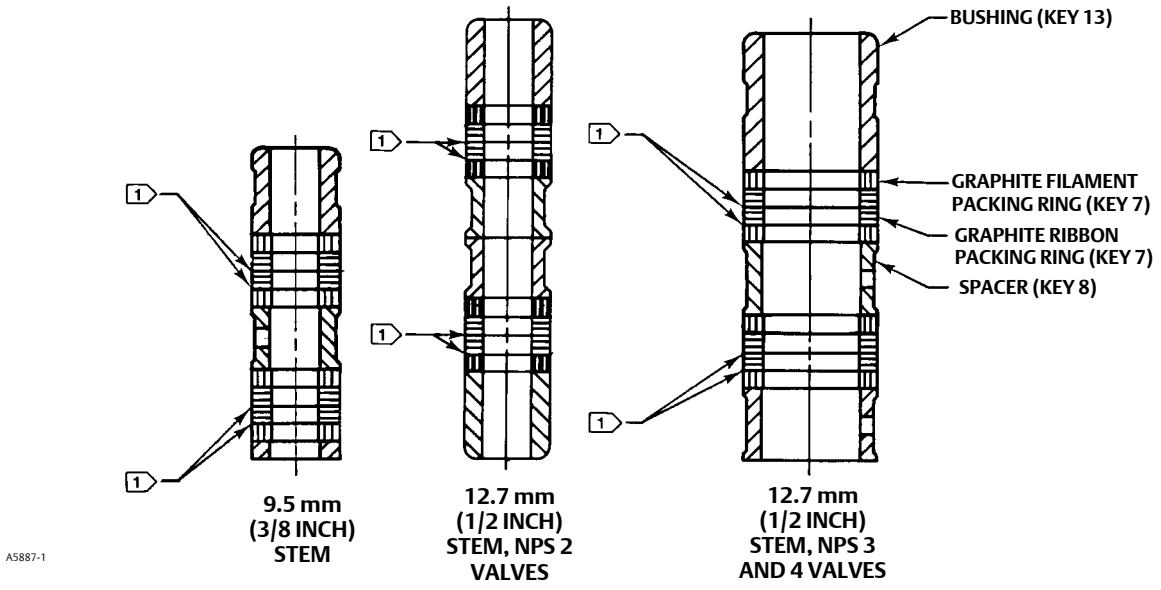


Figure 15. Double Graphite Ribbon/Filament Arrangements for ENVIRO-SEAL Bellows Seal Bonnets



Note:
1 0.102 mm (0.004 inch) thick sacrificial zinc washers: Use only one below each graphite ribbon ring.

Group 1 Actuators

54, 71, & 90 mm (2-1/8, 2-13/16, & 3-9/16 Inch) Yoke Boss
472 & 473
585C & 585CR
1B
644 & 645
655
657 & 667--76 mm (3-inch) max travel
1008--except 90 mm (3-9/16 inch) yoke boss with 51 mm (2-inch) travel

Key 2* Micro-Flow and Micro-Flute Valve Plug

VALVE SIZE, NPS	VALVE PLUG	PORT DIAMETER		VALVE STEM CONNECTION		VALVE PLUG MATERIAL		
		mm	Inch	mm	Inch	S31600 (316 SST) w/R30006 (Alloy 6) Seat & Tip	N05500	S41600 (416 SST)
1/2, 3/4, 1, 1-1/2, 2	Micro-Flow	4.8	0.1875	9.5	3/8	2V926950332	1V108146222	1V108146172
	Micro-Flute (1 flute)	6.4	0.25			2U868246422	1U844546222	1U844546172
	Micro-Flute (3 flutes)	6.4	0.25			2U868446422	1U844746222	1U844746172

*Recommended spare parts

Key 2* Equal Percentage (Including Micro-Form), Linear, and Quick-Opening Valve Plugs

VALVE SIZE, NPS	VALVE PLUG	PORT DIAMETER		VSC(1)		PLUG MATERIAL				
		mm	Inch	mm	Inch	S31600 (316 SST)	S31600 w/ CoCr-A (Alloy 6) Seat	S31600 w/ CoCr-A Seat & Guide	N05500(2)	S41600 (416 SST)
1/2, 3/4, 1, 1-1/2 & 2	Micro-Form	6.4 9.5 12.7 19.1	0.25 0.375 0.5 0.75	9.5	3/8	15A6500X012 16A5708X012 15A6502X012 16A3335X012	15A6663X012 16A5713X012 15A6659X012 16A3337X012	15A6664X012 16A5711X012 15A6660X012 16A3339X012	15A6500X042 16A5708X042 15A6502X042 16A3335X042	15A6500X052 16A5708X052 15A6502X052 16A3335X052
		6.4 9.5 12.7 19.1	0.25 0.375 0.5 0.75	12.7	1/2	15A6501X012 16A5709X012 15A6503X012 16A3336X012	--- 16A5714X012 15A6661X012 16A3338X012	--- 16A5712X012 15A6662X012 16A3340X012	15A6501X042 16A5709X042 15A6503X042 16A3336X042	15A6501X052 16A5709X052 15A6503X052 16A3336X052
	Quick Opening	25.4	1	9.5 12.7	3/8 1/2	15A6490X012 15A6491X012	15A6516X012 15A6518X012	15A6517X012 15A6519X012	15A6490X042 15A6491X042	15A6490X052 15A6491X052
	Linear	25.4	1	9.5 12.7	3/8 1/2	15A6470X012 15A6471X012	15A6614X012 15A6616X012	15A6615X012 15A6617X012	15A6470X042 15A6471X042	15A6470X052 15A6471X052
	Equal Percentage	25.4	1	9.5 12.7	3/8 1/2	15A6480X012 15A6481X012	15A6634X012 15A6636X012	15A6635X012 15A6637X012	15A6480X042 15A6481X042	15A6480X052 15A6481X052
1-1/2	Quick Opening	38.1	1.5	9.5 12.7	3/8 1/2	15A6492X012 15A6493X012	15A6520X012 15A6522X012	15A6521X012 15A6523X012	15A6492X042 15A6493X042	15A6492X052 15A6493X052
	Linear	38.1	1.5	9.5 12.7	3/8 1/2	15A6472X012 15A6473X012	15A6618X012 15A6620X012	15A6619X012 15A6621X012	15A6472X042 15A6473X042	15A6472X052 15A6473X052
	Equal Percentage	38.1	1.5	9.5 12.7	3/8 1/2	15A6482X012 15A6483X012	15A6638X012 15A6640X012	15A6639X012 15A6641X012	15A6482X042 15A6483X042	15A6482X052 15A6483X052
2, 3, 4	Quick Opening	50.8	2	12.7 19.1	1/2 3/4	15A6494X012 15A6495X012	15A6524X012 15A6526X012	15A6525X012 15A6527X012	15A6494X042 15A6495X042	15A6494X052 15A6495X052
	Linear	50.8	2	12.7 19.1	1/2 3/4	15A6474X012 15A6475X012	15A6622X012 15A6624X012	15A6623X012 15A6625X012	15A6474X042 15A6475X042	15A6474X052 15A6475X052
	Equal Percentage	50.8	2	12.7 19.1	1/2 3/4	15A6484X012 15A6485X012	15A6642X012 15A6644X012	15A6643X012 15A6645X012	15A6484X042 15A6485X042	15A6484X052 15A6485X052
3	Quick Opening	76.2	3	12.7 19.1	1/2 3/4	15A6496X012 15A6497X012	15A6528X012 15A6530X012	15A6529X012 15A6531X012	15A6496X042 15A6497X042	15A6496X052 15A6497X052
	Linear	76.2	3	12.7 19.1	1/2 3/4	15A6476X012 15A6477X012	15A6626X012 15A6628X012	15A6627X012 15A6629X012	15A6476X042 15A6477X042	15A6476X052 15A6477X052
	Equal Percentage	76.2	3	12.7 19.1	1/2 3/4	15A6486X012 15A6487X012	15A6646X012 15A6648X012	15A6647X012 15A6649X012	15A6486X042 15A6487X042	15A6486X052 15A6487X052
4	Quick Opening	101.6	4	12.7 19.1	1/2 3/4	15A6498X012 15A6499X012	15A6532X012 15A6534X012	15A6533X012 15A6535X012	15A6498X042 15A6499X042	15A6498X052 15A6499X052
	Linear	101.6	4	12.7 19.1	1/2 3/4	15A6478X012 15A6479X012	15A6630X012 15A6632X012	15A6631X012 15A6633X012	15A6478X042 15A6479X042	15A6478X052 15A6479X052
	Equal Percentage	101.6	4	12.7 19.1	1/2 3/4	15A6488X012 15A6489X012	15A6650X012 15A6652X012	15A6651X012 15A6653X012	15A6488X042 15A6489X042	15A6488X052 15A6489X052

1. Valve stem connection.
2. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

*Recommended spare parts

Key 2*, 7*, and 8* Valve Plug/Stem Assembly for Plain Bonnet

VALVE SIZE, NPS	VALVE PLUG	PORT DIA		VSC(1)		PLUG MATERIAL				
		mm	Inch	mm	Inch	S31600 (316 SST)	S31600 w/ CoCr-A (Alloy 6) Seat	S31600 w/ CoCr-A Seat & Guide	N05500(2)	S41600 (416 SST)
1/2, 3/4, 1, 1-1/2, & 2	Micro-Flow Micro-Flute (1 flute) Micro-Flute (3 flutes)	4.8 6.4 6.4	0.1875 0.25 0.25	9.5	3/8	---	---	2V9269X00A2 2U8682X0032 2U8684X0032	---	1V1081X0142 1U8445X0032 1U8447X00E2
	Micro-Form	6.4 9.5 12.7 19.1	0.25 0.375 0.5 0.75	9.5	3/8	15A6500X082 16A5708X092 15A6502X072 16A3335X112	15A6663X022 16A5713X032 15A6659X022 16A3337X042	15A6664X042 16A5711X022 15A6660X042 16A3339X022	15A6500X152 16A5708X182 15A6502X102 16A3335X212	15A6500X092 16A5708X112 15A6502X112 16A3335X132
		6.4 9.5 12.7 19.1	0.25 0.375 0.5 0.75	12.7	1/2 x 3/8	--- --- 15A6502X162 16A3335X142	--- --- 15A6659X082 16A3337X032	15A6664X022 16A5711X042 15A6660X082 16A3339X092	---	15A6500X252 16A5708X132 15A6502X152 16A3335X182
	Quick Opening	25.4	1	9.5 12.7	3/8 1/2 x 3/8	--- ---	15A6516X022 ---	15A6517X022 ---	--- ---	15A6490X092 15A6490X072
	Linear	25.4	1	9.5 12.7	3/8 1/2 x 3/8	15A6470X092 15A6470X072	--- ---	15A6615X022 15A6615X032	--- ---	15A6470X102 15A6470X122
	Equal Percentage	25.4	1	9.5 12.7	3/8 1/2 x 3/8	15A6480X102 15A6480X202	15A6634X042 15A6634X072	15A6635X022 15A6635X042	15A6480X152 ---	15A6480X112 15A6480X172
1-1/2	Quick Opening	38.1	1.5	9.5	3/8	15A6492X102	15A6520X032	15A6521X022	---	15A6492X082
	Linear	38.1	1.5	9.5	3/8	15A6472X132	---	15A6619X022	---	15A6472X072
	Equal Percentage	38.1	1.5	9.5	3/8	15A6482X102	15A6638X032	15A6639X022	---	15A6482X112
2	Quick Opening	50.8	2	12.7	1/2	15A6494X082	---	15A6525X022	---	15A6494X072
	Linear	50.8	2	12.7	1/2	15A6474X132	---	15A6623X022	---	15A6474X072
	Equal Percentage	50.8	2	12.7	1/2	15A6484X072	15A6642X042	15A6643X032	15A6484X102	15A6484X112
3	Quick Opening	50.8	2	12.7	1/2	---	---	---	---	15A6494X092
	Linear	50.8	2	12.7	1/2	15A6474X172	---	---	---	15A6474X152
	Equal Percentage	50.8	2	12.7	1/2	15A6484X152	---	15A6643X062	---	15A6484X172
	Quick Opening	76.2	3	12.7	1/2	15A6496X082	---	15A6529X022	---	15A6496X072
	Linear	76.2	3	12.7	1/2	15A6476X092	---	15A6627X022	---	15A6476X082
	Equal Percentage	76.2	3	12.7	1/2	15A6486X082	15A6646X022	15A6647X032	---	15A6486X062
4	Equal Percentage	50.8	2	12.7	1/2	---	15A6642X082	---	---	15A6484X182
	Quick Opening	101.6	4	12.7	1/2	---	---	---	---	15A6498X072
	Linear	101.6	4	12.7	1/2	15A6478X072	---	---	---	15A6478X062
	Equal Percentage	101.6	4	12.7	1/2	15A6488X112	15A6650X022	15A6651X022	---	15A6488X072

1. Valve stem connection.
2. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 3*, 26* Seat Ring Retainer and Bushing Assembly[1] [2]

VALVE SIZE, NPS		SEAT RING RETAINER/BUSHING MATERIAL		
		CB7Cu-1/S17400 (17-4PH SST)	CF8M/R30006 (316 SST/Alloy 6)	M35-1/N05500[3]
1/2, 3/4, & 1		25A6683X062	25A6683X072	25A6683X172
1-1/2		25A6685X072	25A6685X082	25A6685X142
2	Full	25A6687X062	25A6687X112	25A6687X192
	Restricted	25A6687X092	25A6687X132	25A6687X182
3		25A6689X152	25A6689X132	25A6689X142
4	Full	35A6691X062	35A6691X082	35A6691X092
	Restricted	35A6691X102	17A4161X082	35A6691X112

1. Seat ring retainer (only) part numbers are listed in the parts list on page 28.
2. Micro-Flow and Micro-Flute constructions do not use bushings.
3. M35-1/N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 7* Stem (for use with Group 1 Actuators)

VALVE SIZE, NPS	STEM DIAMETER		STEM MATERIAL		
	mm	Inch	S31600	N05500	S20910 (NACE)
1/2, 3/4, 1, 1-1/2	9.5	3/8	1U388835162	10A8823XA22	1U3888X0222
	12.7	1/2	1U388935162	1U3889X0012	1U3889X0042
	12.7 x 9.5	1/2 x 3/8	1U530935162	1U530946222	1U5309X0082
2	12.7	1/2	1U388935162	1U3889X0012	1U3889X0042
	12.7 X 9.5	1/2 X 3/8	1U530935162	1U530946222	1U5309X0082
	19.1	3/4	1U226535162	1U226550192	1U2265X0042
3	12.7	1/2	1K586935162	10A8840XH32	1K5869X0102
	19.1	3/4	10A9265XJ62	1U226550192	1U2265X0042
4 (restricted capacity trim)	12.7	1/2	1J320535162	1J3205X0062	1J3205X0072
	19.1	3/4	1U230835162	1U230847492	1U2308X0072
4 (full capacity trim)	12.7	1/2	1K586935162	10A8840XH32	1K5869X0102
	19.1	3/4	1U226535162	1U226550192	1U2265X0042

*Recommended spare parts

Key 8* Pin

VALVE SIZE, NPS	VALVE PLUG STYLE	VSC[1]		PIN MATERIAL	
		mm	Inch	S31600 (316 SST)	N04400[2]
1/2 thru 2	Micro-Flow & Micro-Flute w/ metal seats	9.5	3/8	1B599235072	1B599240032
	Micro-Flute w/comp seats & Micro-Form	9.5 12.7	3/8 1/2	1B599335072 1D5423X00B2	1B5993X00B2 1D5423X0012
1/2 thru 1-1/2	Linear, Equal Percentage & Quick Opening	9.5 12.7	3/8 1/2	1B599335072 1D5423X00B2	1B5993X00B2 1D5423X0012
2	Linear, Equal Percentage & Quick Opening (full cap)	12.7 19.1	1/2 3/4	1B599835072 1B813635072	1B599840032 1B8136X0102
	Linear, Equal Percentage & Quick Opening (restricted port)	9.5 12.7	3/8 1/2	1B599335072 1D5423X00B2	1B5993X00B2 1D5423X0012
3	All	12.7 19.1	1/2 3/4	1B599835072 1B813635072	1B599840032 1B8136X0102
4	Full Capacity	12.7 19.1	1/2 3/4	1B599835072 1B813635072	1B5998X00C2 1B8136X0102
	Restricted	12.7 19.1	1/2 3/4	1B599335072 1F723635072	1B5993X00B2 1B813640032

1. Valve stem connection.
2. N04400 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 9* Seat Ring (non-vaned) for Metal Seats

VALVE SIZE, NPS	PORT DIA		S31600 (316 SST)	S31600 w/ CoCr-A (ALLOY 6) SEAT	S31600 w/ CoCr-A SEAT & BORE	N05500[1]	S41600 (416 SST)
	mm	Inch					
1/2, 3/4, and 1	4.8 6.4 9.5 12.7	0.1875 0.25 0.375 0.5	1V108335072 1U285235072 1U285335072 1U285435072	2V626250332 2U855946052 2U856046052 2U856146052	25A5710X012 25A5711X012 1U2853X0012 26A0651X012	1V108346222 1U285246222 1U285346222 1U825446222	1V108346172 1U285246172 1U285346172 1U285446172
	19.1	0.75	1U285535072	2U856246052	- - -	1U2855X0092	1U285546172
	25.4	1	1U285635072	2U856346052	- - -	1U285646222	1U285646172
1-1/2	4.8 6.4 9.5 12.7 19.1	0.1875 0.25 0.375 0.5 0.75	15A6512X012 15A6513X012 17A6075X012 15A6514X012 16A3350X012	25A8564X012 15A6537X012 27A6076X012 15A6538X012 26A3351X012	25A6536X012 25A6539X012 27A6079X012 26A0653X012 26A3352X012	15A6512X042 15A6513X042 17A6075X042 15A6514X042 16A3350X042	15A6512X052 15A6513X052 17A6075X052 15A6514X052 16A3350X052
	25.4	1	15A6515X012	15A6654X012	- - -	15A6515X042	15A6515X052
	38.1	1.5	15A6504X012	15A6655X012	- - -	15A6504X042	15A6504X052
2	4.8 6.4 9.5 12.7 19.1	0.1875 0.25 0.375 0.5 0.75	15A6692X012 15A6693X012 17A4091X022 15A6694X012 16A3353X012	25A8565X012 25A6698X012 27A6080X012 25A6699X012 26A3354X012	25A6696X012 25A6697X012 27A6081X012 26A0656X012 26A3355X012	15A6692X042 15A6693X042 17A4091X052 15A6694X042 16A3353X042	15A6692X052 15A6693X052 17A4091X012 15A6694X052 16A3353X052
	25.4	1	15A6695X012	25A1085X012	- - -	15A6695X042	15A6695X052
	50.8	2	15A6505X012	15A6656X012	- - -	15A6505X042	15A6505X052
3	50.8	2	25A5713X012	25A5714X012	- - -	25A5713X042	25A5713X052
	76.2	3	15A6506X012	15A6657X012	- - -	15A6506X042	15A6506X052
4	50.8	2	25A5715X012	25A5716X012	- - -	25A5715X042	25A5715X052
	101.6	4	15A6507X012	15A6658X012	- - -	15A6507X042	15A6507X052

1. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

*Recommended spare parts

Key 9* Seat Ring (vaned) for Metal Seats(1)

VALVE SIZE, NPS	PORT DIA		CF8M (316 SST)	CF8M w/ CoCr-A (ALLOY 6) SEAT	CA15 (410 SST)(2)
	mm	Inch			
1/2, 3/4, and 1	19.1	0.75	37B8773X012	38B0600X012	37B8773X022
	25.4	1	37B8771X012	38B0601X012	37B8771X022
1-1/2	25.4	1	37B9001X012	38B0602X012	37B9001X022
	38.1	1.5	37B8999X012	38B0603X012	37B8999X022
2	25.4	1	37B8765X012	38B0604X012	37B8765X022
	50.8	2	37B8763X012	38B0605X012	37B8763X022
3	50.8	2	37B9009X012	38B0606X012	37B9009X022
	76.2	3	37B9007X012	38B0607X012	37B9007X022
4	50.8	2	37B8781X012	38B0608X012	37B8781X022
	101.6	4	37B8779X012	38B0609X012	37B8779X022

1. Emerson Process Management recommends that the Performance+ vaned seat ring be used for non-viscous, flow-up, liquid applications.
2. Vaned seat ring material is CA15 (410 SST) which is cast equivalent of S41600 (416 SST).

Key 9* Seat Ring (non-vaned) for Composition Seats

VALVE SIZE, NPS	PORT DIAMETER		S31600 (316 SST)	N05500(1)	S41600 (416 SST)
	mm	Inch			
1/2, 3/4, & 1	6.4 9.5	0.25 0.375	13A5872X012 13A5873X012	13A5872X062 13A5873X062	13A5872X022 13A5873X032
1-1/2	6.4 9.5	0.25 0.375	16A3467X012 17A6078X012	16A3467X042 17A6078X042	16A3467X052 17A6078X052
2	6.4 9.5	0.25 0.375	16A3468X012 17A6077X012	16A3468X042 17A6077X042	16A3468X052 17A6077X052

1. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 10* Bonnet Gasket
Key 12* Spiral Wound Gasket
Key 13* Seat Ring Gasket
Key 25* Shim

Valve Size, NPS	Key Number	Gasket Set 2[1]	Gasket Set 3[1]
1/2 - 3/4 & 1	Set	RGASKETX162	10A8170X042
	10	1R2859X0042	10A8163X012
	12	1R286099442	10A8184X012
	13	1R2862X0062	10A8177X012
	25	16A1936X012	16A1936X022
1-1/2	Set	RGASKETX172	10A8171X032
	10	1R3101X0032	10A8164X012
	12	1R309999442	10A8185X012
	13	1R3098X0052	10A8178X012
	25	16A1937X012	16A1937X022
2	Set	RGASKETX182	10A8172X032
	10	1R3299X0042	10A8165X012
	12	1R329799442	10A8186X012
	13	1R3296X0042	10A8179X042
	25	16A1938X012	16A1938X022
3	Set	RGASKETX202	10A8174X032
	10	1R3484X0042	10A8167X012
	12	1R348299442	10A8188X012
	13	1R3481X0052	10A8181X032
	25	16A1940X012	16A1940X022
4	Set	RGASKETX212	- - -[2]
	10	1R3724X0042	10A8168X012
	12	1R372299442	10A8189X012
	13	1J5047X0062	10A8182X032
	25	16A1941X012	16A1941X022

1. See table below for description of gasket sets.
2. Consult your Emerson Process Management sales office for gasket set part number.

Gasket Selection Criteria

Gasket Set	Seat Ring Gasket	Bonnet Gasket	Spiral Wound Gasket	Shim	Temperature Capabilities
2[1]	316 SST/graphite flat sheet	316 SST/graphite flat sheet	N06600 / graphite	S31600	-198 to 593°C (-325 to 1100°F)
3	PTFE-coated N04400	PTFE-coated N04400	N04400/PTFE	N04400	-73 to 149°C (-100 to 300°F)

1. FGM gasket set.

Key 26* Bushing

Valve Size, NPS	S17400 (17-4PH SST)	R30006 (Alloy 6)	N05500[1]
1/2, 3/4, & 1	15A6508X012	15A6508X022	15A6508X052
1-1/2	15A7511X012	15A7511X022	15A7511X052
2 (rest. port)	15A6509X012	15A6509X022	15A6509X052
2 (full port)	15A6510X012	15A6510X022	15A6510X052
3	15A7491X012	15A7491X022	15A7491X052
4 (rest. port)	15A5712X012	15A5712X022	15A5712X052
4 (full port)	15A6511X012	15A6511X022	15A6511X052

1. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 27* Valve Plug Guide (composition seat only)

VALVE PLUG	VALVE STEM CONNECTION		PORT DIA		MATERIAL			
	mm	Inch	mm	Inch	S31600 (316 SST)	N05500(1)	S41600 (416 SST)	S31600 w/CoCr-A (Alloy 6)
Micro-Flute	9.5	3/8	6.4	0.25	16A3440X012	16A3440X042	---	19A5814X012
Micro-Form	9.5	3/8	6.4 9.5 12.7 19.1	0.25 0.37 5 0.5 0.75	16A3440X012 16A5703X012 16A3445X012 26A3449X012	16A3440X042 16A5703X042 16A3445X042 26A3449X042	16A3440X052 16A5703X052 16A3445X052 26A3449X052	19A5814X012 19A5815X012 17A7250X012 28A8115X012
	12.7	1/2	9.5 12.7 19.1	0.375 0.5 0.75	16A5707X012 16A3446X012 26A3450X012	16A5707X042 16A3446X042 26A3450X042	16A5707X052 16A3446X052 26A3450X052	19A5815X012 19A5817X012 29A5812X012
Equal Percentage	9.5 12.7 9.5 12.7 12.7 19.1 12.7 19.1	3/8 1/2 3/8 1/2 1/2 3/4 1/2 3/4	25.4 25.4 38.1 50.8 76.2 76.2 102 102	1 1 1.5 2 3 3 4 4	26A3453X012 26A3454X012 26A3457X012 26A3460X012 26A3470X012 26A3471X012 26A3463X012 26A3464X012	26A3453X042 26A3454X042 26A3457X042 26A3460X042 26A3470X042 26A3471X042 26A3463X042 26A3464X042	26A3453X052 26A3454X052 26A3457X052 26A3460X052 26A3470X052 26A3471X052 26A3463X052 26A3464X052	29A5806X012 29A5807X012 28A1253X012 29A5813X012 29A5811X012 29A5810X012 29A5808X012 29A5809X012

1. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 30* Tip

VALVE SIZE, NPS	VALVE PLUG	PORT DIA		VALVE STEM CONNECTION		MATERIAL			
		mm	Inch	mm	Inch	S31600 (316 SST)	Alloy 6	N05500(1)	S41600 (416 SST)
1/2,3/4 1, 1-1/2, & 2	Micro-Flute (1 flute) Micro-Flute (3 flutes)	6.4	0.25	9.5	3/8	--- ---	13A5863X032 13A5865X032	13A5863X042 13A5865X022	--- ---
	Micro-Form	6.4 9.5 12.7 19.1	0.25 0.375 0.5 0.75	9.5	3/8	13A6160X022 16A5704X012 1R9537X0022 1R9540X0012	--- --- --- ---	13A6160X062 16A5704X042 1R9537X0062 1R9540X0072	13A6160X012 16A5704X052 1R9537X0012 1R9540X0042
		9.5 12.7 19.1	0.375 0.5 0.75	12.7	1/2	16A5704X012 1R9537X0022 1R9540X0012	--- --- ---	16A5704X042 1R9537X0062 1R9540X0072	16A5704X052 1R9537X0012 1R9540X0042
	Equal Percentage	25.4 38.1 50.8	1 1.5 2	9.5 & 12.7 9.5 12.7	3/8 & 1/2 3/8 1/2	1R953835072 16A3458X012 12A3889X012	--- --- ---	1R9538X0032 16A3458X042 12A3889X042	1R9538X0012 16A3458X052 12A3889X052
3	Equal Percentage	76.2	3	12.7 & 19.1	1/2 & 3/4	16A3469X012	---	16A3469X042	16A3469X052
4	Equal Percentage	101.6	4	12.7 & 19.1	1/2 & 3/4	12A3760X022	---	12A3760X012	12A3760X052

1. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

*Recommended spare parts

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Emerson Process Management
Marshalltown, Iowa 50158 USA
Sorocaba, 18087 Brazil
Chatham, Kent ME4 4QZ UK
Dubai, United Arab Emirates
Singapore 128461 Singapore

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Fulflo

HYDRAULIC BYPASS RELIEF VALVES

the Quiet Ones

CHATTER FREE PERFORMANCE



MADE IN THE USA

FULFLO SPECIALTIES COMPANY . . .

Pioneers in Fluid Power

Established in 1912, FULFLO was incorporated in 1933 under its present name and trademark. Patents for the original guided piston, direct-acting relief valve were obtained in 1935, coincident with the onset of fluid power systems. The need for providing large flows without excessive bulk was subsequently met by the pilot-valve-controlled relief valve, a patent on which was issued to FULFLO in 1943 (U.S. Patent No. 2,333,522).

FULFLO is located in Blanchester, Ohio just 30 miles northeast of Cincinnati, close to some of the state's largest manufacturing centers. Blanchester is served by air from Greater Cincinnati Airport and alternately from Dayton Municipal Airport.

From Cincinnati, travel Interstate 71 north to Interstate 275, east to US 28 and northeast to Blanchester.

From Dayton, travel Interstate 75 south to Route 123 and southeast to Blanchester.

If you plan to visit FULFLO, advise us of your itinerary and we will be happy to assist with transportation and hotel arrangements.

TERMS AND CONDITIONS

Product Information. Please include complete product data as described in the catalog. **Note:** All valves will be set midrange pressure of the spring, unless otherwise specified.

Instructions. All requirements specific to a customer's order must be stated on original purchase order. This includes, but is not limited to, tagging, markings, documentation, packaging, ship via collect account numbers, etc… All requirements regarding a puchase order should be verified by the faxed acknowledgment.

Shipping Information. Please include purchaser's name, complete address and requested routing. Product many be shipped via Ground, insured parcel post or commercial motor freight.

Guarantee. Fulflo products are guaranteed against defects in workmanship or material for one year after date of shipment. Fulflo is not liable for any damages resulting from misuse or misapplication of its product.

Specifications. For continued improvement of our product line, we reserve the right to change product specifications without prior notice.

Cancellations. Charges are based on work accomplished prior to the receipt of cancellation.

Returned Material. An RGA (Return Goods Authorization) Number **must** be issued before returning any valves, parts not accepted.

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Restocking. Product returned is subject to a restocking charge. Restocking fee is 25% of List Price on standard product line. Special products are subject to additional charges.

Prices. F.O.B. Blanchester, Ohio. Prices are subject to change without notice.

Terms. Net 30 days to buyers with approved credit: all other shipments are C.O.D., MC / or VISA.

Invoicing. Buyers will be invoiced by Fulflo Specialties, 459 E. Fancy Street, Blanchester, Ohio 45107.

Delivery. Deliveries are scheduled after receipt of orders which should include all required technical information. Shipping dates are **estimated** based on conditions prevailing at the time of quotation, but are not guaranteed. Fulflo shall not be liable for delays in delivery due to causes beyond its reasonable control. Fulflo shall not be liable for any special or consequential damages caused by or resulting from delay, failure to manufacture or deliver.

Minimum Order. Minimum order charge required is $30.00.

Expediting Fee. Orders may be subject to a 20% net expediting fee.

Change Order Fee. There is a $25.00 change order fee, per order.

DUE TO ENGINEERING UPGRADING, THE DIMENSIONS AND SPECIFICATIONS ARE SUBJECT TO CHANGE, BUT ARE CORRECT HERE AT TIME OF PRINTING.

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SPECIALTY VALVES

Please contact Fulflo direct for special applications. We provide special valves or modified valves to meet your application.

VALVE SIZING...Use of Performance Charts

FULFLO GUIDED PISTON VALVES

The trademark FULFLO expresses the basic principle that the relief valve must have flow capacity equal to that of the pipe lines to which it is connected. The sliding piston concept and internal design contours of FULFLO valves provide unique flow and stability characteristics for reliable performance without chatter.

FULFLO valves are designed to operate reliably at pressures as low as 2 PSI and as high as 1000 PSI. The FULFLO valve reduces velocities through all but the controlling interface of the valve thereby minimizing system power loss.

Unlike ordinary direct acting relief valves, FULFLO guided piston valves are less responsive to transient pressure surges thereby eliminating the tendency to pound, squeal or chatter. Quiet, stable, efficient performance is assured in both load regulation and system protection applications.

FULFLO valves operate effectively with all types of liquids in the full range of viscosities including hydraulic oils, water, solvents and chemicals.

FULFLO valves are not designed to be positive shut off, and will pass a minimal amount of leakage before the set pressure.

FULFLO valves are NOT designed for use with air, gas or steam.

Since the FULFLO relief valve is a flow-modulating device, pressure flow characteristics are completely different from spring loaded poppet or ball check valves. Both types remain substantially tight up to *cracking pressure*. When this pressure is exceeded, the "conventional" valve pops open with a pressure drop at very low flow and an exponential pressure rise as the flow increases.

In contrast the FULFLO valve causes a pressure rise, *over-pressure*, as soon as flow starts; pressure increases almost proportionally with flow. Springs and areas on FULFLO valves are carefully designed to minimize this over-pressure.

Both pressures are important in sizing a valve. *Cracking pressure* must be selected high enough to permit system operation at its maximum rated pressure and flow. *Over-pressure* is limited by the system's capability to withstand the additional pressure and the motor's ability to sustain the pump output at the increased pressure for the required time interval.

The over-pressure to produce a certain flow is a function of valve size and spring constant and can be determined with the aid of the over-pressure charts given for the different valve sizes. The valve performance charts are based on tests made with oil of 150 SSU viscosity at 100° F and may be used with reasonable accuracy within the conventional range of oil viscosities from 30 to 500 SSU. For operation with high viscosity fluids, consult FULFLO's engineering department.

In sizing a valve, the first attempt should be to select a valve equal in size to the pipe to which it is connected. A larger or smaller valve may be used to suit individual requirements, depending on the permissible amount of over-pressure. Assume we have selected a 3/4" valve for 17 GPM flow and a cracking pressure of 325 PSI. By referring to the pressure range chart, we find that we may use either a "YS" or a "ZS" spring.

Assuming a "YS" spring, draw a line horizontally at 17 GPM in the 3/4" valve chart, to intersect the slanted line marked "YS" and drop a vertical line to the over-pressure scale to read an over-pressure of 44 PSI. The 17 GPM will be discharged at a pressure of 325 + 44 or 369 PSI. The percentage of over-pressure would be 44/325 X 100 or 13.5%.

If a "ZS" spring is used, extend the horizontal line to the "ZS" slope and the over-pressure is 70 PSU. The pressure to pass 17 GPM would be 325 + 70 or 395 PSI and the over-pressure would be 21.5%. If the over-pressure is higher than desired for the particular application, the procedure may be repeated for the next larger size valve.

In some cases, maximum flow through a valve at a given pressure is specified. To determine the cracking pressure, assume a 3/4" valve is to pass 12 GPM at 50 PSI. A horizontal line drawn from the 12 GPM capacity to the intersection with the "WS" spring line results in an over-pressure of 14 PSI, therefore the cracking pressure must be 50 – 14 or 36 PSI, and the percentage of over-pressure of only 9 PSI, but the cracking pressure would be 14/36 x 100 or 38.8%. The use of a "US" spring would produce an over pressure of only 9 PSI but the cracking pressure would then be 50 – 9 or 41 PSI, which would exceed the rating of the "US" spring.

For sizing valves for higher viscosity than 500 SSU, the following formula is used:

$$\sqrt[4]{\frac{V2}{V1}} \times \text{area of valve for 150 SSU}$$

V1 = 150 SSU

V2 = higher viscosity

Assume we have the following application,

GPM = 10

Viscosity = 12,000 SSU

Normally for 10 GPM a 1/2" valve would be used. Referring to the orifice area chart on page 9, to find the area of a 1/2" valve. The area is .305.

$$\sqrt[4]{\frac{12000}{150}} = \sqrt[4]{80} = 2.99$$

2.99 x .305=.9120 area needed to pass 10 GPM

Again referring to the orifice area chart, we find that the area of 1¼" valve is 1.224. Therefore a 1¼" valve would be used. To find the over-pressure refer to the performance chart for a 1¼" valve.

Performance charts based on actual test results are available on request. For additional information contact THE FULFLO SPECIALTIES CO.

PIPE SIZING...Use of the Nomograph

The flow velocity, which must first be determined, is dependent on the viscosity of the fluid and the permissible flow resistance in the piping. Lower velocities are for higher viscosity fluids and/or lower pressure drops; higher velocities are for less viscous fluids and cases where higher pressure drops can be tolerated. In all cases, allowable suction velocities are much lower and the lowest velocities should be used for the more viscous fluids and/or higher suction lifts.

Suction velocities are much more critical than discharge velocities. Too high a discharge velocity may only result in excessive power loss but an excessive suction velocity may make the system inoperative or cause damage to the pump and system.

After the velocity has been selected, the nomograph chart is used to determine the inside diameter of the pipe at a given flow rate. For example, assume a flow of 17 gpm and a velocity of 12 fps for the discharge pipe is required. Draw a line from the 12 fps point on the velocity scale through the 17 gpm point on the flow rate scale and the extended line intersects the pipe inside diameter scale at 0.76 inches. This inside diameter applies to either pipe or tubing.

The correct pipe or tube size also depends on the pressure it must carry. The conversion chart for pipe sizes and schedules facilitates this section.

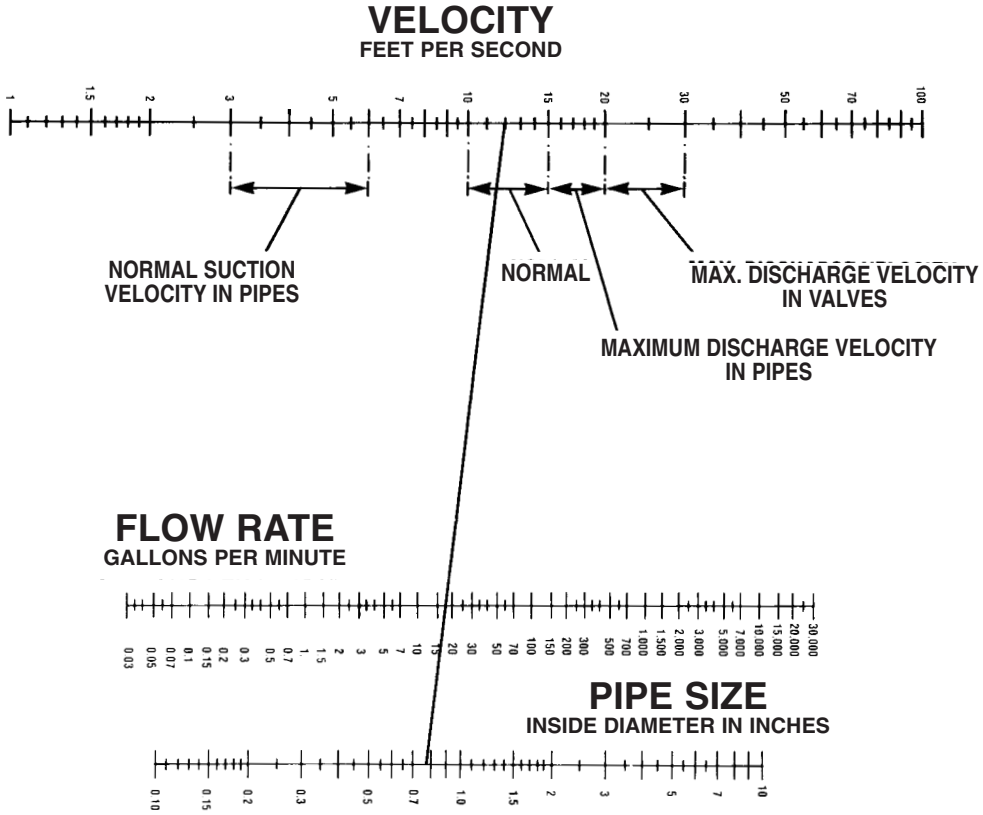
Note the different weights or piping are grouped under various schedule numbers. Approximate pressure for each schedule number may be computed from the formula.

$$\text{Pressure} = \frac{S}{1000} \times \text{schedule number}$$

S is the permissible stress to which the pipe is subjected. Thus, for a stress of 10,000 psi, the allowable pressure is equal to ten times the schedule number. Higher pressures may be carried if higher stresses are allowed.

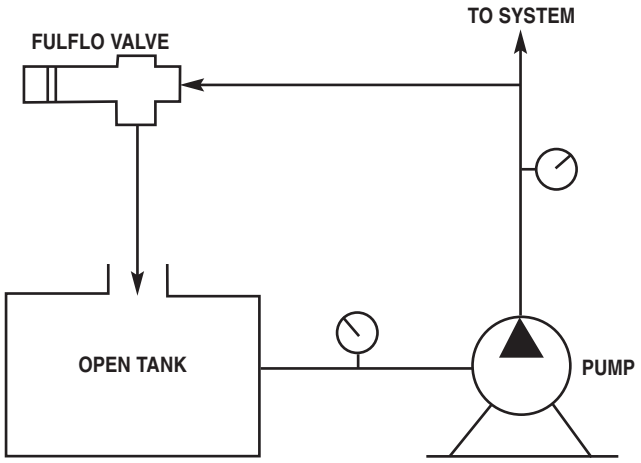
In the example, a schedule 40 pipe is more than adequate for 250 psi. Twice the wall thickness of a 3/4" schedule 40 pipe of 0.226 or 0.976". Since the actual outside diameter of a 3/4" schedule 40 pipe is 1.05", the selection of a 3/4" pipe is adequate.

A 3/4" Fulflo relief valve should be selected. Operational characteristics of this valve, that is cracking pressure and overpressure, may be determined from the performance chart precisely in the manner explained in the example. The maximum discharge pressure of 285 psi is still well below the safe carrying capacity of the pipe. The design of the Fulflo valves is such that if used within their rating and with properly selected springs, the overpressure is not sufficient to endanger system or system components.



APPLICATIONS

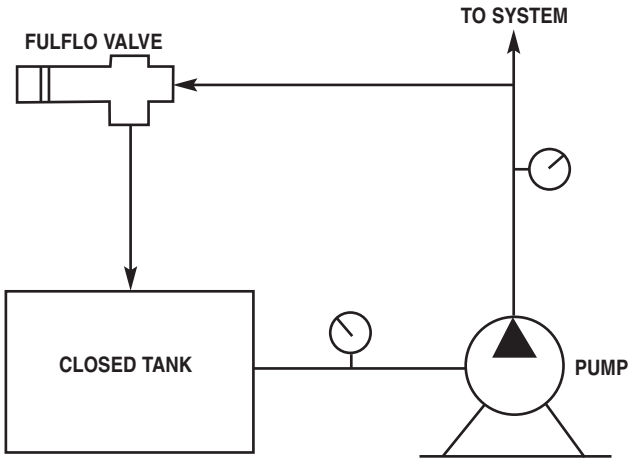
SYSTEM 1



OPEN TANK

VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

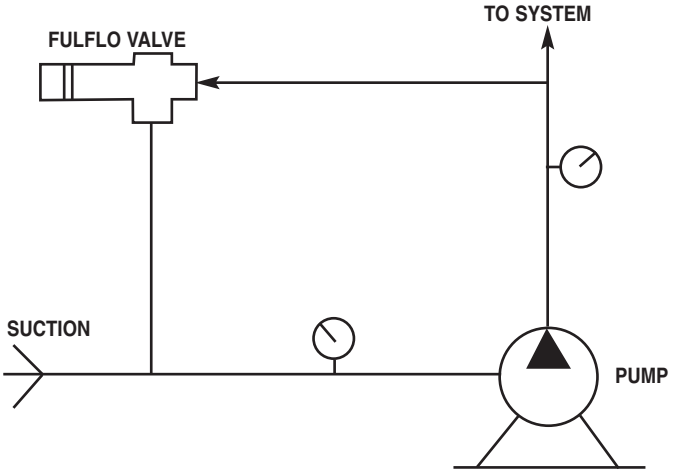
SYSTEM 2



CLOSED TANK

TANK PRESSURE + VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

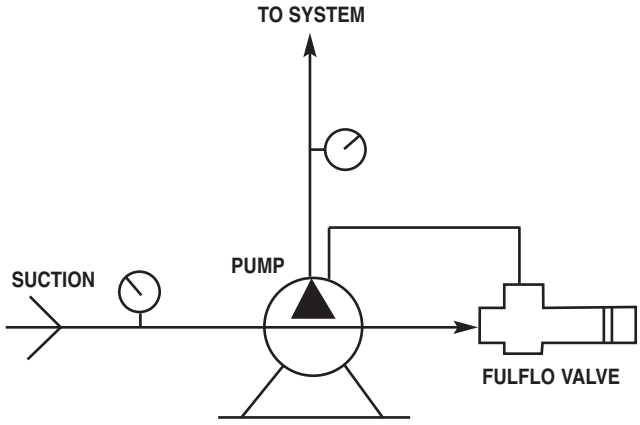
SYSTEM 3



CLOSED LOOP

SUCTION PRESSURE + VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

SYSTEM 4



PUMP INTERNAL RELIEF

FOR PUMPS WITH (2) SUCTION PORTS AND (2) DISCHARGE PORTS

SUCTION PRESSURE + VALVE SET PRESSURE EQUALS SYSTEM OPERATING PRESSURE

SPRING MATERIAL & TEMPERATURE CHART

VALVE SIZE	PART NO.	MATERIAL					MAX TEMP.				ASTM SPEC.				
		17-7PHSS	18-8SS	CHR. VANADIUM	OIL TEMP.	MUSIC WIRE	650 F	550 F	425 F	250 F	313 TYPE 631	A581 COND. A	A 231	229	228
3/8"	207-AS		•					•				•			
	207-US		•					•				•			
	207-WS		•					•				•			
	207-XS		•					•				•			
	207-YS	•					•				•				
	207-ZS	•					•				•				
	207-RS	•					•				•				
	207-TS	•					•				•				
	207-A					•				•					•
	207-U					•				•					•
	207-W				•					•				•	
	207-X				•					•				•	
	207-Y			•					•				•		
	207-Z			•					•				•		
	207-RS		•					•				•			
	207-TS		•					•				•			
1/2"	307-AS		•					•				•			
	307-US		•					•				•			
	307-WS		•					•				•			
	307-XS	•					•				•				
	307-YS	•					•				•				
	307-ZS	•					•				•				
	307-RS	•					•				•				
	307-TS	•					•				•				
	307-A					•				•					•
	307-U				•					•				•	
	307-W				•					•				•	
	307-X					•				•					•
	307-Y				•					•				•	
	307-Z				•					•				•	
	307-RS		•					•				•			
	307-TS		•					•				•			
3/4"	407-AS		•					•				•			
	407-US		•					•				•			
	407-WS		•					•				•			
	407-XS	•					•				•				
	407-YS	•					•				•				
	407-ZS	•					•				•				
	407-U				•					•				•	
	407-W				•					•				•	
	407-X			•					•				•		
	407-Y			•					•				•		
	407-Z				•					•				•	
1"	507-AS		•					•				•			
	507-US		•					•					•		
	507-WS		•					•					•		
	507-XS	•					•				•				
	507-YS	•					•				•				
	507-ZS	•					•				•				
	507-A				•					•				•	
	507-U				•					•				•	
	507-W				•					•				•	
	507-X			•					•				•		
	507-Y				•					•				•	
	507-Z				•					•				•	
	507-R			•					•				•		

VALVE SIZE	PART NO.	MATERIAL					MAX TEMP.				ASTM SPEC.				
		17-7PHSS	18-8SS	CHR. VANADIUM	OIL TEMP.	CHROME SILICON	650 F	550 F	425 F	250 F	313 TYPE 631	A581 COND. A	A 231	229	228
1 1/4"	607-AS		•					•				•			
	607-US		•					•				•			
	607-WS		•					•				•			
	607-XS	•					•				•				
	607-YS	•					•				•				
	607-ZS	•					•				•				
	607-A				•					•				•	
	607-U				•					•				•	
	607-W				•					•				•	
	607-Y				•					•				•	
	607-Z				•					•				•	
	607-R			•					•				•		
1 1/2"	707-AS		•					•				•			
	707-US		•					•				•			
	707-WS		•					•				•			
	707-XS	•					•				•				
	707YS	•					•				•				
	707-ZS	•					•				•				
	707-A				•					•				•	
	707-U				•					•				•	
	707-W				•					•				•	
	707-X				•					•				•	
	707-Y				•	•				•				•	
	707-Z				•					•				•	
	707-R				•					•				•	
2"	807-AS		•					•				•			
	807-US		•					•				•			
	807-WS		•					•				•			
	807-XS	•					•				•				
	807-YS	•					•				•				
	807-ZS	•					•				•				
	807-A				•					•				•	
	807-U				•					•				•	
	807-W				•					•				•	
	807-X				•					•				•	
	807-Y				•					•				•	
	807-Z	•					•				•				
2 1/2"	A0960D		•					•				•			
	A0961C			•					•				•		
	A0970D		•					•				•			
	A0971C			•					•				•		
	A0980D		•					•				•			
3"	A1060D		•					•				•			
	A1061C			•					•				•		
	A1070D		•					•				•			
	A1071C			•					•				•		
	A1080D		•					•				•			
4"	A1160D		•					•				•			
	A1170D		•					•				•			
	A1181D		•					•				•			
4" 3" 2 1/2"	A1190D		•					•				•			

SAE O-RING BOSS CONNECTIONS

VALVE SIZE	SAE NUMBER								
	5	6	8	10	12	16	20	24	32
3/8”	X	X	X						
1/2”		X	X	X					
3/4”					X				
1”					X	X	X		
1 1/4”							X	X	
1 1/2”								X	
2”									X

SAE (Society Automotive Engineers)

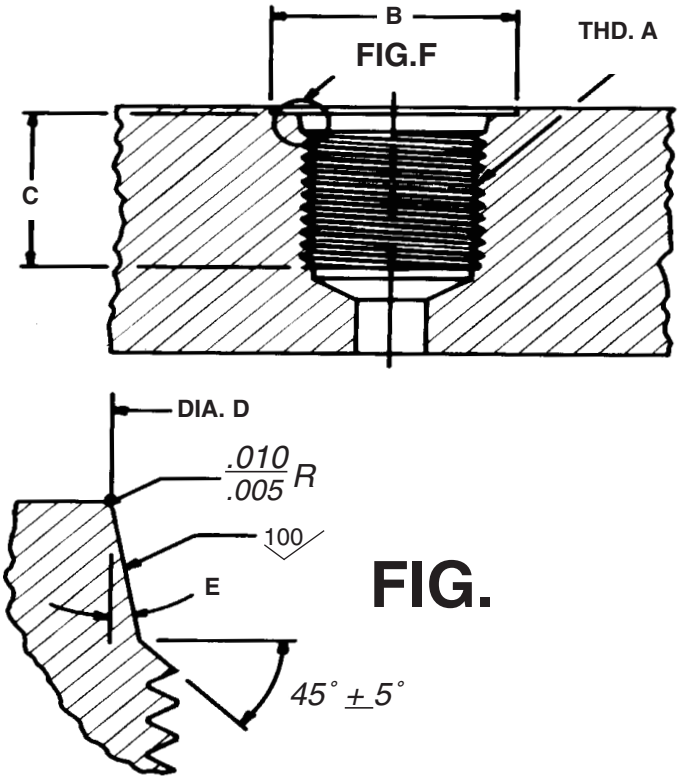


FIG.

DIMENSIONS (INCHES)

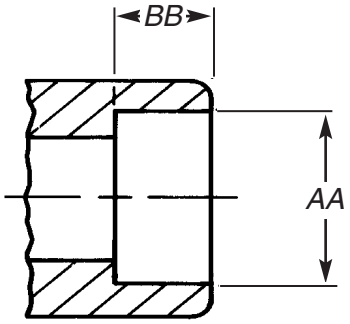
SAE NO.	A	B	C	D	E
5	1/2”-20	.937	.547	.550	12˚F
6	9/16”-18	1.000	.609	.616	12˚F
8	3/4”-16	1.218	.688	.811	12˚F
10	7/8”-14	1.375	.781	.942	15˚F
12	1 1/16”-12	1.656	.906	1.148	15˚F
16	1 5/16”-12	2.000	.906	1.398	15˚F
20	1 5/8”-12	2.312	.906	1.713	15˚F
24	1 7/8”-12	2.562	.906	1.962	15˚F
32	2 1/2”-12	3.192	.906	2.587	15˚F

VALVE SIZE	SAE NO.	MATERIAL			
		CAST IRON	BRASS	STEEL	STAINLESS
3/8”	5	SVJ-2039	SVB-2039	SVS-2039	SVSS-2039
	6	SVJ-2036	SVB-2036	SVS-2036	SVSS-2036
	8	SVJ-2042	SVB-2042	SVS-2042	SVSS-2042
1/2”	6	SVJ-3065	SVB-3065	SVS-3065	SVSS-3065
	8	SVJ-3066	SVB-3066	SVS-3066	SVSS-3066
	10	SVJ-3051	SVB-3051	SVS-3051	SVSS-3051
	12	SVJ-4049	SVB-4049	SVS-4049	SVSS-4049
1”	12	SVJ-5084	SVB-5084	SVS-5084	SVSS-5084
	16	SVJ-5071	SVB-5071	SVS-5071	SVSS-5071
	20	SVJ-5083	SVB-5083	SVS-5083	SVSS-5083
1 1/4”	20	SVJ-6065	SVB-6065	SVS-6065	SVSS-6065
	24	SVJ-6066	SVB-6066	SVS-6066	SVSS-6066
1 1/2”	24	SVJ-7050	SVB-7050	SVS-7050	SVSS-7050
2”	32	SVJ-8047	SVB-8047	SVS-8047	SVSS-8047

SOCKET WELD & STANDARD MATERIALS

SOCKET WELD

VALVE SIZE	MODEL NUMBER		AA		BB
	STEEL	STAINLESS	MIN.	MAX.	
3/8"	SVS-2033	SVSS-2033	.685	.690	.312
1/2"	SVS-3037	SVSS-3037	.850	.855	.437
3/4"	SVS-4038	SVSS-4038	1.060	1.065	.562
1"	SVS-5024	SVSS-5024	1.325	1.330	.625
1 1/4"	SVS-6058	SVSS-6058	1.670	1.675	.750
1 1/2"	SVS-7067	SVSS-7067	1.910	1.915	.812
2"	SVS-8070	SVSS-8070	2.410	2.415	.875



ASTM/ASME SPECIFICATIONS

Adjusting Screws 303

Stop Rings, Glands, Bonnets
- Brass – ASTM B16
- Steel – ASTM 108-79
- Stainless Steel – ASME ASME SA479
  Stop Rings Only Class 316

Caps
- Cast Iron – 401 thru 801 ASTM A 126-42 Class A
- Brass – 201-B thru 501-B ASTM B16
- Brass – 601B thru 801-B ASME B62
- Steel – All models ASTM 108-79
- Stainless Steel – All models ASME SA479 Class 303

Locknuts, Retainers
- Steel – ASTM 108-79
- Stainless Steel – ASTM A582 Class 303
- Brass – ASTM B16

Pistons
- Hardened Steel – ASTM 108-79
- 416 Stainless Steel – ASTM A 582 Cond. A
- 303 Stainless Steel – ASTM A 582 Class 303

Bodies
- Cast Iron – ASTM A126-42 Class A
- Brass – ASME B62
- Steel – ASTM A 216 Grade WCB
- Stainless Steel – ASTM A 351 CF8M

Material Codes
(Unless Otherwise Specified)
- A – 416 Stainless Steel
- J – Cast Iron (No Part # Suffix)
- B – Brass
- S – Steel
- SS – Stainless Steel

O-RING & PAD MATERIAL SPECIFICATIONS

MATERIAL	SUFFIX CODE	COMPOUND	TEMP. RANGE		ASTM SPEC.
			MIN.	MAX.	
BUNA	R	B 46	-40˚F	257˚F	D2000
ETHYLENE-PROPYLENE	EPR	E 50	-67˚F	302˚F	D2000
VITON	RV	V 14	-31˚F	437˚F	D2000
SILICONE	RS	S 71	-103˚F	482˚F	D2000
TEFLON	RT	– –	-423˚F	500˚F	D2000
NEOPRENE	RN	– –	-67˚F	284˚F	D2000
AFLAS	RA	– –	-25˚F	450˚F	D2000

MAX / MIN TEMP. OF BODIES

MATERIAL	MIN TEMP.	MAX TEMP.
CAST IRON	-20˚F	400˚F
BRASS	-20˚F	400˚F
STEEL	-30˚F	600˚F
STAINLESS STEEL	-50˚F	600˚F

MAXIMUM ALLOWABLE WORKING PRESSURE

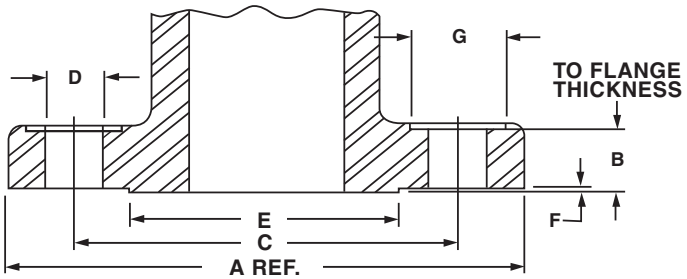
CAST IRON	1500 PSI
BRASS	1500 PSI
STEEL	2000 PSI
STAINLESS STEEL	2000 PSI

ORIFICE AREA & PISTON/BODY TOLERANCES

DIMENSIONS IN INCHES

VALVE SIZE	PISTON DIA. ±.000-.0003	AREA IN 2	BODY GO RC 3 FIT	BODY NO GO RC 3 FIT
3/8	.4985	.195	.4993	.4999
1/2	.6235	.305	.6243	.6249
3/4	.7485	.440	.7493	.7499
1	.9985	.783	.9993	1.0003
1 1/4	1.2485	1.224	1.2495	1.2507
1 1/2	1.4985	1.764	1.4995	1.5007
2	1.9985	3.167	1.9997	2.0011
2 1/2	2.6500	5.515	2.6517	2.6527
3	3.1235	7.663	3.1247	3.1261
4	4.1222	13.346	4.1250	4.1262

FLANGE AND DRILLING DIMENSIONS (INCHES)



CLASS 150 (BRASS – CAST IRON – STEEL – STAINLESS STEEL)

Valve Size	A Flange Diameter	B Flange Thickness		C Bolt Circle Diameter	D Bolt Holes Diameter	E Raised Face Diameter	F Raised Face Height	G Spotface Diameter	Number of Bolts
		Brass	CI/Steel						
1”	4 1/4”	3/8”	9/16”	3 1/8”	5/8”	2”	1/16”	1.12	4
1 1/4”	4 5/8”	13/32”	5/8”	3 1/2”	5/8”	2 1/2”	1/16”	1.12	4
1 1/2”	5”	7/16”	11/16”	3 7/8”	5/8”	2 7/8”	1/16”	1.12	4
2”	6”	1/2”	3/4”	4 3/4”	3/4”	3 5/8”	1/16”	1.37	4
2 1/2”*	7”	N/A	7/8”	5 1/2”	3/4”	4 1/8”	1/16”	1.37	4
3”*	7 1/2”	N/A	15/16”	6”	3/4”	5”	1/16”	1.37	4
4”*	9”	N/A	15/16”	7 1/2”	3/4”	6 3/16”	1/16”	1.37	8

Note: Brass flanges conform to 150# ANSI B 16.24 *except* with raised face. Cast iron and steel flanges conform to 150# ANSI B 16.5 steel specifications.
*Available in Cast Iron & Steel only. 125-250 AARH flange finish (Steel & Stainless Steel only)

CLASS 250 (CAST IRON)

Valve Size	A Flange Diameter	B Flange Thickness	C Bolt Circle Diameter	D Bolt Holes Diameter	E Raised Face Diameter	F Raised Face Height	G Spotface Diameter	Number of Bolts
1”	4 7/8”	11/16”	3 1/2”	3/4”	2 11/16”	1/16”	1.37	4
1 1/4”	5 1/4”	3/4”	3 7/8”	3/4”	3 1/16”	1/16”	1.37	4
1 1/2”	6 1/8”	13/16”	4 1/2”	7/8”	3 9/16”	1/16”	1.56	4
2”	6 1/2”	7/8”	5	3/4”	4 3/16”	1/16”	1.37	8

Note: Cast iron flanges conform to 250# ANSI B 16.2 steel specifications.

CLASS 300 (BRASS – STEEL – STAINLESS STEEL)

Valve Size	A Flange Diameter	B Flange Thickness	C Bolt Circle Diameter	D Bolt Holes Diameter	E Raised Face Diameter	F Raised Face Height	G Spotface Diameter	Number of Bolts
1”	4 7/8”	11/16”	3 1/2”	3/4”	2”	1/16”	1.37	4
1 1/4”	5 1/4”	3/4”	3 7/8”	3/4”	2 1/2”	1/16”	1.37	4
1 1/2”	6 1/8”	13/16”	4 1/2”	7/8”	2 7/8”	1/16”	1.56	4
2”	6 1/2”	7/8”	5”	3/4”	3 5/8”	1/16”	1.37	8
2 1/2”	7 1/2”	1”	5 7/8”	7/8”	4 1/8”	1/16”	1.56	8
3”	8 1/4”	1 1/8”	6 5/8”	7/8”	5”	1/16”	1.56	8
4”	10”	1 1/4”	7 7/8”	7/8”	6 3/16”	1/16”	1.56	8

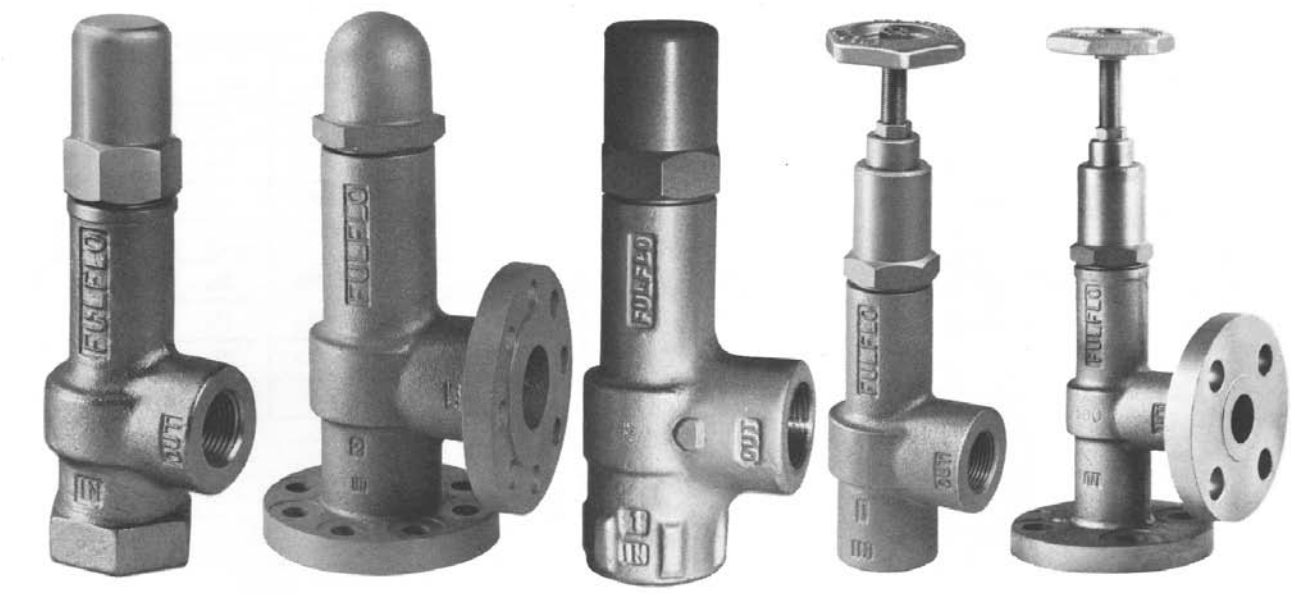
Note: Available in steel and cast iron only. Brass flanges conform to 300# ANSI B 16.24 *except* with raised face.
Steel flanges conform to 300# ANSI B 16.5 steel specifications. 125-250 AARH flange finish (Steel & Stainless Steel only)

CLASS 600 (STEEL – STAINLESS STEEL)

Valve Size	A Flange Diameter	B Flange Thickness	C Bolt Circle Diameter	D Bolt Holes Diameter	E Raised Face Diameter	F Raised Face Height	G Spotface Diameter	Number of Bolts
1”	4 7/8”	15/16”	3 1/2”	3/4”	2”	1/4”	1.37	4
1 1/4”	5 1/4”	1 1/16”	3 7/8”	3/4”	2 1/2”	1/4”	1.37	4
1 1/2”	6 1/8”	1 1/8”	4 1/2”	7/8”	2 7/8”	1/4”	1.56	4
2”	6 1/2”	1 1/4”	5”	3/4”	3 5/8”	1/4”	1.37	8
2 1/2”	7 1/2”	1 3/8”	5 7/8”	7/8”	4 1/8”	1/4”	1.56	8
3”	8 1/4”	1 1/2”	6 5/8”	7/8”	5”	1/4”	1.56	8
4”	10 3/4”	1 3/4”	8 1/2”	1”	6 3/16”	1/4”	1.78	8

Note: Cast iron and steel flanges conform to 600# ANSI B 16.5 steel specifications. 125-250 AARH flange finish (Steel & Stainless Steel only)
Note: Special Flanges With Drilling On Or Off Center And Smooth Or Raised Face Are Available Upon Request.

V-SERIES VALVES



Standard with Screw Connections | Standard with Flange Connections | Stainless Steel with Screw Connections | Handwheel with Screw Connections | Handwheel with Flange Connections

APPLICATION

The Fulflo “V” Series range in size from 3/8” through 2” and operate efficiently with liquids of any viscosity at pressures from 2 to 1000 P.S.I. The “V” series valves are available in flange or screw type...cartridge or handwheel in a choice of brass, cast iron, steel and stainless steel.

Widely used in a variety of applications, the “V” series valves are ideally suited in hydraulic and lubricating systems for load regulation and system protection. Special trim or packings are available for use with fire resisting fluids and other liquids of this type. Unusual applications and special requirements should be referred to our engineering staff for recommendation.

INSTALLATION

Fulflo valves can be mounted in any position. A tee may be inserted in the pump discharge line to mount the valve. The correct size of valve should be installed, preferably matching the pump discharge line. Screw the valve into the nipple in the tee, or in the case of the flange style, bolt the valve to the companion flange screwed into the nipple. When the valve is used for frequent bypassing of oil pressure, its outlet should be piped back to the tank. Care must be taken to have the discharge well below the oil level in the tank to prevent air entrainment and erratic operation.

Only if the valve is used as safety or overload relief and operates infrequently may its discharge be piped back into the pump suction line. Frequent or continuous operation under these conditions will cause excessive heating of the oil and possible damage.

SETTING VALVES

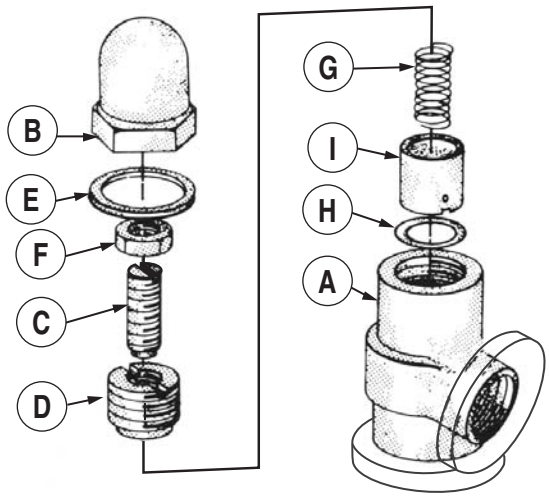
Valves may be set with a hydraulic hand pump for cracking pressure. If a test stand is available, valve should be connected to the discharge header with the pump bypass open, and the bypass gradually closed until the desired pressure registers on the gauge. Adjust valve adjusting screw until valve slightly bleeds at the set bypass pressure and lock adjusting screw.

Fulflo valves are not designed to be positive shut-off, and will pass a minimal amount of leakage before the set pressure. If a valve is required to bypass a given amount of fluid at a given pressure, a test stand having a flow meter in the pump discharge line must be available. With a valve adjusted for cracking pressure as above, continue closing bypass until the required flow registers on the flow meter and observe pressure. Readjust pressure, if necessary, to obtain desired pressure at desired flow.

MAINTENANCE

Fulflo valves provide reliable "chatter-free" operation when the system is free of abrasives and foreign matter. Continuous filtration of the liquid used is strongly recommended.

TYPICAL DISASSEMBLY OF STANDARD TYPE VALVE

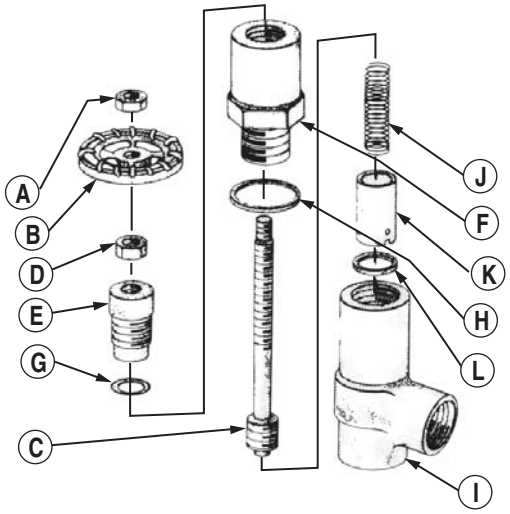


To dismantle valve for inspection or cleaning:

1. Remove cap "B"
2. Remove O-Ring "E"
3. Remove lock nut "F"
4. Remove adjusting screw "C"
5. Remove retainer "D"
6. Remove spring "G"
7. Remove piston "I"
8. Remove stop ring "H" (Not Recommended)
   (Special tooling is required to install new stop ring.)

Inspect valve bore and piston for wear and scoring. Replace broken or damaged parts. Clean all parts thoroughly and re-assemble by reversing the above procedure.

TYPICAL DISASSEMBLY OF HANDWHEEL TYPE VALVE



To dismantle the valve for inspection or cleaning:

1. Release spring tension by backing off handwheel as far as it will go.
2. Remove lock nut "A" or set screw and take off handwheel "B"
3. Remove lock nut "D"
4. Unscrew and remove gland "E"
5. Unscrew and remove bonnet "F"
6. Remove O-Ring "H"
7. Remove adjusting screw "C" (turn clockwise and pull out from bottom of bonnet "F")
8. Remove O-ring packing "G"
9. Remove spring "J"
10. Remove piston "K"
11. Remove stop ring "L" (Not Recommended)

(Special tooling is required to install new stop ring.)

Inspect valve bore and piston for wear or scoring. Replace broken or damaged parts. Clean all parts thoroughly and re-assemble by reversing the above procedure.

ASSEMBLY NUMBER IDENTIFICATION CHART

Symbol No.	Designation	Code	Description
1	Style	None H	Standard Model Handwheel Model
2	Series	V	
3	Material	J B S SS	Cast iron Brass Steel Stainless Steel (300 Series Stainless)
4	Connections	None F	Screw Connections Flange Connections 300# Flange Class Standard (250# Flange Class - Cast Iron Standard)
5	Size	-2 -3 -4 -5 -6 -7 -8	3/8” 1/2” 3/4” 1” 1 1/4” 1 1/2” 2”
6,7,8	ASA Flange Rating	None -150 -600	300# Flange Standard (no designation required)
9	Flange Style 150# & 600# Only	A B C D	Raised Face, Staggered Bolt Centers Smooth Face, Staggered Bolt Centers Raised Face, Bolts on Valve Centerline Smooth Face, Bolts on Valve Centerlne
10	O-Ring Material	R RV RS RT RA EPR RN	Buna O-Ring Cap Seal (standard) Viton O-Ring Cap Seal Silicone O-Ring Cap Seal Teflon O-Ring Cap Seal Aflas O-Ring Cap Seal Ethylene Propylene Neoprene
11	Options	SP P	Steel Parts (used on cast iron only) Panel Mount on Handwheel Series
12	Piston Material	/HS /SS /3SS	Hardened Steel 416 Stainless Steel 303 Stainless Steel
13	Spring	/AS /US /WS /XS /YS /ZS	
14	Setting		Desired Pressure Setting

EXAMPLES:

VJ-5RVSP/HS/WS

V	J	-5	RV	SP	/HS	/WS
Series	Cast Iron	1”	Viton O-Ring	Steel Parts	H.S. Piston	WS Spring

VJF-5R/HS/WS

V	J	F	-5	R	/HS	/WS
Series	Cast Iron	Flanged	1”	Buna O-Ring	H.S. Piston	WS Spring

VJF-5-150AR/HS/WS

V	J	F	-5	-150	A	R	/HS	/WS
Series	Cast Iron	Flanged	1”	Rating	Style	Buna O-Ring	H.S. Piston	WS Spring

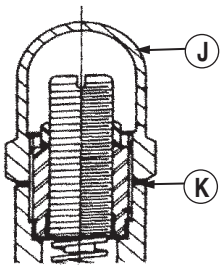
NOTE: Stainless steel pistons are supplied on brass valves, unless hardened steel is specified. Hardened steel pistons are supplied on cast iron or steel unless stainless steel is specified. Buna O-Rings are supplied as standard unless other material is specified.

STANDARD PRESSURE RANGE CHART

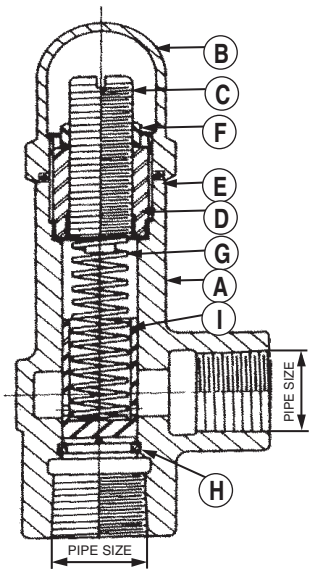
Valve Pipe Size	Valve Flange Size	SPRING PRESSURE AND IDENTIFICATION NO.															
		BLACK-AS		RED-US		GREEN-WS		YELLOW-XS		WHITE-YS		BLUE-ZS		PURPLE-TS		BROWN-RS	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
3/8”		3	15	7	35	30	100	60	175	150	350	300	500	400	600	550	750
1/2”		3	15	7	35	30	100	60	175	150	350	300	500	400	600	550	750
3/4”		3	15	7	35	30	100	60	175	150	350	300	500				
1”	1”	3	15	7	35	30	100	60	175	150	350	300	500				
1 1/4”	1 1/4”	3	15	7	35	30	100	60	175	150	350	300	500				
1 1/2”	1 1/2”	3	15	7	35	30	100	60	175	150	350	300	500				
2”	2”	3	15	7	35	30	100	60	175	150	350	250	600				

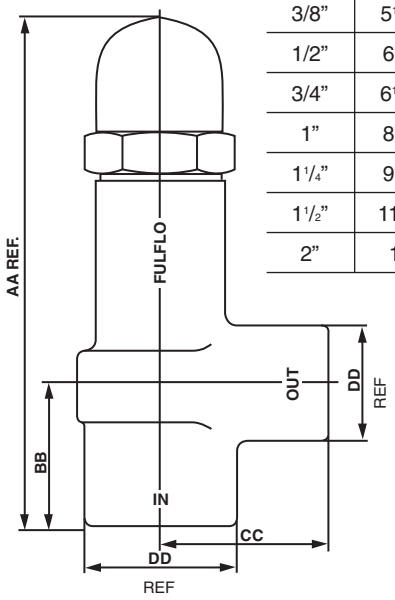
+/-1-5 PSI ON ALL SPRING RANGES

DIMENSIONS



CAP
(GASKET SEAL)





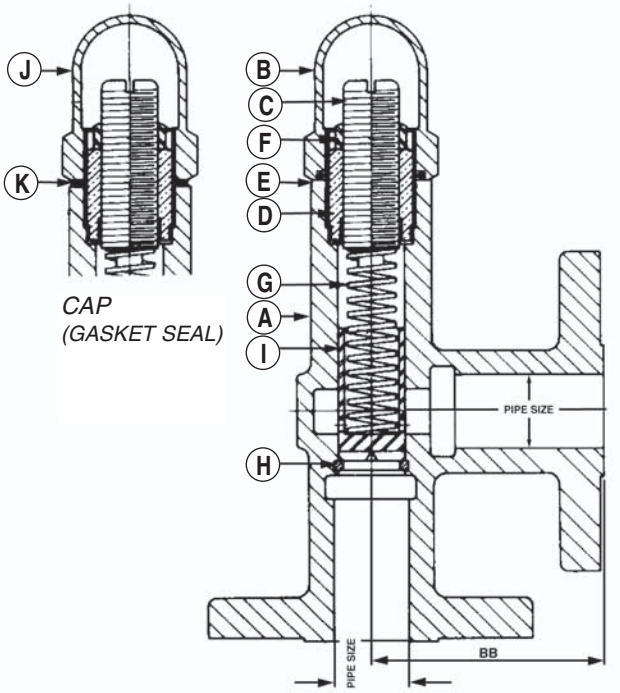
Valve Size	DIMENSIONS IN INCHES			
	AA	BB	CC	DD
3/8"	$5^{11}/_{32}$	$1^{11}/_{32}$	$1^{11}/_{32}$	$1^{3}/_{8}$
1/2"	$6^{3}/_{16}$	$1^{11}/_{16}$	$1^{7}/_{16}$	$1^{7}/_{16}$
3/4"	$6^{15}/_{16}$	$1^{15}/_{16}$	$1^{13}/_{16}$	$1^{11}/_{16}$
1"	$8^{7}/_{32}$	$2^{9}/_{32}$	$2^{9}/_{32}$	$2^{1}/_{16}$
$1^{1}/_{4}$"	$9^{9}/_{16}$	$2^{9}/_{16}$	$2^{9}/_{16}$	$2^{1}/_{2}$
$1^{1}/_{2}$"	$11^{1}/_{16}$	$2^{11}/_{16}$	$2^{11}/_{16}$	$2^{7}/_{8}$
2"	13	3	3	$3^{1}/_{4}$

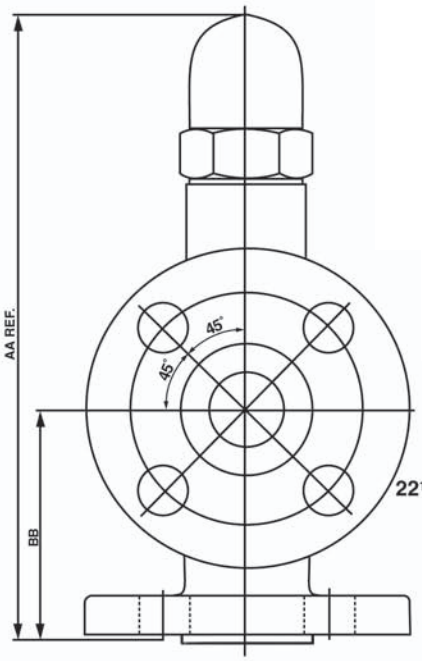
PARTS LIST

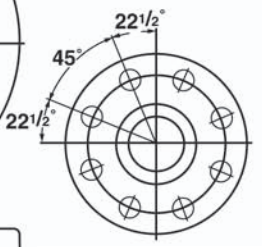
SYM.	NAME	MODEL	VALVE SIZE						
			3/8"	1/2"	3/4"	1"	$1^{1}/_{4}$"	$1^{1}/_{2}$"	2"
A	BODY	VJ, VJ-SP VB VS VSS	200 200-B 200-S 200-SS	300 300-B 300-S 300-SS	400 400-B 400-S 400-SS	500 500-B 500-S 500-SS	600 600-B 600-S 600-SS	700 700-B 700-S 700-SS	800 800-B 800-S 800-SS
B	CAP (O-RING SEAL)	VJ, VJ-SP VB VS VSS	201-SR 201-BR 201-SR 201-SSR	301-SR 301-BR 301-SR 301-SSR	401-R 401-BR 401-SR 401-SSR	501-R 501-BR 501-SR 501-SSR	601-R 601-BR 601-SR 601-SSR	701-R 701-BR 701-SR 701-SSR	801-R 801-BR 801-SR 801-SSR
C	ADJUSTING SCREW	VJ, VB VS, VJ-SP VSS	202-B 202-S 202-SS	302-B 302-S 302-SS	402-B 402-S 402-SS	502-B 502-S 502-SS	602-B 602-S 602-SS	702-B 702-S 702-SS	802-B 802-S 802-SS
D	RETAINER	VJ, VB VS, VJ-SP VSS	203-B 203-S 203-SS	303-B 303-S 303-SS	403-B 403-S 403-SS	503-B 503-S 503-SS	603-B 603-S 603-SS	703-B 703-S 703-SS	803-B 803-S 803-SS
E	O-RING †	VJ, VJ-SP, VB, VS VSS	204-* 204-RT	304-* 304-RT	404-* 404-RT	504-* 504-RT	604-* 604-RT	704-* 704-RT	804-* 804-RT
F	LOCK NUT	VJ, VJ-SP, VS, VB VSS	205-S 205-SS	305-S 305-SS	405-S 405-SS	505-S 505-SS	605-S 605-SS	705-S 705-SS	805-S 805-SS
G	SPRING †	ALL MODELS	207-**	307-**	407-**	507-**	607-**	707-**	807-**
H	STOP RING	VJ, VB VS, VJ-SP VSS	208-B 208-S 208-SS	308-B 308-S 308-SS	408-B 408-S 408-SS	508-B 508-S 508-SS	608-B 608-S 608-SS	708-B 708-S 708-SS	808-B 808-S 808-SS
I	PISTON †	HARDENED STEEL 416 STAINLESS STEEL 303 STAINLESS STEEL	206 206-A 206-SS	306 306-A 306-SS	406 406-A 406-SS	506 506-A 506-SS	606 606-A 606-SS	706 706-A 706-SS	806 806-A 806-SS
J	CAP (GASKET SEAL)	VJ, VJ-SP VB VS	201-S 201-B 201-S	301-S 301-B 301-S	401 401-B 401-S	501 501-B 501-S	601 601-B 601-S	701 701-B 701-S	801 801-B 801-S
K	GASKET †	VJ, VB VS, VJ-SP	204 204-S	304 304-S	404 404-S	504 504-S	604 604-S	704 704-S	804 804-S

* See o-ring selection chart
** See spring pressure chart
† Recommended spare parts

DIMENSIONS







FOR 2" VALVE ONLY

DIMENSIONS IN INCHES

Valve Size	AA	BB
1"	9 1/2"	3 1/2"
1 1/4"	10 13/16"	3 3/4"
1 1/2"	12 7/16"	4 1/16"
2"	14 9/16"	4 9/16"

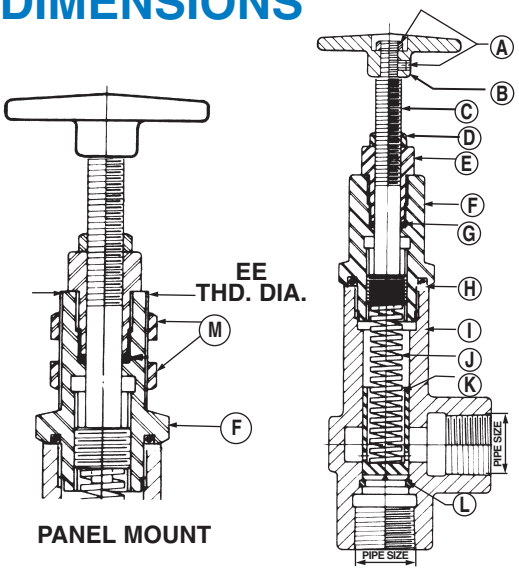
Note: Dimensions reflect 150# and 300# only

PARTS LIST

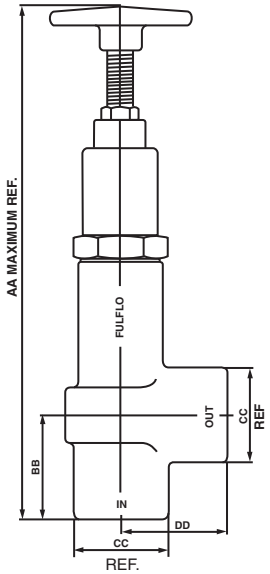
SYM.	NAME	MODEL	VALVE SIZE			
			1"	1 1/4"	1 1/2"	2"
A	BODY	VJF, VJF-SP VBF VSF VSSF	500-F 500-BF 500-SF 500-SSF	600-F 600-BF 600-SF 600-SSF	700-F 700-BF 700-SF 700-SSF	800-F 800-BF 800-SF 800-SSF
B	CAP (O-RING SEAL)	VJF, VJF-SP VBF VSF VSSF	501-R 501-BR 501-SR 501-SSR	601-R 601-BR 601-SR 601-SSR	701-R 701-BR 701-SR 701-SSR	801-R 801-BR 801-SR 801-SSR
C	ADJUSTING SCREW	VJF, VBF VSF, VJF-SP VSSF	502-B 502-S 502-SS	602-B 602-S 602-SS	702-B 702-S 702-SS	802-B 802-S 802-SS
D	RETAINER	VJF, VBF VSF, VJF-SP VSSF	503-B 503-S 503-SS	603-B 603-S 603-SS	703-B 703-S 703-SS	803-B 803-S 803-SS
E	O-RING †	VJF, VJF-SP VBF, VSF VSSF	504* 504-* 504-RT	604* 604-* 604-RT	704* 704-* 704-RT	804* 804-* 804-RT
F	LOCK NUT	VJF, VJF-SP VSF, VBF VSSF	505-S 505-S 505-SS	605-S 605-S 605-SS	705-S 705-S 705-SS	805-S 805-S 805-SS
G	SPRING †	ALL MODELS	507-**	607-**	707-**	807-**
H	STOP RING	VJF, VBF VJF-SP, VSF VSSF	508-B 508-S 508-SS	608-B 608-S 608-SS	708-B 708-S 708-SS	808-B 808-S 808-SS
I	PISTON †	HARDENED STEEL 416 STAINLESS STEEL 303 STAINLESS STEEL	506 506-A 506-SS	606 606-A 606-SS	706 706-A 706-SS	806 806-A 806-SS
J	CAP (GASKET SEAL)	VJF, VJF-SP VBF VSF	501 501-B 501-S	601 601-B 601-S	701 701-B 701-S	801 801-B 801-S
K	GASKET †	VJF, VBF VJF-SP, VSF	504 504-S	604 604-S	704 704-S	804 804-S

* See o-ring selection chart
** See spring pressure chart
† Recommended spare parts

DIMENSIONS



PANEL MOUNT



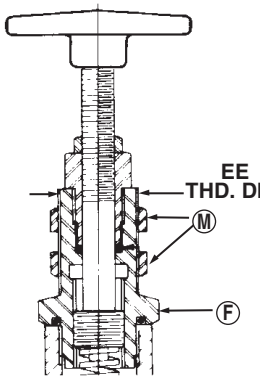
Valve Size	DIMENSIONS IN INCHES				
	AA	BB	CC	DD	EE
3/8"	8 1/8	1 11/32	1 3/16	1 3/8	7/8
1/2"	9 5/8	1 11/16	1 7/16	1 7/16	1 1/8
3/4"	9 3/16	1 15/16	1 11/16	1 13/16	1 3/8
1"	12 7/16	2 9/32	2 1/16	2 9/32	1 3/8
1 1/4"	13 7/16	2 9/16	2 1/2	2 9/16	1 5/8
1 1/2"	17 1/16	2 11/16	2 7/8	2 11/16	2 1/4
2"	17 1/16	3	3 3/8	3	2 1/4

PARTS LIST

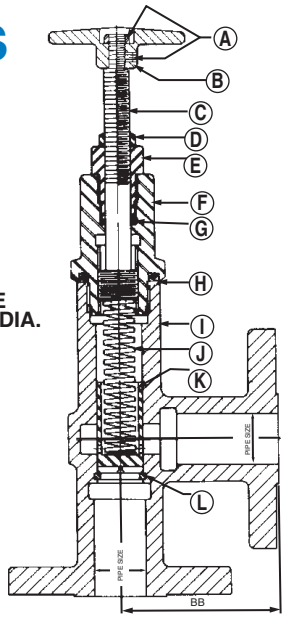
SYM.	NAME	MODEL	VALVE SIZE						
			3/8"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
A	LOCK NUT OR SET SCREW	ALL MODELS	1/4"-20 COMM.	1/4"-20 COMM.	205-S	205-S	1/4"-20 COMM.	1/4"-20 COMM.	1/4"-20 COMM.
B	HANDWHEEL	ALL MODELS	229	229	429	429	629	629	629
C	ADJUSTING SCREW	HVJ(P), HVS(P) HVB(P) HVSS(P)	222-S 222-B 222-SS	322-S 322-B 322-SS	422-S 422-B 422-SS	522-S 522-B 522-SS	622-S 622-B 622-SS	722-S 722-B 722-SS	822-S 822-B 822-SS
D	LOCK NUT	HVJ(P), HVS(P) HVB(P) HVSS(P)	205-S 205-S 205-SS	205-S 205-S 205-SS	305-S 305-S 305-SS	305-S 305-S 305-SS	655-S 655-S 655-SS	655-S 655-S 655-SS	655-S 655-S 655-SS
E	GLAND	HVJ(P), HVS(P) HVB(P) HVSS(P)	225-S 225-B 225-SS	325-S 325-B 325-SS	525-S 525-B 525-SS	525-S 525-B 525-SS	625-S 625-B 625-SS	725-S 725-B 725-SS	825-S 825-B 825-SS
F	BONNET	HVJ, HVS HVB HVSS HVJ(P), HVS(P) HVB(P) HVSS(P)	223-SR 223-BR 223-SSR 228-SR 228-BR 228-SSR	323-SR 323-BR 323-SSR 328-SR 328-BR 328-SSR	423-SR 423-BR 423-SSR 428-SR 428-BR 428-SSR	523-SR 523-BR 523-SSR 528-SR 528-BR 528-SSR	623-SR 623-BR 623-SSR 628-SR 628-BR 628-SSR	723-SR 723-BR 723-SSR 728-SR 728-BR 728-SSR	823-SR 823-BR 823-SSR 828-SR 828-BR 828-SSR
G	O-RING †	HVJ(P), HVS(P) HVB(P) HVSS(P) only	224* 224-* 224-RT	224* 224-* 224-RT	424* 424-* 424-RT	424* 424-* 424-RT	624* 624-* 624-RT	624* 624-* 624-RT	624* 624-* 624-RT
H	O-RING †	HVJ(P), HVS(P) HVB(P) HVSS(P) only	204* 204-* 204-RT	304* 304-* 304-RT	404* 404-* 404-RT	504* 504-* 504-RT	604* 604-* 604-RT	704* 704-* 704-RT	804* 804-* 804-RT
I	BODY	HVJ(P) HVB(P) HVS(P) HVSS(P)	200 200-B 200-S 200-SS	300 300-B 300-S 300-SS	400 400-B 400-S 400-SS	500 500-B 500-S 500-SS	600 600-B 600-S 600-SS	700 700-B 700-S 700-SS	800 800-B 800-S 800-SS
J	SPRING †	ALL MODELS	207-**	307-**	407-**	507-**	607-**	707-**	807-**
K	PISTON †	HARDENED STEEL 416 STAINLESS STEEL 303 STAINLESS STEEL	206 206-A 206-SS	306 306-A 306-SS	406 406-A 406-SS	506 506-A 506-SS	606 606-A 606-SS	706 706-A 706-SS	806 806-A 806-SS
L	STOP RING	HVJ(P), HVS(P) HVB(P) HVSS(P)	208-S 208-B 208-SS	308-S 308-B 308-SS	408-S 408-B 408-SS	508-S 508-B 508-SS	608-S 608-B 608-SS	708-S 708-B 708-SS	808-S 808-B 808-SS
M	LOCK NUTS 2 REQ'D	HVJ(P), HVS(P), HVB(P) HVSS(P)	505-S 505-S 505-SS	605-S 605-S 605-SS	705-S 705-S 705-SS	705-S 705-S 705-SS	805-S 805-S 805-SS	745-S 745-S 745-SS	745-S 745-S 745-SS

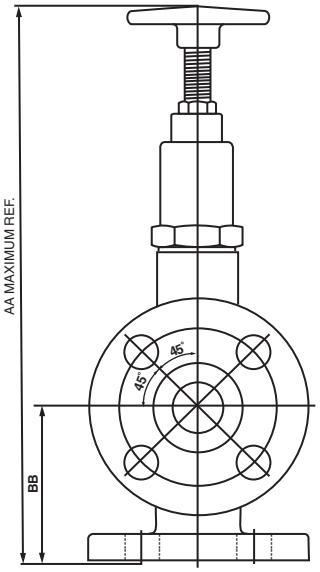
* See o-ring selection chart
** See spring pressure chart
† Recommended spare parts

DIMENSIONS



PANEL MOUNT

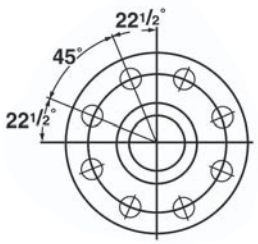




DIMENSIONS IN INCHES

Valve Size	AA	BB	EE
1”	13 11/16	3 1/2	1 3/8
1 1/4”	14 11/16	3 3/4	1 5/8
1 1/2”	18 7/16	4 1/16	2 1/4
2”	18 5/8	4 9/16	2 1/4

Note: Dimensions reflect 150# and 300# only



FOR 2” VALVE ONLY

PARTS LIST

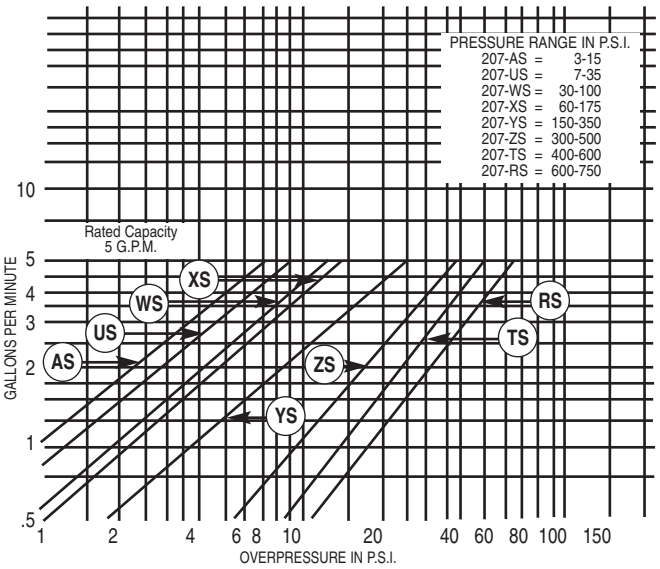
SYM.	NAME	MODEL	DIMENSIONS IN INCHES			
			1”	1 1/4”	1 1/2”	2”
A	LOCK NUT OR SET SCREW	ALL MODELS	205-S	1/4”-20 COMM.	1/4”-20 COMM.	1/4”-20 COMM.
B	HANDWHEEL	ALL MODELS	429	629	629	629
C	ADJUSTING SCREW	HVJF(P) HVSF(P) HVBF(P) HVSSF(P)	522-S 522-B 522-SS	622-S 622-B 622-SS	722-S 722-B 722-SS	822-S 822-B 822-SS
D	LOCK NUT	HVJF(P), HVSF(P) HVBF(P) HVSSF(P) only	305-S 305-S 305-SS	655-S 655-S 655-SS	655-S 655-S 655-SS	655-S 655-S 655-SS
E	GLAND	HVJF(P), HVSF(P) HVBF(P) HVSSF(P)	525-S 525-B 525-SS	625-S 625-B 625-SS	725-S 725-B 725-SS	825-S 825-B 825-SS
F	BONNET	HVJF, HVSF HVBF HVSSF HVJF(P) HVBF(P), HVSF(P) HVSSF(P)	523-SR 523-BR 523-SSR 528-SR 528-BR 528-SSR	623-SR 623-BR 623-SSR 628-SR 628-BR 628-SSR	723-SR 723-BR 723-SSR 728-SR 728-BR 728-SSR	823-SR 823-BR 823-SSR 828-SR 828-BR 828-SSR
G	O-RING †	HVJF(P), HVSF(P) HVBF(P) HVSSF(P) only	424* 424-* 424-RT	624* 624-* 624-RT	624* 624-* 624-RT	624* 624-* 624-RT
H	O-RING †	HVJF(P), HVSF(P) HVBF(P) HVSSF(P) only	504* 504-* 504-RT	604* 604-* 604-RT	704* 704-* 704-RT	804* 804-* 804-RT
I	BODY	HVJF(P) HVBF(P) HVSF(P) HVSSF(P)	500-F 500-BF 500-SF 500-SSF	600-F 600-BF 600-SF 600-SSF	700-F 700-BF 700-SF 700-SSF	800-F 800-BF 800-SF 800-SSF
J	SPRING †	ALL MODELS	507-**	607-**	707-**	807-**
K	PISTON †	HARDENED STEEL 416 STAINLESS STEEL 303 STAINLESS STEEL	506 506-A 506-SS	606 606-A 606-SS	706 706-A 706-SS	806 806-A 806-SS
L	STOP RING	HVJF(P), HVSF(P) HVBF(P) HVSSF(P)	508-S 508-B 508-SS	608-S 608-B 608-SS	708-S 708-B 708-SS	808-S 808-B 808-SS
M	LOCK NUTS 2 REQ’D	HVJF(P), HVSF(P), HVBF(P) HVSSF(P)	705-S 705-S 705-SS	805-S 805-S 805-SS	745-S 745-S 745-SS	745-S 745-S 745-SS

* See o-ring selection chart
** See spring pressure chart
† Recommended spare parts

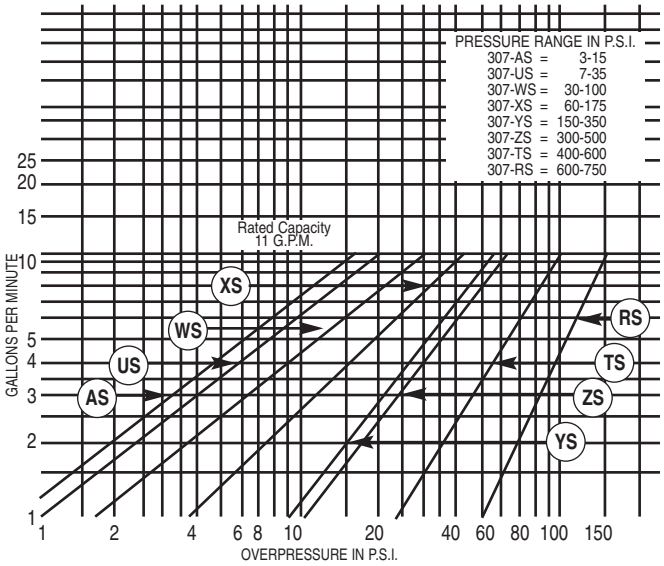
V-SERIES PERFORMANCE CHARTS

All valve tests 110˚F. to 120˚F. Oil Viscosity 150 S.S.U. at 100˚F.
(Charts good from 30 to 500 S.S.U.)

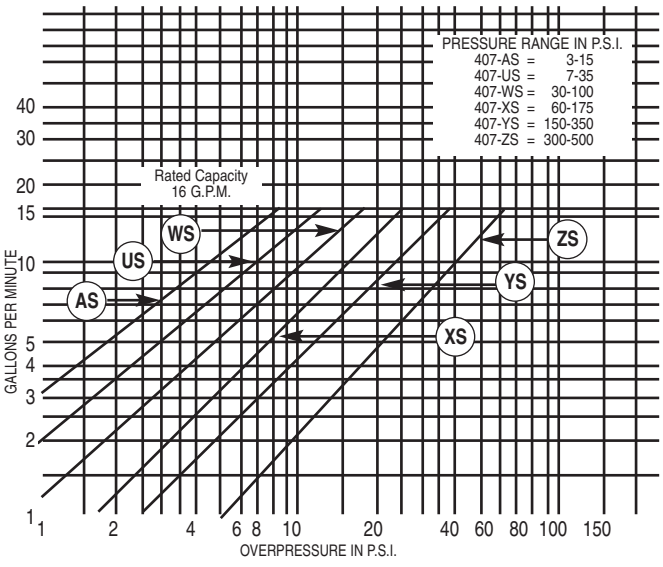
3/8" VALVE TESTS



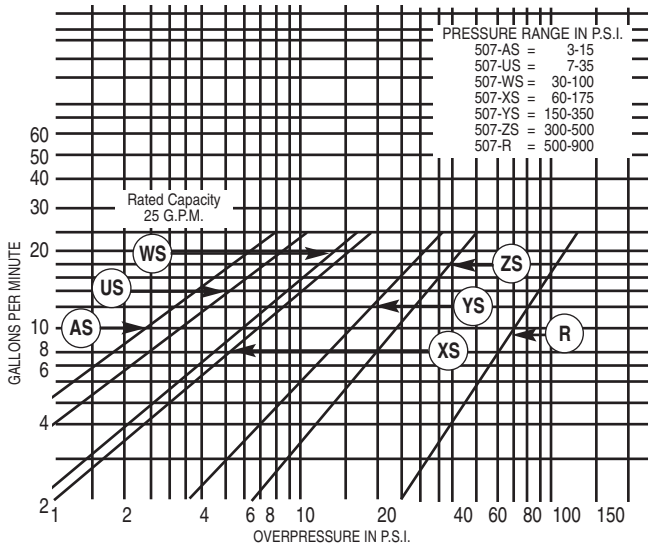
1/2" VALVE TESTS



3/4" VALVE TESTS



1" VALVE TESTS

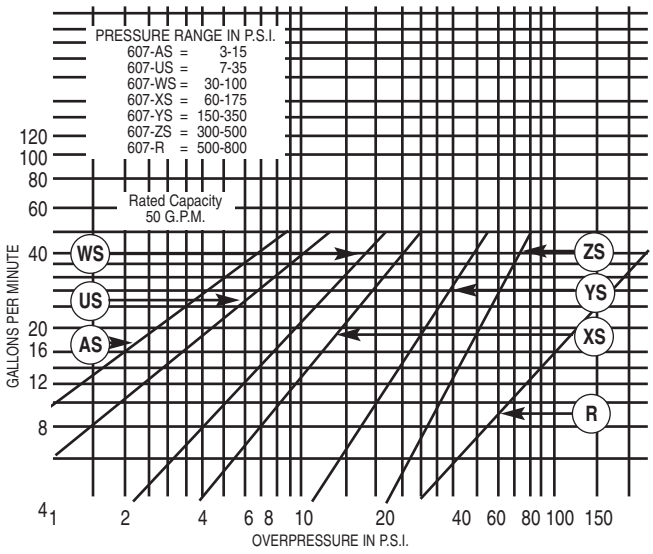


Overpressure - The pressure increase or accumulation above the set pressure when the valve is discharging flow.

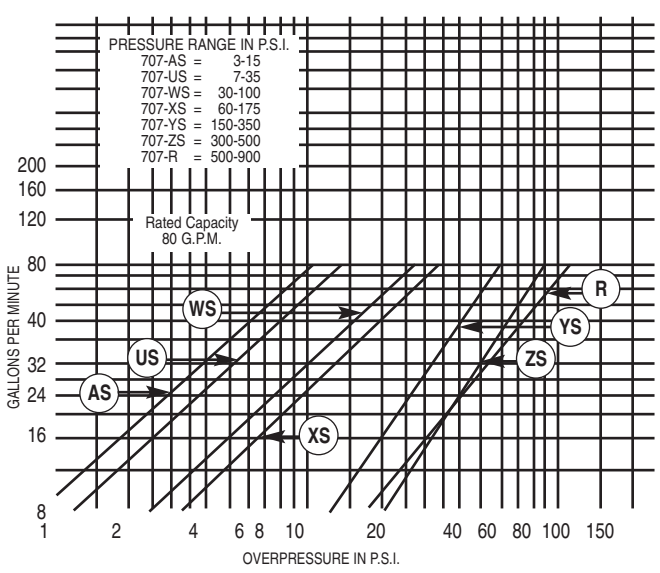
V-SERIES PERFORMANCE CHARTS

All valve tests 110˚F. to 120˚F. Oil Viscosity 150 S.S.U. at 100˚F.
(Charts good from 30 to 500 S.S.U.)

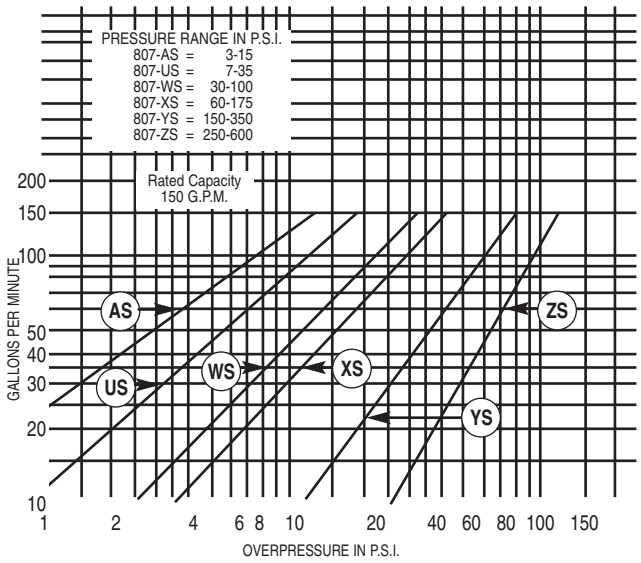
1¼" VALVE TESTS



1½" VALVE TESTS



2" VALVE TESTS



Overpressure - The pressure increase or accumulation above the set pressure when the valve is discharging flow.

FV2000 SERIES VALVE



The Fulflo FV2000 Series valve is similar to the V-Series valve, includes a new safer design that protects liquid and gasses from venting out of the valve during normal operation and adjustment conditions. This valve has been especially designed to prevent the adjusting screw from backing out while making adjustments to the pressure setting. An o-ring has been incorporated around the adjusting screw to further prevent liquid from escaping.

APPLICATION

The Fulflo “FV” Series range in size from 3/8” through 2” and operate efficiently with liquids of any viscosity at pressures from 2 to 1000 P.S.I. The “FV” series valves are available in flange or screw type... in a choice of brass, cast iron, steel and stainless steel.

Widely used in a variety of applications, the “FV” series valves are ideally suited in hydraulic and lubricating systems for load regulation and system protection. Special trim or packings are available for use with fire resisting fluids and other liquids of this type. Unusual applications and special requirements should be referred to our engineering staff for recommendation.

INSTALLATION

Fulflo valves can be mounted in any position. A tee may be inserted in the pump discharge line to mount the valve. The correct size of valve should be installed, preferably matching the pump discharge line. Screw the valve into the nipple in the tee, or in the case of the flange style, bolt the valve to the companion flange screwed into the nipple. When the valve is used for frequent bypassing of oil pressure, its outlet should be piped back to the tank. Care must be taken to have the discharge well below the oil level in the tank to prevent air entrainment and erratic operation.

Only if the valve is used as safety or overload relief and operates infrequently may its discharge be piped back into the pump suction line. Frequent or continuous operation under these conditions will cause excessive heating of the oil and possible damage.

SETTING VALVES

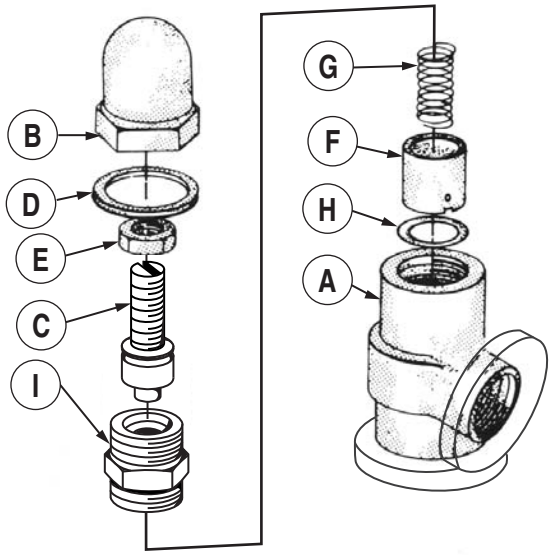
Valves may be set with a hydraulic hand pump for cracking pressure. If a test stand is available, valve should be connected to the discharge header with the pump bypass open, and the bypass gradually closed until the desired pressure registers on the gauge. Adjust valve adjusting screw until valve slightly bleeds at the set bypass pressure and lock adjusting screw.

Fulflo valves are not designed to be positive shut-off, and will pass a minimal amount of leakage before the set pressure. If a valve is required to bypass a given amount of fluid at a given pressure, a test stand having a flow meter in the pump discharge line must be available. With a valve adjusted for cracking pressure as above, continue closing bypass until the required flow registers on the flow meter and observe pressure. Readjust pressure, if necessary, to obtain desired pressure at desired flow.

MAINTENANCE

Fulflo valves provide reliable "chatter-free" operation when the system is free of abrasives and foreign matter. Continuous filtration of the liquid used is strongly recommended.

TYPICAL DISASSEMBLY OF STANDARD TYPE VALVE



To dismantle valve for inspection cleaning:

1. Remove cap "B"
2. Remove O-Ring "D"
3. Remove lock nut "E"
4. Remove adjusting screw "C"
5. Remove bonnet "I"
6. Remove spring "G"
7. Remove piston "F"
8. Remove stop ring "H" (Not Recommended)
   (Special tooling is required to install new stop ring.)

Inspect valve bore and piston for wear and scoring. Replace broken or damaged parts. Clean all parts thoroughly and re-assemble by reversing the above procedure.

No Leaking, Dripping, Spills or Venting

The Fulflo FV2000 Series valve includes a new safer design that prevents liquid and gasses from venting out of the valve during normal operation and adjustment conditions. This valve has been especially designed to prevent the adjusting screw from backing out while making adjustments to the pressure setting. An o-ring has been incorporated around the adjusting screw to further prevent liquid from escaping.

Operates Efficiently and Effectively

The FV2000 Series valves can be mounted in any position with sizes ranging from 3/8" through 2", and will operate efficiently with any application or viscosity at pressures from 2 to 1000 psi. Flange or screw connections are available in brass, cast iron, steel or stainless steel. All parts are completely interchangeable and convertible with other Fulflo V-Series valves.

Fulflo Valve Advantages

These valves offer Fulflo's patented "chatter-free" performance and are ideally suited for hydraulic and lubricating system protection. All Fulflo valves include a patented modulating piston design with absolute or differential pressure operation. Our advanced modulating operation allows Fulflo valves to be used in many different applications including positive displacement or centrifugal pump and system protection. Fulflo valves can be mounted in any position.

FV-SERIES

ASSEMBLY NUMBER IDENTIFICATION CHART

Symbol No.	Designation	Code	Description
1	Series	FV	
2	Material	J B S SS	Cast iron Brass Steel Stainless Steel (300 Series Stainless)
3	Connections	None F	Screw Connections Flange Connections 300# Flange Class Standard (250# Flange Class - Cast Iron Standard)
4	Size	-2 -3 -4 -5 -6 -7 -8	3/8” 1/2” 3/4” 1” 1 1/4” 1 1/2” 2”
5,6,7	ASA Flange Rating	None -150 -600	300# Flange Standard (no designation required)
8	Flange Style 150# & 600# only	A B C D	Raised Face, Staggered Bolt Centers Smooth Face, Staggered Bolt Centers Raised Face, Bolts on Valve Centerline Smooth Face, Bolts on Valve Centerlne
9	O-Ring Material	R RV RS RA EPR RN	Buna O-Ring Cap Seal (standard) Viton O-Ring Cap Seal Silicone O-Ring Cap Seal Aflas O-Ring Cap Seal Ethylene Propylene Neoprene
10	Piston Material	/HS /SS /3SS	Hardened Steel 416 Stainless Steel 303 Stainless Steel
11	Spring	/AS /US /WS /XS /YS /ZS	
12	Setting		Desired Pressure Setting

EXAMPLES:

FVJ-5RV/HS/WS

FV	J	-5	RV	/HS	/WS
Series	Cast Iron	1”	Viton O-Ring	H.S. Piston	WS Spring

FVJF-5R/HS/WS

FV	J	F	-5	R	/HS	/WS
Series	Cast Iron	Flanged	1”	Buna O-Ring	H.S. Piston	WS Spring

FVJF-5-150AR/HS/WS

FV	J	F	-5	-150	A	R	/HS	/WS
Series	Cast Iron	Flanged	1”	Rating	Style	Buna O-Ring	H.S. Piston	WS Spring

NOTE: Stainless steel pistons are supplied on brass valves, unless hardened steel is specified. Hardened steel pistons are supplied on cast iron or steel unless stainless steel is specified. Buna O-Rings are supplied as standard unless other material is specified.

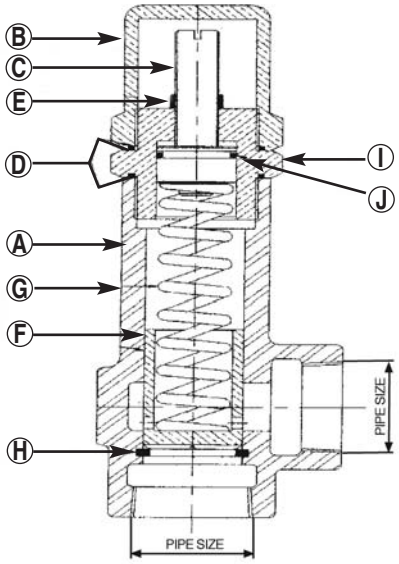
STANDARD PRESSURE RANGE CHART

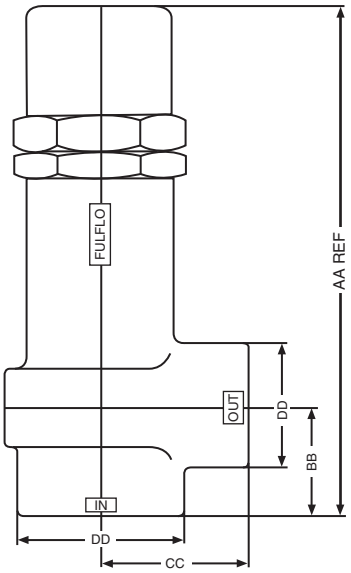
Valve Pipe Size	Valve Flange Size	SPRING PRESSURE AND IDENTIFICATION NO.															
		BLACK-AS		RED-US		GREEN-WS		YELLOW-XS		WHITE-YS		BLUE-ZS		PURPLE-TS		BROWN-RS	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
3/8”		3	15	7	35	30	100	60	175	150	350	300	500	400	600	550	750
1/2”		3	15	7	35	30	100	60	175	150	350	300	500	400	600	550	750
3/4”		3	15	7	35	30	100	60	175	150	350	300	500				
1”	1”	3	15	7	35	30	100	60	175	150	350	300	500				
1 1/4”	1 1/4”	3	15	7	35	30	100	60	175	150	350	300	500				
1 1/2”	1 1/2”	3	15	7	35	30	100	60	175	150	350	300	500				
2”	2”	3	15	7	35	30	100	60	175	150	350	250	600				

FV-SERIES

FVJ *Cast Iron* **FVS** *Steel*
FVB *Brass* **FVSS** *Stainless Steel*

DIMENSIONS





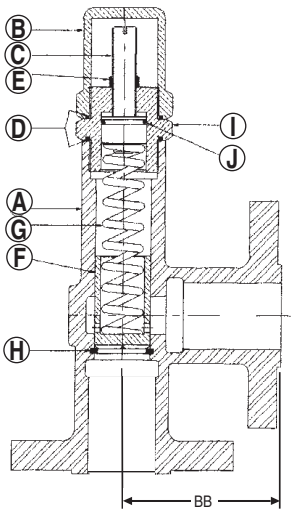
Valve Size	DIMENSIONS IN INCHES			
	AA	BB	CC	DD
3/8"	$5^{31}/_{32}$	$1^{11}/_{32}$	$1^{11}/_{32}$	$1^{3}/_{8}$
1/2"	$7^{3}/_{32}$	$1^{11}/_{16}$	$1^{7}/_{16}$	$1^{7}/_{16}$
3/4"	$7^{5}/_{16}$	$1^{15}/_{16}$	$1^{13}/_{16}$	$1^{11}/_{16}$
1"	$9^{1}/_{32}$	$2^{9}/_{32}$	$2^{9}/_{32}$	$2^{1}/_{16}$
$1^{1}/_{4}$"	$10^{1}/_{16}$	$2^{9}/_{16}$	$2^{9}/_{16}$	$2^{1}/_{2}$
$1^{1}/_{2}$"	$12^{15}/_{32}$	$2^{11}/_{16}$	$2^{11}/_{16}$	$2^{7}/_{8}$
2"	$13^{3}/_{4}$	3	3	$3^{1}/_{4}$

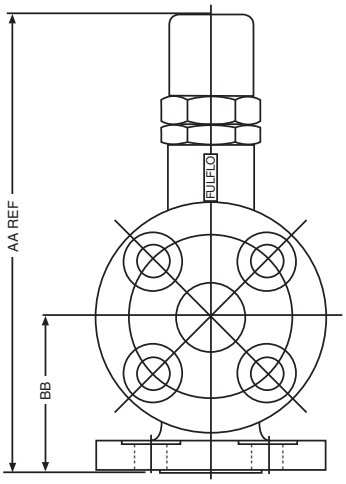
PARTS LIST

SYM.	NAME	MODEL	VALVE SIZE						
			3/8"	1/2"	3/4"	1"	$1^{1}/_{4}$"	$1^{1}/_{2}$"	2"
A	BODY	FVJ FVB FVS FVSS	200 200-B 200-S 200-SS	300 300-B 300-S 300-SS	400 400-B 400-S 400-SS	500 500-B 500-S 500-SS	600 600-B 600-S 600-SS	700 700-B 700-S 700-SS	800 800-B 800-S 800-SS
B	CAP	FVJ FVB FVS FVSS	201-SR 201-BR 201-SR 201-SSR	301-SR 301-BR 301-SR 301-SSR	401-SR 401-BR 401-SR 401-SSR	501-SR 501-BR 501-SR 501-SSR	601-SR 601-BR 601-SR 601-SSR	701-SR 701-BR 701-SR 701-SSR	801-SR 801-BR 801-SR 801-SSR
C	ADJUSTING SCREW	FVJ FVB FVS FVSS	202-S8 202-B8 202-S8 202-SS8	302-S8 302-B8 302-S8 302-SS8	402-S8 402-B8 402-S8 402-SS8	502-S8 502-B8 502-S8 502-SS8	602-S8 602-B8 602-S8 602-SS8	702-S8 702-B8 702-S8 702-SS8	802-S8 802-B8 802-S8 802-SS8
D	O-RING † (2 REQUIRED)	FVJ FVB FVS FVSS	204-* 204-* 204-* 204-*	304-* 304-* 304-* 304-*	404-* 404-* 404-* 404-*	504-* 504-* 504-* 504-*	604-* 604-* 604-* 604-*	704-* 704-* 704-* 704-*	804-* 804-* 804-* 804-*
E	LOCK NUT	FVJ FVB FVS FVSS	205-S 205-S 205-S 205-SS	305-S 305-S 305-S 305-SS	305-S 305-S 305-S 305-SS	505-S 505-S 505-S 505-SS	505-S 505-S 505-S 505-SS	505-S 505-S 505-S 505-SS	505-S 505-S 505-S 505-SS
F	PISTON †	HARDENED STEEL 416 STAINLESS STEEL 303 STAINLESS STEEL	206 206-A 206-SS	306 306-A 306-SS	406 406-A 406-SS	506 506-A 506-SS	606 606-A 606-SS	706 706-A 706-SS	806 806-A 806-SS
G	SPRING †	ALL MODELS	207-**	307-**	407-**	507-**	607-**	707-**	807-**
H	STOP RING	FVJ FVB FVS FVSS	208-S 208-B 208-S 208-SS	308-S 308-B 308-S 308-SS	408-S 408-B 408-S 408-SS	508-S 508-B 508-S 508-SS	608-S 608-B 608-S 608-SS	708-S 708-B 708-S 708-SS	808-S 808-B 808-S 808-SS
I	BONNET	FVJ FVB FVS FVSS	223-S4 223-B4 223-S4 223-SS4	323-S4 323-B4 323-S4 323-SS4	423-S4 423-B4 423-S4 423-SS4	523-S4 523-B4 523-S4 523-SS4	623-S4 623-B4 623-S4 623-SS4	723-S4 723-B4 723-S4 723-SS4	823-S4 823-B4 823-S4 823-SS4
J	O-RING † (1 REQUIRED)	FVJ FVB FVS FVSS	7058-* 7058-* 7058-* 7058-*	7006-* 7006* 7006-* 7006-*	7025-* 7025-* 7025-* 7025-*	7003-* 7003-* 7003-* 7003-*	7061-* 7061-* 7061-* 7061-*	7062-* 7062-* 7062-* 7062-*	504-* 504-* 504-* 504-*

* See o-ring selection chart
** See spring pressure chart
† Recommended spare parts

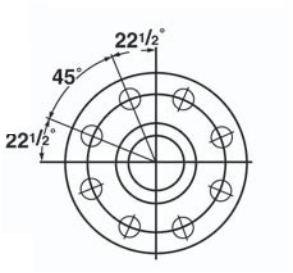
DIMENSIONS





DIMENSIONS IN INCHES		
Valve Size	AA	BB
1”	$10^{5}/_{16}$”	$3^{1}/_{2}$”
$1^{1}/_{4}$”	$11^{13}/_{16}$”	$3^{3}/_{4}$”
$1^{1}/_{2}$”	$12^{5}/_{8}$”	$4^{1}/_{16}$”
2”	$15^{5}/_{16}$”	$4^{9}/_{16}$”

Note: Dimensions reflect 150# and 300# only



FOR 2” VALVE ONLY

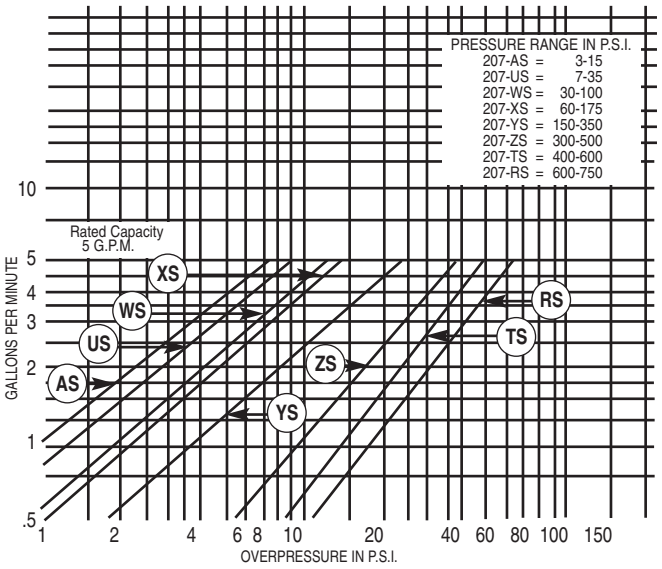
PARTS LIST

SYM.	NAME	MODEL	VALVE SIZE			
			1”	$1^{1}/_{4}$”	$1^{1}/_{2}$”	2”
A	BODY	FVJF FVBF FVSF FVSSF	500-F 500-BF 500-SF 500-SSF	600-F 600-BF 600-SF 600-SSF	700-F 700-BF 700-SF 700-SSF	800-F 800-BF 800-SF 800-SSF
B	CAP	FVJF FVBF FVSF FVSSF	501-R 501-BR 501-SR 501-SSR	601-R 601-BR 601-SR 601-SSR	701-R 701-BR 701-SR 701-SSR	801-R 801-BR 801-SR 801-SSR
C	ADJUSTING SCREW	FVJF FVBF FVSF FVSSF	502-S8 502-B8 502-S8 502-SS8	602-S8 602-B8 602-S8 602-SS8	702-S8 702-B8 702-S8 702-SS8	802-S8 802-B8 802-S8 802-SS8
D	O-RING † (2 REQUIRED)	FVJF FVBF FVSF FVSSF	504-* 504-* 504-* 504-*	604-* 604-* 604-* 604-*	704-* 704-* 704-* 704-*	804-* 804-* 804-* 804-*
E	LOCK NUT	FVJF FVBF FVSF FVSSF	505-S 505-S 505-S 505-SS	505-S 505-S 505-S 505-SS	505-S 505-S 505-S 505-SS	505-S 505-S 505-S 505-SS
F	PISTON †	HARDENED STEEL 416 STAINLESS STEEL 303 STAINLESS STEEL	506 506-A 506-SS	606 606-A 606-SS	706 706-A 706-SS	806 806-A 806-SS
G	SPRING †	ALL MODELS	507-**	607-**	707-**	807-**
H	STOP RING	FVJF FVBF FVSF FVSSF	508-S 508-B 508-S 508-SS	608-S 608-B 608-S 608-SS	708-S 708-B 708-S 708-SS	808-S 808-B 808-S 808-SS
I	BONNET	FVJF FVBF FVSF FVSSF	523-S4 523-B4 523-S4 523-SS4	623-S4 623-B4 623-S4 623-SS4	723-S4 723-B4 723-S4 723-SS4	823-S4 823-B4 823-S4 823-SS4
J	O-RING † (1 REQUIRED)	FVJF FVBF FVSF FVSSF	7003-* 7003-* 7003-* 7003-*	7061-* 7061-* 7061-* 7061-*	7062-* 7062-* 7062-* 7062-*	504-* 504-* 504-* 504-*

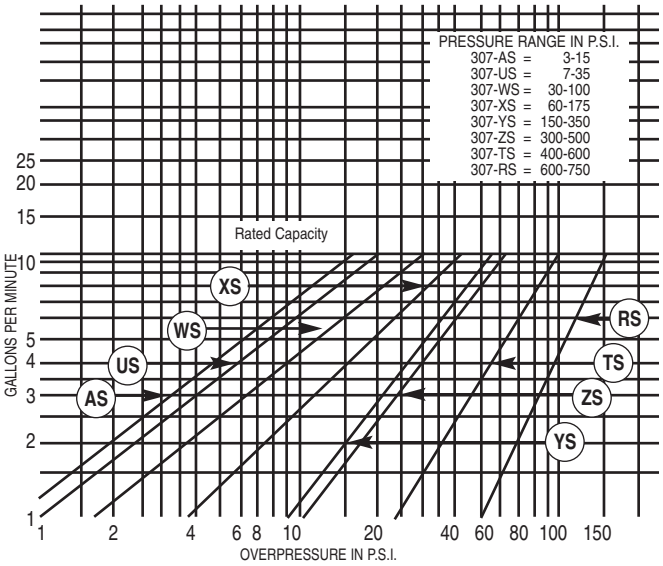
* See o-ring selection chart
** See spring pressure chart
† Recommended spare parts

All valve tests 110˚F. to 120˚F. Oil Viscosity 150 S.S.U. at 100˚F.
(Charts good from 30 to 500 S.S.U.)

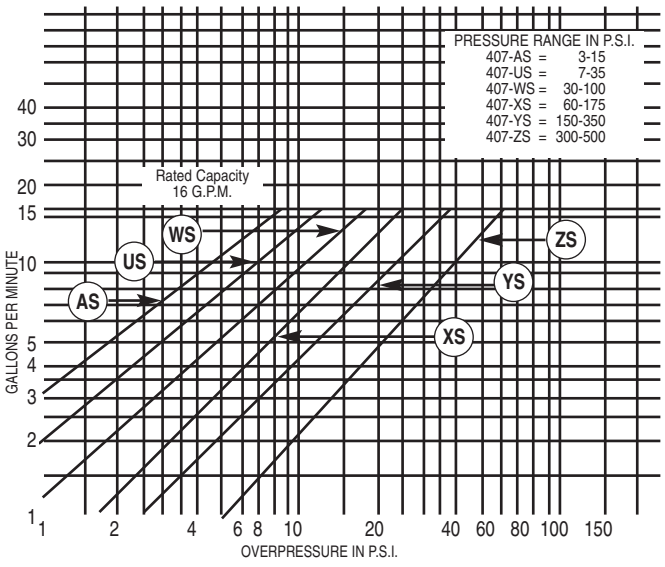
3/8" VALVE TESTS



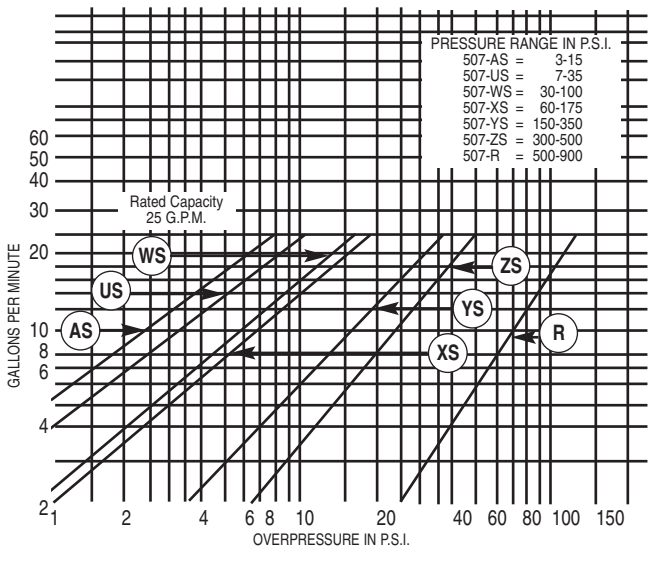
1/2" VALVE TESTS



3/4" VALVE TESTS



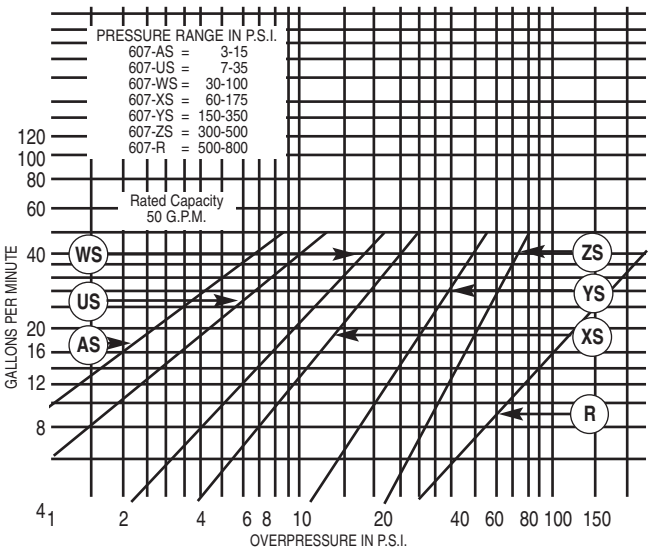
1" VALVE TESTS



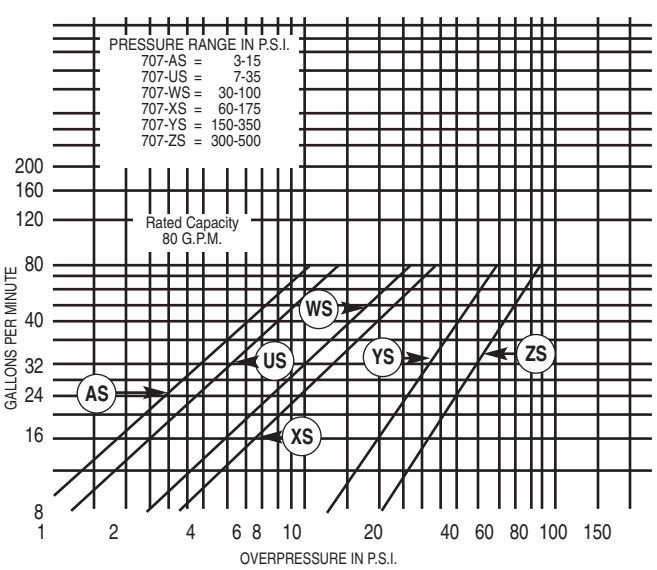
Overpressure - The pressure increase or accumulation above the set pressure when the valve is discharging flow.

All valve tests 110˚F. to 120˚F. Oil Viscosity 150 S.S.U. at 100˚F.
(Charts good from 30 to 500 S.S.U.)

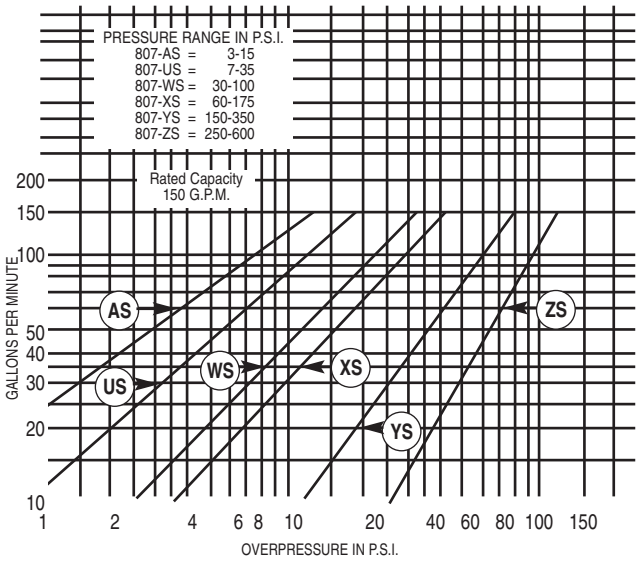
1¼" VALVE TESTS



1½" VALVE TESTS



2" VALVE TESTS



Overpressure - The pressure increase or accumulation above the set pressure when the valve is discharging flow.

A-SERIES VALVES



APPLICATION

The Fulflo “A” Series feature both direct acting and internal pilot operated models with either screw or flange type connections. The threaded valves are available in both 2½” and 3” sizes in either cast iron or steel. The flange type valves also include a 4” model and may be specified with 150#, 300# or 600# ANSI flanges. Note that 600# is available in steel and SS only.

The direct acting valves operate at pressures to 150 P.S.I.; the internal pilot operated models at pressures to 500 P.S.I. Both types handle large flows of liquid of all viscosities encountered in industrial practice.

The “A” Series valves may be used in a variety of applications including hydraulic and lubrication systems for load regulation and system protection.

Unusual applications and special or stainless steel requirements should be referred to our engineering staff for recommendation.

INSTALLATION

Fulflo valves can be mounted in any position. A tee may be inserted in the pump discharge line to mount the valve. The pipe lines carrying the heavy valves must be well supported and overhung weights avoided. The correct size of valve must be used, preferably equal to the size of the pipe line to which they are connected. Threaded valves (AAD and ACD) may be threaded into pipe nipples. Overhung weights on threads should be avoided. Flanged valves (AADF and ACDF) are bolted to the companion flange which may be threaded or welded to the pipe. The outlet of the valve should be piped to the supply tank, unless specific applications call for alternate piping of return lines. Care must be taken to have the discharge well below the oil level in the tank to prevent air entrainment and erratic operation.

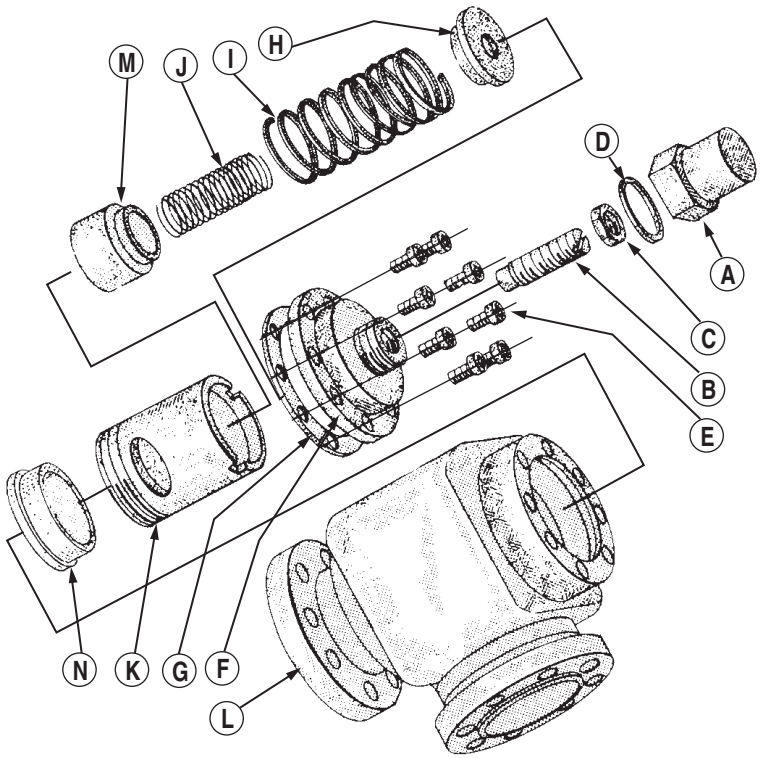
SETTING VALVES

Valve may be set with a hydraulic hand pump for cracking pressure. If a test stand is available, valve should be connected to the discharge header with the pump bypass open, and the bypass gradually closed until the desired pressure registers on the gauge. **"Direct"** Adjust valve adjusting screw until valve slightly bleeds at the set bypass pressure and lock adjusting screw. **"Pilot"** Adjust valve adjusting screw until approximately 5-7 GPM is flowing through the valve, at that point the main piston will open and then the valve will be considered at the set point, then lock adjusting screw. If a valve is required to bypass a given amount of fluid at a given pressure, a test stand having a flow meter in the pump discharge line must be available. With a valve adjusting for cracking pressure as above, continue closing bypass until the required flow registers on the flow meter and observe pressure. Readjust pressure, if necessary, to obtain desired pressure at desired flow.

MAINTENANCE

Fulflo valves provide reliable "chatter-free" operation when the system is free of abrasives and foreign matter. Continuous filtration of the liquid used is strongly recommended.

DISASSEMBLY OF DIRECT ACTING VALVES



To dismantle the valve for inspection or cleaning:

1. Remove cap "A" and gasket "D"
2. Remove lock nut "C"
3. Remove adjusting screw "B"
4. Remove cap screws "E"
5. Remove bonnet "F"
6. Remove gasket "G"
7. Remove spring retainer "H"
8. Remove spring or springs "I" and "J"
9. Remove piston "M"
10. Unscrew and withdraw cylinder "K"
11. Remove retaining bushing "N" if necessary

Inspect cylinder bore and piston for wear or scoring. Replace broken or damaged parts. Clean all parts thoroughly and re-assemble as follows:

Reverse process of disassembly from operation 11 to 6, then thread adjusting screw "B" into bonnet "F" so that it may be guided into the recess of spring retainer "H", while re-assembling bonnet "F" to body "L". Then proceed with steps 5, 4, 2, 1, in reverse order.

ASSEMBLY NUMBER IDENTIFICATION CHART

Symbol No.	Designation	Code	Description
1	Series	A	
2	Material	A C	Cast Iron Cast Steel
3	Type	D P	Direct Acting Internal Pilot Operated
4 & 5	Size	09 10 11	2½" 3" 4"
6	Connection	None F	Screw Type Flange
7,8,9	ASA Flange Rating	150# 300# 600#	
10	Flange Style Only	A B C D	Raised Face, Staggered Bolt Centers Smooth Face, Staggered Bolt Centers Raised Face, Bolts on Valve Centerline Smooth Face, Bolts on Valve Centerline
11	O-Ring Material	R RV RS RT RA EPR RN	Buna O-Ring Cap Seal (Standard) Viton O-Ring Cap Seal Silicone O-Ring Cap Seal Teflon O-Ring Cap Seal Aflas O-Ring Cap Seal Ethylene Propylene Neoprene

EXAMPLE:

ACP09R

A	C	P	09	R
Series	Steel	Pilot Operated	2½"	Buna

NOTE: Special valves are prefixed by numbers assigned by the factory.

EXAMPLE:

Specify:

1. Valve Model Number
2. O-Ring Identification Number
3. Piston Material
4. Spring Part Number
5. Spring pressure range or desired pressure setting.

SERIES "A" VALVES (Direct Acting) PRESSURE RANGE CHART

Valve Size	Symbol	Spring Part No.	Pressure Range
2½"	I	A0960D	7-57 P.S.I.
	I	A0961C	8-75 P.S.I
	I & J	A0960D and A0970D	14-115 P.S.I.
	I & J	A0961C and A0971C	16-150 P.S.I.
3"	I	A1060D	5-50 P.S.I.
	I	A1061C	5-67 P.S.I.

NOTE: Springs suffixed with "C" are Chrome Vanadium, "D" indicates Stainless Steel. For pressures other than listed, consult factory.

(Continued)

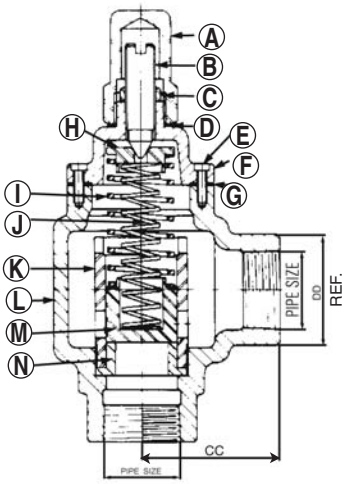
3"	I & J	A1060D and A1070D	10-100 P.S.I.
	I & J	A1061C A1071C	10-135 P.S.I.
4"	I	A1160D	2-37 P.S.I.
	I & J	A1160D and A1170D	4-75 P.S.I.

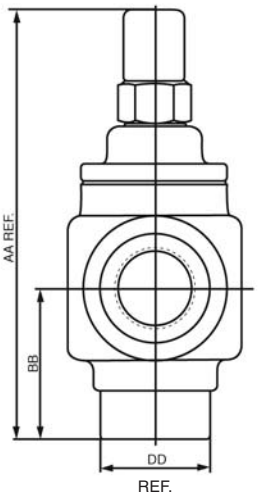
SERIES "A" VALVES (Pilot Operated)

Valve Size	Symbol	Spring Part No.	Pressure Range
2½"	O & J	A0980D and A1190D	50-500 P.S.I.
3"	O & J	A1080D and A1190D	50-500 P.S.I.
4"	O & J	A1181D and A1190D	50-500 P.S.I.

A-SERIES 2½" and 3" (Direct Acting)

DIMENSIONS





Valve Size	DIMENSIONS IN INCHES			
	AA	BB	CC	DD
2½"	15 9/16	5 1/2	5 1/16	4
3"	17 1/2	6 5/8	6 3/8	4 7/8

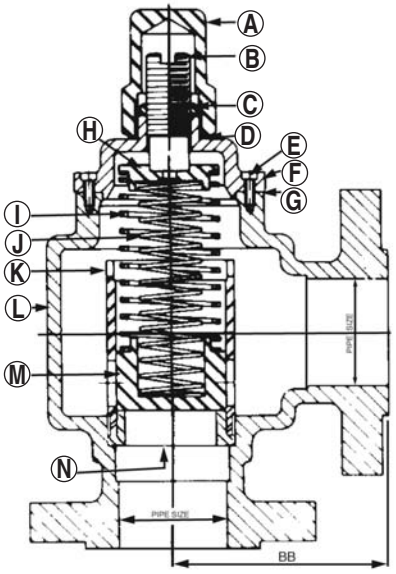
PARTS LIST

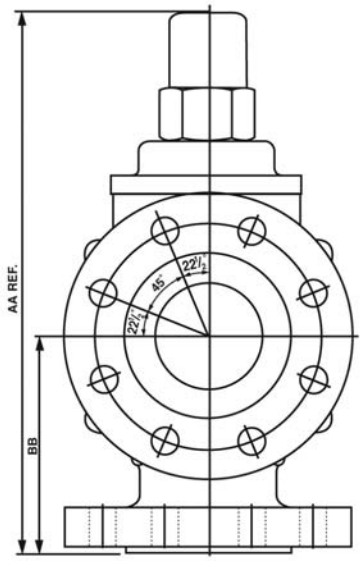
Symbol	NAME	VALVE SIZE	
		2½"	3"
A	Cap	A1101CR	A1013CR
B	Adjusting Screw	A0922C	A1022C
C	Lock Nut	605-S	705-S
D	O-Ring †	604-R	704-R
E	Cap Screw	3/8 x 1 SHCS	3/8 x 1 SHCS
F	Bonnet Cast Iron Steel	 A0909A A0909C	 A1009A A1009C
G	Gasket †	A0903E	A1003E
H	Spring Retainer	A0916C	A1016C
I	Spring †	See Chart	See Chart
J	Spring †	See Chart	See Chart
K	Cylinder †	A0908C	A1008C
L	Body Cast Iron Steel	 A0900A A0900C	 A1000A A1000C
M	Piston † Hardened Steel Stainless Steel	 A0906C A0906D	 A1006C A1006D
N	Retaining Bushing	A0911C	A1011C

† Recommended spare parts

A-SERIES 2½", 3" and 4" (Direct Acting)

DIMENSIONS





DIMENSIONS IN INCHES			
Valve Size	Flange Rating	AA	BB
2½	150# 300#	15 12/16	5 3/4
2½	600#	16 3/16	6 1/8
3	150# 300#	17 1/8	6 1/4
3	600#	17 1/2	6 5/8
4	150# 300#	20	7 15/16
4	600#	20 3/16	8 1/8

Note! Refer to Page 10 for Flange and Drilling Dimensions.

PARTS LIST

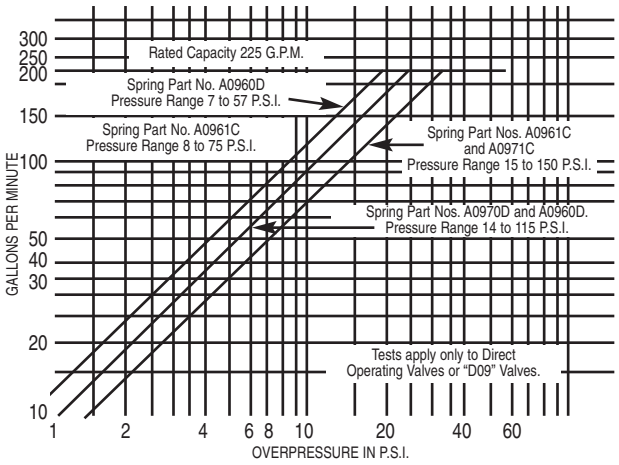
Symbol	NAME	VALVE SIZE		
		2½"	3"	4"
A	Cap	A1101CR	A1013CR	A1113CR
B	Adjusting Screw	A0922C	A1022C	A1122C
C	Lock Nut	605-S	705-S	805-S
D	O-Ring †	604-R	704-R	804-R
E	Cap Screw	3/8 x 1 SHCS	3/8 x 1 SHCS	3/8 x 1 SHCS
F	Bonnet Cast Iron Steel	 A0909A A0909C	 A1009A A1009C	 A1109A A1109C
G	Gasket †	A0903E	A1003E	A1103E
H	Spring Retainer	A0916C	A1016C	A1116C
I	Spring †	See Chart	See Chart	See Chart
J	Spring †	See Chart	See Chart	See Chart
K	Cylinder †	A0908C	A1008C	A1108C
L	Body Cast Iron 150# 300# Steel 150# 300# 600#	A0900AF150A A0900AF300A A0900CF150A A0900CF300A A0900CF600A	A1000AF150A A1000AF300A A1000CF150A A1000CF300A A1000CF600A	A1100AF150A A1100AF300A A1100CF150A A1100CF300A A1100CF600A
M	Piston † Hardened Steel Stainless Steel	 A0906C A0906D	 A1006C A1006D	 A1106C A1106D
N	Retaining Bushing	A0911C	A1011C	A1111C

† Recommended spare parts

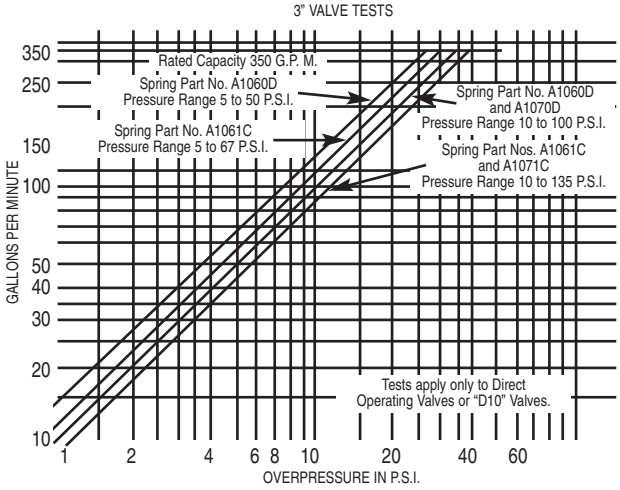
A-SERIES PERFORMANCE CHARTS
(Direct Acting)

All valve tests 110˚F. to 120˚F. Oil Viscosity 150 S.S.U. at 100˚F.
(Charts good from 30 to 500 S.S.U.)

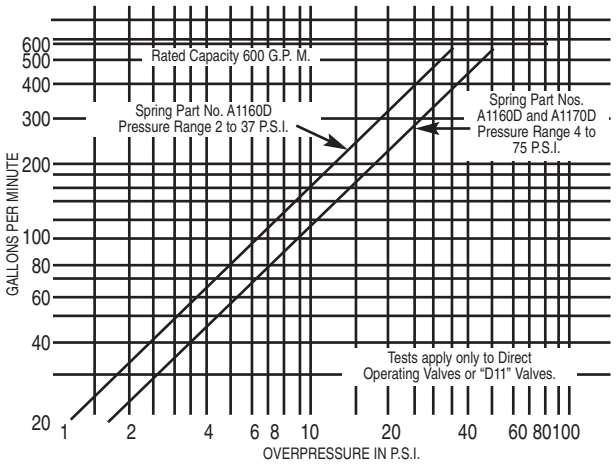
2½" VALVE TESTS



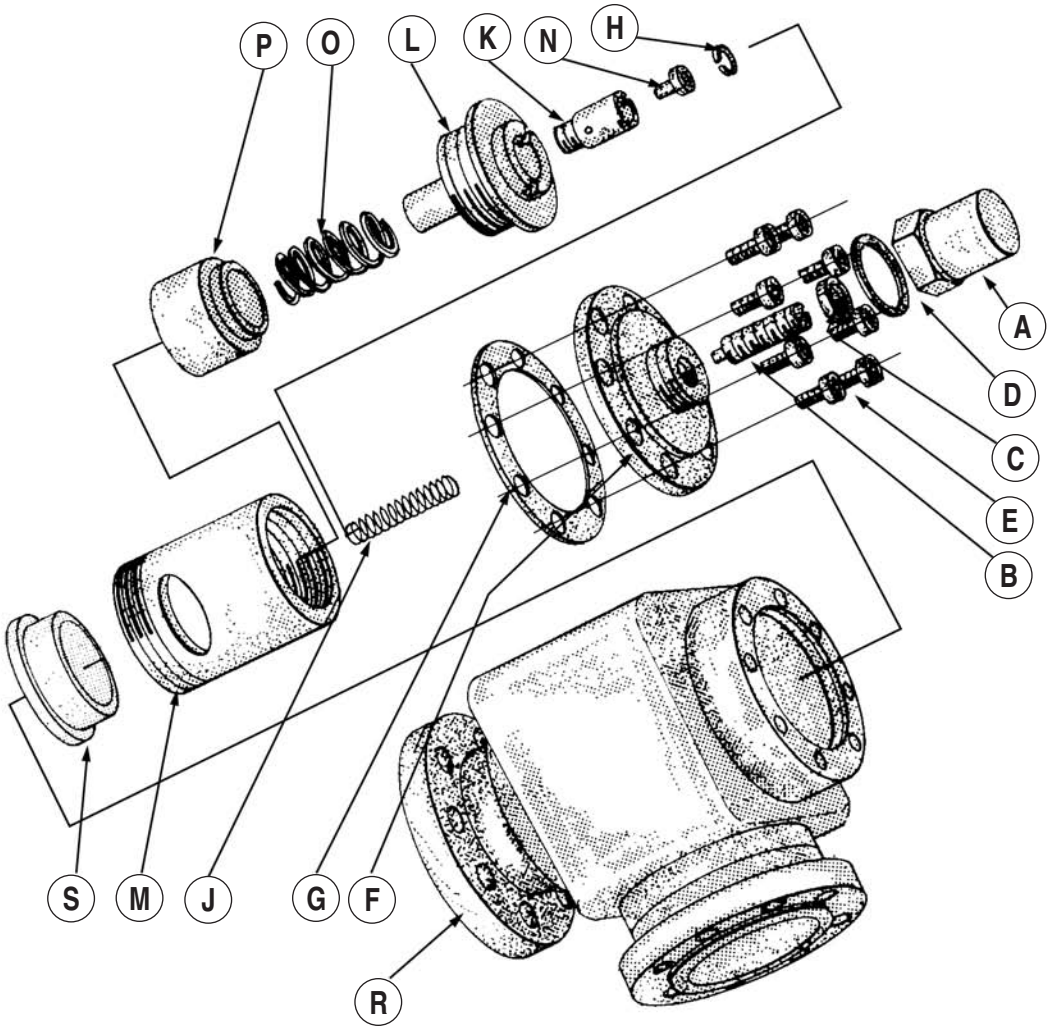
3" VALVE TESTS



4" VALVE TESTS



Overpressure - The pressure increase or accumulation above the set pressure when the valve is discharging flow.



DISASSEMBLY OF INTERNAL PILOT OPERATED VALVES

To dismantle the valve for inspection or cleaning:

1. Remove cap “A” and gasket “D”
2. Remove nut “C”
3. Remove adjusting screw “B”
4. Remove cap screws “E”
5. Remove bonnet “F”
6. Remove gasket “G”
7. Remove pilot spring “J”
8. Unscrew and withdraw cylinder “M” (do not unscrew cylinder retainer “L”)
9. Unscrew and remove cylinder retainer “L”, after removing cylinder “M”.

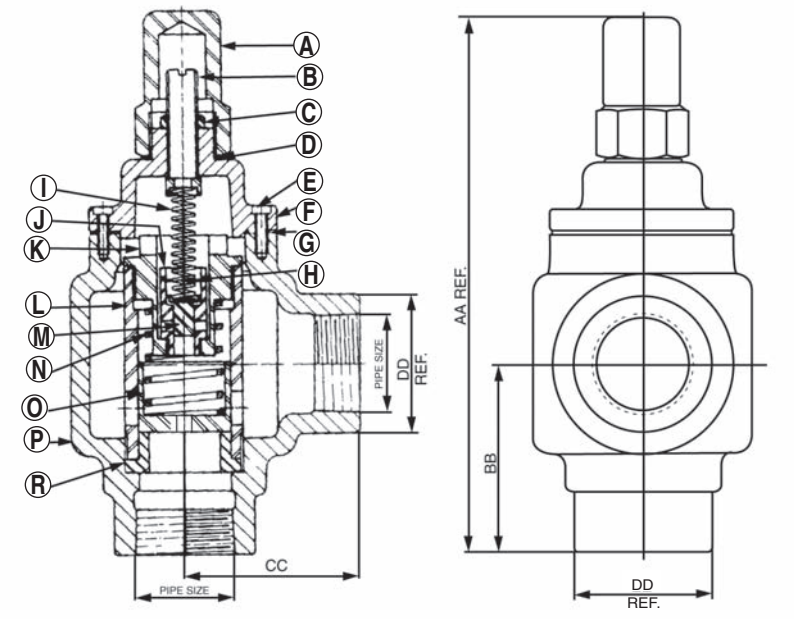
   Caution: hold in vise. Balance spring “O” under heavy compression.
10. Unscrew and remove piston retainer “K”
11. Remove retaining ring “H”
12. Remove pilot piston “N”
13. Remove balance spring “O”
14. Remove piston “P”
15. Remove retaining bushing “S” if necessary

Inspect bores of both piston retainer “K” and cylinder “M”. Inspect pistons “N” and “P” for wear or scoring. Replace broken or damaged parts. Clean all parts thoroughly and re-assemble as follows:

Reverse process of disassembly from operation 16 to 6, then thread adjusting screw “B” into bonnet “F”, while re-assembling “F” to body “R”. Then proceed with steps 5, 4, 2, 1 in reverse order.

A-SERIES 2½" and 3" (Internal Pilot Operated)

DIMENSIONS



Valve Size	DIMENSIONS IN INCHES			
	AA	BB	CC	DD
2½"	15⅝	5½	5 1/16	4
3"	16½	6⅝	6⅜	4⅞

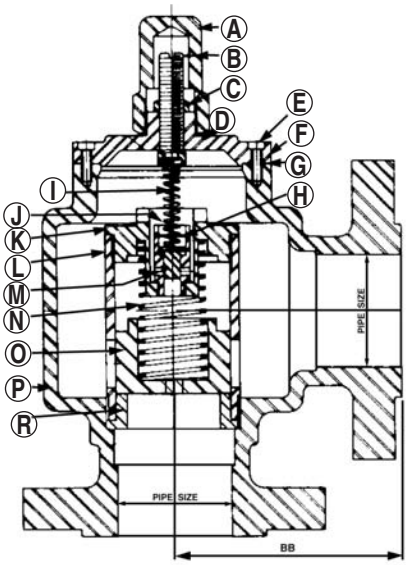
PARTS LIST

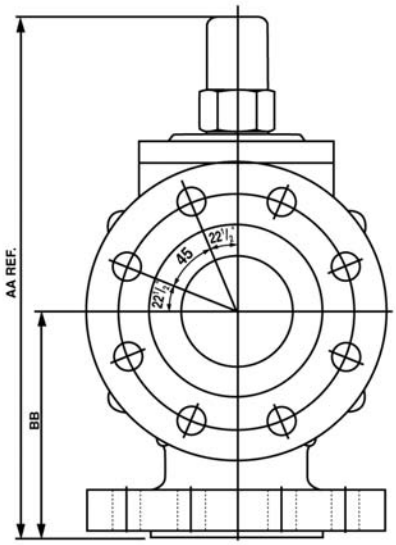
Symbol	NAME	VALVE SIZE	
		2½"	3"
A	Cap	A1101CR	A1101CR
B	Adjusting Screw	A1102C	A1102C
C	Lock Nut	505-S	505-S
D	O-Ring †	604-R	604-R
E	Cap Screw	3/8 x 1 SHCS	3/8 x 1 SHCS
F	Bonnet Cast Iron Steel	 A0919A A0919C	 A1019A A1019C
G	Gasket †	A0903E	A1003E
H	Retainer Ring †	A1120D	A1120D
I	Pilot Spring †	A1190D	A1190D
J	Piston Retainer †	A1118C	A1118C
K	Cylinder Retainer	A0912C	A1012C
L	Cylinder †	A0928C	A1028C
M	Pilot Piston † Hardened Steel Stainless Steel	 A1115C A1115D	 A1115C A1115D
N	Balance Spring †	A0980D	A1080D
O	Piston † Hardened Steel Stainless Steel	 A0936C A0936D	 A1036C A1036D
P	Body Cast Iron Steel	 A0900A A0900C	 A1000A A1000C
R	Retaining Bushing	A0911C	A1011C

† Recommended spare parts

A-SERIES 2½", 3" and 4"
(Internal Pilot Operated)

DIMENSIONS





DIMENSIONS IN INCHES			
Valve Size	Flange Rating	AA	BB
2½	150# 300#	15⅞	5¾
2½	600#	16¼	6⅛
3	150# 300#	16⅛	6¼
3	600#	16½	6⅝
4	150# 300#	18³/₁₆	7¹⁵/₁₆
4	600#	18⅜	8⅛

PARTS LIST

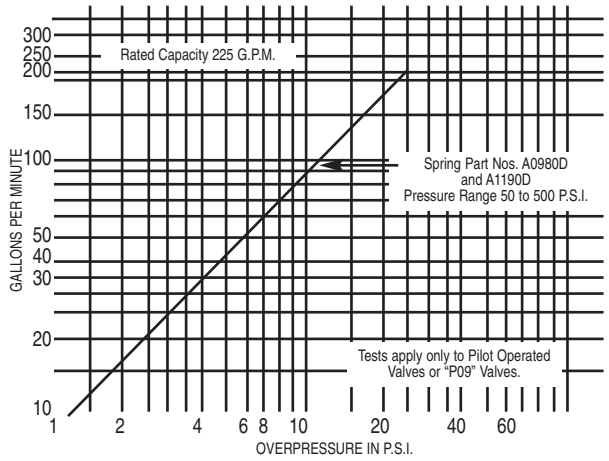
Symbol	NAME			VALVE SIZE		
				2½"	3"	4"
A	Cap			A1101CR	A1101CR	A1101CR
B	Adjusting Screw			A1102C	A1102C	A1102C
C	Lock Nut			505-S	505-S	505-S
D	O-Ring †			604-R	604-R	604-R
E	Cap Screw			3/8 x 1 SHCS	3/8 x 1 SHCS	3/8 x 1 SHCS
F	Bonnet Cast Iron Steel			 A0919A A0919C	 A1019A A1019C	 A1119A A1119C
G	Gasket †			A0903E	A1003E	A1103E
H	Retainer Ring †			A1120D	A1120D	A1120D
I	Pilot Spring †			A1190D	A1190D	A1190D
J	Piston Retainer †			A1118C	A1118C	A1118C
K	Cylinder Retainer			A0912C	A1012C	A1112C
L	Cylinder †			A0928C	A1028C	A1128C
M	Pilot Piston † Hardened Steel Stainless Steel			 A1115C A1115D	 A1115C A1115D	 A1115C A1115D
N	Balance Spring †			A0980D	A1080D	A1181D
O	Piston † Hardened Steel Stainless Steel			 A0936C A0936D	 A1036C A1036D	 A1136C A1136D
P	Body	Cast Iron	150# 300#	A0900AF150A A0900AF300A	A1000AF150A A1000AF300A	A1100AF150A A1100AF300A
		Steel	150# 300# 600#	A0900CF150A A0900CF300A A0900CF600A	A1000CF150A A1000CF300A A1000CF600A	A1100CF150A A1100CF300A A1100CF600A
R	Retaining Bushing			A0911C	A1011C	A1111C

† Recommended spare parts

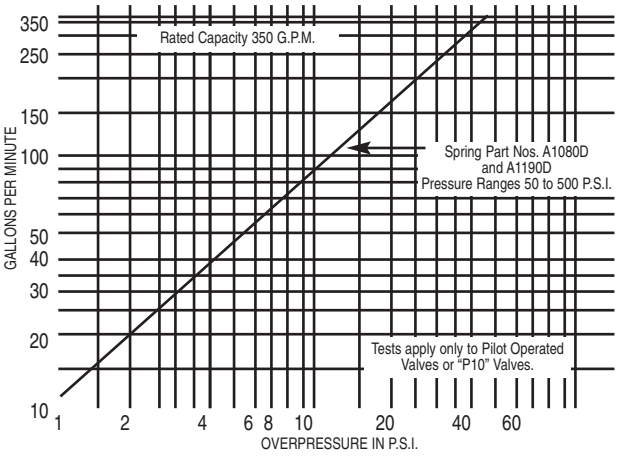
A-SERIES PERFORMANCE CHARTS
(Internal Pilot Operated)

All valve tests 110˚F. to 120˚F. Oil Viscosity 150 S.S.U. at 100˚F.
(Charts good from 30 to 500 S.S.U.)

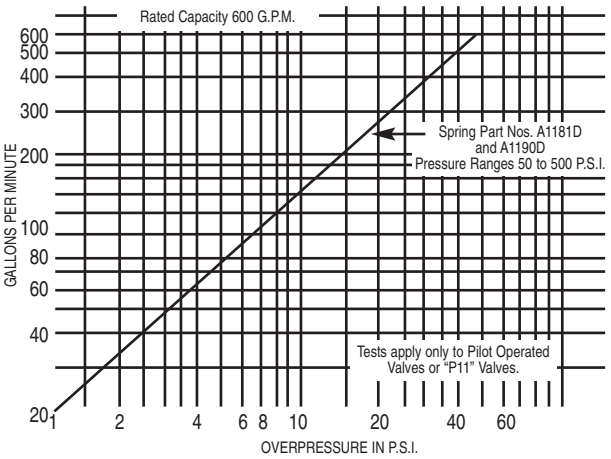
2½" VALVE TESTS



3" VALVE TESTS



4" VALVE TESTS



Overpressure - The pressure increase or accumulation above the set pressure when the valve is discharging flow.

SVB-SERIES VALVES*



*Underwriter Listed

APPLICATION

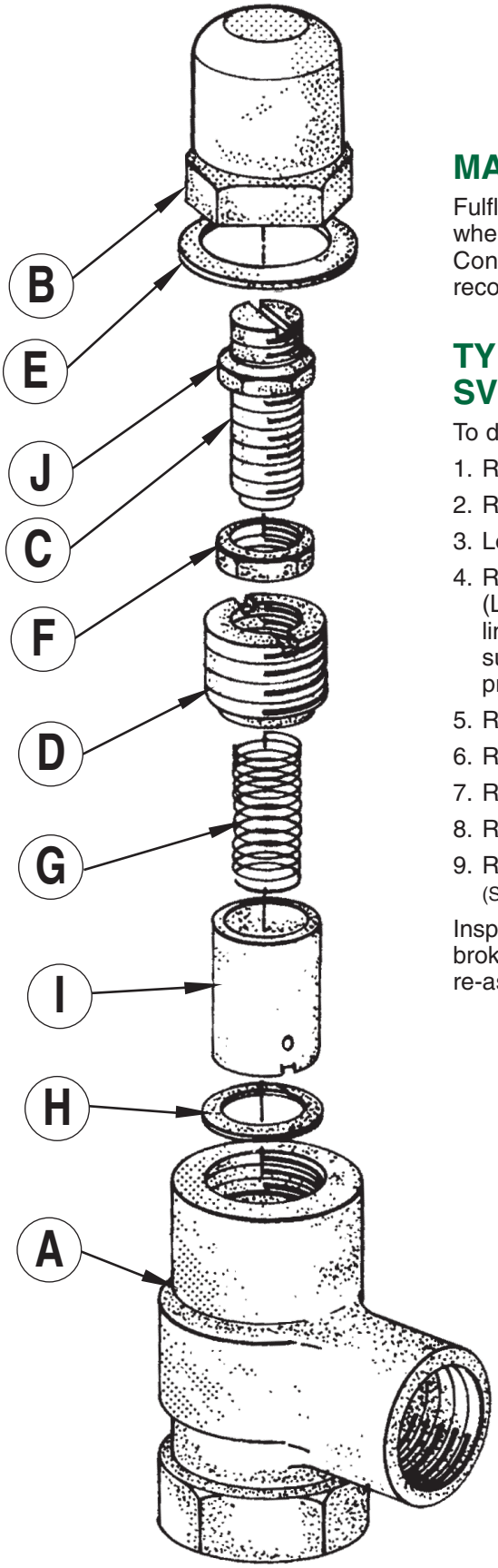
The Fulflo “SVB” Series, Underwriter Listed, range in size from 3/8” through 1” and operate efficiently with liquids of any viscosity at pressures from 7 through 500 P.S.I. The “SVB” valves are of brass construction with threaded connections.

Primarily designed for use with fuel oils on oil burner service, the “SVB” valves may be used wherever Underwriter Listed valves are required. Each valve is pre-set to the specified pressure and is equipped with a limiting device to prevent over-adjustment.

INSTALLATION

Fulflo valves can be mounted in any position. A tee may be inserted in the pump discharge line to mount the valve. The correct size of valve should be installed, preferably matching the pump discharge line. Screw the valve into the nipple in the tee. When the valve is used for frequent bypassing of oil under pressure, its outlet should be piped back to the tank. Care must be taken to have the discharge well below the oil level in the tank to prevent air entrainment and erratic operations.

Only if the valve is used as safety or overload relief and operates infrequently may its discharge be piped back into the pump suction line. Frequent or continuous operation under these conditions will cause excessive heating of the oil and possible damage.



MAINTENANCE

Fulflo valves provided reliable “chatter-free” operation when the system is free of abrasives and foreign matter. Continuous filtration of the liquid used is strongly recommended.

TYPICAL DISASSEMBLY OF SVB VALVES

To dismantle valve for inspection and cleaning:

1. Remove cap “B”
2. Remove gasket “E” (replace, if necessary)
3. Loosen lock nut “F”
4. Remove adjusting screw “C”
   (Limit collar “J” is soldered to adjusting screw “C”, to limit the maximum pressure to which the valve may be subjected.) Limit collar is set at 25% above normal pressure setting.
5. Remove lock nut “F”
6. Remove retainer “D”
7. Remove spring “G”
8. Remove piston “I”
9. Remove stop ring “H” (Not Recommended)
   (Special tooling is required to install new stop ring.)

Inspect valve bore and piston for wear or scoring. Replace broken or damaged parts. Clean all parts thoroughly and re-assemble by reversing the above procedure.

SVB-SERIES

ASSEMBLY NUMBER IDENTIFICATION CHART

Symbol Number	Designation	Code	Description
1	Style	S	Underwriter Listed
2	Series	V	–
3	Material	B	Brass
4 or 5	Size	-25 -35 -45 -55	3/8” 1/2” 3/4” 1”
6	Spring	See Chart	See Spring Pressure Chart
7	Piston	0 1 2 3	Hardened Steel, deep grove Stainless Steel, deep grove Hardened Steel, shallow groove Stainless Steel, shallow groove

EXAMPLE:

SVB-55ZSO

S	V	B	-55	ZS	O
Underwriter’s Listed	Series	Brass	1”	Spring	Hardened Steel Piston, Deep Groove

HOW TO ORDER

Specify:

1. Valve Model Number
2. Spring Letter
3. Piston Number
4. Pressure Setting

NOTE: A definite pressure setting is required due to Underwriter restrictions. A limiting device is furnished to prevent over-adjustment more than 25% above set pressure.

SETTING VALVES

Valve may be set with a hand pump for cracking pressure. It will be noted that the maximum set pressure is limited by the collar “J” soldered to the adjusting screw “C”.

If a test stand is available, valve should be connected to the discharge header with the pump bypass open, and the bypass gradually closed until the desired pressure registers on the gauge. Adjust valve adjusting screw until valve slightly bleeds at the set bypass pressure and lock adjusting screw.

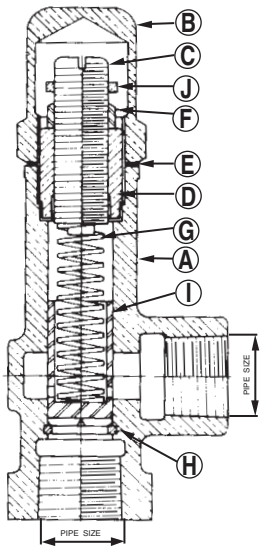
If valve is required to bypass a given amount of fluid at a given pressure, a test stand having a flow meter in the pump discharge line must be available. With valve adjusted for cracking pressure as above, continue closing bypass until the required flow registers on the flow meter and observe pressure. Re-adjust pressure, if necessary, to obtain desired pressure at desired flow.

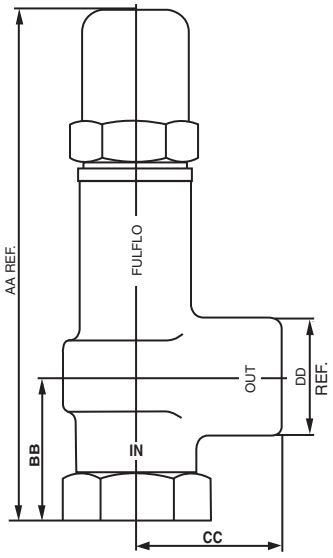
UNDERWRITER VALVE PRESSURE RANGE CHART

Pipe Size	“U.L.” Symbol	SPRING PRESSURE RANGE AND PART NO. SUFFIX									
		RED-US		GREEN-WS		YELLOW-XS		WHITE-YS		BLUE-ZS	
		Low	High	Low	High	Low	High	Low	High	Low	High
3/8”	SVB-25	7	35	30	100	60	175	150	350	300	500
1/2”	SVB-35	7	35	30	100	60	175	150	350	300	500
3/4”	SVB-45	7	35	30	100	60	175	150	350	300	500
1”	SVB-55	7	35	30	100	60	175	150	350	300	500

SVB-SERIES (Brass)

DIMENSIONS





Pipe Size	"U.L." Symbol	DIMENSIONS IN INCHES			
		AA	BB	CC	DD
3/8"'	SVB-25	$5^{11}/_{32}$	$1^{11}/_{32}$	$1^{11}/_{32}$	$1^{3}/_{8}$
1/2"	SVB-35	$6^{3}/_{16}$	$1^{11}/_{16}$	$1^{7}/_{16}$	$1^{7}/_{16}$
3/4"	SVB-45	$6^{15}/_{16}$	$1^{15}/_{16}$	$1^{13}/_{16}$	$1^{11}/_{16}$
1"	SVB-55	$8^{7}/_{32}$	$2^{9}/_{32}$	$2^{9}/_{32}$	$2^{1}/_{16}$

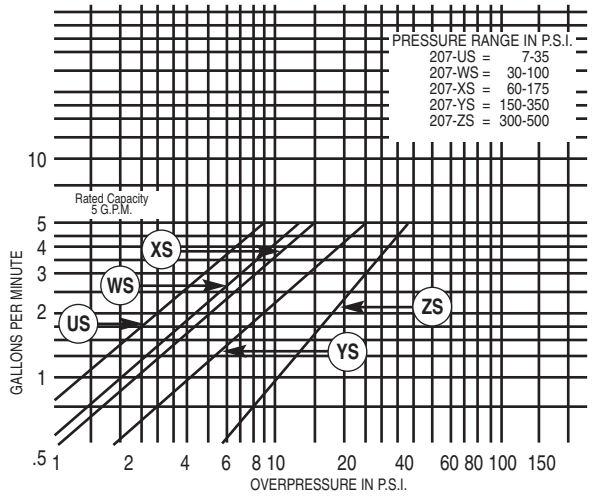
PARTS LIST

Symbol	NAME	VALVE SIZE			
		3/8"	1/2"	3/4"	1"
A	Body	200-B	300-B	400-B	500-B
B	Cap	201-B	301-B	401-B	501-B
C	Adjusting Screw	202-B	302-B	402-B	502-B
D	Retainer	203-B	303-B	403-B	503-B
E	Gasket	204	304	404	504
F	Lock Nut	205-S	305-S	405-S	505-S
G	Spring	See Chart	See Chart	See Chart	See Chart
H	Stop Ring	208-B	308-B	408-B	508-B
I	Piston Hardened Steel Stainless Steel	 206 206-A	 306 306-A	 406 406-A	 506 506-A
J	Limit Collar	221-B	321-B	421-B	521-B

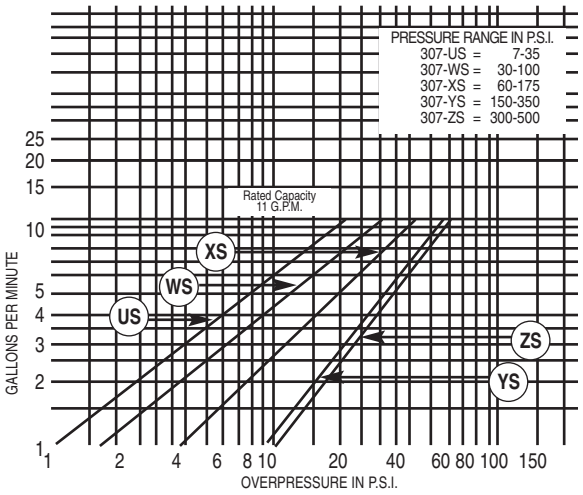
SVB-SERIES PERFORMANCE CHARTS

All valve tests 110˚F. to 120˚F. Oil Viscosity 150 S.S.U. at 100˚F.
(Charts good from 30 to 500 S.S.U.)

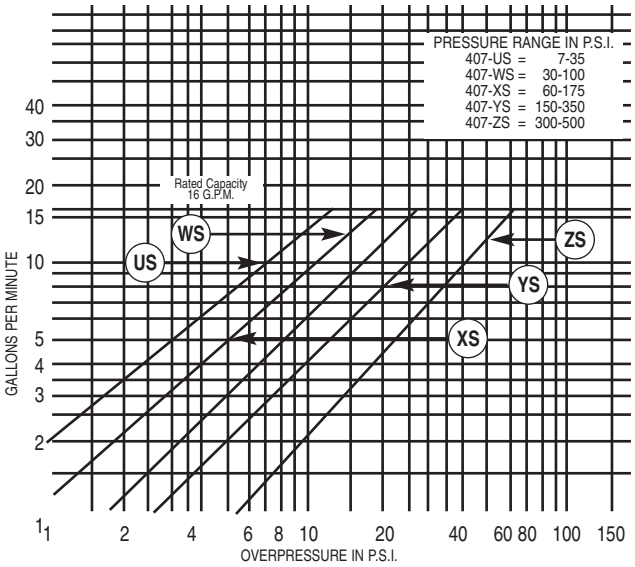
3/8" VALVE TESTS



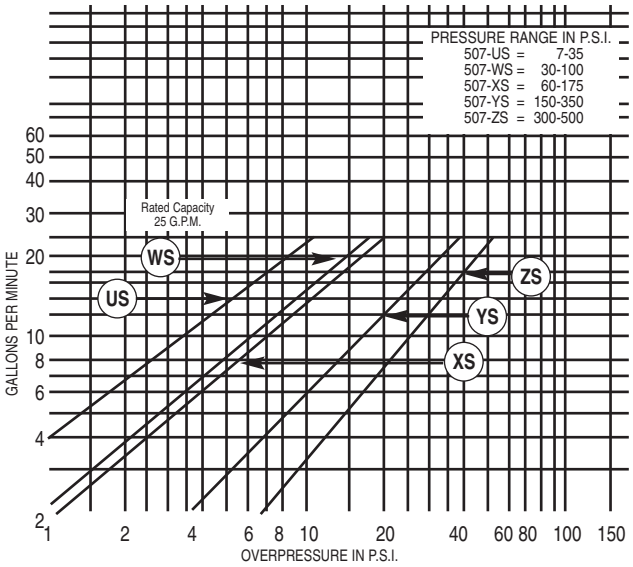
1/2" VALVE TESTS



3/4" VALVE TESTS



1" VALVE TESTS



Overpressure - The pressure increase or accumulation above the set pressure when the valve is discharging flow.

NOTES

NOTES

459 Fancy Street • Blanchester, OH 45107 • PH: (937) 783-2411 • F: (937)783-4983 • Email: fulflo@info.com • www.fulflo.com

TYPICAL APPLICATIONS

Combustion Equipment
- Circulating Oil Systems
- Heating Equipment on Railroad Cars
- Package and Industrial Boilers
- Oil Burning Equipment

Machine Tools
- Valves are used for:
  - Regulation of Lubricating System Pressure
  - Regulation of Pressure for Hydraulic Feeds
  - Regulation of Coolant Pressure
- Boring Machines
- Drills (Radial, Single or Multiple Spindle)
- Grinders (Surface, Cylindrical, Centerless and Universal)
- Lathes (Engine, Turret, Automatic)
- Milling Machines
- Hydraulic Tracing Units

Hydraulic Manufacturing and Processing Equipment
- Stamping Presses
- Press Brakes
- Molding Presses
- Rams
- Crushers
- Bending and Forming Equipment

Hydraulic Test Stands
- To Maintain Specific Pressures
- As Safety Relief Valve to Protect Pumps, Gauges, etc.
- Aircraft Test Equipment and Ground Support Equipment
- Equipment Test Racks
- Pressure Test Racks

Hydraulic Power Units
- Used in Basic Tank, Pump and Motor Systems

Material Handling Equipment
- Hydraulic Hoists
- Hydraulic Elevators
- Hydraulic Platforms

Special Equipment
- Fire Equipment
- Laundry Equipment
- Coal Mining Equipment
- Road Spraying Machinery
- Car Washing Machinery
- Cleaning Machinery (Steam or Solution)
- Industrial Sewing Machines
- Dairy Machinery
- Special and Custom Engineered Industrial Machinery
- Equipment for Oxygen and Industrial Gasses

Industrial Air Conditioning Equipment
- Pumps - Filters

Engines and Turbines, Lubrication and Control System
- Diesel Engines
- Steam Turbines
- Hydraulic Turbines
- Gas Turbines

Mobile Equipment
Industrial Compressors

Processing Systems
- Public Utilities
  - Maintaining City Water System Pressures
  - Protection and Control of Fire Hydrant Pressures
- Oil Refineries
- Chemical Plants
- Distilleries
- Irrigation Systems
- Steel Mill and Processing Plants
- Food Processing Plants
- Papermill and Pulp Processing Plants

Liquids Handled
- Hydraulic Oils
- Water (Treated, Purified and Salt Water)
- Dry Cleaning Solvent
- Heated Tar (Pumped)
- Heated Molasses (Pumped)
- Anhydrous Ammonia
- Edible Fats and Oils
- Processed Liquid Foods
- Processed Petroleum Products

VALVE DEFINITIONS

Pressure Safety Valve (PSV)
A pressure safety valve actuated by inlet static pressure and characterized by rapid opening or rapid popping action. this safety valve is tight shut-off and is for safety only. Meets ASME SEC. VIII (Not a Fulflo valve)

Pressure Relief Valve (PRV)
A pressure relief device designed to re-close and prevent further flow after normal conditions have been restored. (Fulflo)

Relief Valve (RV)
A spring loaded pressure relief valve, actuated by the static pressure upstream of the valve. The valve opens normally in proportion to the increase in pressure over the set pressure. (Fulflo)

Safety Relief Valve (SRV)
A pressure relief valve characterized by rapid opening or pop-action in direct proportion to the pressure increase, depending on the application. (Fulflo)

Conventional Safety Relief Valve (CSRV)
A spring-loaded pressure relief valve whose performance characteristics are directly affected by change in the back pressure of the valve. (Fulflo)

Backpressure
The pressure existing at the outlet of a pressure relief valve, due to the pressure in the discharge system. the pressure can be constant or variable. It is the sum of the superimposed and build-up pressure.

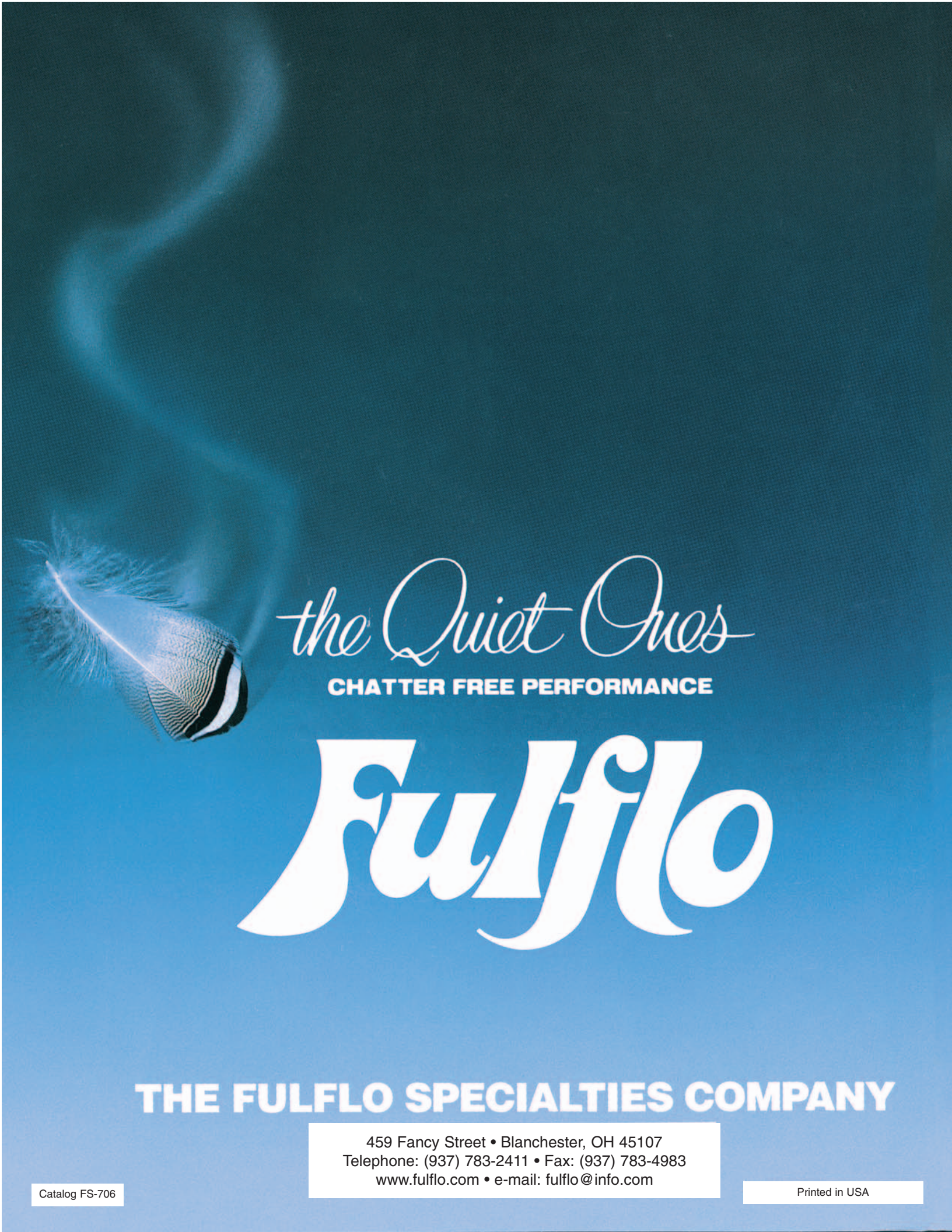
Cracking Pressure
The pressure which the valve starts to leak flow through the valve, but before the set pressure.

Set Pressure
The inlet pressure the valve is adjusted to open, maintain or control under service conditions.

Differential Set Pressure
The pressure differential between the set pressure and constant superimposed backpressure.

Superimposed Backpressure
The static pressure existing at the outlet of the relief device at the time the device is required to operate. It is a result of pressure in the discharge system coming from another source. This pressure may be constant or variable.

Overpressure
The pressure increase or accumulation above the set pressure when the valve is discharging flow.



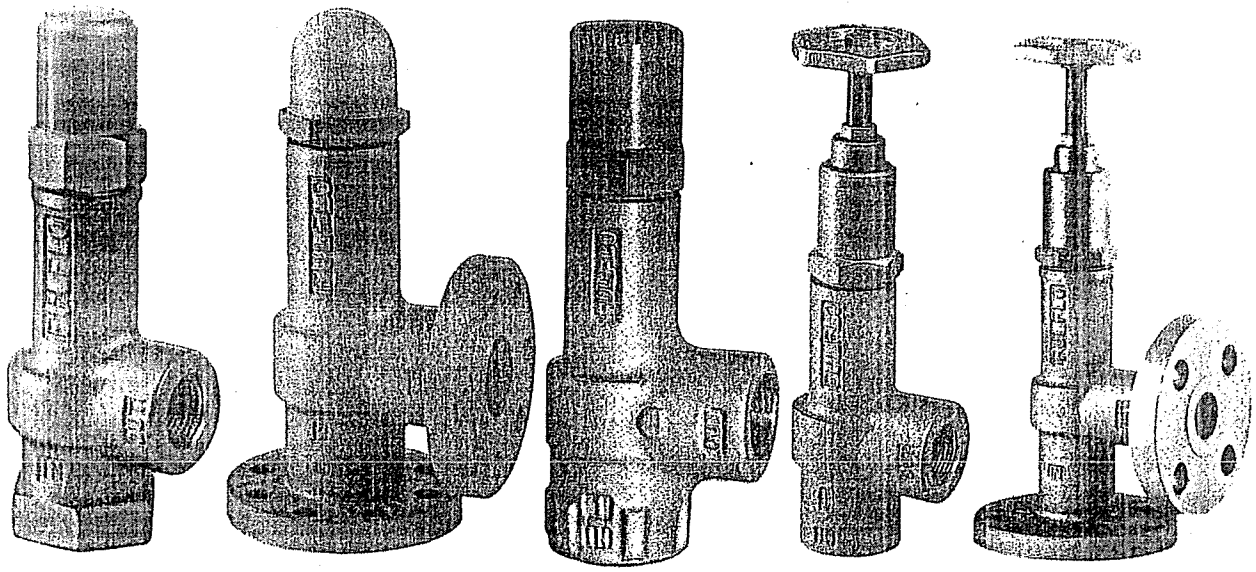
THE FULFLO SPECIALTIES COMPANY

459 Fancy Street • Blanchester, OH 45107
Telephone: (937) 783-2411 • Fax: (937) 783-4983
www.fulflo.com • e-mail: fulflo@info.com

Catalog FS-706

Printed in USA

V-SERIES VALVES



Standard with Screw Connections | Standard with Flange Connections | Stainless Steel with Screw Connections | Handwheel with Screw Connections | Handwheel with Flange Connections

APPLICATION

The Fulflo "V" Series range in size from 3/8" through 2" and operate efficiently with liquids of any viscosity at pressures from 2 to 1000 P.S.I. The "V" series valves are available in flange or screw type...cartridge or handwheel in a choice of brass, cast iron, steel and stainless steel.

Widely used in a variety of applications, the "V" series valves are ideally suited in hydraulic and lubricating systems for load regulation and system protection. Special trim or packings are available for use with fire resisting fluids and other liquids of this type. Unusual applications and special requirements should be referred to our engineering staff for recommendation.

INSTALLATION

Fulflo valves can be mounted in any position. A tee may be inserted in the pump discharge line to mount the valve. The correct size of valve should be installed, preferably matching the pump discharge line. Screw the valve into the nipple in the tee, or in the case of the flange style, bolt the valve to the companion flange screwed into the nipple. When the valve is used for frequent bypassing of oil pressure, its outlet should be piped back to the tank. Care must be taken to have the discharge well below the oil level in the tank to prevent air entrainment and erratic operation.

Only if the valve is used as safety or overload relief and operates infrequently may its discharge be piped back into the pump suction line. Frequent or continuous operation under these conditions will cause excessive heating of the oil and possible damage.

SETTING VALVES

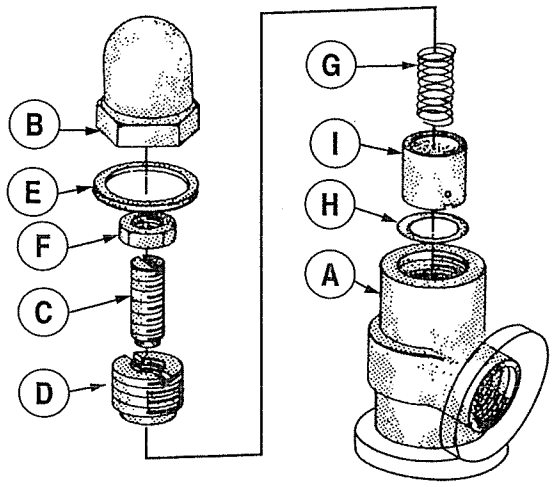
Valves may be set with a hydraulic hand pump for cracking pressure. If a test stand is available, valve should be connected to the discharge header with the pump bypass open, and the bypass gradually closed until the desired pressure registers on the gauge. Adjust valve adjusting screw until valve slightly bleeds at the set bypass pressure and lock adjusting screw.

Fulflo valves are not designed to be positive shut-off, and will pass a minimal amount of leakage before the set pressure. If a valve is required to bypass a given amount of fluid at a given pressure, a test stand having a flow meter in the pump discharge line must be available. With a valve adjusted for cracking pressure as above, continue closing bypass until the required flow registers on the flow meter and observe pressure. Readjust pressure, if necessary, to obtain desired pressure at desired flow.

MAINTENANCE

Fulflo valves provide reliable "chatter-free" operation when the system is free of abrasives and foreign matter. Continuous filtration of the liquid used is strongly recommended.

TYPICAL DISASSEMBLY OF STANDARD TYPE VALVE

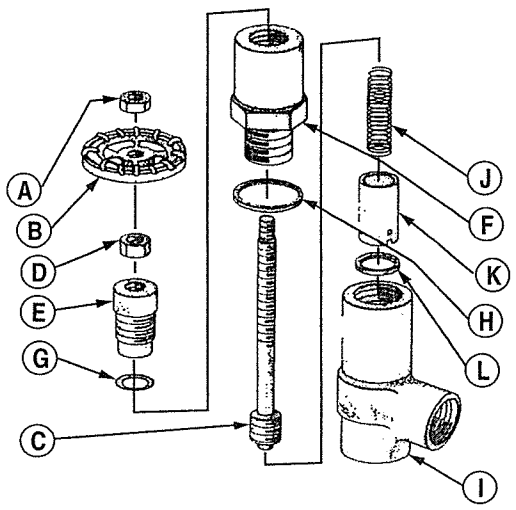


To dismantle valve for inspection or cleaning:

1. Remove cap "B"
2. Remove O-Ring "E"
3. Remove lock nut "F"
4. Remove adjusting screw "C"
5. Remove retainer "D"
6. Remove spring "G"
7. Remove piston "I"
8. Remove stop ring "H" (Not Recommended)
   (Special tooling is required to install new stop ring.)

Inspect valve bore and piston for wear and scoring. Replace broken or damaged parts. Clean all parts thoroughly and re-assemble by reversing the above procedure.

TYPICAL DISASSEMBLY OF HANDWHEEL TYPE VALVE



To dismantle the valve for inspection or cleaning:

1. Release spring tension by backing off handwheel as far as it will go.
2. Remove lock nut "A" or set screw and take off handwheel "B"
3. Remove lock nut "D"
4. Unscrew and remove gland "E"
5. Unscrew and remove bonnet "F"
6. Remove O-Ring "H"
7. Remove adjusting screw "C" (turn clockwise and pull out from bottom of bonnet "F")
8. Remove O-ring packing "G"
9. Remove spring "J"
10. Remove piston "K"
11. Remove stop ring "L" (Not Recommended)

(Special tooling is required to install new stop ring.)

Inspect valve bore and piston for wear or scoring. Replace broken or damaged parts. Clean all parts thoroughly and re-assemble by reversing the above procedure.

ASSEMBLY NUMBER IDENTIFICATION CHART

Symbol No.	Designation	Code	Description
1	Style	None H	Standard Model Handwheel Model
2	Series	V	
3	Material	J B S SS	Cast iron Brass Steel Stainless Steel (300 Series Stainless)
4	Connections	None F	Screw Connections Flange Connections 300# Flange Class Standard (250# Flange Class - Cast Iron Standard)
5	Size	-2 -3 -4 -5 -6 -7 -8	3/8" 1/2" 3/4" 1" 1¼" 1½" 2"
6,7,8	ASA Flange Rating	None -150 -600	300# Flange Standard (no designation required)
9	Flange Style 150# & 600# Only	A B C D	Raised Face, Staggered Bolt Centers Smooth Face, Staggered Bolt Centers Raised Face, Bolts on Valve Centerline Smooth Face, Bolts on Valve Centerlne
10	O-Ring Material	R RV RS RT RA EPR RN	Buna O-Ring Cap Seal (standard) Viton O-Ring Cap Seal Silicone O-Ring Cap Seal Teflon O-Ring Cap Seal Aflas O-Ring Cap Seal Ethylene Propylene Neoprene
11	Options	SP P	Steel Parts (used on cast iron only) Panel Mount on Handwheel Series
12	Piston Material	/HS /SS /3SS	Hardened Steel 416 Stainless Steel 303 Stainless Steel
13	Spring	/AS /US /WS /XS /YS /ZS	
14	Setting		Desired Pressure Setting

EXAMPLES:

VJ-5RVSP/HS/WS

V	J	-5	RV	SP	/HS	/WS
Series	Cast Iron	1"	Viton O-Ring	Steel Parts	H.S. Piston	WS Spring

VJF-5R/HS/WS

V	J	F	-5	R	/HS	/WS
Series	Cast Iron	Flanged	1"	Buna O-Ring	H.S. Piston	WS Spring

VJF-5-150AR/HS/WS

V	J	F	-5	-150	A	R	/HS	/WS
Series	Cast Iron	Flanged	1"	Rating	Style	Buna O-Ring	H.S. Piston	WS Spring

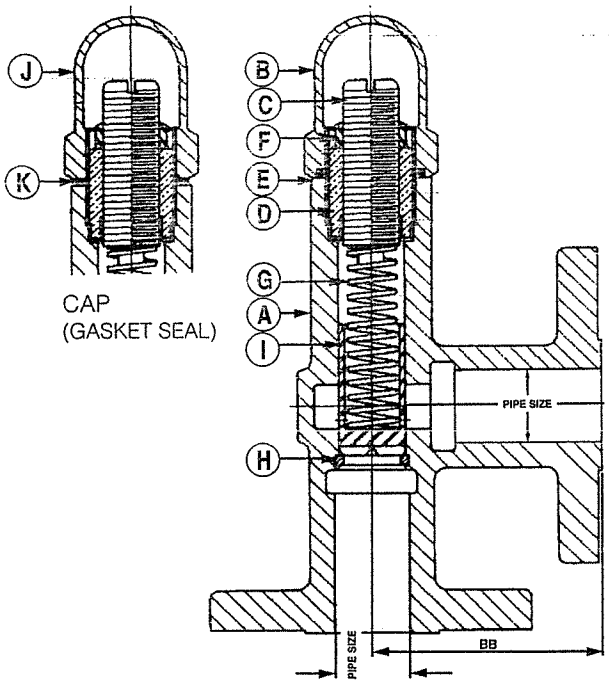
NOTE: Stainless steel pistons are supplied on brass valves, unless hardened steel is specified. Hardened steel pistons are supplied on cast iron or steel unless stainless steel is specified. Buna O-Rings are supplied as standard unless other material is specified.

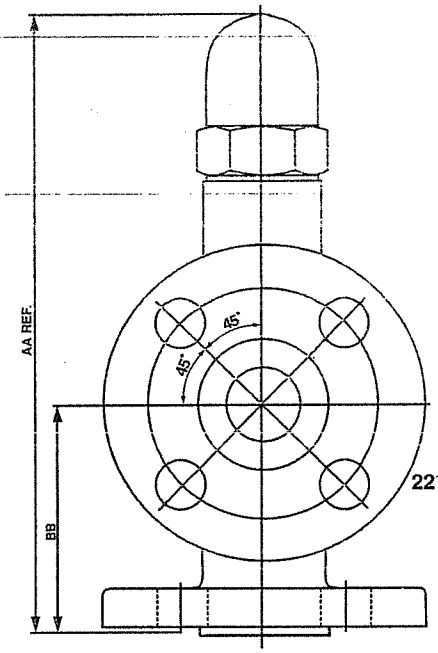
STANDARD PRESSURE RANGE CHART

Valve Pipe Size	Valve Flange Size	SPRING PRESSURE AND IDENTIFICATION NO.															
		BLACK-AS		RED-US		GREEN-WS		YELLOW-XS		WHITE-YS		BLUE-ZS		PURPLE-TS		BROWN-RS	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
3/8"		3	15	7	35	30	100	60	175	150	350	300	500	400	600	550	750
1/2"		3	15	7	35	30	100	60	175	150	350	300	500	400	600	550	750
3/4"		3	15	7	35	30	100	60	175	150	350	300	500				
1"	1"	3	15	7	35	30	100	60	175	150	350	300	500				
1¼"	1¼"	3	15	7	35	30	100	60	175	150	350	300	500				
1½"	1½"	3	15	7	35	30	100	60	175	150	350	300	500				
2"	2"	3	15	7	35	30	100	60	175	150	350	250	600				

+/-1-5 PSI ON ALL SPRING RANGES

DIMENSIONS

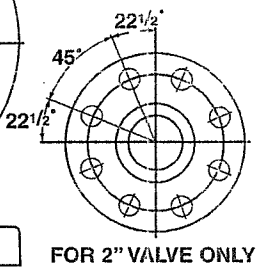




DIMENSIONS IN INCHES

Valve Size	AA	BB
1"	9 1/2"	3 1/2"
1 1/4"	10 13/16"	3 3/4"
1 1/2"	12 7/16"	4 1/16"
2"	14 9/16"	4 9/16"

Note: Dimensions reflect 150# and 300# only



FOR 2" VALVE ONLY

PARTS LIST

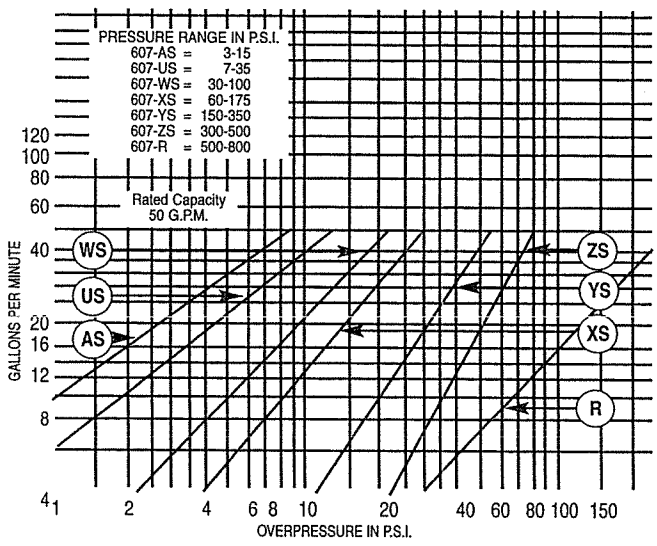
SYM.	NAME	MODEL	VALVE SIZE			
			1"	1 1/4"	1 1/2"	2"
A	BODY	VJF, VJF-SP VBF VSF VSSF	500-F 500-BF 500-SF 500-SSF	600-F 600-BF 600-SF 600-SSF	700-F 700-BF 700-SF 700-SSF	800-F 800-BF 800-SF 800-SSF
B	CAP (O-RING SEAL)	VJF, VJF-SP VBF VSF VSSF	501-R 501-BR 501-SR 501-SSR	601-R 601-BR 601-SR 601-SSR	701-R 701-BR 701-SR 701-SSR	801-R 801-BR 801-SR 801-SSR
C	ADJUSTING SCREW	VJF, VBF VSF, VJF-SP VSSF	502-B 502-S 502-SS	602-B 602-S 602-SS	702-B 702-S 702-SS	802-B 802-S 802-SS
D	RETAINER	VJF, VBF VSF, VJF-SP VSSF	503-B 503-S 503-SS	603-B 603-S 603-SS	703-B 703-S 703-SS	803-B 803-S 803-SS
E	O-RING †	VJF, VJF-SP VBF, VSF VSSF	504* 504-* 504-RT	604* 604-* 604-RT	704* 704-* 704-RT	804* 804-* 804-RT
F	LOCK NUT	VJF, VJF-SP VSF, VBF VSSF	505-S 505-S 505-SS	605-S 605-S 605-SS	705-S 705-S 705-SS	805-S 805-S 805-SS
G	SPRING †	ALL MODELS	507-**	607-**	707-**	807-**
H	STOP RING	VJF, VBF VJF-SP, VSF VSSF	508-B 508-S 508-SS	608-B 608-S 608-SS	708-B 708-S 708-SS	808-B 808-S 808-SS
I	PISTON †	HARDENED STEEL 416 STAINLESS STEEL 303 STAINLESS STEEL	506 506-A 506-SS	606 606-A 606-SS	706 706-A 706-SS	806 806-A 806-SS
J	CAP (GASKET SEAL)	VJF, VJF-SP VBF VSF	501 501-B 501-S	601 601-B 601-S	701 701-B 701-S	801 801-B 801-S
K	GASKET †	VJF, VBF VJF-SP, VSF	504 504-S	604 604-S	704 704-S	804 804-S

* See o-ring selection chart
** See spring pressure chart
† Recommended spare parts

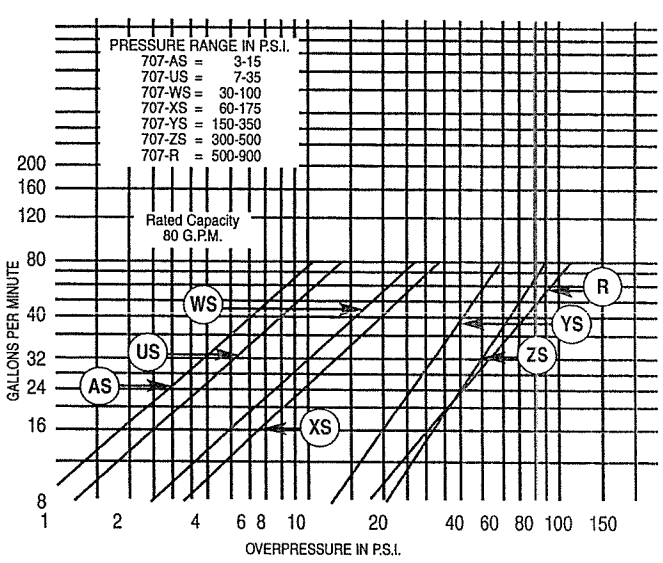
V-SERIES PERFORMANCE CHARTS

All valve tests 110°F. to 120°F. Oil Viscosity 150 S.S.U. at 100°F.
(Charts good from 30 to 500 S.S.U.)

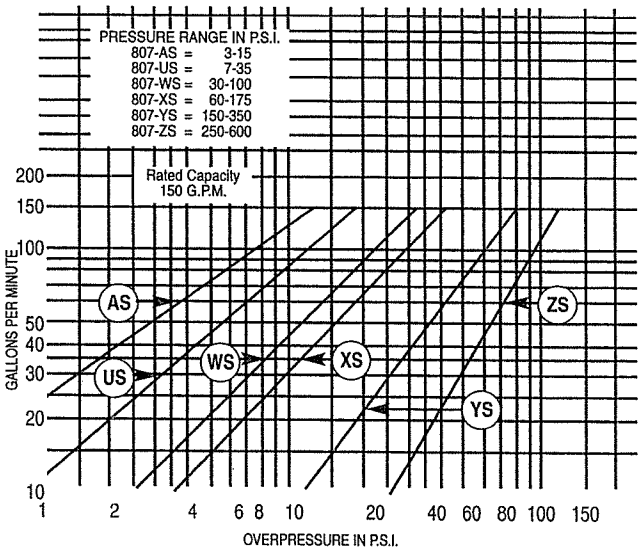
1¼" VALVE TESTS



1½" VALVE TESTS



2" VALVE TESTS

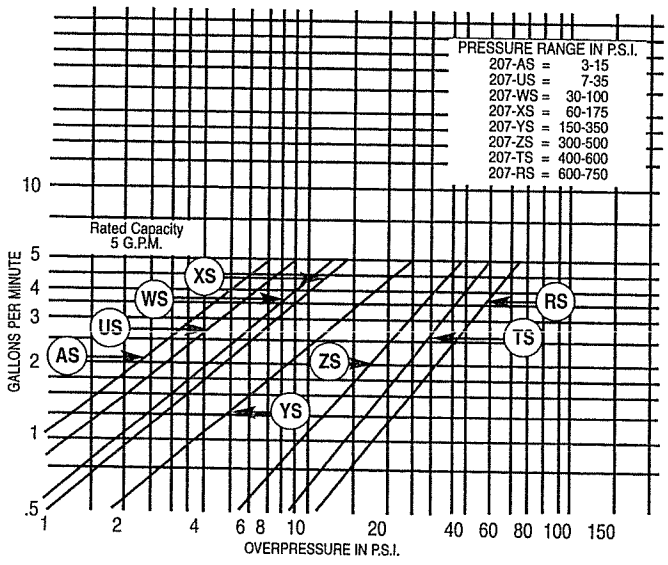


Overpressure - The pressure increase or accumulation above the set pressure when the valve is discharging flow.

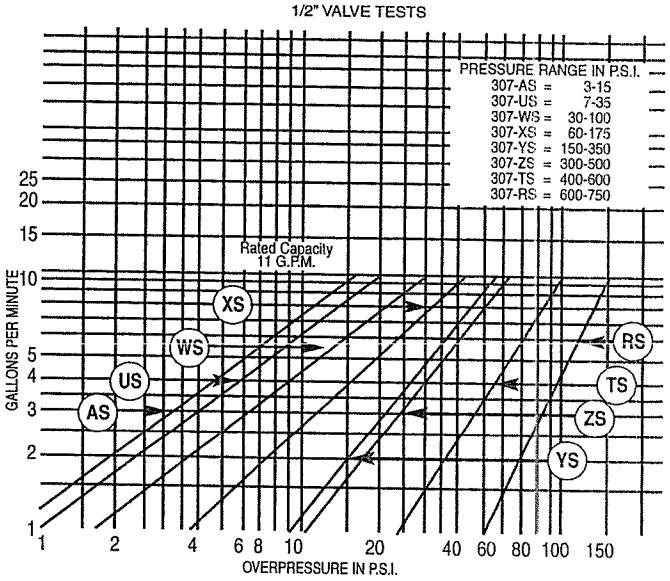
V-SERIES PERFORMANCE CHARTS

All valve tests 110°F. to 120°F. Oil Viscosity 150 S.S.U. at 100°F.
(Charts good from 30 to 500 S.S.U.)

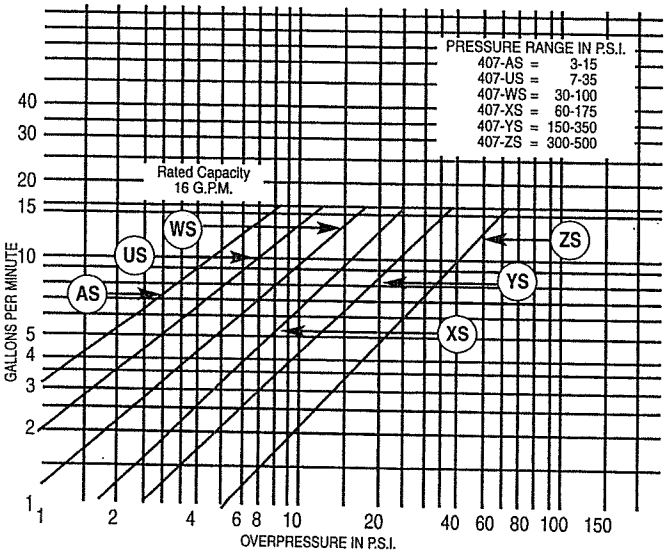
3/8" VALVE TESTS



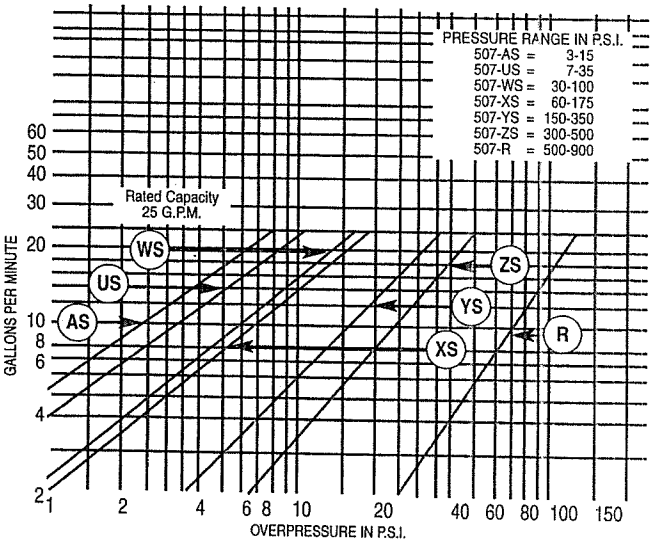
1/2" VALVE TESTS



3/4" VALVE TESTS



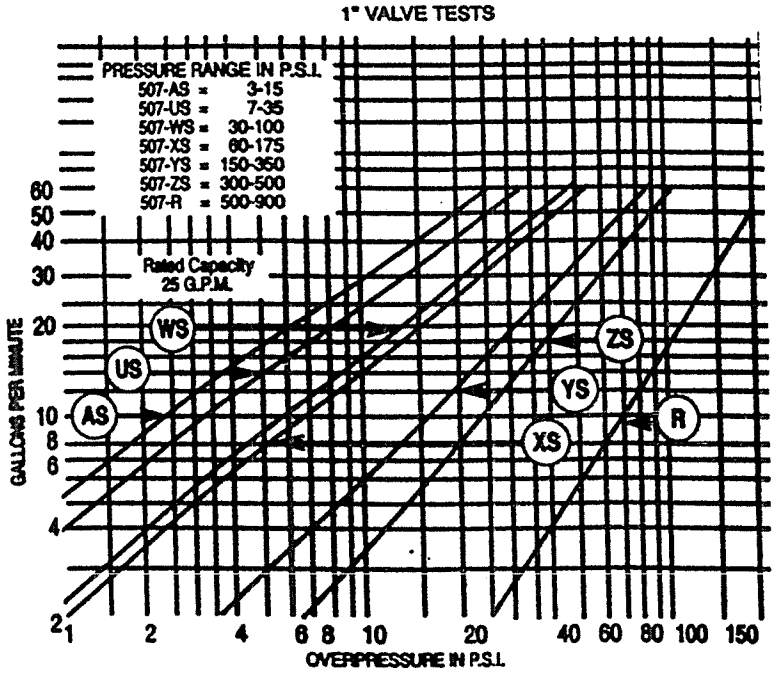
1" VALVE TESTS



Overpressure - The pressure increase or accumulation above the set pressure when the valve is discharging flow.

HOW TO READ A FULFLO PERFORMANCE CHART

(Charts good from 30 to 500 SSU)
**For viscosity above 500 SSU contact Fulflo



* Overpressure is the pressure rise above the set pressure for a given amount of flow through a valve.

*Set pressure is when valve will regulate pressure.

* Full open (GPM) is when you add set pressure and overpressure.

* Valves are not designed to be positive shut off, and will pass a minimal amount of leakage before the set pressure.

EXAMPLE ONE: **CUSTOMER NEEDS 25 GPM, 125 PSI SET PRESSURE, 300 SSU OIL APPLICATION.**
EXAMPLE TWO: **CUSTOMER NEEDS 20 GPM, 50 PSI SET PRESSURE, 33 SSU WATER APPLICATION.**
EXAMPLE THREE: **CUSTOMER NEEDS 15 GPM, 60 PSI SET PRESSURE, 150 SSU OIL APPLICATION.**

STEP ONE: SELECT PERFORMANCE CHART BASED ON MAXIMUM FLOW (GPM) REQUIRED THROUGH THE VALVE.

Example One: 1" Valve Required
Example Two: 1" Valve Required
Example Three: 1" Valve Required

STEP TWO: DETERMINE WHAT SPRING RANGE (ABOVE) BASED ON SYSTEM PRESSURE VALVE IS TO MAINTAIN OR RELIEVE.

Example One: XS spring 60-175 PSI range
Example Two: WS spring 30-100 PSI range
Example Three: WS spring 30-100 PSI range

STEP THREE: FROM MAXIMUM GPM, FOLLOW HORIZONTALLY ACROSS TO INTERSECTION WITH SPRING DIAGONAL LINE, DROP STRAIGHT DOWN TO READ OVERPRESSURE REQUIRED TO PASS MAXIMUM GPM.

Example One: 25 GPM intersection w/XS spring, Drop down to overpressure = 20 PSI
Example Two: 20 GPM intersection w/WS spring, Drop down to overpressure = 13 PSI
Example Three: 15 GPM intersection w/WS spring, Drop down to overpressure = 9 PSI

STEP FOUR: ADD OVERPRESSURE TO SET PRESSURE TO DETERMINE WHAT THE MAXIMUM PRESSURE THE SYSTEM WILL SEE.

Example One: If set pressure wanted is 125 PSI Using XS spring, add 20 PSI OP to Pass 25 GPM @ 145 PSI. (valve fully open @ 145 PSI)
Example Two: If set pressure wanted is 50 PSI Using WS spring, add 13 PSI OP to Pass 20 GPM @ 63 PSI. (valve fully open @ 63 PSI)
Example Three: If set pressure wanted is 60 PSI Using WS spring, add 9 PSI OP to Pass 15 GPM @ 69 PSI. (valve fully open @ 69 PSI)

STEP FIVE: IF MAXIMUM PRESSURE IS TOO HIGH FOR THE APPLICATION, THEN CHOOSE A LARGER SIZE VALVE AND REPEAT STEPS THREE AND FOUR. **(See catalog for larger size valve charts)**

Large Size – Alloys

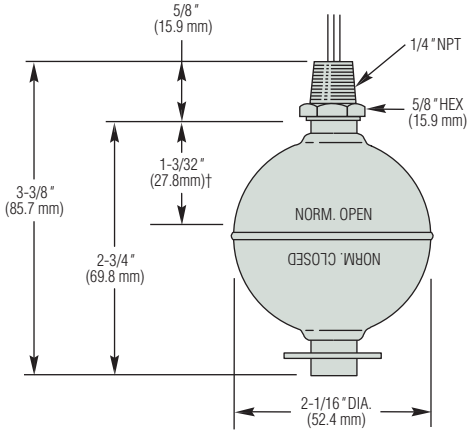
LS-1950 – All Stainless Steel For High Pressure and Temperature

For high performance applications, the LS-1950 provides high temperature and pressure capabilities. Materials of construction comply with FDA food contact regulations.



Exceptionally accurate and rugged for higher temperatures and in pressurized or corrosive liquids. For oils, water and chemicals.

Dimensions



†L_1= Switch actuation level, nominal (based on a liquid specific gravity of 1.0 and N.O. dry circuit – dimension will vary for N.C. circuit).

Common Specifications

Electrical Termination: No. 18 AWG, 24˝ L., Polymeric Lead Wires (except Part No. 79999 which has Teflon® lead wires).

Approvals: LS-1950 Series switches are U.L. Recognized – File No. E45168 and are CSA Listed - File No. 30200 (Part No. 79999 is U.L. Recognized only).

Switch Operation: Selectable, N.O. or N.C., by inverting float on unit stem. Units are shipped N.O. unless otherwise specified.

How to Order – Select Part Number based on specifications required.

Series Number	Materials: Stem and Mounting	Materials: Float	Min. Liquid Sp. Gr.	Operating Temperature	Pressure, PSI, Max.	Switch[1]	Part Number
LS-1950	316 Stainless Steel		0.75	-40°F to +300°F (-40°C to +149°C)	750	SPST, 20 VA	**01950** ⚡
						SPST, 100 VA[2]	**26717** ⚡
				-40°F to +480°F (-40°C to +249°C)		SPST, 20 VA	**79999** ⚡

Notes
1. See "Electrical Data" on Page X-5 for more information.
2. UL Resistive Rated

⚡ – Stock Items.

John Crane



Filtration Systems

Instruction and Operating Manual

smiths
bringing technology to life

INDUFIL

Index

Page

(Index / Index / Indice / Índice / Índice / Индекс / Index / 目次 / 指數 / Indeksere / Innehåll / Hakemisto / Register / Indeks / Index / Obsah / Obsah / İçindekiler / Индекс)

1. General Caution 2

(Allgemeine warnungen / Avertissements généraux / Avvertenze generali / Cautelas gerais / Precauciones generales / Общие Предупреждения / Algemene waarschuwingen / 一般的注意 / 整体警告/ Alminnelige Forholdsregler / Allmänna varningar / Yleiset varoitukset / Generelle sikkerhedsregler / Ostrzeżenia Ogólne / Általános Figyelmeztetések / Všeobecná upozornění / Všeobecné upozornenia / Genel Uyar / Жалпы қауіпсіздік шаралары)

2. Pictogram Explanation 12

(Symbolerklärung / Explication des icônes / Icona spiegazione / Explicação ícone / Explicación de los iconos / Разъяснение пиктограмм / Pictogram uitleg / アイコンの説明 / 图标解释 / Pictogram forklaring / Symbolförklaring / Piktogrammien selitykset / Folklaring af ikoner / Znaczenie piktogramów / Piktogram Magyarázat / Vysvětlení piktogramů / Vysvetlenie piktogramov / Piktogram Açıklanması / Таңбалардың түсіндірмесі)

3. Single Filter 13

(Einzel filter / Simple filtre / Filtro Singoli / Filtro simples / Solo filtro / Одинарный Фильтр / Single filter / 単式フィルター / 单过滤器 / Enkelt filter / Enkelt filter / Yksittäinen suodatin / Enkel Filter / Filtr pojedynczy / Szimpla szűrő / Jednoduchý filtr / Jednoduchý filter / Tek Filtre / Жалғыз сүзгі)

3.1 Filter Element Replacement 14

(Filterelement ersetzt / Remplacé élément filtrant / Elemento filtro di ricambio / Substituição do elemento filtrante / Sustitución del elemento filtrante / Замена фильтрующего элемента / Filterelement vervangen / フィルター部分の交換 / 濾芯更換 / Filterelement Erstatning / Ersättning av filterelement / Suodatinelementin vaihto / Udskiftning af filter element / Zamiana elementu filtrującego / Szűrőelem csere / Výměna filtračních elementů / Výmena filtračných elementov / Filtre Öğe Değiştirilmesi / Сүзу элементін ауыстыру)

4. Duplex Filter 18

(Doppel filter / Filtre en duplex / Duplex di filtro / Filtro duplex / Doble filtro / Сдвоенный Фильтр / Duplex filter / 複式フィルター / 双工滤波器 / Duplex filter / Dubbelfilter / Kaksiosainen suodatin / Duplex filter / Filtr podwójny / Dupla szűrő / Duální filtr / Duálny filter / Dupleks Filtre / Қосарланған сүзгі)

4.1 Changing over Duplex Filter 19

(Umschaltung Duplex Filter / Changement de filtre sur Duplex / Passaggio del Duplex di Filtro / Mudando ao longo do Filtro Duplex / Cambiando a lo argo del filtro Duplex / Замена сдвоенного фильтра / Omschakeling duplex filter / 複式フィルターへの切替 / 雙工濾波器的變化 / Skifting av Duplex filter / Skiftande av dubbelfilter / Kaksiosaisen suodattimen vaihto / Udskiftning af duplex filter / Zamiana filtru podwójnego / Dupla szűrő csere / Náhrada duálního filtru / Náhrada duálneho filtru / Dupleks Filtreye Geçme / Бір сүзгіден екіншісіне ауысу (қосарланған сүзгілер жүйесінде ауыстыру үшін)

4.2 Filter Element Replacement 21

(Filterelement ersetzt / Remplacé élément filtrant / Elemento filtro di ricambio / Substituição do elemento filtrante / Sustitución del elemento filtrante / Замена фильтрующего элемента / Filterelement vervangen / フィルター部分の交換 / 濾芯更換 / Filterelement Erstatning / Ersättning av filterelement / Suodatinelementin vaihto / Udskiftning af filter element / Zamiana elementu filtrującego / Szűrőelem csere / Výměna filtračních elementů / Výmena filtračných elementov / Filtre Öğe Değiştirilmesi / Сүзу элементін ауыстыру)

5. Options 25

(Optionen / En option / Opzionale / Opcional / Facultativo / Опции / Opties / オプション / 可選 / Valgfrie / Optioner / Vaihtoehdot / Tilvalg / Opcje / Opciók / Opce / Opcie / Seçenekler / Опциялар)

5.1 Ball Valve 26

(Kugelkähne / Vanne à bille / Valvola a sfera / Válvula esférica / Válvula de bola / Шаровой клапан / Kogelkraan / ボール弁 / 式球閥 / Kuleventil / Kulventil / Palloventtiili / Kugleventil / Zawór kulisty / Golyóscsap / Kulový ventil / Guľový ventil / Küresel Vana / Шар тәрізді)

5.2 Double Block and Bleed 28

(Zweifache Absperr-Ablassarmatur / Armature de vidange et d'arrêt jumelée / Doppio blocco e sfiato / Shut-off válvulas de drenagem duplas / Armadura de cierre y descarga doble / Двойной стопорный спускной клапан / Dubbel blok en aftap / ダブルブロックおよびブリードバルブ / 双块和流血 / Dobbelt lukke-avløps ventil / Dubbel block- och avluftningsventil / DBB-venttiilit / Dobbel stop-og drænerings ventil / Podwójny zabezpieczający zawór spustowy / Kettős záró és leeresztő szelep / Duální uzavírací vypouštěcí ventil / Duálny uzatvárací vypúšťací ventil / Çift Kapama-ve-Tahliye Vanas / Қосарланған тоқтату шығару клапаны)

5.3 Magnet Core 31

(Magnetkern / Noyau magnétique / Nucleo magnetico / Núcleo magnético / Núcleo magnético / Магнитный сердечник / Magnetische Kern / 磁石コア / 磁芯 / Magnetisk kjerne / Magnetkärna / Magneettiydin / Magnetisk kerne / Rdzeń magnesowy / Mágneses forgórész / Magnetické jádro / Magnetické jadro / Mıknatıs Çekirdeği / Магниттік өзек)

5.4 Pop-up Indicator 34

(Pop-Up-Anzeiger / Indicateur flottant / Indicatore a comparsa / Pop-up indicador / Indicador flotante / Всплывающий индикатор / Pop-up indicator / ポップアップ表示機器 / 弹出式指示灯 / Pop-up indicator / Pop-up indikator / Pop-up ilmaisin / Pop-up indikator / Indykator pływający / Pop-up indikátor / Pop-up indicátor / Pop-up indikátor / Açılır Gösterge / Қалқымалы индикатор)

5.5 Level Indicator 36

(Vorratsanzeiger / Indicateur du niveau / Indicatore di livello / Indicador de nível / Indicador de Nivel / Индикатор уровня / Niveau indicator / レベル表示機器 / 水平 指示器 / Nivå indicator / Nivåindikator / Tasoilmaisin / Niveau Indilator / Indykator poziomu / Szintindikátor / Indikátor úrovně / Indikátor úrovne / Düzey Göstergesi / Деңгей көрсеткіші)

GENERAL CAUTIONS

1. Service and Maintenance of the filter is to be carried out by qualified personnel.
2. The filter is suitable for the design pressure/temperature conditions and corrosion allowance as stated on the drawing and nameplate. Before the equipment is taken into use, it has to be properly earthed. It is strongly recommended to carry out an earthing continuity test before starting up the unit. Good earthing is necessary to prevent sparks due to static electricity.
3. The filter has not been designed to withstand any external forces and moments, unless otherwise stated on the drawing or calculations, such as:
   3.1. Forces and moments resulting from wind loading.
   3.2. Forces and moments resulting snow and ice.
   3.3. Forces and moments resulting from earthquakes.
   3.4. Forces and moments resulting from supporting structures.
   3.5. Forces and moments resulting from piping connections.
   3.6. Forces resulting from rapid fluctuations in pressure.
   3.7. Force resulting from vibrations.
4. The filter cover or any connection are not to be removed from the filter whilst the filter is under pressure.
5. Please be aware that the medium in the filter can contain toxic or explosive mixtures. During service and maintenance operations the guidelines as stated on the Material Safety Data Sheets of the medium should be adhered to.
6. When the filter is installed, the surface of the filter could be hot. The filter should therefore be placed in such a way that physical contact with the filter can be avoided.
7. The filter could be delivered without any safety device, before the filter is taken into use all the following safety devices as a minimum are to be fitted within the system in which the filter is enclosed.
   7.1. Safety (relief) valve.
   7.2. Temperature and pressure indicators.
   7.3. Pressure Differential Indicator connected to the inlet and outlet of the filter to check the pressure drop over the filter.
8. Suitable valves are to be provided on all vent and drain connections (either by Indufil BV or the user).
9. When the Filter has been dropped, the filter is not suitable anymore for service.
10. The filter element needs to be inspected and replaced every 12 months or if the pressure drop over the filter reaches the limit value of 1 bar, whichever comes first.
11. Elements have to be disposed in accordance with local law and regulation regarding the medium and expected contaminations that can be trapped in the filter.
12. Care must be taken not to spill medium or contamination when changing and disposing of the used elements.
13. The filter is designed to handle ambient temperatures from the project specifications. But be aware that there is no instrumentation to monitor and act on exceedance of the limitations. User must assure proper monitoring and acting upon exceeding of the ambient temperature limits. Improper actions can lead to severe damage, resulting in loss of productivity.
14. If NR-13 is applicable; maintenance has to be performed by certified personnel of the customer. This according to the regulations of NR-13 (13.10) in combination with the filter category (13.8.8).

ALLGEMEINE WARNUNGEN

1. Bedienung und Wartung des Druckbehälters soll von sachverständigem Personal durchgeführt werden.
2. Bevor die Anlage in Betrieb genommen wird, muss sie zuerst richtig geerdet werden. Es ist sehr empfehlungswert, vor dem Starten der Anlage eine Erdungsprüfung durchzuführen.
3. Der Druckbehälter ist nicht dafür entworfen, irgendwelchen äußeren Kräften und Momenten zu widerstehen - es sei denn, solche sind auf der Zeichnung oder Berechnung erwähnt -, wie
   3.1. Kräften und Momenten infolge von Windlasten.
   3.2. Kräften und Momenten infolge von Eis und Schnee.
   3.3. Kräften und Momenten infolge von Erdbeben.
   3.4. Kräften und Momenten durch Stützgerüste.
   3.5. Kräften und Momenten durch Rohrverbindungen.
   3.6. Kräften infolge schneller Druckschwankungen.
   3.7. Kräften infolge von Schwingungen.
4. Wenn der Druckbehälter unter Druck steht, darf weder der Deckel noch irgendein Verbindungsstück von dem Druckbehälter entfernt werden.
5. Wir machen Sie darauf aufmerksam, dass dieser Filter toxische und explosionsgefährliche Gemische enthalten kann. Bei Bedienung und Wartung soll man die Vorschriften auf den Werkstoffsicherheitsdatenblättern für den Inhalt befolgen.
6. Bei der Filterinstallation kann seine Oberfläche sich erhitzen. Daher sollte der Druckbehälter so eingebaut werden, dass Körperkontakt mit dem Druckbehälter unmöglich wird.
7. Der Filter kann ohne Schutzanlagen geliefert werden, müssen noch vor Inbetriebnahme des Druckbehälters alle Sicherheitsvorrichtungen an dem kompletten System montiert werden. Zu diesen Sicherheitsvorrichtungen gehören mindestens:
   7.1. Sicherheits- oder Überdruckventile.
   7.2. Temperatur und Druck Indikatoren.
   7.3. An dem Einlass- und Ablassventil des Druckbehälters montierte Differenzdruckanzeiger zur Überwachung des Druckverlustes über dem Druckbehälter.
8. Alle Entlüftungen und Ablässe müssen mit geeigneten Ventilen ausgestattet werden (entweder durch Indufil BV oder den Anwender).
9. Wenn der Druckbehälter umgekippt ist, ist er nicht mehr für Inbetriebsetzung geeignet.
10. Die Entsorgung der Filterelementen soll gemäß örtlichen gesetzlichen Bestimmungen erfolgen sowie Normen in Bezug auf Flussmittel und eventuelle schädliche Substanzen, die in den Filter geraten können.
11. Üben Sie Sicherheitsmaßnahmen aus, um Flüssigkeitsentladung oder Kontaminationen während Ersetzung oder Entsorgung von verbrauchten Elementen auszuschließen.

AVERTISSEMENTS GÉNÉRAUX

1. Le service et la maintenance du filtre ne peuvent être effectués que par le personnel qualifié.
2. Le filtre est destiné à fonctionner dans les conditions de la pression / de la température projetées et dans le milieu de corrosion et d´érosion admissible comme il est indiqué dans le dessin et sur la plaque.
3. Le présent filtre n'est pas destiné à la résistance aux forces extérieures et aux couples, si l'autre n'est pas indiqué sur les dessins et dans les calculs, p.ex.:
   3.1. Forces et moments causés par la pression du vent .
   3.2. Forces et moments causés par la neige et la glace.
   3.3. Forces et moments causés par le tremblement de terre.
   3.4. Forces et moments causés par des constructions de support.
   3.5. Forces et moments causés par des raccords de conduite.
   3.6. Forces causées par des variations brusques de la pression.
   3.7. Forces causées par des vibrations.
4. On ne peut pas enlever le couvercle du filtre ou son raccord quand le filtre est sous pression.
5. Nous prêtons votre attention sur ce que le présent filtre peut contenir les mélanges toxiques ou inflammables . Pendant des travaux de service et de maintenance réguliers il faut suivre des directives concernant des contenances qui sont spécifiées dans le Document sur la sécurité du matériel (Material Safety Data Sheets).
6. Lors de l'installation du filtre sa surface peut se chauffer. C´est pour cela que le filtre devrait être installé de manière que le contact physique avec le filtre ne soit pas possible.
7. Le filtre peut être livré sans dispositifs de protection; avant de mettre le filtre en service tous les dispositifs de sécurité doivent être connectés au système auquel le filtre appartient. Ces dispositifs sont au moins:
   7.1. Une soupape de sûreté.
   7.2. Température et indicateurs de pression.
   7.3. Un indicateur de la différences de pression connectés à l´entrée et à la sortie du filtre (s´il n´est pas déjà installé) qui sert à contrôler la chute de pression dans le filtre.
8. Des valves appropriées doivent être fournies sur tout les passage d'évent et de purge (par Indufil BV ou l'utilisateur).
9. Si la pression dans le filtre a diminué, le filtre ne sert plus au service.
10. L'élément filtrant doit être inspecté et remplacé au moins tous les 12 mois, ou bien dès que la perte de charge du filtre atteint la valeur limite de 1 bar.
11. L'utilisation des éléments du filtre doit s'effectuer selon la législation locale et les normes concernant les milieux liquides et les substances nocives possibles qui peuvent se pénétrer dans le filtre.
12. Observez les mesures de sécurité pour exclure la fuite du liquide et la contamination au cours du remplacement et de l'utilisation des éléments usés.
13. Le filtre est conçu pour supporter les températures ambiantes indiquées dans les spécifications du projet. Mais soyez conscient qu'il n'y a pas d'instrumentation permettant de contrôler et d'agir en cas de dépassement des limites. L'utilisateur doit assurer un suivi continu et la mise en place d'actions appropriées en cas de dépassement des limites de température ambiante. Des mesures inadéquates peuvent endommager sévèrement le filtre, entraînant une perte de productivité.

AVVERTENZE GENERALI

1. Riparazioni e la manutenzione vanno fatte solo dal personale qualificato.
2. Il filtro è idoneo per le condizioni alla pressione di progetto / a temperatura di progetto ed allo scostamento ammissibile di corrosione/ di erosione – come riportato sul disegno e sulla targhetta. Prima di usare l'installazione, la spina deve essere collegata con presa di terra. Raccomandiamo un test di continuità messa a terra prima di mettere in moto l'unita. Una messa a terra e necessario per evitare una scintilla elettrica.
3. Questo filtro non è progettato per resistere alle forze e momenti esterni, salvo diversamente specificato nei disegni e calcoli, p.e.
   3.1. Da forze e momenti causati dalla pressione del vento.
   3.2. Da forze e momenti causati dal peso di neve e ghiaccio.
   3.3. Da forze e momenti causati dal terremoto.
   3.4. Da forze e momenti causati dalle costruzioni di supporto.
   3.5. Da forze e momenti causati da giunti di tubazione.
   3.6. Da forze causate dal cambiamento improvviso della pressione.
   3.7. Da forze causate dalle vibrazioni.
4. Non va mai levato il corpo del filtro o del giunto, se il filtro è sotto la pressione.
5. Attenzione: questo filtro può contenere miscele tossiche o esplosive. Durante i lavori di riparazione o di manutenzione vanno mantenute tutte le direttive e norme riguardanti il contenuto, riportate nelle Istruzioni di sicurezza (Material Safety Data Sheets).
6. Se il filtro viene istallato senza isolanti la superficie del filtro può risultare calda. Per questo motivo il filtro va sistemato in maniera tale da renderne impossibile il contatto fisico.
7. Il filtro può essere consegnato senza dispositivi di sicurezza; prime di mettere il filtro in esercizio, bisogna inserire nel sistema, in cui viene chiuso il filtro, tutti i dispositivi di sicurezza. Questo è il minimo di dispositivi di sicurezza:
   7.1. Valvola si sicurezza.
   7.2. Indicatori di temperatura e pressione.
   7.3. Indicatore della differenza della pressione (PDI) messo all'entrata ed all'uscita del filtro (se non è stato ancora istallato), serve per controllare l'abbassamento della pressione del filtro.
8. Tutti i giunti di ventilazione e di scarico devono essere muniti delle rispettive valvole (o dall'Indufil BV o dall'utente).
9. Se il filtro si abbassa, non è piu' idoneo al lavoro.
10. E' necessario controllare e sostituire l'elemento filtrante al massimo ogni 12 mesi o nel momento in cui la caduta di pressione attraverso l'elemento raggiunge il valore limite di 1 bar.
11. Elementi devono essere smaltiti in conformità alle leggi locali e regolamentazione per quanto riguarda le contaminazioni fluido e prevede che possono essere intrappolate nel filtro.
12. Ogna fare attenzione a non versare liquidi o la contaminazione a cambiare e lo smaltimento degli elementi utilizzati.
13. Il filtro è idoneo per operare alla temperatura ambientale richiesta dalle specifiche di progetto. Ma sappiamo che non è prevista strumentazione per monitorare ed agire nel caso si superino questi limiti. L'utente deve assicurare un controllo continuo al fine di agire immediatamente al superamento della temperatura ambientale linite. Azioni non corrette possono condurre a danni severi con conseguente perdita della produttività.

CAUTELAS GERAIS

1. Serviço e manutenção do filtro devem ser feitos pelo pessoal qualificado.
2. O filtro é conveniente para as condições de pressão/temperatura do projecto e para o desvio de corrosão / erosão admissível, como afirmado no desenho e na plaqueta da casa.
3. Este filtro não é projetado para resistir aos momentos e forças e externos, salvo o contrário não é indicado nos desenhos e cálculos, por exemplo:
   3.1. Forças e momentos resultados de pressão do vento.
   3.2. Forças e momentos resultados de neve e gelo.
   3.3. Forças e momentos resultados de terremoto.
   3.4. Forças e momentos resultados de construções de suporte.
   3.5. Forças e momentos resultados de junções de tubos.
   3.6. Forças resultadas de mudanças rápidas de pressão.
   3.7. Forças resultadas de vibrações.
4. A cobertura do filtro ou junções não se devem remover do filtro sob pressão.
5. Chamamos a sua atenção para o fato que esse filtro pode conter misturas tóxicas ou explosivas. Durante as operações do serviço e manutenção, é preciso observar os princípios gerais a respeito de conteúdos mencionados nas folhas de dados de segurança de material (Material Safety Data Sheets).
6. Ao instalar o filtro a superfície deste último pode aquecer. Portanto, o filtro devia estar instalado de maneira que impessa qualquer contacto físico com o filtro.
7. O filtro pode ser fornecido sem dispositivos de protecção, antes de por o filtro em serviço, todos os dispositivos de segurança devem estar instalados no sistema onde o filtro está incluído. Pelo menos, os dispositivos seguintes devem-se usar:
   7.1. Válvula de segurança.
   7.2. Temperatura e indicadores de pressão.
   7.3. Indicador de differença de pressão colocado sobre a entrada e a saída do filtro (se já não instalado), que controla o abaixamento de pressão do filtro.
8. Todas as conexões para desaeração e descarga de água devem ser equipadas com as válvulas convenientes (pela Indufil BV ou usuário).
9. Se o filtro baixa, não é mais conveniente para o trabalho.
10. O elemento filtrante deve ser inspecionado e substituído a cada 12 meses ou quando a diferença de pressão sobre o filtro (pressão In/Out) atingir o valor limite de 1 bar, o que ocorrer primeiro.
11. Utilização de elementos do filtro deve ser realizada de acordo com as leis locais e regulamentos aplicáveis aos meios líquidos e substâncias possivelmente nocivas que podem entrar no filtro.
12. Tome precauções para evitar o derramamento de líquido ou a contaminação durante a substituição e eliminação dos elementos usados.
13. O filtro é projetado para operar com a temperatura ambiente de acordo a especificações do projeto. No entanto, não há instrumentos para monitorar e controlar essas condições de temperatura. O usuário deve assegurar o devido acompanhamento e controle ao ultrapassar os limites de temperatura ambiente especificados em projeto. Ações inadequadas podem provocar danos graves, resultando em perda de produtividade.
14. Se NR-13 é aplicável; manutenção deve ser realizada por pessoal certificado do cliente. Isto de acordo com os regulamentos da NR-13 (13.10) em combinação com a categoria de filtro (13.8.8)

PRECAUCIONES GENERALES

1. El servicio y mantenimiento del filtro debe ser llevado a cabo por el personal cualificado.
2. El filtro es apropiado para las condiciones de diseño con respecto a la presión/temperatura y la corrosión/erosión así como está previsto en el plano y sobre la placa. Se recomienda fuertemente que se conduzca la prueba de continuidad a tierra antes de arrancar la unidad. Una buena toma de tierra es necesaria para evitar chispas causadas por la electricidad estática.
3. El filtro no ha sido diseñado para soportar todas las fuerzas y momentos externos, a menos que se indique lo contrario en el dibujo o cálculos, como por ejemplo:
   3.1. Las fuerzas y momentos resultantes de la presión del vientro.
   3.2. Las fuerzas y momentos resultantes de la nieve y el hielo.
   3.3. Las fuerzas y momentos resultantes de los terremotos.
   3.4. Las fuerzas y momentos resultantes de las estructuras de apoyo.
   3.5. Las fuerzas y momentos resultantes de las conexiones de tuberías.
   3.6. Las fuerzas resultantes de fluctuaciones rápidas de la presión.
   3.7. La fuerza resultante de vibraciones.
4. Queda prohibido quitar la cubierta del filtro o cualquier conexión del filtro mientras el mismo esté bajo presión.
5. Por favor tenga en cuenta que el contenido del filtro puede contener mezclas tóxicas o explosivas. Durante el servicio y mantenimiento es preciso adherirse a las pautas indicadas en la hoja de datos sobre seguridad del material.
6. Cuando el filtro está instalado, la superficie del filtro puede estar caliente. Por lo tanto es necesario ponerlo de tal forma que contacto físico con el filtro sea imposible.
7. El filtro puede ser entregado sin ningún dispositivo de seguridad, antes de poner el filtro en uso es necesario instalar los dispositivos de seguridad dentro del sistema donde está encerrado el filtro. Tales dispositivos serán como mínimo:
   7.1. Válvula de seguridad (escape).
   7.2. Temperatura e indicadores de presión.
   7.3. Indicador de diferencial de presión instalado a la entrada y salida del filtro (si no está instalado ya), para comprobar la caída de presión en el filtro.
8. Es preciso poner las válvulas apropiadas en todas las conexiones de descarga y drenaje (por Indufil BV o por el usuario).
9. En el caso de que el filtro se caiga no será apto para el servicio posterior.
10. La utilización de los elementos del filtro debe realizarse según la legislación local y las normas que se refieren a los medios líquidos y sustancias tóxicas posibles que pueden penetrar en el filtro.
11. Se debe tener cuidado de no derramar el líquido o la contaminación en el cambio y la eliminación de los elementos utilizados.

ОБЩИЕ ПРЕДУПРЕЖДЕНИЯ

1. Ремонт и уход за фильтром разрешается выполнять только квалифицированному персоналу.
2. Фильтр подходящий для расчетного давления / температуры, условий и коррозию, как указано на рисунке и паспортной табличке. Перед оборудование введено в эксплуатацию, оно должно быть надлежащим образом заземлены. Настоятельно рекомендуется проводить заземления тест непрерывности перед запуском устройства. Хорошо заземления необходимо для не позволение искры из-за статического электричества.
3. Данный фильтр не рассчитан на сопротивление внешним силам и моментам, если иное не указано на чертежах и в расчетах, например:
   3.1. Силам и моментам, вызванным давлением ветра.
   3.2. Силам и моментам, вызванным снегом и льдом.
   3.3. Силам и моментам, вызванным землетрясением.
   3.4. Силам и моментам, вызванным опорными конструкциями.
   3.5. Силам и моментам, вызванным трубопроводными соединениями.
   3.6. Ссилам, вызванным внезапными изменениями давления.
   3.7. Силам, вызванным вибрациями.
4. Запрещается снимать крышку фильтра или устранять соединения от фильтра, если фильтр находится под давлением.
5. Обращаем ваше внимание на то, что в данном фильтре могут содержаться токсичные или взрывоопасные смеси. Поэтому во время регулярных ремонтных работ или работ по техобслуживанию надо неукоснительно соблюдать инструкции, касающиеся содержания вещества и приводимые в Предохранительных документах материала (Material Safety Data Sheets).
6. При установке фильтра, поверхность фильтра может быть горячим. Поэтому фильтр следует устанавливать в таком положение, что физический контакт с фильтром можно избежать.
7. Фильтр может поставляться без каких-либо защитных устройств, до введения в эксплуатацию все предохранительные устройства остаются внутри системы, к которой должен быть подключен фильтр. Эти устройства, как минимум, служат как:
   7.1. Предохранительный (аварийный) вентиль.
   7.2. Температура и давление показателей.
   7.3. Указатель разницы давления (PDI), установленный на входе и выходе фильтра (если еще не встроен) и служащий для контроля за понижением давления фильтра.
8. Все продувочные и выпускные соединения должны быть обеспечены подходящими клапанами (либо предприятием Индуфил БВ (Indufil BV) либо потребителем).
9. Если фильтр снизился, фильтр для работы уже не годится.
10. Фильтрующий элемент должен быть проверены и заменены каждые 12 месяцев или, если падение давления на фильтре достигает предельного значения 1 бар, что наступит раньше.
11. Утилизация элементов фильтра должна производиться в соответствии с местным законодательством и нормами в отношении жидких сред и возможных вредных веществ, которые могут попасть в фильтр.
12. Фильтр предназначен для обработки температуре окружающей среды от проектных спецификаций. Но знайте, что нет приборов для мониторинга и действовать от превышения ограничений. Пользователь должен обеспечить надлежащий контроль и воздействие на превышение предельных температур окружающей среды. Неправомерные действия могут привести к серьезным повреждениям, что приводит к потере производительности.
13. Проявляйте меры предосторожности, чтобы исключить разлив жидкости или загрязнения в процессе замены и утилизации отработанных элементов.

ALGEMENE WAARSCHUWINGEN

1. Bediening en onderhoud van het filter dient door gekwalificeerd personeel te worden uitgevoerd.
2. Het filter is geschikt voor de ontwerpdruk/temperatuuromstandigheden en de toegestane corrosie-/erosietoeslagen zoals vermeld op de tekening en naamplaat. Voordat het materiaal in gebruik wordt genomen moet het goed geaard zijn. Het is ten stelligste aanbevolen om een aardingstest uit te voeren alvorens de unit in gebruik te nemen. Goede aarding is noodzakelijk om vonken door statische elektriciteit te voorkomen.
3. Het filter is er niet op ontworpen, om welke uitwendige krachten en momenten dan ook te doorstaan – tenzij anders aangegeven op de tekening of berekening -, zoals:
   3.1. Krachten en momenten voortvloeiende uit windbelasting.
   3.2. Krachten en momenten voortvloeiende uit ijs en sneeuw.
   3.3. Krachten en momenten voortvloeiende uit aardbevingen.
   3.4. Krachten en momenten overgedragen via de ondersteuning van het filter.
   3.5. Krachten en momenten overgedragen via leidingaansluitingen.
   3.6. Krachten voortvloeiende uit snelle drukschommelingen.
   3.7. Krachten voortvloeiende uit trillingen.
4. Zolang het filter nog onder druk staat, mag de filterdeksel of welke aansluiting dan ook niet van het drukvat worden verwijderd.
5. Let erop, dat de inhoud van het filter toxische of explosieve mengsels kan bevatten. Tijdens bediening en onderhoud dient men zich te houden aan de aanwijzingen op de materiaalveiligheidsbladen van het medium welke door het filter stroomt.
6. Wanneer het filter zonder isolatie wordt geïnstalleerd, kan de buitenzijde van het filter heet worden. Daarom dient het filter zo te worden geplaatst, dat lichaamscontact met het filter verhinderd wordt.
7. Aangezien het filter zonder beveiligingsconstructie kan zijn geleverd, moeten alvorens het filter in gebruik wordt genomen eerst alle veiligheidsinrichtingen worden aangesloten op het complete systeem. Onder deze veiligheidsapparatuur vallen op z'n minst de volgende voorzieningen:
   7.1. Beveiligings- en aftapkleppen.
   7.2. Temperatuur en drukaanwijzers.
   7.3. Drukverschilmeters op de in- en uitlaat van het filter, om het drukverlies over het filter te controleren.
8. Alle ontluchtings- en aftapverbindingen dienen te zijn voorzien van afsluiters (door Indufil BV of de gebruiker).
9. Wanneer het filter is omgevallen, is het filter niet meer geschikt voor gebruik.
10. Het filter element dient elke 12 maanden geïnspecteerd en vervangen te worden of eerder, wanneer het drukverlies over het filter de grenswaarde van 1 bar heeft bereikt
11. Elementen moeten worden afgevoerd in overeenstemming met de lokale wet- en regelgeving ten aanzien van het medium en de te verwachten verontreinigingen die aanwezig kunnen zijn in het filter.
12. Het filter is ontworpen voor de project specifieke omgevingstemperatuur. Let op dat er geen instrumentatie geïnstalleerd is om de overschrijding van de maximale temperatuur te monitoren. De gebruiker is verantwoordelijk voor een juiste monitoring van de temperatuur en het nemen van de juiste acties wanneer de maximale temperatuur overschreden wordt. Onjuiste acties kunnen leiden tot ernstige schade, wat resulteert in verlies van productiviteit.
13. Er moet voorzichtigheid worden betracht, om geen medium of verwijding tijdens het veranderen en verwijderen van de gebruikte elementen te morsen.

一般的注意

1. フィルターの保守点検は有資格者によって行われるものとします。
2. フィルターは、製図や銘板に表示のある圧力・温度状況および腐れ代に適した設計になっています。設備を使用する前に、適切なアース工事を行なってください。ユニットを動作させる前にアース導通テストの実施を強く推奨します。正しくアース工事を行うことで、静電気による火花を防止することができます。
3. フィルターは、製図や計算値に明記されていない限り、以下に挙げるような外的な力やモーメントに耐えるような設計になっていません。すなわち、
   3.1. 風荷重に起因する力およびモーメント
   3.2. 雪と氷に起因する力およびモーメント
   3.3. 地震に起因する力およびモーメント
   3.4. 支持構造物に起因する力およびモーメント
   3.5. 配管接続に起因する力およびモーメント
   3.6. 圧力の急激な変化に起因する力
   3.7. 振動に起因する力
4. フィルターが圧力を受けている時に、フィルターカバーもしくは何らかの接続をフィルターから取り外すことを禁止します。
5. フィルター内の媒体は、毒性または爆発性混合物を含み得ることに注意してください。保守点検時には、媒体のMSDS(製品安全データシート)に記載されているガイドラインに従ってください。
6. フィルターがセットされると、フィルター表面が高温になる可能性があります。従って、フィルターとの物理的接触を避けるような位置にセットする必要があります。
7. フィルターには安全装置が同梱されていません。フィルターを使用する前に以下に挙げる最低限の安全装置を、フィルターを含む設備内に取り付けるようにしてください。
   7.1. 安全弁(逃し弁)
   7.2. 温度および圧力表示機器
   7.3. フィルター面にかかる圧力を確認するためにフィルターの注入口と排出口に差圧計を接続してください。
8. すべての排気および排水接続に対して適切なバルブが(Indufil B.V社もしくはユーザーのいずれかよって)設置される必要があります。
9. フィルターが水分を含んでしまった場合、そのフィルターをそれ以上使用しないでください。
10. フィルター媒体およびフィルターに溜まった汚染物質に関しては、現地の法律や規則に基づいて該当部品等を処理しなければなりません。
11. 使用済み部品等の交換および処理時に媒体や汚染物質をこぼさないように注意してください。
12. NR-13が適用される場合、保守は顧客側の認定された担当者によって行われます。これは、NR-13　則（13.10）とフィルターのカテゴリー（13.8.8）の組み合わせに従っています。

整体警告

1. 过滤器的维修和维护应该由高水准的人员来进行操作。
2. 过滤器适合在估算压力/温度条件下的工作，以及允许的侵蚀， 腐蚀，就像是在图纸上和产品表格上所标出的一样。
3. 该过滤器没有计算过承受外部的力量和因素，除非另有说明的图纸和计算。，比如：
   3.1. 风力加载造成的力和因.
   3.2. 冰雪造成的力和因素.
   3.3. 地震造成的力和因素.
   3.4. 支撑结构造成的力和因素.
   3.5. 管道连接造成的力和因素.
   3.6. 在压力快速浮动的情况下产生的力.
   3.7. 在震动中产生的力.
4. 过滤器的盖或是其它的接头不应该被取下，如果过滤器正在受压的话
5. 我们提请您注意以下事实，即该过滤器可能含有有毒物质或爆炸性的混合物。在进行维护或技术服务工作时，必须要遵循与所含材料安全列表所推荐的提示。
6. 当安装过滤器，过滤器表面可热。该过滤器，因此，应放置在这样一种方式，与身体接触的过滤器是不可能的
7. 该过滤器可交付无任何安全装置，所以在将过滤器投入使用前应该将所有防护性的装置安装在过滤器工作的系统内。以下装置是必配的：
   7.1. 防护（卸）阀.
   7.2. 温度和压力指标.
   7.3. 安装在过滤器收放中的压力表（如果没有安装），为了检测过滤器中的压力下降。
8. 相关的阀门安装在通风和排水连接系统中（Indufil BV公司或是使用者）
9. 在过滤器脱落后，它就已经不能在工作了
10. 过滤器元件处置应符合当地的法律和按照有关液体和可能产生的有害物质能够进入过滤器的规定办理。
11. 必须小心，不要对泄漏物变化和处置中使用的元素的液体或污染。

ALMINNELIGE FORHOLDSREGLER

1. Service og vedlikehold av filteret må utføres kun av kvalifisert personell.
2. Filteret er tilpasset de trykk- og temperaturforhold og korrosjons-/erosjonsbetingelser, slik som det står på tegningen og navneplaten.
3. Filteret er ikke laget for å motstå ytre mekaniske krefter, med mindre dette er nevnt på tegningen eller beregningene, slik som:
   3.1. Krefter og moment fra vind.
   3.2. Krefter og moment fra snø og is.
   3.3. Krefter og moment fra jordskjelv.
   3.4. Krefter og moment fra støttekonstruksjoner.
   3.5. Krefter og moment fra rørforbindelser.
   3.6. Krefter fra hurtige trykkforandringer.
   3.7. Kraft fra vibrasjoner.
4. Filterdekselet eller hvilken som helst annen forbindelse skal ikke fjernes fra filteret mens filteret er under trykk.
5. Vær klar over, at filterinnholdet kan inneholde giftige og eksplosive blandinger. Ved service og vedlikehold må man følge retningslinjene som er å finne på vedkommende datablad (Material Safty Data Sheets).
6. Vær oppmerksom på at dette filter kan inneholde giftige eller eksplosive blandinger. Filteret må derfor plasseres på en slik måte, at man ungår fysisk kontakt med filteret.
7. Filteret kan leveres uten noen sikkerhetsutstyr; før filteret blir tat i bruk må sikkerhetsinnretningene monteres det systemet som filteret kobles til. Disse innretningene er et minimum:
   7.1. Sikkerhetsventil.
   7.2. Temperatur og trykk indikatorer.
   7.3. En trykkdifferensialindikator (PDI) som monteres på inntakssiden og utløpssiden av filteret (hvis den ikke allerede er montert), for å sjekke et eventuelt trykkfall i filteret.
8. Alle ventilasjons- og tappeforbindelser skal utstyres med passende ventiler (enten av Indufil BV eller brukeren).
9. Er filteret falt ned, kan det ikke lenger brukes.
10. Los elementos tienen que ser eliminados de acuerdo con las leyes locales y regulaciones con respecto a la contaminación del fluido y se espera que pueda estar atrapado en el filtro.
11. Se debe tener cuidado de no derramar el líquido o la contaminación en el cambio y la eliminación de los elementos utilizados.

ALLMÄNA VARNINGAR

1. Filter service och underhåll ska genomföras endast av kvalificerade personalen.
2. Filtret är lämpligt för trycket och temperatur samt korrosion tillstånd som anvisats på tekningen och skylten. Filtret ska jordas ordentligt före användningen. Det är nödvändigt att genomföra jordningsprov innan att sätta på filtret. En bra jordning behövs för att förebygga gnistor av statistisk elektricitet.
3. Filtret är inte avsett för att förebygga de yttre krafterna och moment, med mindre än det är anvisat på tekningen eller beräkningen, som nedan:
   3.1 Krafter och moment orsakade av vindkrafter.
   3.2 Krafter och moment orsakade av snö och is.
   3.3 Krafter och moment orsakade av jordbävning.
   3.4 Krafter och moment orsakade av stödkonstruktion.
   3.5 Krafter och moment orsakade av rörkopplingar.
   3.6 Krafter och moment orsakade av tryckförändringar.
   3.7 Krafter och moment orsakade av vibrering.
4. Locket av filtret och vilka som helst kopplingar ska inte tas ut från filtret medan det är under trycket.
5. Det är nödvändigt att lägga märke till att filterinnehåll han rymma giftiga eller explosiva blandningar. Vid service och underhåll av filtret ska man följa alla riktningslinjer anvisade i denna bruksanvisning.
6. Det är viktigt att notera att filtrets yttre sidor kan uppvärmas när filtret är satt på. Filtret ska därför placeras så att man undviker en fysisk kontakt med filtret.
7. Filtret kan levereras utan någon säkerhetsutrustning. Innan att börja använda filtret ska man minimalt montera alla följande utrustningar i systemet som filtret är kopplat till:
   7.1 Säkerhetsventil.
   7.2 Temperatur och tryck indikatorer.
   7.3 Detektor av tryckdifferens (PDI) som monteras på filtrets ingång och utgång för att mäta ett eventuellt tryckfall i filtret.
8. Det är nödvändigt att inställa ventiler på både ventilationskopplingar och backkopplingar (av Indufil BV eller användaren).
9. I fall av filtrets nedfall kan det inte längre vara i bruk.
10. Filterelement ska återvinnas enligt lokal lagstiftning och reglering gällande filtrets innehåll och möjliga nersmittningar som kunde ha hamnat i filtret.
11. Ersättning eller återvinning av brukade element ska genomföras försiktigt för att undvika spill av filterinnehåll eller nersmittningar.
12. Om NR-13 gäller, ska underhåll genomföras av användarens certifierade personal. Det pågår enligt NR-13:s regleringar (13.10), i sammansättning med filterkategori (13.8.8).

YLEISET VAROITUKSET

1. Suodattimen huolto ja kunnossapito on suoritettava ammattitaitoisen henkilökunnan toimesta.
2. Suodatin soveltuu piirroksessa ja nimikyltissä osoitettuun mitoituspaineeseen/lämpötilaan ja syöpymisvaraan. Ennen laitteen käyttöön ottamista, se tulee maadoittaa oikeaoppisesti. On erittäin suositeltavaa suorittaa maadoituksen jatkuvuuden mittaus ennen laitteen käynnistystä. Hyvä maadoitus on välttämätöntä estääksesi kipinöiden synnyn staattisen sähkön takia.
3. Suodatinta ei ole suunniteltu kestämään ulkoisia voimia tai momentteja, ellei niitä ole erikseen mainittu piirroksessa tai laskelmissa, kuten:
   3.1. Tuulikuorman aiheuttamat voimat ja momentit.
   3.2. Lumen ja jään aiheuttamat voimat ja momentit.
   3.3. Maanjäristysten aiheuttamat voimat ja momentit.
   3.4. Tukirakenteiden aiheuttamat voimat ja momentit.
   3.5. Putkistoliitäntöjen aiheuttamat voimat ja momentit.
   3.6. Paineen nopeista vaihteluista aiheutumat voimat.
   3.7. Tärinän aiheuttama voima.
4. Suodattimen kantta tai sen liitäntöjä ei saa poistaa, kun suodatin on paineen alaisena.
5. Muista, että suodattimen väliaine voi sisältää myrkyllisiä tai räjähtäviä seoksia. Huolto- ja kunnossapito-operaatioiden aikana on noudettava väliaineen käyttöturvallisuustiedotteiden mukaisia ohjeita.
6. Kun suodatin on asennettu, sen pinta saattaa olla kuuma. Tämän takia suodattimen tulisi olla sijoitettuna niin, että fyysinen kontakti sen kanssa on vältettävissä.
7. Suodatin saattaa tulla toimitettuna ilman mitään turvalaitteita, mutta ennen sen käyttöön ottamista vähintäänkin seuraavat turvalaitteet tulee olla asennettuna siihen järjestelmään, johon suodatin kytketään.
   7.1. Turva- (varo-) venttiili.
   7.2. Lämpötila- ja painemittarit.
   7.3. Suodattimen sisään- ja ulostuloon kytketty paine-eron mittari suodattimen painehäviön tarkasteluun.
8. Jokaiseen aukon ja laskuputken liitäntään tulee asentaa sopiva venttiili (joko Indufil BV:n tai käyttäjän toimesta)
9. Kun suodatin on pudotettu, se ei sovellu enää käyttöön.
10. Elementit on hävitettävä paikallisten asetusten ja lakien mukaisesti suodattimen väliaineen ja suodattimeen jääneiden oletettavien saasteiden osalta.
11. Huolehdi, että väliainetta tai saasteita ei vuoda, kun vaihdat tai hävität käytettyjä elementtejä.
12. Jos NR-13 on sovellettavissa; huolto tulee suorittaa asiakkaan ammattitaitoisen henkilöstön toimesta. Tämä on tehtävä NR-13 (13.10) asetusten mukaisesti, suodatinkategorian (13.8.8) yhteydessä.

GENERELLE SIKKERHEDSREGLER

1. Service og vedligehold af filteret må kun udføres af kvalificeret personale.
2. Filteret er indrettet til tryk-og temperaturforhold og korrosions-/erosions betingelser , som det er angivet på tegningen og typeskiltet.
3. Filteret er ikke designet til at modstå eksterne mekaniske kræfter , medmindre andet er angivet på tegningen eller i beregninger, såsom:
   3.1. Kræfter og moment fra vind.
   3.2. Kræfter og moment fra sne og is.
   3.3. Kræfter og moment fra jordskælv.
   3.4. Kræfter og moment fra støttestrukturer.
   3.5. Kræfter og drejningsmoment fra røranslutninger.
   3.6. Kræfter fra hurtige trykændringer.
   3.7. Kræfter fra vibrationer.
4. Filterdækslet , eller enhver kan ikke blive fjernet fra filteret når filteret er under tryk.
5. Vær opmærksom på , at indholdet af filter kan være giftig og indeholde eksplosive blandinger. Ved servicering og vedligeholdelse skal du følge de retningslinjer, der findes i de relevante MSDS (Material Safety datablade) .
6. Den installeret filter kan have en varm overflade. Filteret skal derfor placeres på en sådan måde, at først og fremmest fysisk kontakt med filteret bliver forhindret.
7. Filteret kan leveres uden sikkerhedsanordning , derfor, før filteret tages i brug skal alle (se nedenunder pkt.7.1-7.3) sikkerhedsanordninger som et minimum monteres i systemet, hvor filteret er installeret.
   7.1. Sikkerhedsventil.
   7.2. Temperatur- og trykindikatorer.
   7.3. Trykforskel indikator (PDI), forbundet med filterets indløbs- og udløbspassager til at kontrollere trykfaldet gennem filteret.
8. Egnede ventiler skal installeres på alle udluftnings -og dræneringsforbindelser (enten af Indufil BV eller af brugeren).
9. Når filteret er droppet , er det ikke egnet for brug længere.
10. Elementer skal bortskaffes i overensstemmelse med lokal lovgivning og regulering med hensyn til det i filteret brugte media og forventede forureninger, der kan blive fanget af filteret.
11. Man skal være forsigtig med ikke at spilde det filtrerede medium eller forurening i elementet under udskiftning og bortskaffelse af de brugte filterelementer.
12. Hvis NR- 13 er anvendelig; vedligeholdelse skal udføres af kundensautoriseret personale. Dette gælder i henhold til reglerne i NR-13 (13.10) i kombination med filter kategori (13.8.8) .

OSTRZEŻENIA OGÓLNE

1. Naprawa i utrzymanie filtru powinno być wykonywane przez personel wykwalifikowany.
2. Filtr jest obliczony na warunki pracy, przy których zachowane są: ciśnienie projektowe / temperatura projektowa i dopuszczalne odchylenie korozyjne / erozyjne, czyli zgodnie z parametrami podanymi na rysunku i tabliczce.
3. Wytrzymałość danego filtru nie jest obliczona na oddziaływanie sił i momentów zewnętrznych, jeżeli inne dane nie są przytoczone na rysunkach i w obliczeniach, na przykład:
   3.1. Sił i momentów, spowodowanych przez ciśnienie wiatru.
   3.2. Sił i momentów, spowodowanych przez śnieg i lód.
   3.3. Sił i momentów, spowodowanych przez trzęsienie ziemi.
   3.4. Sił i momentów, spowodowanych przez konstrukcje oporowe.
   3.5. Sił i momentów, spowodowanych przez połączenia rurociągowe.
   3.6. Sił spowodowanych przez nagłe zmiany ciśnienia.
   3.7. Sił spowodowanych przez wibracje.
4. Zabronione jest zdejmowanie pokrywy filtru lub usunięcie połączenia od filtru, jeżeli filtr znajduje się pod ciśnieniem.
5. Zwracamy uwagę na to, że dany filtr może zawierać mieszanki toksyczne lub grożące wybuchem. Dlatego podczas regularnych prac naprawczych lub przeprowadzania obsługi technicznej należy ściśle przestrzegać instrukcji, dotyczących zawartości substancji i podanych w dokumentach zabezpieczających materiału (Material Safety Data Sheets).
6. Podczas instalacji filtru jego powierzchnia może nagrzewać się. Dlatego filtr należy instalować w takim miejscu, w którym będzie wykluczony kontakt fizyczny z nim.
7. Filtr może być dostarczany bez jakichkolwiek urządzeń ochronnych, do uruchomienia wszystkie urządzenia ochronne zostają wewnątrz układu, do którego powinien być połączony filtr. Urządzenia te, to co najmniej:
   7.1. Zawór bezpieczeństwa (awaryjny).
   7.2. Wskaźniki temperatury i ciśnienia.
   7.3. Wskaźnik różnicy ciśnienia (PDI), zainstalowany na wejściu i wyjściu filtra, (jeżeli nie jest wmontowany) przeznaczony do kontroli spadku ciśnienia w filtrze.
8. Wszystkie połączenia do przedmuchiwania i podłączenia wyjściowe powinny być zaopatrzone w odpowiednie zawory (przez firmę Indufil BV) lub przez użytkownika).
9. Jeżeli filtr upadł, to nie nadaje się do użycia.
10. Utylizacja elementów filtru powinna być przeprowadzana zgodnie z miejscowym ustawodawstwem i normami, dotyczącymi środowisk ciekłych i ewentualnych substancji szkodliwych, które mogą trafić do filtru.
11. Należy zachować środki ostrożności, aby wykluczyć wylew płynu lub spowodowanie zanieczyszczenia w procesie zamiany i utylizacji zużytych elementów.
12. Jeżeli stosowany jest przepis NR-13, obsługa powinna być wykonywana przez certyfikowany personel klienta. Jest to zgodne z przepisem NR-13 (13.10) w połączeniu z kategorią filtru (13.8.8).

ÁLTALÁNOS FIGYELMEZTETÉSEK

1. A szűrő javitását és karbantartását csak szakképzett szakember végezheti.
2. A szűrő olyan körülmények között használható, melyeknél a tervezett nyomás/ a tervezett hőmérséklet és korrózió/ erózió eltérés nem változik, azaz a rajzon és a táblázatban feltüntetett paraméterek szerint. Használat előtt a berendezést megfelelően földelni kell. Nyomatékosan javasoljuk a készülék üzemeltetése előtt, ellenőrizze a földelés épségét. Megfelelő földelés a statikus energia által keletkező szikraképződés kizárása érdekében szükséges.
3. Az adott szűrő nem áll ellen külső kihatásnak, ha a rajzok és a számitások mást nem tartalmazznak, például:
   3.1. Szél nyomása okozta erő és nyomaték.
   3.2. Hó és jég okozta erő és nyomaték.
   3.3. Fölrengés okozta erő és nyomaték.
   3.4. Alapkonstrukció okozta erő és nyomaték.
   3.5. Csővezeték illesztése okozta erő és nyomaték.
   3.6. Hirtelen nyomásváltozás okozta erő.
   3.7. Rezgések okozta erő.
4. Tilos a szűrő fedelének vagy csatlakozásainak levétele, ha a szűrő nyomás alatt van.
5. Felhívjuk figyelmét, hogy az adott szűrő tartalmazhat mérgező vagy robbanásveszélyes anyagokat. Ezért, folyamatos javítási vagy karbantartási munkálatoknál szigorúan be kell tartani a veszélyes anyagokkal kapcsolatos utasításokat, melyeket megtalálhatja a mellékelt biztonságvédelmi dokumentációban (Material Safety Data Sheets).
6. A szűrő szerelésekor, az utóbbi felülete felmelegszik. Ezért a szűrőt olyan helyre kell szerelni, ahol a szűrővel való fizikai kontaktus teljesen kizárt.
7. A szűrőt bármilyen védő szerkezet nélkül is szállíthatják, üzembe helyezés időpontjáig, minden egyes védelmi szerkezet, melyhez a szűrő csatlakoztatva lesz, a szűrő belsejében marad.
   7.1. Biztonsági (vész) szelep.
   7.2. Hőmérsékleti és nyomásparaméterek.
   7.3. Nyomáskülömbség jelző (PDI), mely a szűrő bemenetnél és kimenetnél van felszerelve (hf nincs beszerelve), mely ellenőrzi a nyomás csökkenését a szűrőben.
8. Az összes leürítő és kimeneti csatlakozás megfelelő szelepekkel kell legyen ellátva (vagy a gyártó Indufil BV által, vagy a felhasználó által).
9. Abban az esetben ha a szűrő leereszkedett, a szűrő további használata kizárt.
10. A szűrő elemeinek megsemmisitését a szűrőbe kerülhető folyékony vagy más káros hatású anyagok megsemmisitésével kapcsolatos helyi jogszabályoknak megfelelően kell elvégezni.
11. Szűrő cseréje vagy megsemmisitése alkalmával folyékony és veszélyes anyagok környezetbe való kikerülése kizárása érdekében, tartsa be a megfelelő biztonságvédelmi szabályokat.
12. NR-13 szabvány használata esetén, a készülék karbantartását csak megfelelő tanúsítvánnyal rendelkező szakember végezheti. Ez, az NR-13 (13.10 pont) szabvány követelményeiből adódik, az adott osztályúszűrő figyelembevételével (13.8.8 pont).

VŠEOBECNÁ UPOZORNĚNÍ

1. Servis a údržbu smí provádět pouze kvalifikovaný personál.
2. Tento filtr je určen k použití při výpočtovém tlaku/výpočtových teplotních podmínkách a toleranci pro korozi/erozi, které jsou uvedeny ve výkrese a na továrním štítku. Než toto zařízení bude uvedeno do provozu, musí být řádně uzemněno. Důrazně se doporučuje provést před spuštěním této jednotky kontrolu kontinuity uzemnění. Spolehlivé uzemnění zamezí vzniku jiskry statické elektřiny.
3. Filtr není určen k použití v jakýchkoli extrémních podmínkách a momentech, pro provoz pod vlivem jakýchkoli extrémních sil, pokud není to ve výkresech a výpočtech stanoveno jinak. Jde například o:
   3.1. Síly a momenty vznikající zatížením větrem.
   3.2. Síly a momenty vznikající zatížením sněhem a ledem.
   3.3. Síly a momenty vznikající následkem zemětřesení.
   3.4. Síly a momenty vznikající vlivem působení nosných konstrukcí.
   3.5. Síly a momenty vznikající vlivem působení míst spojení potrubí.
   3.6. Síly a momenty vznikající následkem značných tlakových rozdílů.
   3.7. Síly vznikající následkem vibrací.
4. Nesmí se otevírat víko filtru nebo odpájet od něho připojovací hrdla pokud je filtr pod tlakem.
5. Upozorňujeme na to, že médiun uvnitř filtru může obsahovat jedovaté nebo výbušné směsi. Během servisních a technických prácí se musí dodržovat základní ustanovení, která se týkají materiálu výrobku a jsou uvedena v technické bezpečnostní dokumentace (Material Safety Data Sheets).
6. Pokud je filtr instalován, může se pak povrch tohoto filtru zahřívat. Je třeba proto rozmístit filtr tak, aby se mohlo vyhnout fizyckého kontaktu s filtrem.
7. Bezpečnostní zařízení nejsou součástí dodávky tohoto filtru. Před uvedením filtru do provozu je třeba v systému, kde se montuje tento ventil, instalovat všechna potřebná bezpečnostní zařízení. Bezpečnostní zařízení musí se přinejmenším skládat z:
   7.1. Pojistného (přepouštěcího) ventilu.
   7.2. Indikátorů teploty a tlaku.
   7.3. Diferenciálního manometru připojeného ke vtoku a výtoku (výpusti) filtru (pokud není ještě instalován) pro kontrolu tlakových ztrat ve filtru.
8. Odpovídající záklopky musí být instalovány na všech místech připojení ventilů a odvodů (buď firmou Indufil BV nebo uživatelem).
9. V případě spadnutí filtru na zem, nehodí se pak pro další provoz.
10. Recyklace elementů filtru musí probíhat v souladu s lokálním zákonodárstvím a podle příslušných předpisů, týkajících se kapalného média, kapalin a možných očekávaných nečistot, které se mouhou dostat dovnitř a mohou být zachyceny ve filtru.
11. Přijměte bezpečnostní opatření, aby nedošlo k rozlití media resp. tekutiny či úniku nečistot během výměny resp. likvidace použitých elementů.
12. Pokud platí NR-13, údržba musí být prováděna certifikovanými pracovníky zákazníka. Vyplývá to z předpisu NR-13 (13.10) ve shodě s kategorií filtru (13.8.8).

VŠEOBECNÉ UPOZORNĚNIA

1. Inštalácia a údržba musia byť vykonávané kvalifikovaným personálom.
2. Tento filter je určený na použitie pri konštrukčnom tlaku / výpočtových teplotných podmienkach a toleranciu pre koróziu / eróziu, ktoré sú uvedené vo výkrese a na továrenskom štítku. Pred uvedením zariadenia do prevádzky, musí byť zariadenie riadne uzemnené. Dôrazne sa odporúča vykonať kontrolu kontinuity uzemnenia obvodov pred zapnutím jednotky. Spoľahlivé uzemnenie zamedzí vzniku iskry statickej elektriny.
3. Filter nie je určený na použitie v akýchkoľvek extrémnych podmienkach a momentoch, pre prevádzku pod vplyvom akýchkoľvek extrémnych síl, pokiaľ nie je to vo výkresoch a výpočtoch stanovené inak, ako je napríklad:
   3.1. Sily a momenty vznikajúce od zaťaženia vetrom.
   3.2. Sily a momenty vznikajúce od zaťaženia snehom a ľadom.
   3.3. Sily a momenty vznikajúce následkom zemetrasenia.
   3.4. Sily a momenty vznikajúce vplyvom pôsobenia nosných konštrukcií.
   3.5. Sily a momenty z potrubných spojov.
   3.6. Sily a momenty vyplývajúce z kolísania tlaku.
   3.7. Sily vyplývajúce z vibrácií.
4. Nesmie sa otvárať veko filtra alebo odpájet od filtru pripojovacie hrdlá, ak je filter pod tlakom.
5. Upozorňujeme na to, že médiun vnútri filtra môže obsahovať jedovaté alebo výbušné zmesi. Počas servisných a údržbových postupov sa musí dodržovať základné ustanovenia, ktoré sa týkajú materiálu výrobku a ktoré sú uvedené v technickej bezpečnostnej dokumentácii (Material Safety Data Sheets).
6. Keď je filter nainštalovaný, povrch filtra sa môže zohrievať. Preto sa filter musí byť inštalovaný v mieste, kde s nim bude vylúčený žiadný fyzický kontakt.
7. Bezpečnostné zariadenia nie sú súčasťou dodávky tohto filtra. pred zavedením filtra do prevádzky je potrebné v systéme, kde sa montuje tento ventil, inštalovať všetky potrebné bezpečnostné zariadenia. Ako minimum, tieto zariadenia sú:
   7.1. Poistný (prepúšťací) ventil.
   7.2. Indikátory teploty a tlaku.
   7.3. Diferenciálny manometr pripojený na vstupe a výstupe filtra (ak nie je eště inštalovaný) pre kontrolu poklesu tlaku vo filtri.
8. Na vsetkych miestach pripojenia ventilov a odvodov musia byť inštalované zodpovedajúce záklopky (buď firmou Indufil BV alebo užívateľom).
9. V prípade spadnutia filtra na zem, nie je pak vhodný na ďalšie použitie.
10. Elementy filtru zlikvidujte podľa zákona a v súlade s miestnymi právnymi predpismy, týkajúcich sa kvapalného média, kvapalín a možných očakávaných nečistôt, ktoré sa môžu dostať dovnútra a môžu byť zachytené filtrom.
11. Prijmite bezpečnostné opatrenia, aby nedošlo k rozliatiu média resp. tekutiny či úniku nečistôt počas výmeny resp. likvidácii použitých elementov.
12. Ak platí NR-13, údržba musí byť vykonávaná certifikovanými pracovníkmi zákazníka. Vyplýva to z predpisu NR-13 (13.10) a v súladu s kategóriou filtra (13.8.8).

GENEL UYARILAR

1. Filtre Servisi ve Bakımı nitelikli eleman tarafından yapılmalıdır.
2. Çizim ve isim levhasın ifade edildiği gibi, Filtre tasarım basınç/sıcaklık koşullarına ve paslanma payına uygundur. Donatım kullanılmadan önce gereği gibi topraklanmalıdır. Tesis çalıştırmaya başlamadan önce topraklama devamlılık deneyi yapmak şiddetle tavsiye edilir. İyi topraklama statik elektrikten dolayı kıvılcımları önlemek için gerektir.
3. Çizim ve hesaplamalarda aksi belirtilmedikçe filtre aşağıdaki gibi herhangi dış kuvvetlere ve momentlere dayanmak için tasarlanmaz:
   3.1. Rüzgar yükünden sonuçlanan kuvvetler ve momentler.
   3.2. Kar ve buzdan sonuçlanan kuvvetler ve momentler.
   3.3. Depremlerden sonuçlanan kuvvetler ve momentler.
   3.4. Mesnet yapılarından sonuçlanan kuvvetler ve momentler.
   3.5. Boru hattı bağlantılarından sonuçlanan kuvvetler ve momentler.
   3.6. Basınçtaki hızlı dalgalanmalardan sonuçlanan kuvvetler.
   3.7. Vibrasyonlardan sonuçlanan kuvvet.
4. Filtre baskı altında iken filtre kapağı veya herhangi bir bağlantı filtreden çıkarılmaz.
5. Toksik veya patlayıcı karışımların filtre ortamında bulunabileceğini lütfen aklınıza getiriniz. Malzeme Güvenlik Bilgi Formunda belirtildiği gibi, ana esaslar servis ve bakım işlemlerinde yerine getirmelidir.
6. Filtre monte edilirken filtre yüzü sıcak olabilir. Bu yüzden filtre, onunla fiziksel temastan kaçınılacak şekilde yerleştirilmelidir.
7. Filtre, emniyet mekanizmasız olarak teslim edilebilir. Filtre kullanılmadan önce aşağıdaki emniyet mekanizmaları asgari olarak filtrenin içine konduğu sisteme yerleştirilmelidir.
   7.1. Güvenlik (basınç düşürme) vanası.
   7.2. Sıcaklık ve basınç göstergeleri.
   7.3. Filtre basınç düşürmesini kontrol etmek için filtre girişi ve çıkışına Basınç Diferansiyel Göstergesi bağlanmıştır.
8. Her havalanma ve boşaltma bağlantıları için uygun vanalar (Indufil BV veya kullanıcı tarafından) sağlanmalıdır.
9. Filtre düşürüldüğünde o artık servise uygun değildir.
10. Elementler, filtreye takılması beklenen kirlilik ortam ile ilgili yerel yasalara ve yönetmeliklere uygun olarak bertaraf edilmelidir.
11. Kullanılmış öğeler değiştirilir ve atılır iken ortamı veya bulaşımı dökmemeye dikkat edilmelidir.
12. NR-13 uygunabilirse, bakım müşterinin sertifikalı elemanı tarafından yapmalıdır. Bu, (13.8.8) filtre kategorisi ile (13.10) NR-13 yönetmeliğine göre olur.

ЖАЛПЫ ҚАУІПСІЗДІК ШАРАЛАРЫ

1. Сүзгіге техникалық қызмет көрсетуді және пайдалануды тек білікті қызметкерлер орындауы керек.
2. Сүзгі сызбада және паспорттық кестеде берілген деректерге сай есептік қысым/температура және есептік коррозия мәні жағдайларында пайдалануға арналған. Жабдықты пайдалануға енгізу алдында тиісті түрде жерге қосу керек. Орнатуды іске қосу алдында қорғағыш жерге қосудың тұтастығын сынауды өткізу ұсынылады. Тиісті түрде жерге қосу статикалық электр салдарынан пайда болуы мүмкін ұшқын шығаруды болдырмау үшін қажет.
3. Сызбалар мен есептеулерде басқалай көрсетілген болмаса, бұл сүзгі сыртқы күштердің және моментердің әсерін шектеуге есептелмеген, атап айтқанда:
   3.1. Жел әсері тудыратын күштердің және моменттердің.
   3.2. Қар мен мұз әсері тудыратын күштердің және моменттердің.
   3.3. Жер сілкінісі тудыратын күштердің және моменттердің.
   3.4. Тірек құрылыстарының әсері тудыратын күштердің және моменттердің.
   3.5. Құбырлардың жалғау муфталары тудыратын күштердің және моменттердің.
   3.6. Қысымның кенет жылдам өзгерістері тудыратын күштердің.
   3.7. Вибрациялар тудырған күштердің.
4. Сүзгі қысым астында болғанда сүзгі қақпағын алуға немесе сүзгі қосылымдарының кез келгенін демонтаждауға тыйым салынады.
5. Бұл сүзгіде уытты немесе жарылғыш қоспалар болуы мүмкін екеніне назар аударыңыз. Сондықтан, профилактикалық жөндеу жұмыстарын немесе техникалық қызмет көрсету жұмыстарын өткізу кезінде жұмыс ортасына қатысты материалдардың қауіпсіздік паспортындағы нұсқауларды бұлжытпай сақтау керек.
6. Орнатылып қойылған сүзгінің беті жұмыс уақытында қызуы мүмкін. Сондықтан сүзгіні бетке тиюін болдырмауға болатындай монтаждау керек.
7. Сүзгі қорғағыш құрылғыларсыз жеткізілуі мүмкін, сүзгіні пайдалануға енгізу алдында төменде көрсетілген сақтандырғыш құрылғылардың барлығы контурында сүзгі орнатылған жүйеде орнатылып қойылған болуы керек.
   7.1. Сақтандырғыш клапан (қысымды босату клапаны).
   7.2. Температура және қысым индикаторлары.
   7.3. Сүзгінің кірісіне және шығысына жалғанған және сүзгідегі қысым айырмасын бақылауға арналған айырма индикаторы.
8. Барлық үрлеу және төгу қосылымдарында сәйкес вентильдер (Indufil BV компаниясы немесе пайдаланушының өзі орнатады) болуы керек.
9. Ластalса (бітел) (сүзгі арқылы қысым айырмасы айтарлықтай болғанда), сүзгі енді пайдалануға жарамсыз.
10. Сүзу элементтерін 12 ай сайын немесе сүзгідегі 1 барды құрайтын қысым айырмасының шекті мәніне жеткенше (қайсысы бірінші болса) тексеру және ауыстыру керек.
11. Сүзу элементтерін утилизациялауды жұмыс орталарын және сүзгіге түсуі мүмкін мүмкін зиянды заттарды утилизациялау туралы жергілікті заңдар мен нормаларға сай өткізу керек.
12. Қолданылған сүзу элементтерін ауыстырғанда және утилизациялағанда жұмыс ортасының төгілуін және ластaлуын болдырмаудың тиісті шараларын қолдану керек.
13. Сүзгі есептік техникалық жағдайларда көрсетілген қоршаған орта температураларында жұмыс істеуге арналған. Көрсетілген шекті мәндерден (температураның) асыру туралы ескертетін арнайы бақылау-өлшеу жабдығы қарастырылмағанын білу керек. Қоршаған орта температурасының шекті мәндерінен асқанда пайдаланушы тиісті бақылауды қамтамасыз етуі және сәйкес әрекеттерді орындауы керек. Тиісті емес әрекеттер ауыр зақымдарға әкеліп, өнімділікті жоғалтуды тудырады.
14. NR-13 нормативін (Бойлерлер және қысым астындағы резервуарлар туралы норматив) қолданған жағдайда; техникалық қызмет көрсетуді пайдаланушының сәйкес сертификаттары бар білікті мамандары жүзеге асыруы керек. Бұл талап NR-13 (13.10) нормативнің шарттарына, әрі сүзгі санатына (13.8.8) қатысты шарттарға сай келеді.

Pictogram Explanation

Open
(Öffnen / Ouvrir / Aprire / Aabra / Abra / Отκройте / Open / 開く / 打开 / Åpne / Öppen / Avaa / Åbne / Otworzyć / Nyitás / Otevřete / Otvorte / Açınız / Ашу)

Close
(Schließen / Fermer / Chiudere / Feche / Cierre / Закройте / Sluiten / 閉じる / 关闭 / Lukk / Stängd / Sulje / Lukke / Zamknąć / Zárás / Zavřete / Zavrite / Kapınız / Жабу)

Don't
(Nicht / Ne pas / Non / Que não / Que no / He / Niet doen / 不可 / 不 / Ikke / Inte / Älä / Gør ikke / Nie / Nem / Ne / Nie / Yapmayınız / Мұны істемеу (рұқсат емес әрекет)

Do
(Tun / Faire / Fare / Fazer / Hacer / Делать / Wel doen / 実行 / 做 / Gjøre / Göra / Tee / Gør / Tak (wykonać) / Igen / Dělejte / Dělajte / Yapınız / Келесіні істеу (қажет әрекет)

Forces - Movements
(Kräften - Bewegung / Les forces - Mouvement / Forza - Movimento / Forças - Movimento / Fuerza - Movimiento / Сил - Движениях / Kracht - Beweging / 力ー運動 / 部队 - 运动 / Force – Bevegelse / Kraft – Rörelse / Voimat - Momentit / Kræfter – bevægelser / Siły – Przemieszczenia / Erő – Mozgás / Síly – Pohyby / Sily – Pohyby / Kuvvetler – Hareketler / Күштер – Қозғалыстар)

Pressurized
(Unter Druck / Sous pression / Pressurizzato / Pressurizado / Presurizado / Под давлением / Onder druk / 加压 / 加压的 / Trykksatt / Under tryck / Paineistettu / Under tryk / Pod ciśnieniem / Nyomás alatt / Pod tlakem / Pod tlakom / Basınçlı / Қысым әсерімен)

Low pressure
(Niederdruck / Basse pression / Bassa pressione / Baixa pressão / De baja presión / Низкое давление / Lage druk / 低压/ 低压力 / Lavtrykk / Nedtryckt / Matala paine / Lav tryk / Niskie ciśnienie / Alacsony nyomás / Nízký tlak / Nízky tlak / Düşük Basınç / Төмен қысым)

Clean
(Sauber / Nettoyer / Pulito / Limpa / Limpio / Очистить / Schoonmaken / 空にする / 清洁 / Rengjør / Rengöra / Puhdista / Ren / Oczyścić / Tisztítás / Očistit / Očistiť / Temizleyiniz / Тазалау)

Optionals - Options Available
(Optionen - Verfügbare optionen / En option - Options disponibles / Opzioni - Opzioni disponibili / Opcional - Opções disponíveis / Opciones - Opciones disponibles / Опции - Доступные опции / Opties – Beschikbare opties / オプションー利用可能なオプション / 选项 -可用选项 / Opsjoner – Opsjoner Tilgjengelig / Optioner – Tillgängliga optioner / Vaihtoehdot – Valittavat vaihtoehdot / Tilvalg tilgængelig / Opcjonalnie – Opcje dostępne / Opciók – Elérhető opciók / Opce – Dostupné opce / Opcie – Dostupné opcie / Seçimliler – Mevcut Seçenekler / Опциялар – Бар опциялар)

Attention
(Achtung / Attention / Attenzione / Atenção / Atención / Внимание / Let op / 注意 / 的注意 / Oppmerksomhet / Uppmärksamhet / Huomio / OBS! / Uwaga / Figyelem / Pozor! / Pozor! / Dikkat / Назар аударыңыз)

Trash - Waste – Disposal
(Müll – Abfall – Entsorgung / Poubelle – Déchets – Disposition / Spazzatura – Rifiuti – Smaltimento / Lixo – Resíduos – Disposição / Корзиной – Отходов – Удаление отходов / Vuilnis – Afval – Verwijderen / ゴミ箱ーゴミー削除 / 垃圾桶 - 废物 - 处置 / Søppelet – Avfall – Avhending / Sopor – Avfall – Bortskaffande / Roska – Jätteet - Hävitys / Afaldskurv – affald – bortskaffelse / Śmieci – Odpady – Utylizacja / Kuka – Hulladék – Hulladékkezelés / Koš – Odpady – Likvidace odpadů / Kôš - Odpady - Likvidácia odpadov / Çöp - Atık – Bertaraf / Қоқыс – Қалдықтар – Қалдықтарды утилизациялау)

New
(Neu / Nouveau / Nuovo / Novo / Nuevo / Новый / Nieuw / 新しいもの / 新 / Nye / Ny / Uusi / Ny / Nowy / Új / Nové / Nové / Yeni / Жаңа)

Re-use
(Wieder-verwendung / Ré-utilisation / Riutilizzo / Reutilização / Reutilización / Повторное использование / Hergebruiken / 再利用 / 重用 / Gjenbruk / Återanvända / Uudelleenkäyttö / Genbrug / Użycie ponowne / Újrahasznosítás / Opětovné použití / Opätovné použitie / Tekrar Kullanma / Қайтадан қолдану)

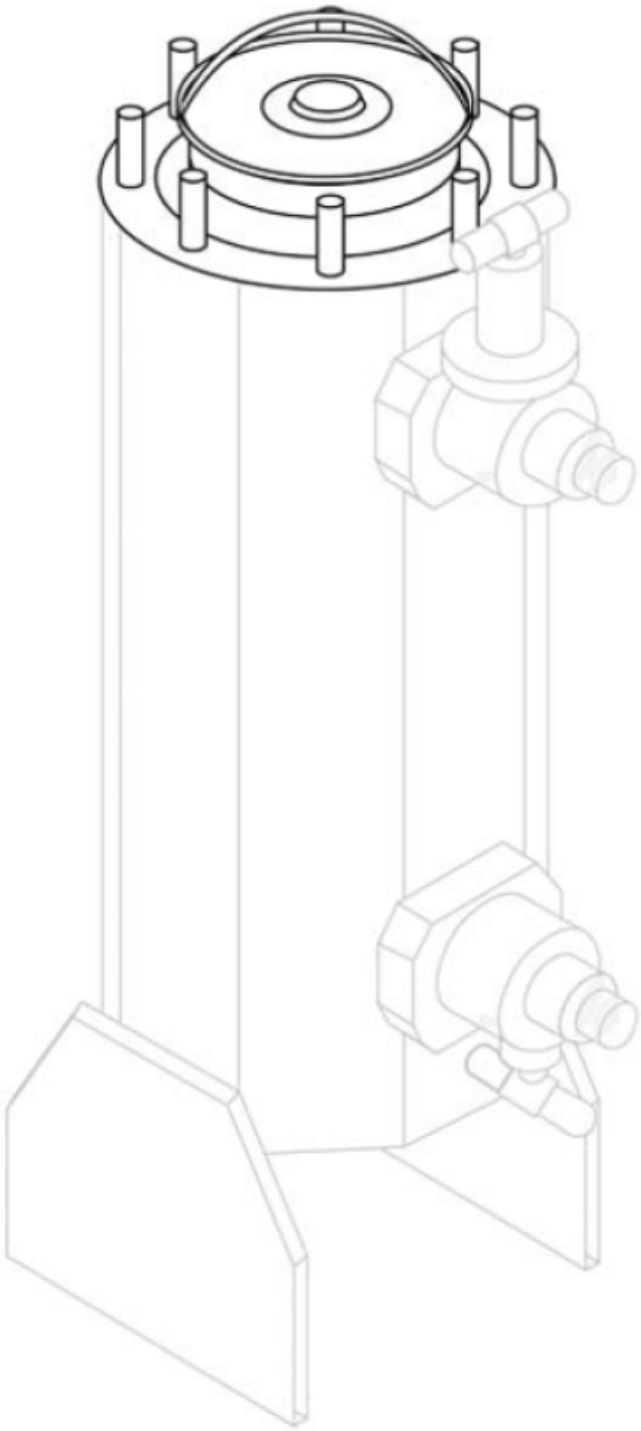
Page
(Seite / La Page / Pagina / Página / Página / Странице / Pagina / ページ / 页 / Siden / Sida / Sivu / Side / Strona / Oldal / Stránka / Stránka / Sayfa / Бет)

Oil
(Öl / Huile / Olio / Óleo / Aceite / Нефтяной / Olie / 石油 / 石油 / Oljen / Olja / Öljy / Olie / Olej / Olaj / Olej / Olej / Yağ / Май)

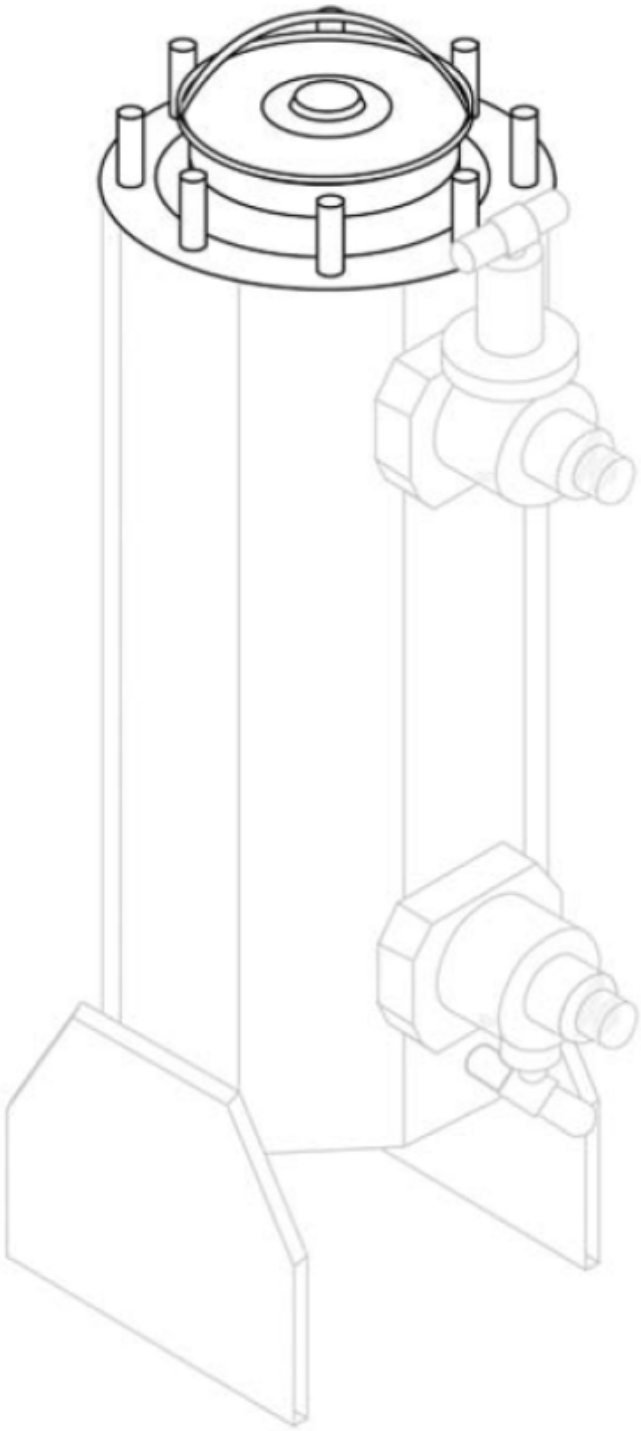
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(Magnet / Aimant / Calamita / Ímã / Imán / Магнит / Magneet / 磁石 / 磁铁 / Magnet / Magnet / Magneetti / Magnet / Magnes / Mágnes / Magnet / Magnet / Mıknatıs / Магнит)

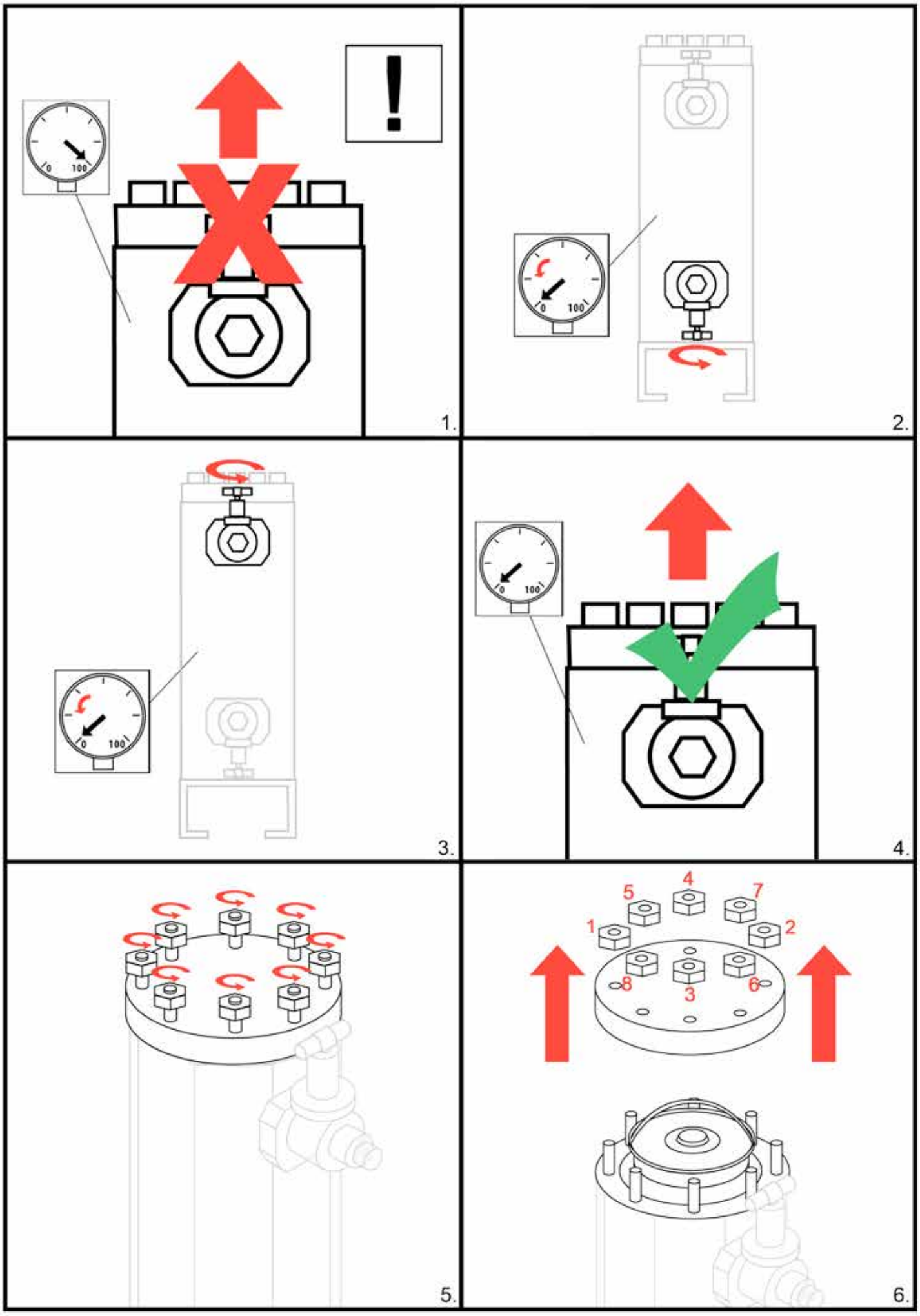
Torque
(Drehmoment / Torque / Della Coppia / Torque / Esfuerzo de Torsión / Крутящий момент / Draaimoment / トルク / 转矩 / Dreiemoment / Vridmoment / Vääntömomentti / Drejemoment / Moment skręcający / Nyomaték / Krouticí moment / Krútiaci moment / Bükme Momenti / Айналдыру моменті)

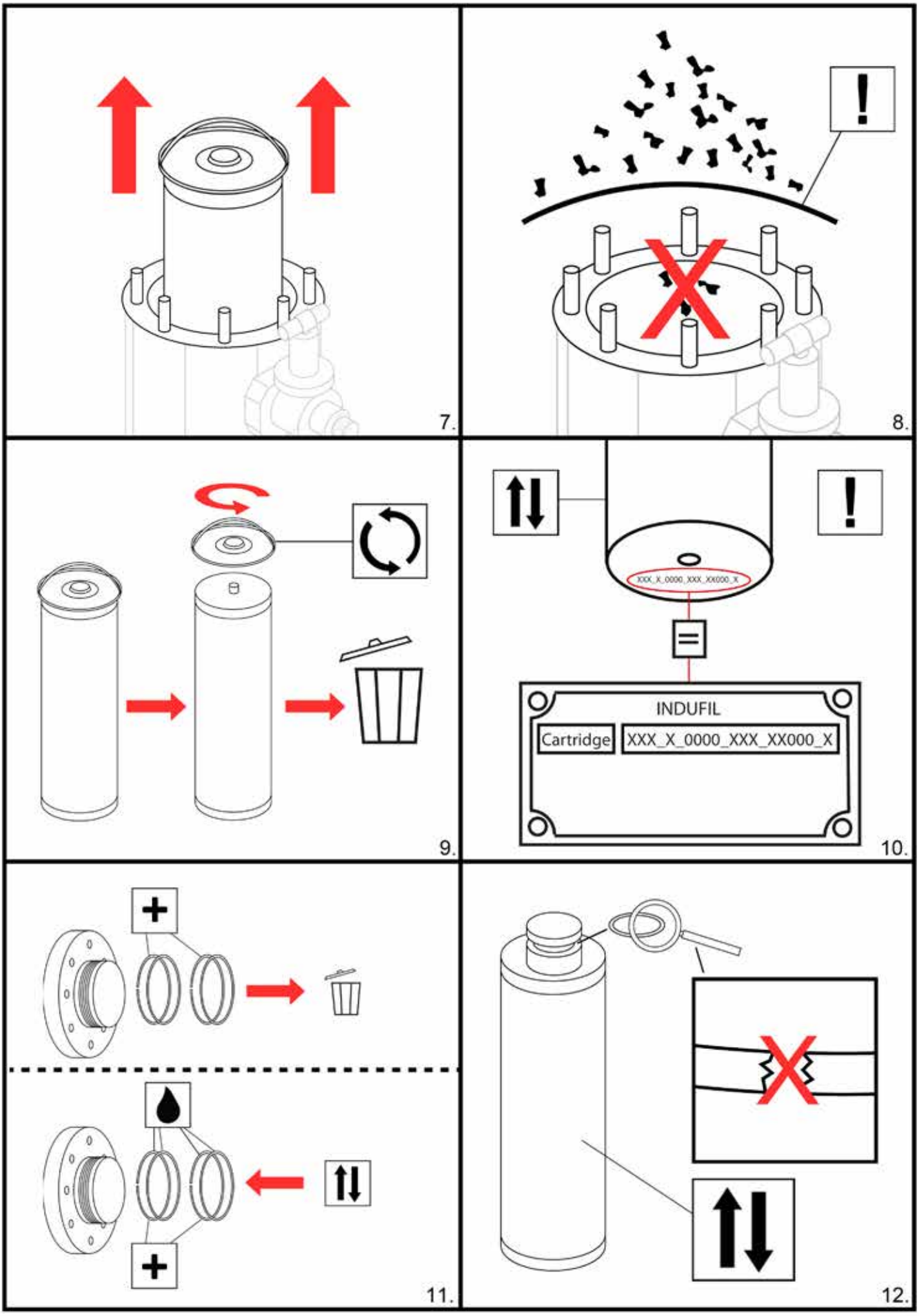
Single Filter

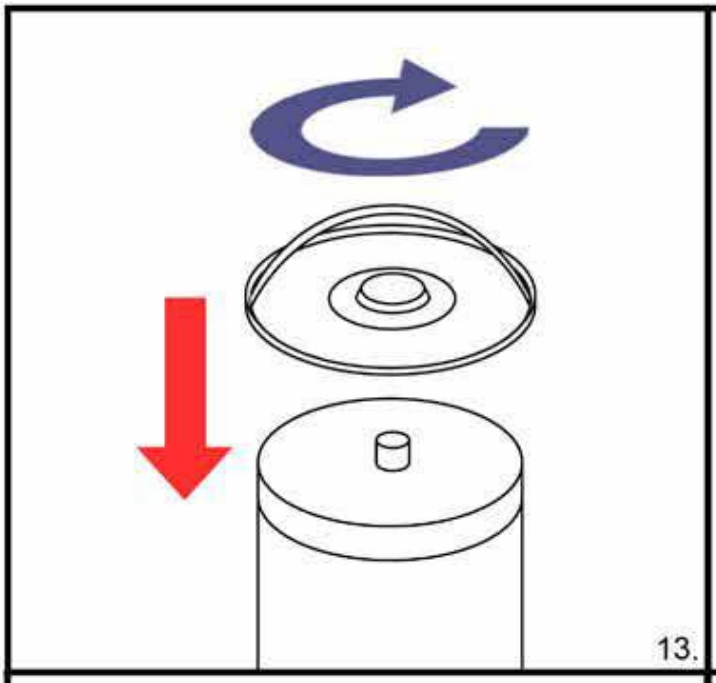


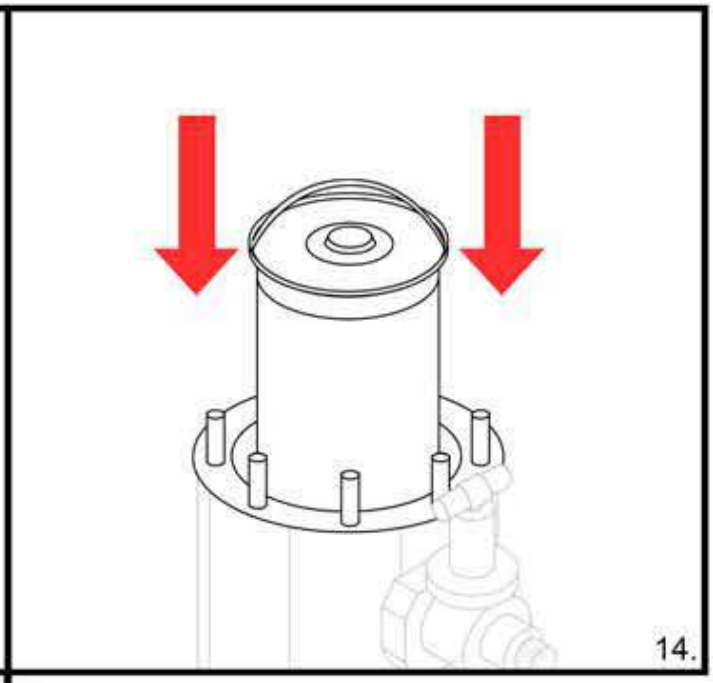
Filter Element Replacement

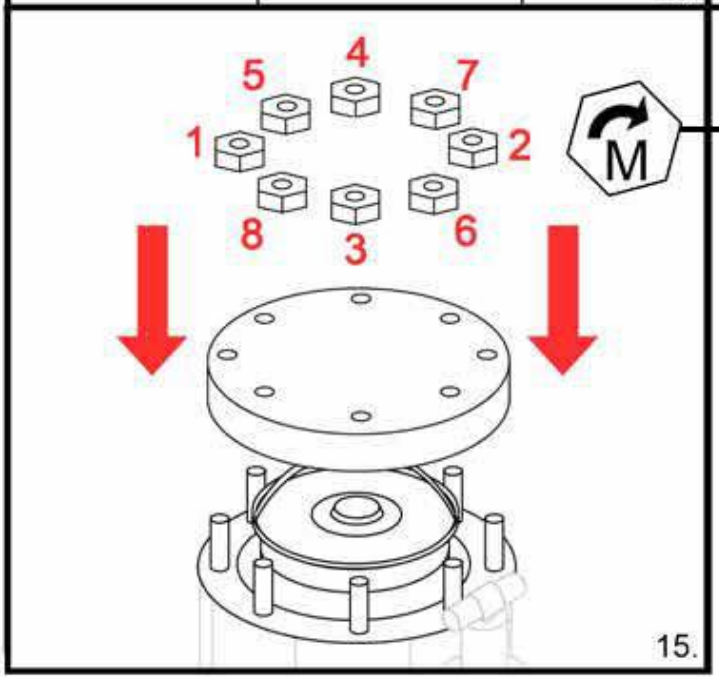



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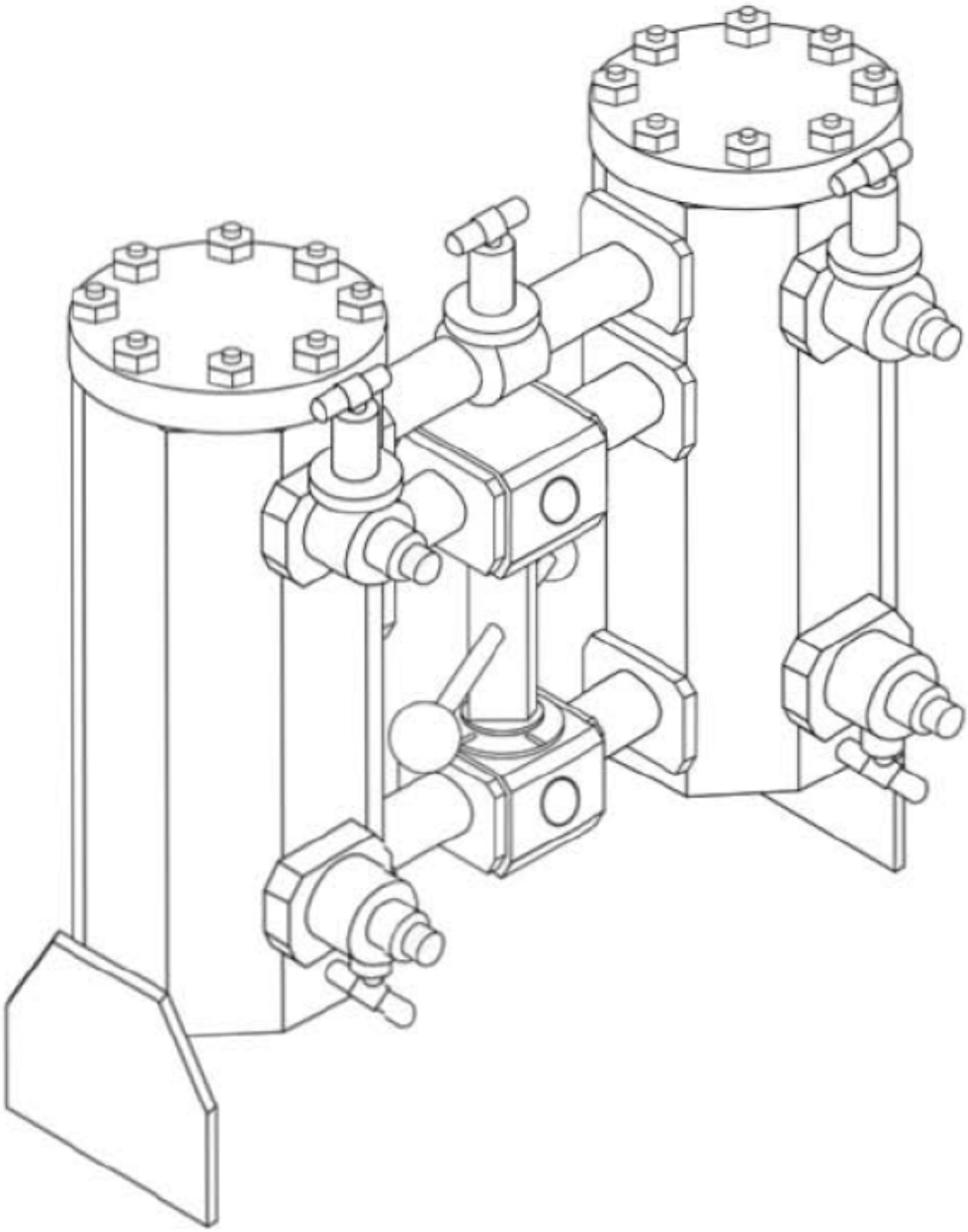






Size	Torque
M12 (½"/13 UNC)	72 Nm
M16 (⅝"/11 UNC)	179 Nm
M20 (¾"/10 UNC)	347 Nm
M24 (1" / 8 UNC)	495 Nm

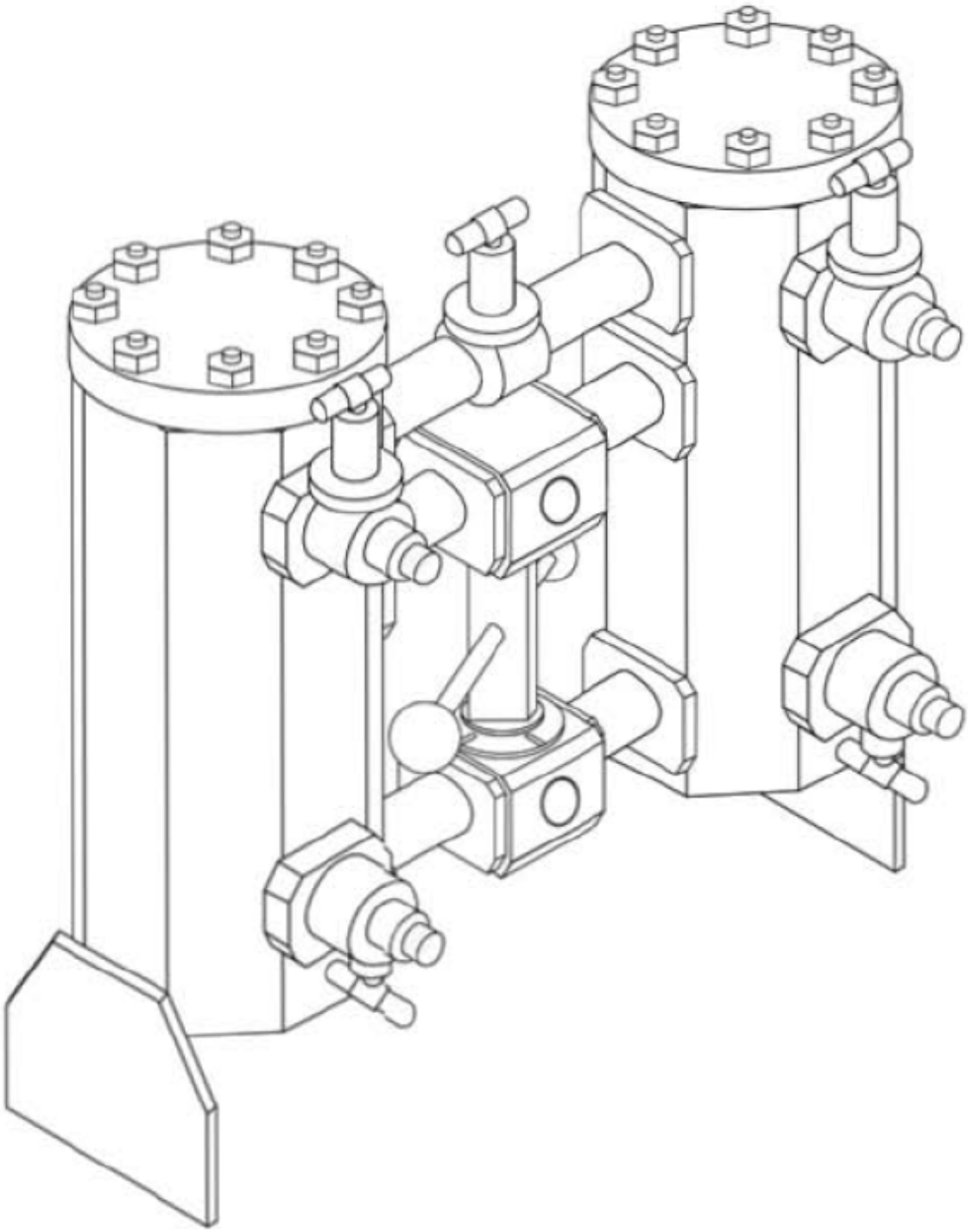
Duplex Filter

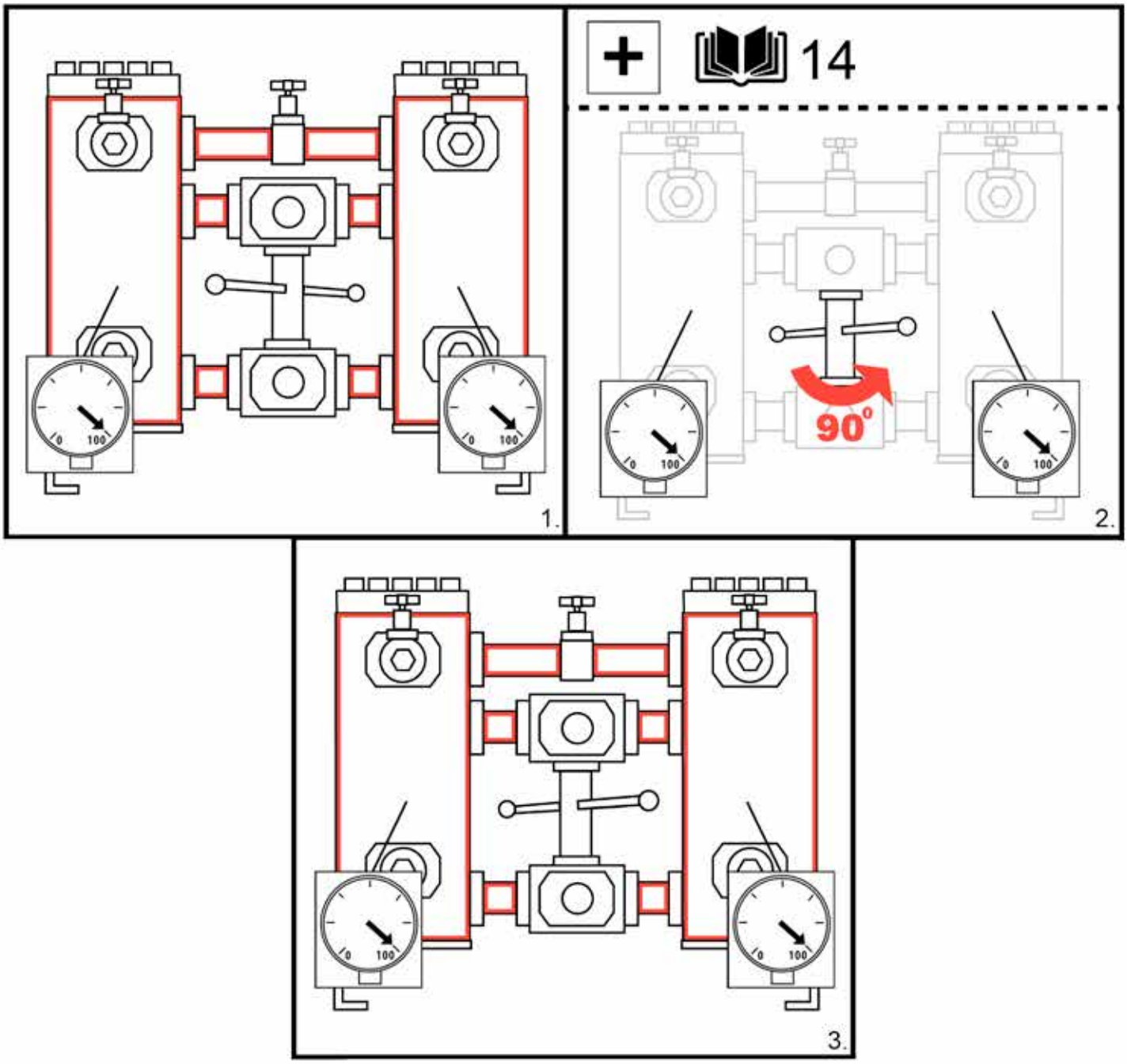


smiths
bringing technology to life

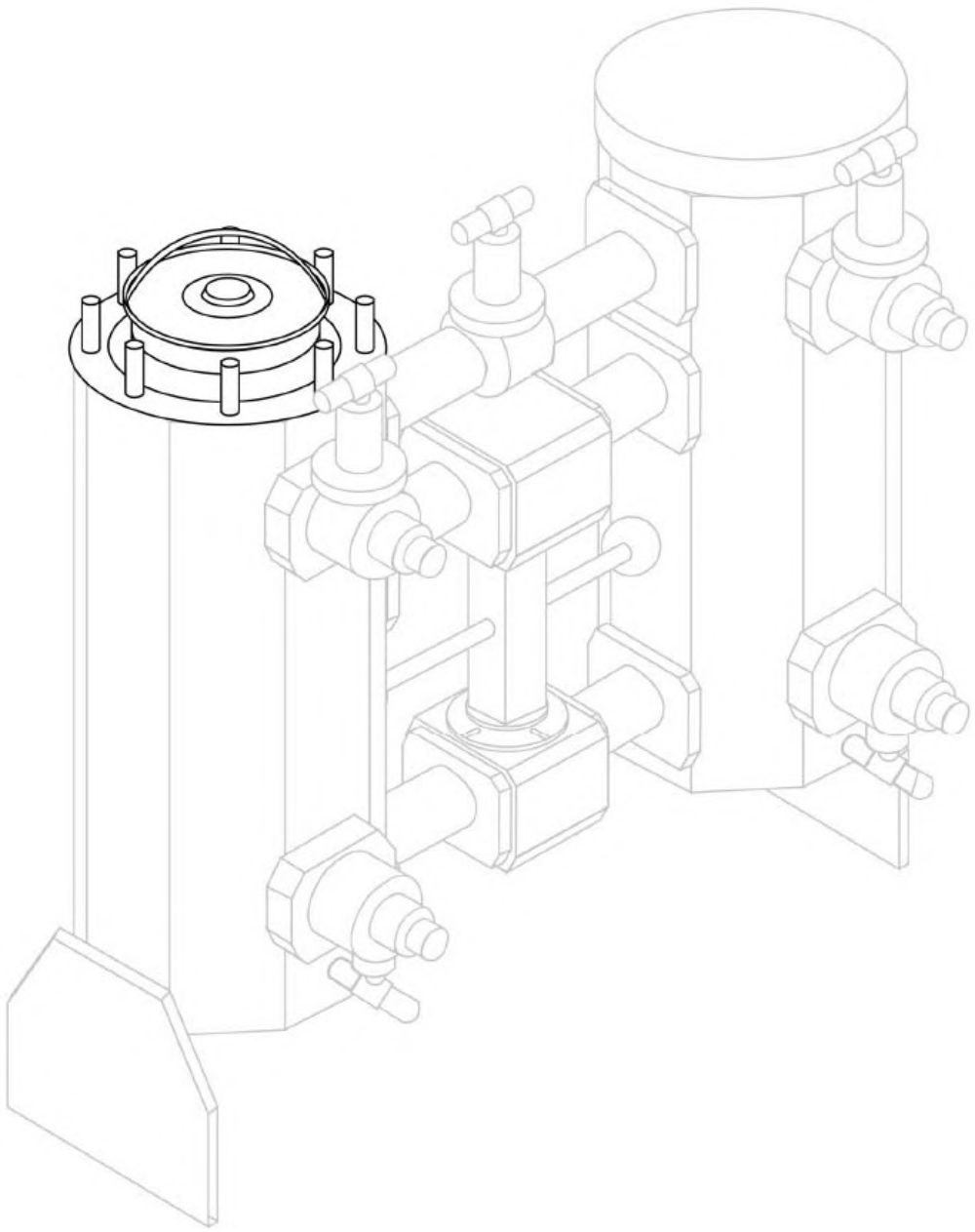
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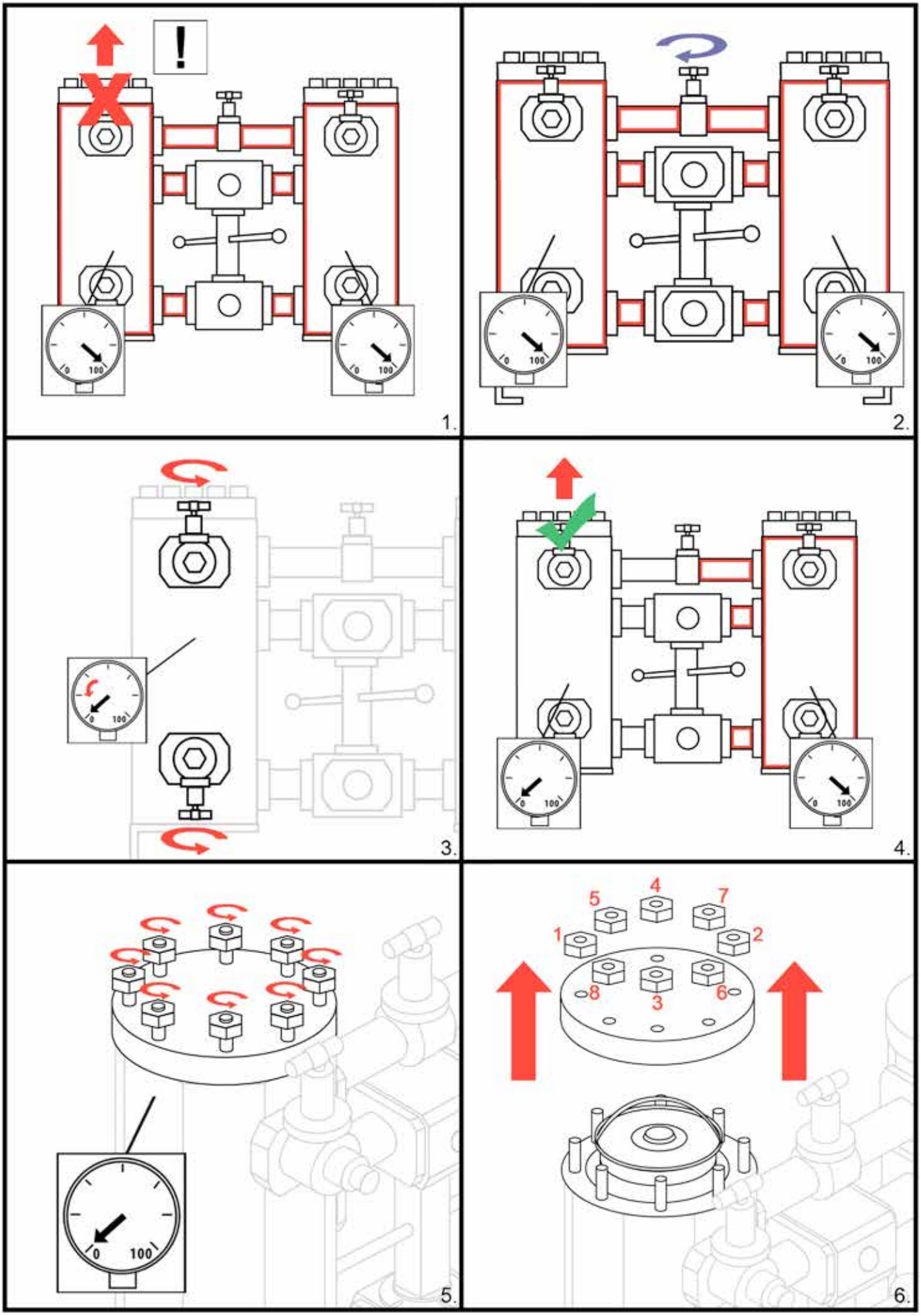
Changing over Duplex Filters

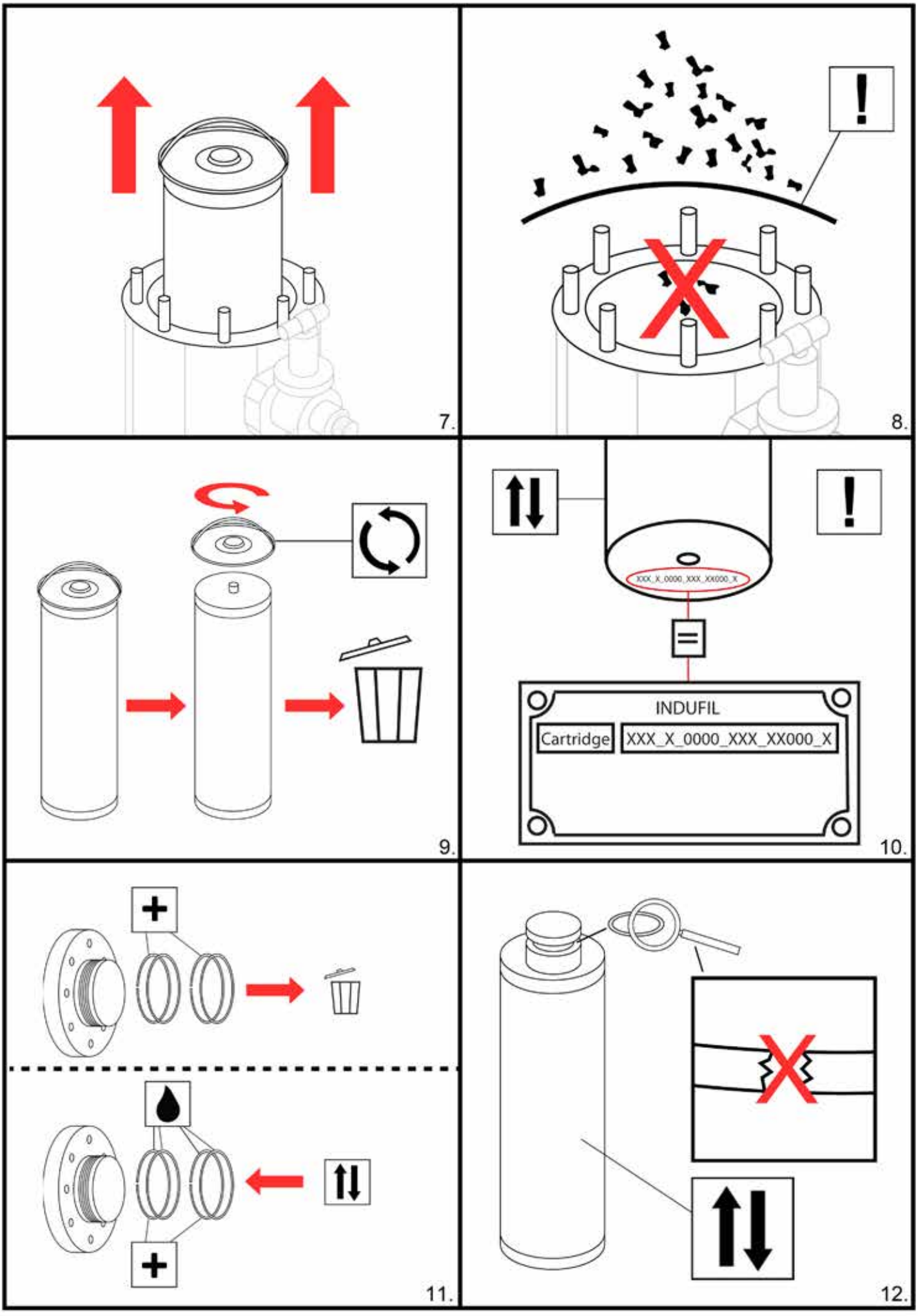


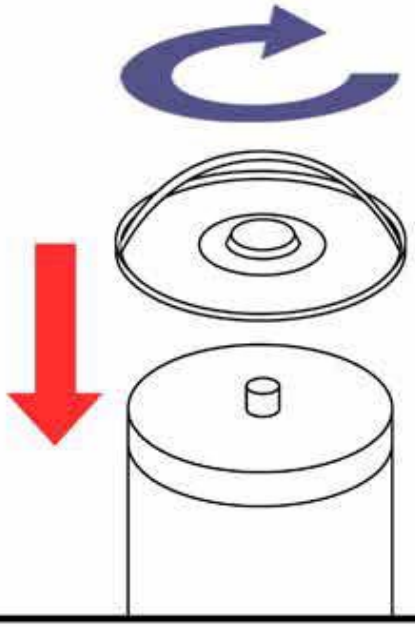

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Filter Element Replacement

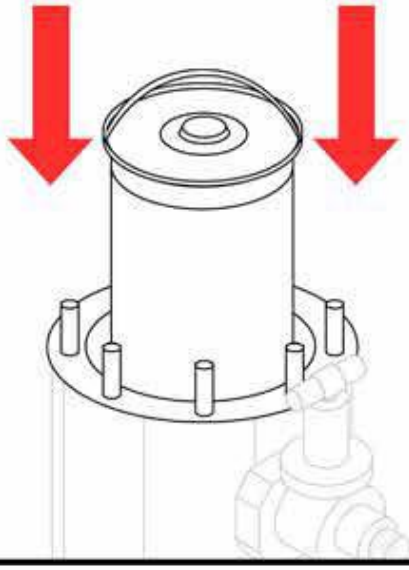



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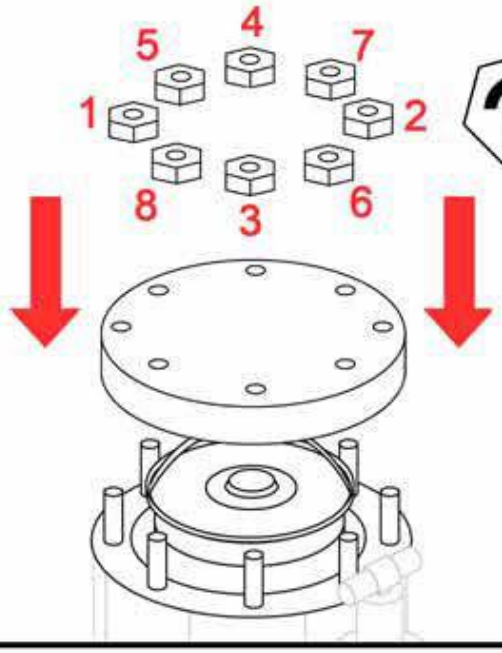

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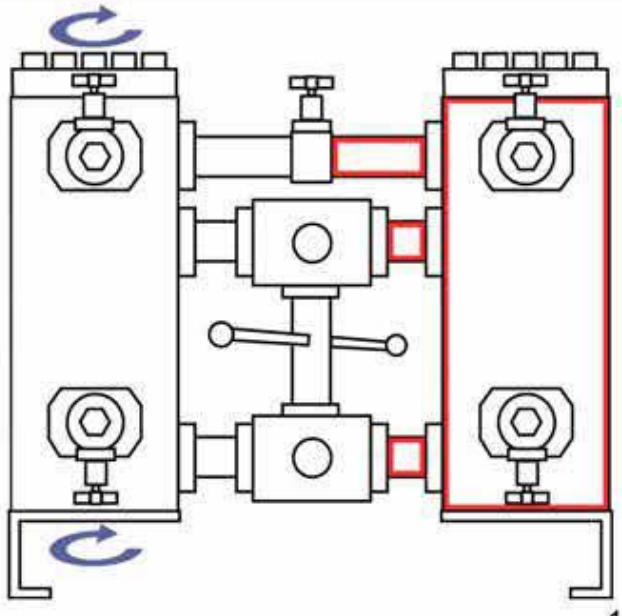


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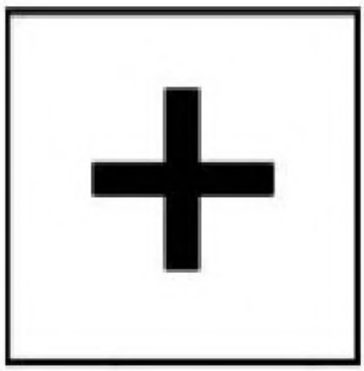


15.

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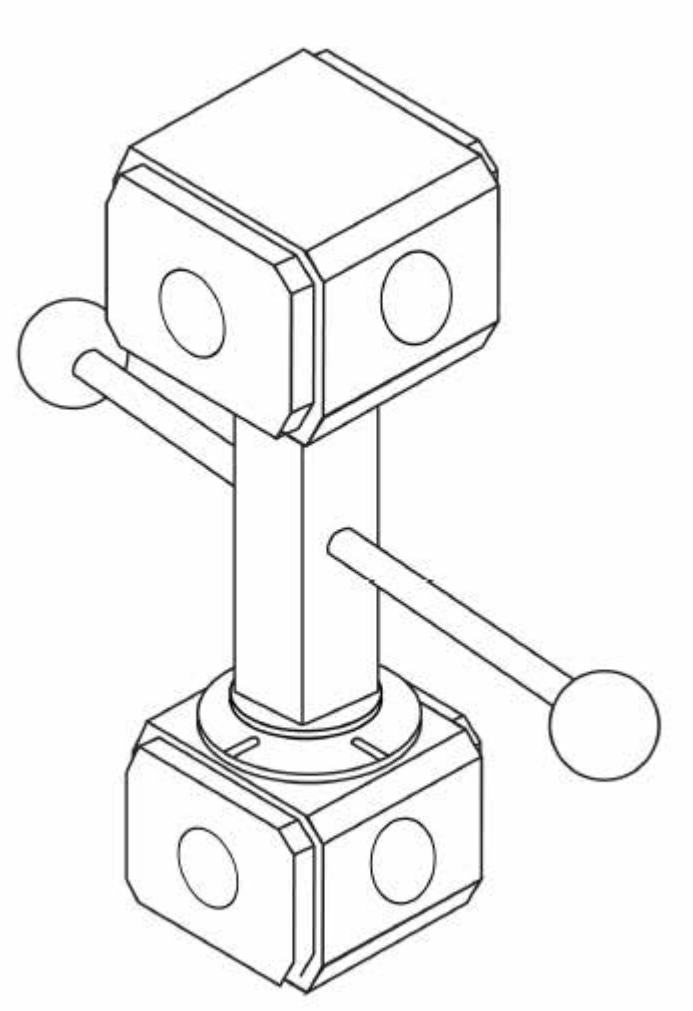


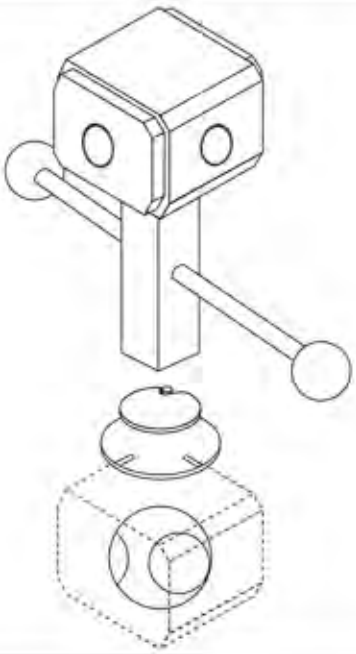
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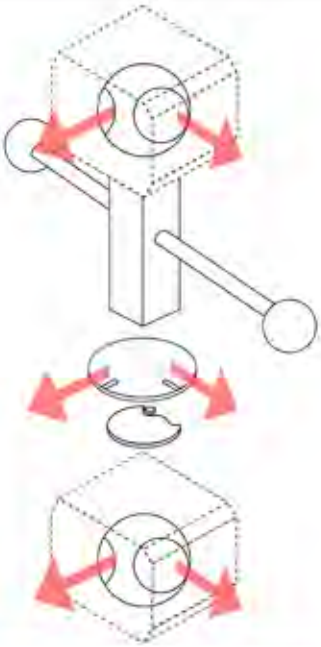
Options

Ball valve

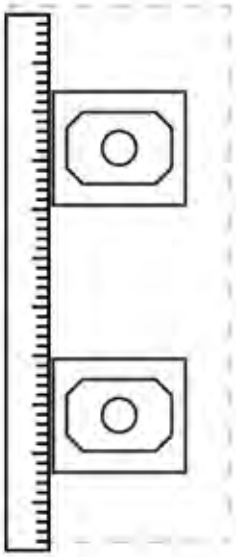




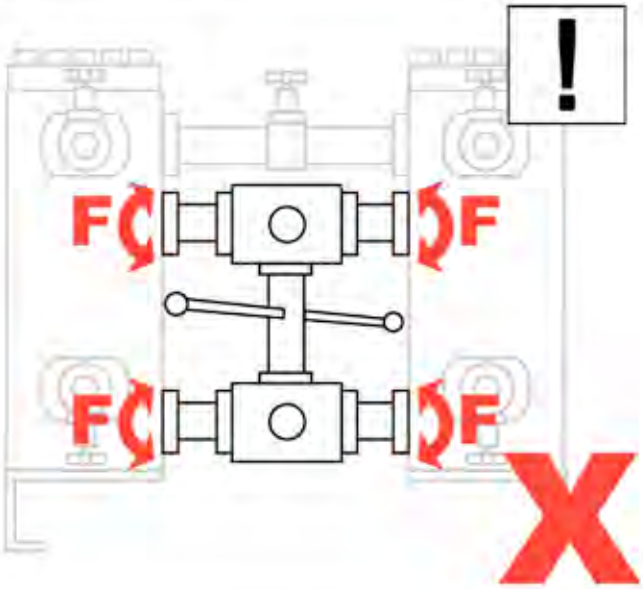
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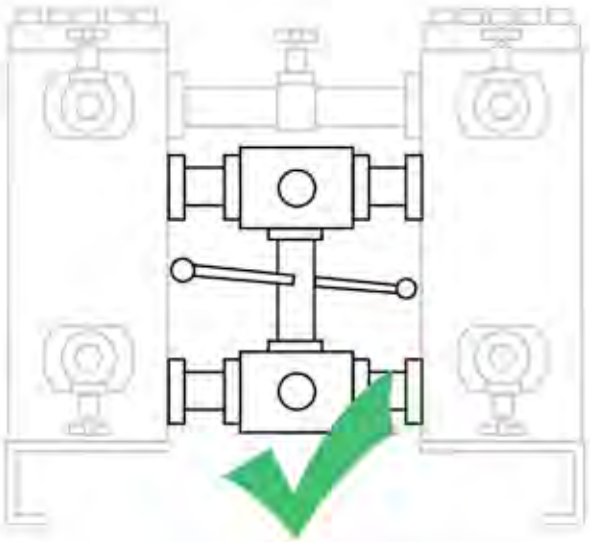
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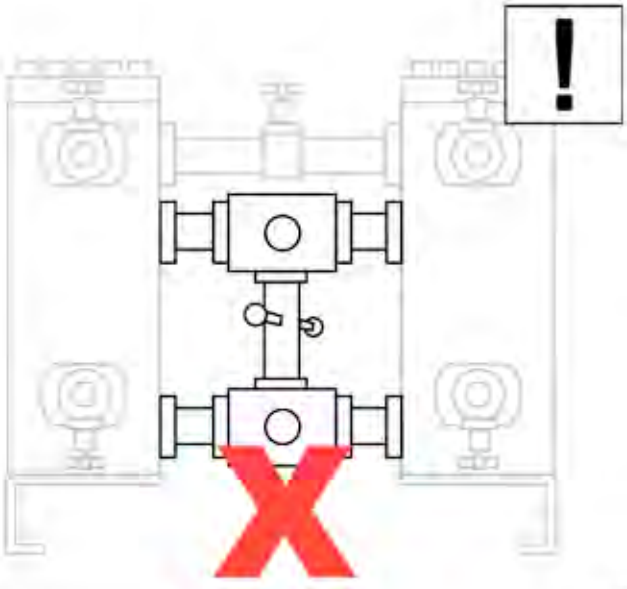
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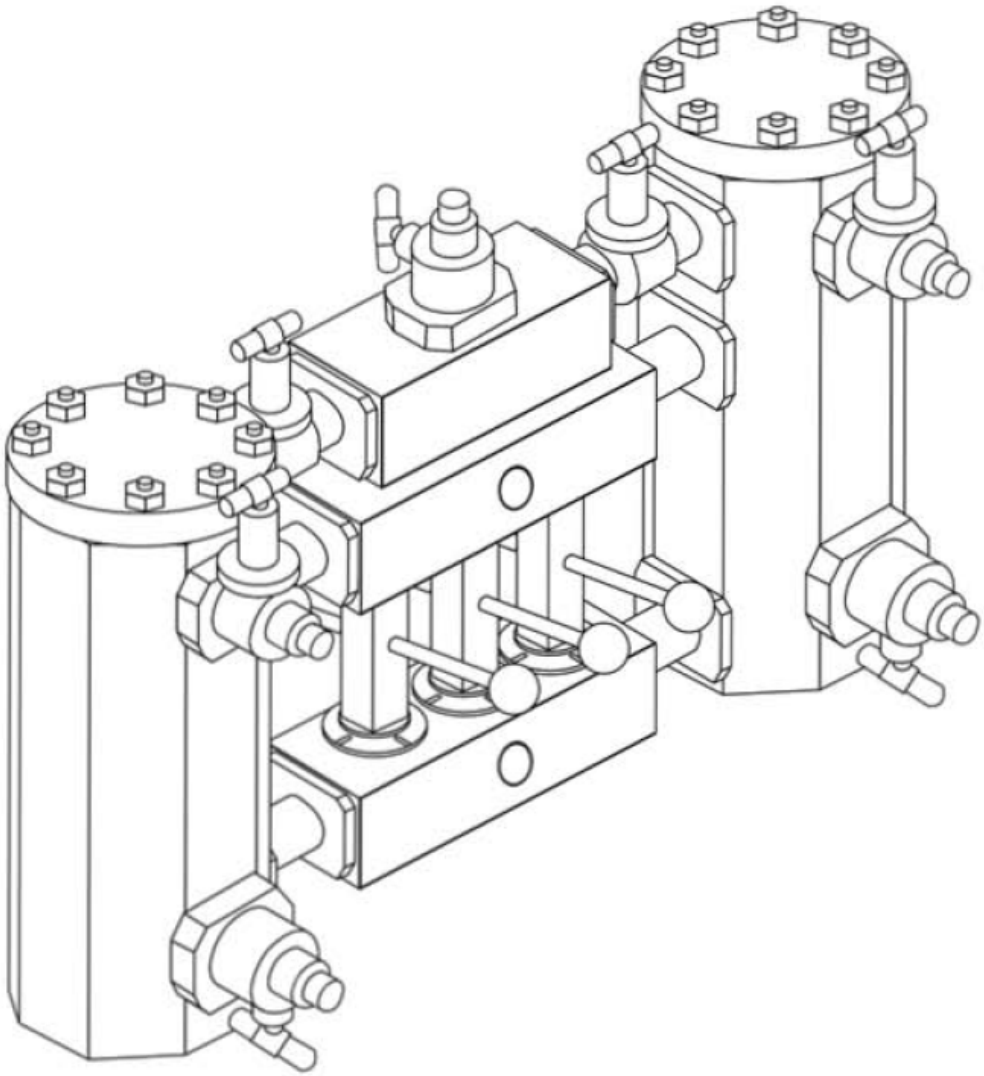


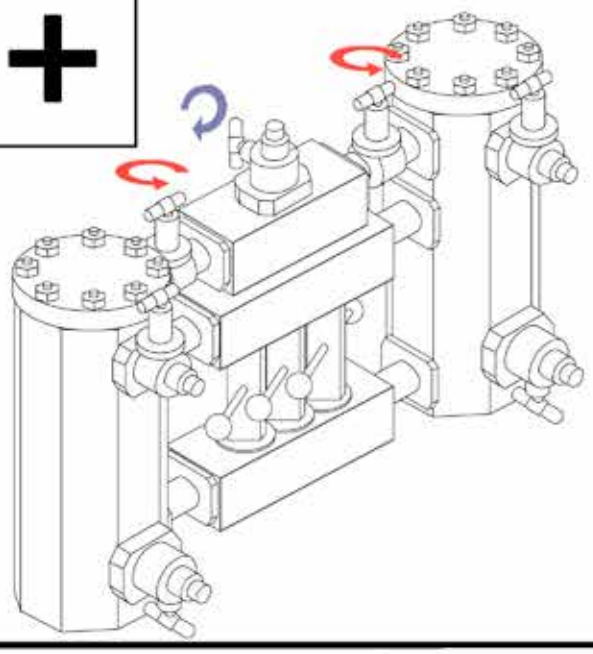
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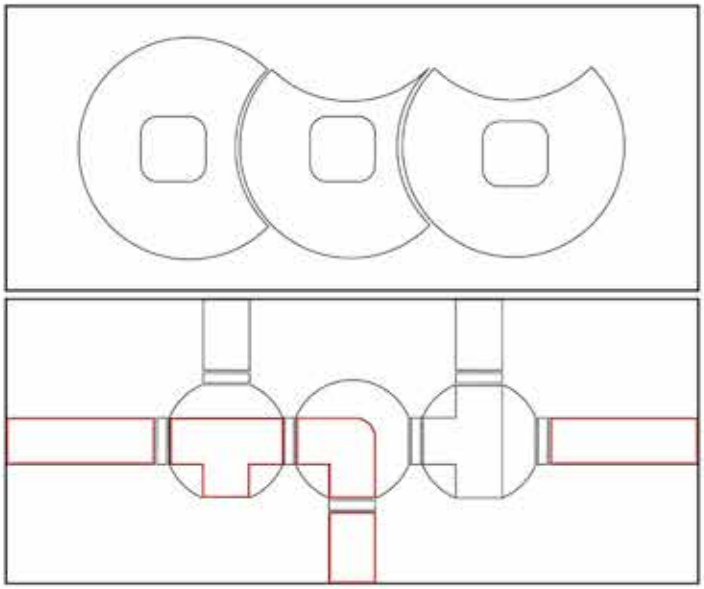


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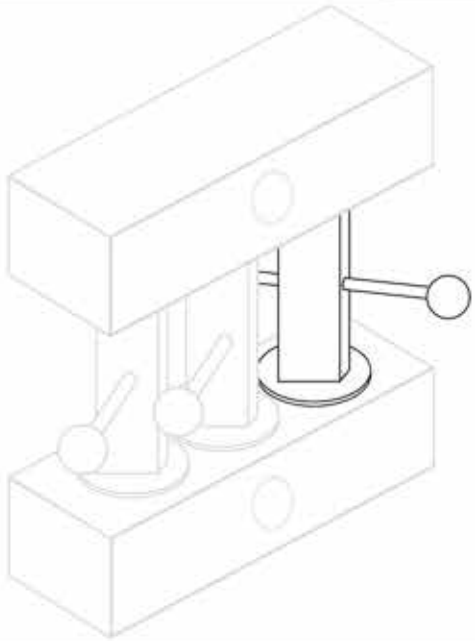
Double Block and Bleed

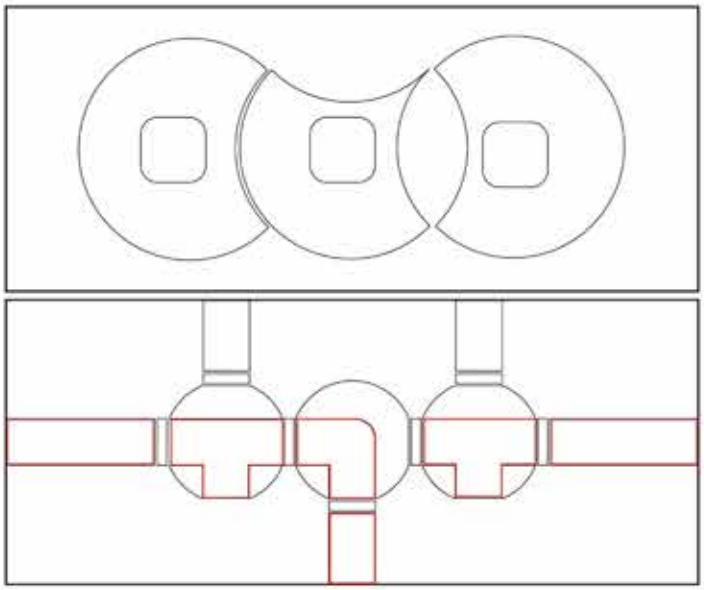




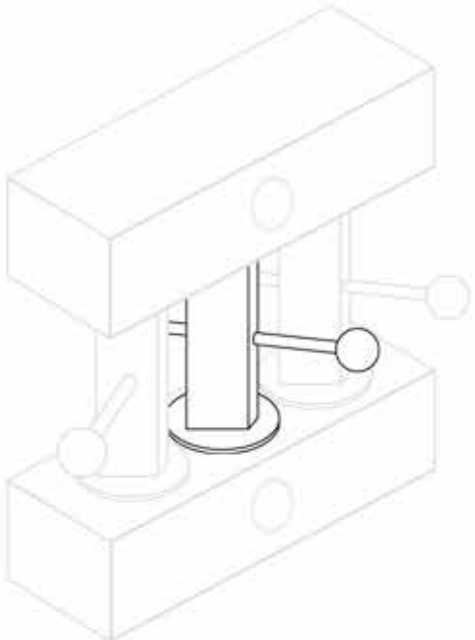


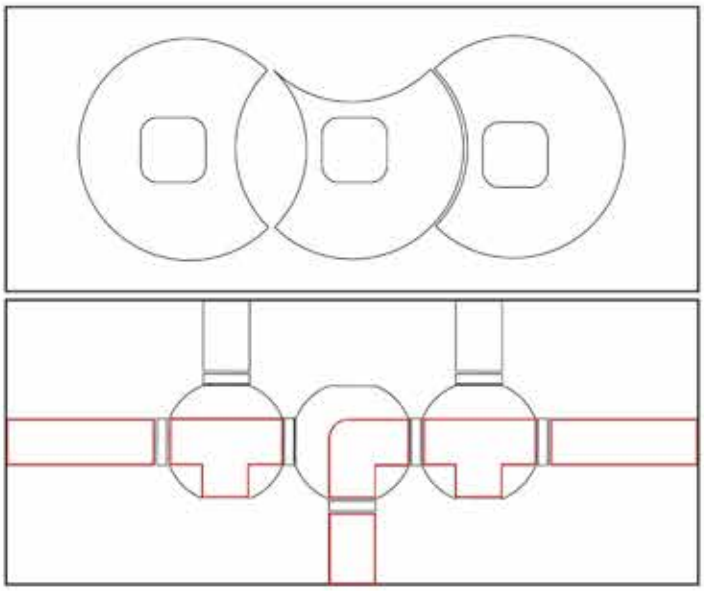
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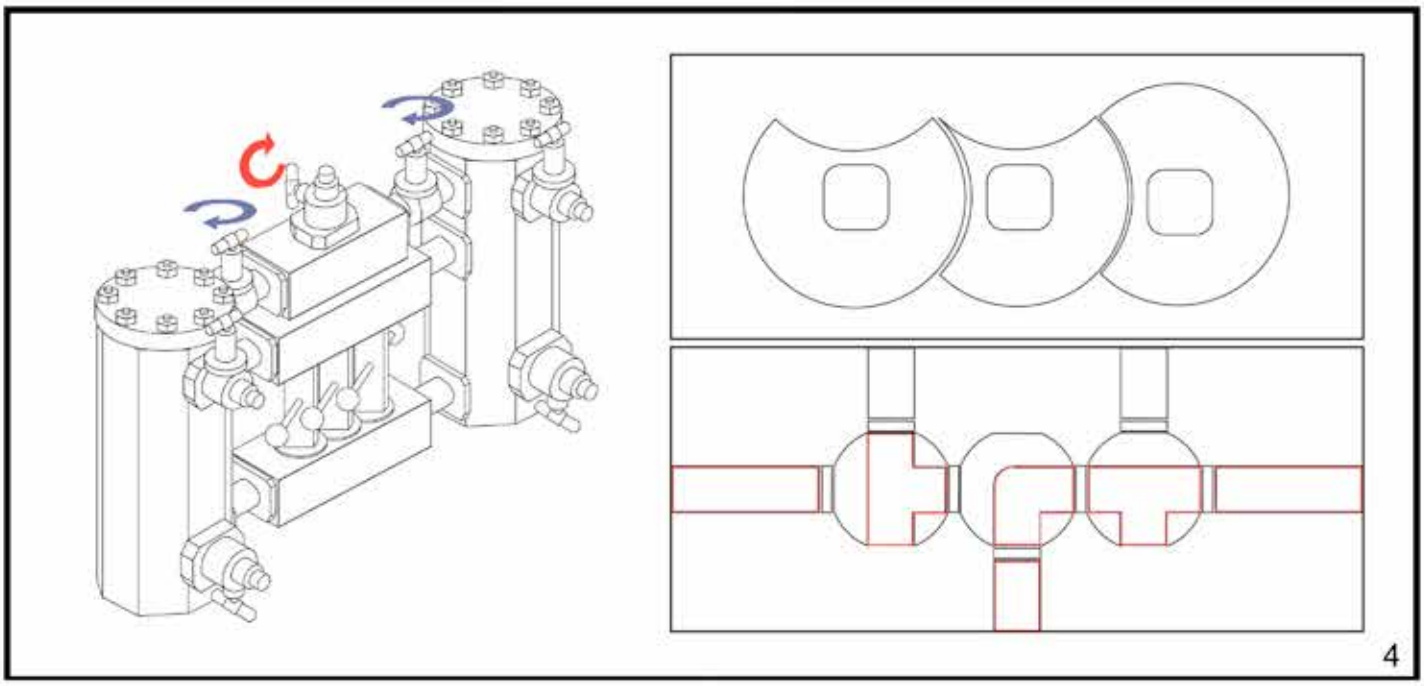


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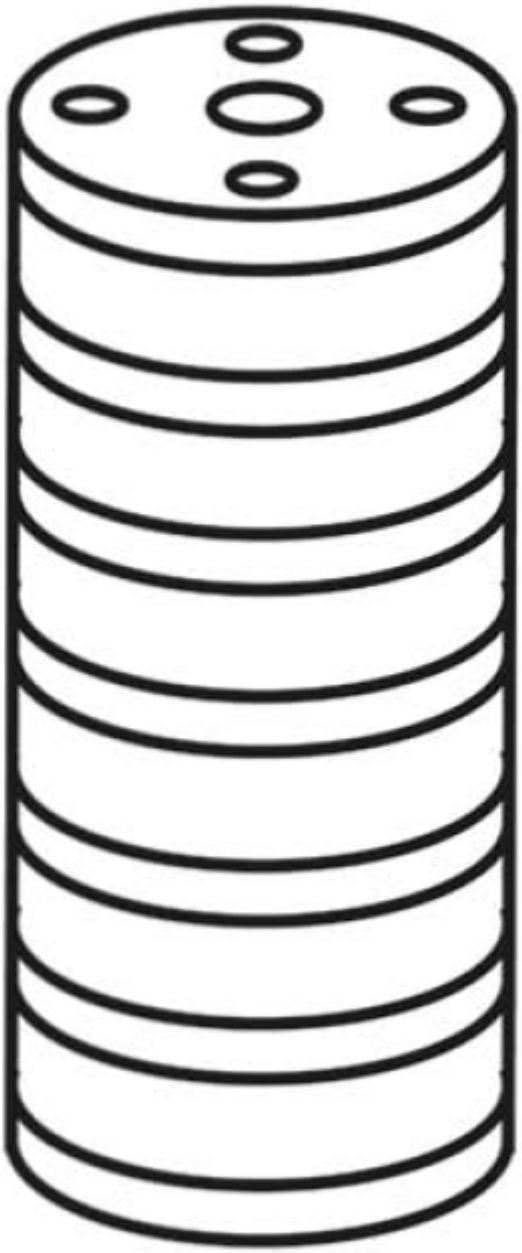


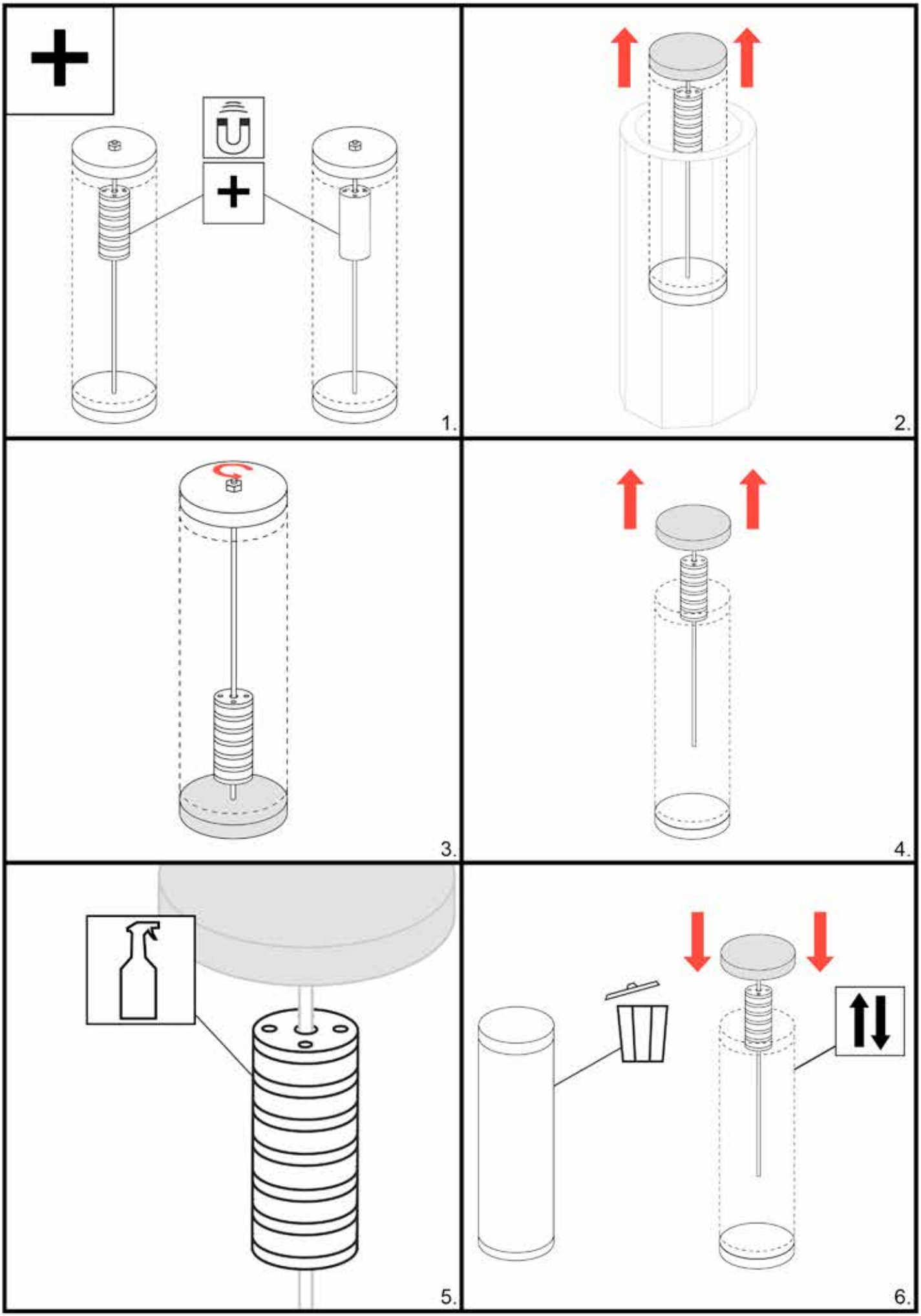
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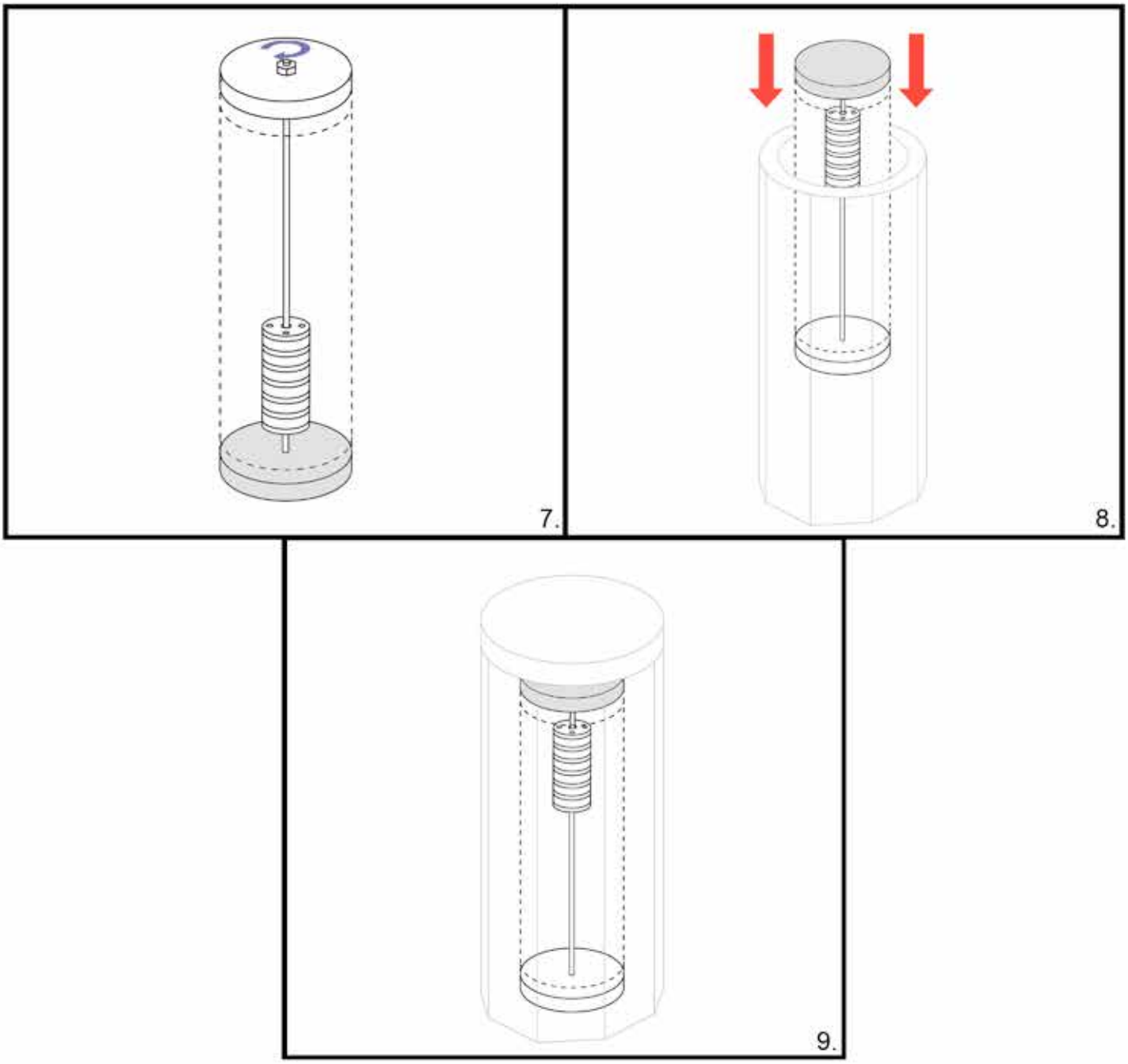


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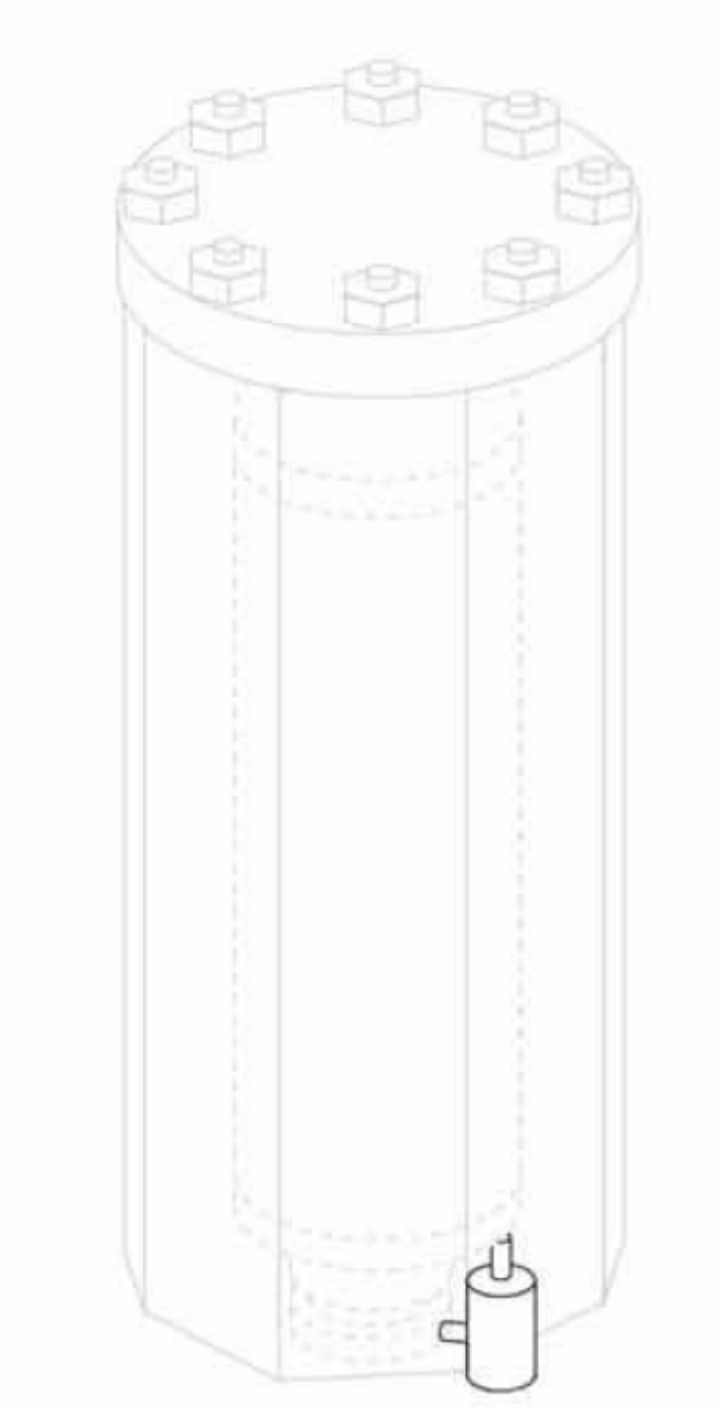
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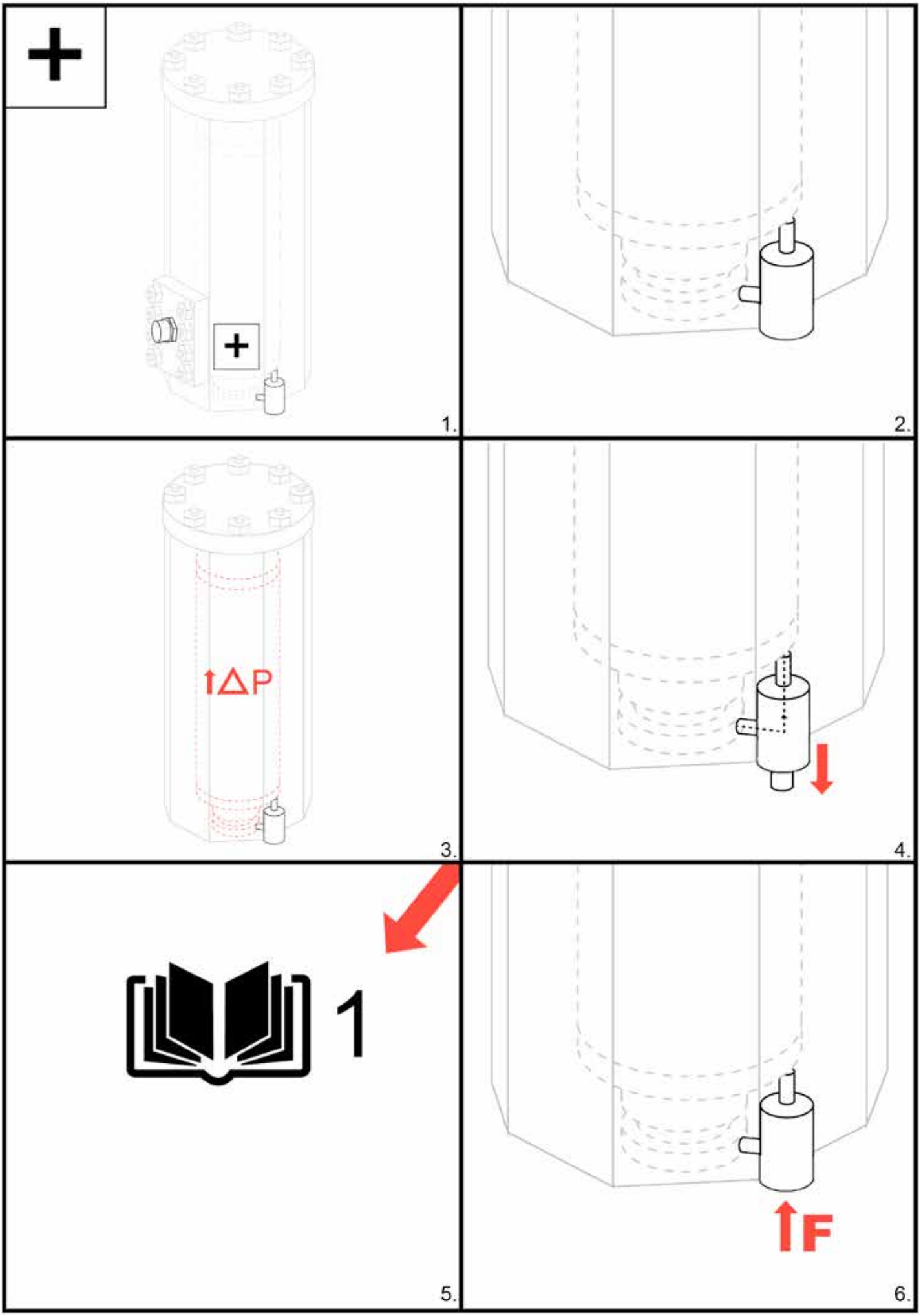



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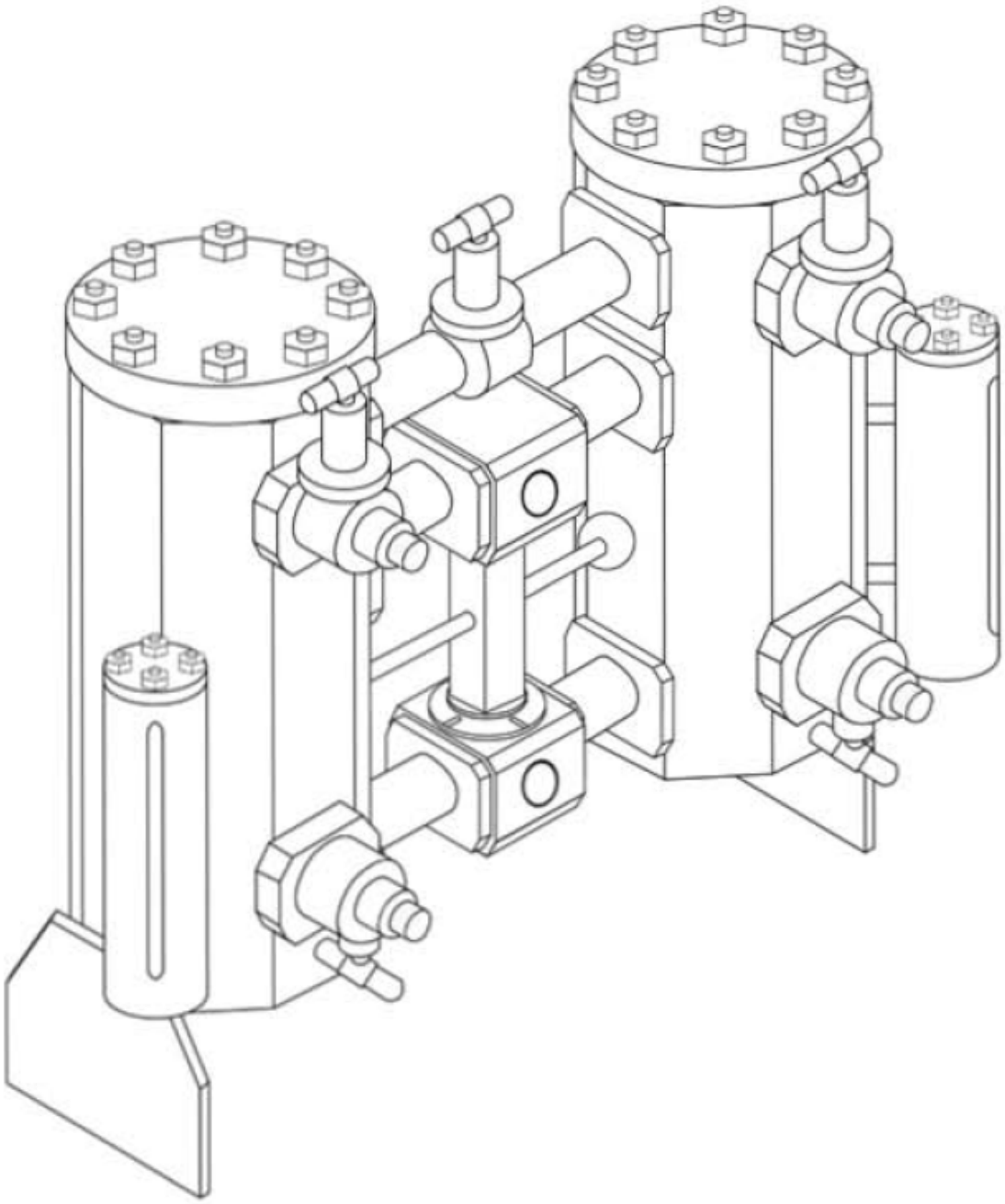

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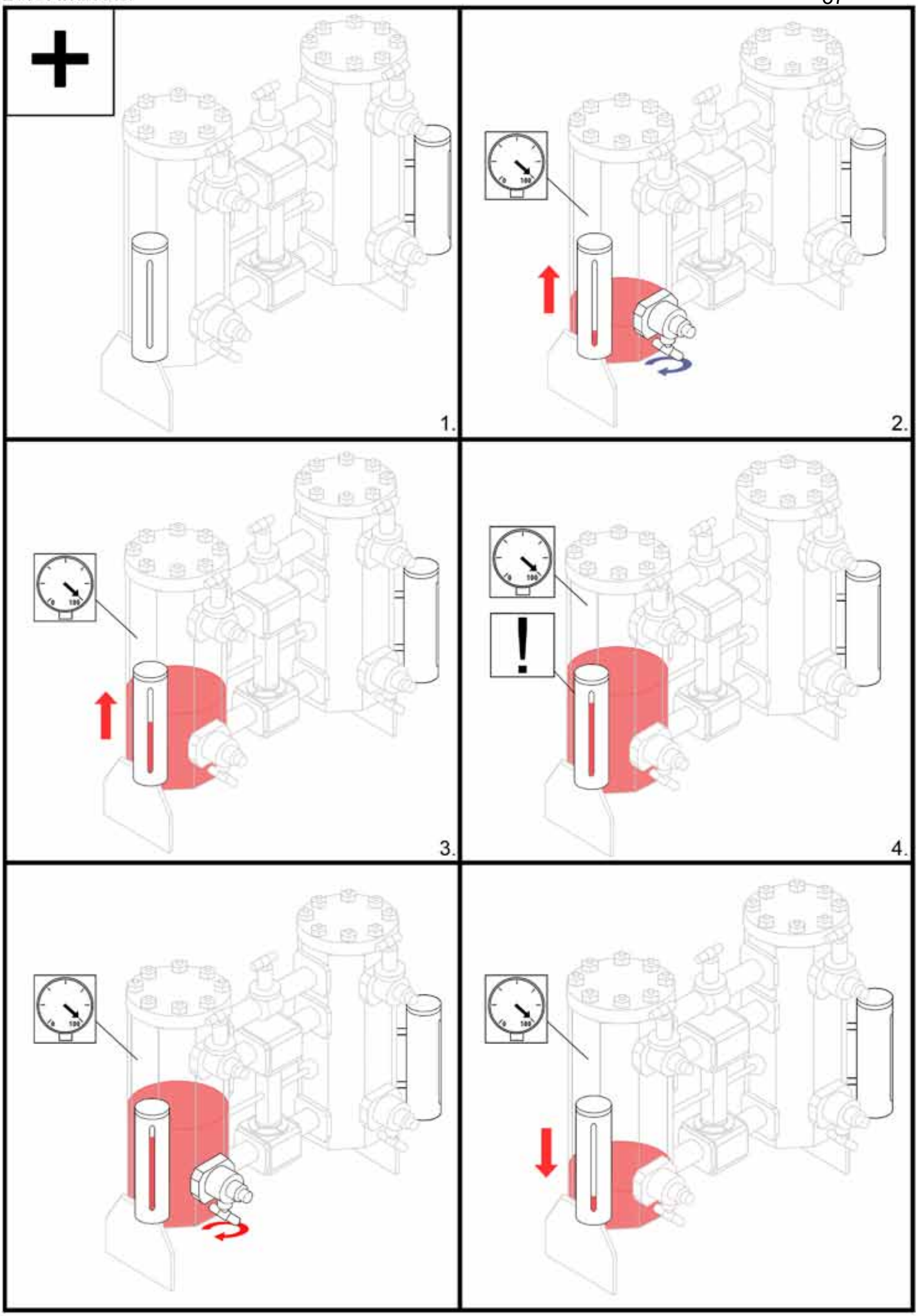
Pop-up Indicator




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↑ΔP
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↑F
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Level Indicator




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4.

DESIGN CALCULATIONS

Project details

Indufil order number	4000852866-30.1
Serial number	4000852866-30.1
Subject	ISSH 1-00085 1"ANSI-600lbs.RF
Filter housing number	046.05.662.01-A / -TC
Design code	ASME VIII div.1 Ed. 2015
Client reference	

Design and test conditions for mechanical calculation			
Design pressure / MAWP	82.7 bar(g)	/	1200 psi(g)
Test pressure	124.1 bar(g)	/	1800 psi(g)
Min. design temp. / MDMT	-28.9 °C	/	-20 °F
Max. design temperature	93.3 °C	/	200 °F
Corrosion allowance	0.00 mm	/	0.00 inch

PED 97/23/EC	No
API 614	Yes

Hydrostatic test pressure

According UG-99: Tp = 1.3*S(20°)/S(t-design)*design pressure = 107.6 bar(g)

According API 614: Tp = 1.5*S(20°)/S(t-design)*design pressure = 124.1 bar(g)

Note: With respect to the specific service of this filter, all loads have been considered (acc. UG-22).
Applicable: internal pressure only.

Conversion Table: According GG-3
1 bar(g) = 14.50377 psi(g)
82.7 bar(g) = 1200 psi(g)
124.1 bar(g) = 1800 psi(g)
Full Vacuum design condition = -14.5 psi(g) @ -28.8888888888889 °C / 93.3333333333333 °C

Indufil BV the Netherlands
Hydrograaf 25
6921 RS Duiven
E-mail: doccontrol@indufil.com

Revision:	0	by :		Initial calculation for approval.	
Drawn :	LKU	Date :	19.10.16	Document number:	4000852866-30.ASME

This calculation is in accordance with, and verified against ASME VIII div 1 ed. 2015 by BWe / SLo. rev: 20 - 23/03/2016.

DESIGN STRESS VALUES

Shell material

	Temperature	Stress value	Material
Material stress at	20 °C =	138.0 MPa	SA182 / SA479 S31600/S31603 (dual certified)
Material stress at	93.3 °C =	138.0 MPa	UHA-23 Sect. II part D. Table 1A

Cover material

	Temperature	Stress value	Material
Material stress at	20 °C =	138.0 MPa	SA182 / SA479 S31600/S31603 (dual certified)
Material stress at	93.3 °C =	138.0 MPa	UHA-23 Sect. II part D. Table 1A

Bolting material

	Temperature	Stress value	Material
Material stress at	20 °C =	152.0 MPa	SA193 Grade B8M Cl.2/SA194 Grade 8M (t<=19)
Material stress at	93.3 °C =	152.0 MPa	UCS-23 Sect. II part D. Table 3

CYLINDRICAL SHELL

According UG-27; shell thickness

tr = ri x P / (S x E - 0.6 x P)

Design pressure	P	8.27	MPa		
Material stress value at t-design	S	138.00	MPa		
Corrosion allowance	c1	0.00	mm	0.00	inch
Mill or dimensional tolerance	c2	0.25	mm		
Internal nominal diameter	Di	62.50	mm	2.46	inch
Nominal wall thickness	tnom	13.30	mm	0.52	inch
Factor (Joint Efficiency)	E	1.00			
		design:			
Internal radius ri = Di/2 +c1 + c2		31.50	mm		
Required wall thickness	tr	1.96	mm		
Total required wall thickness = tr + c1 + c2 =		2.21	mm		
Total required wall thickness due to test pressure		2.52	mm	**O.k.**	

According UG 16(b); Wall thickness not less than:

1.5 + c1 + c2		1.75	mm

According UG-36; Openings in pressure vessels

Nominal diameter opening	dnom	25.00	mm
Nozzle thickness	tn	0.00	mm
Factor	F	1.00	
Factor	E1	1.00	
		design:	
Diameter opening d = dnom + 2 * (c1 + c2)		25.50	mm
Required reinforcement area A = d * tr			mm^2
Available wallthickness t = tnom - c1 - c2			mm
Available reinforcement area is the larger of: Fig UG-37.1			
A.1.1. = (E1 * t - F * tr) * d			mm^2
A.1.2. = (E1* t - F * tr) * (t + tn) * 2			mm^2
Available area	A1		mm^2
Available area due to test pressure	A1		mm^2

Openings in vessels not subject to rapid fluctuations in pressure do not require reinforcement other than that inherent in the construction under the condition that the hole cut in the shell is not greater than 60 mm for these studded connections according UG-36

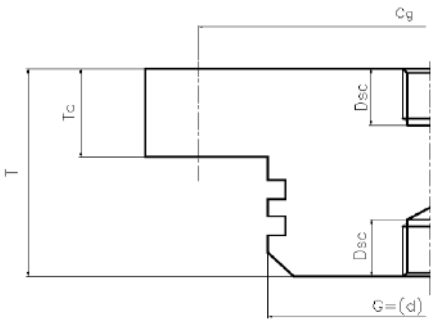
Revision:	0	by :		Initial calculation for approval.	
Drawn :	LKU	Date :	19.10.2016	Document number:	4000852866-30.ASME

This calculation is in accordance with, and verified against ASME VIII div 1 ed. 2015 by BWe / SLo. rev: 20 - 23/03/2016.

TOP COVER

According UG-34(k); For operating conditions

Design pressure	P	8.27	MPa	
Gasket load diameter	G (= d)	58.05	mm	
Bolt circle diameter	Cg	80.00	mm	
Top cover bolt size		5/8 - 11 UNC		
Bolt core diameter	dc	13.13	mm	Acc. ANSI B1.1 / ISO 724
Number of bolts	n	4		
Nominal cover thickness	tnom	40.00	mm	1.57 inch
Nominal edge thickness	tcnom	20.00	mm	
Drill depth studded connection	Dsc	25.00	mm	
Factor (Joint Efficiency)	E	1.00		
Bolting factor	C	0.30		
Corrosion allowance	c1	0.00		
Fabrication tolerance	c2	0.25		
Stress value cover for T-design	Sfo	138.00	MPa	
Stress value cover for T-ambient	Sfa	138.00	MPa	
Stress value bolting for T-design	Sb	152.00	MPa	
Stress value bolting for T-ambient	Sa	152.00	MPa	



Bolting **According UG-34 / Mandatory Appendix 2-5**

		design:		
Am = greater of Wm2/Sa or Wm1/Sb				
Wm2 = 3.14 * b * G * y		0.00	N	
H = 0.785 * G^2 * P		21886.41	N	
Hp = 6.28 *b * G * m * P		0.00	N	
W=Wm1 = H + Hp		21886.41	N	
Wm2/Sa		0.00	mm^2	
Wm1/Sb		143.99	mm^2	
h_G = 0.5 * (Cg - G)		10.98	mm	
Available bolting area	Ab	541.33	mm^2	
Required bolting area	Am	143.99	mm^2	
Required bolt. area due to test press.	Am	166.14	mm^2	**O.k.**

Cover thickness **According UG-34 / UG-43**

trc = d * sqrt([C * P / (S_{fo} * E)] + [1.9 * W * h_G / (S_{fo} * E * d^3)])

Required cover thickness	trc	10.84	mm	
Total required cover thickness = trc +c1 +c2		11.09	mm	
Total required cover thickn. due to test press.		11.90	mm	**O.k.**
Available wall thickness @ studded conn.		15	mm	
Required wall thickness @ studded conn.		2.96	mm	**O.k.**

Cover edge thickness

tre = G * sqrt(1.9 * W * h_G/(S_{fo} * G^3))

Required edge thickness	tre	7.55	mm	
Total required edge thickness = tre + c1 + c2		7.80	mm	
Total required edge thickn. due to test press.		8.36	mm	**O.k.**

Revision:	0	by :		Initial calculation for approval.	
Drawn :	LKU	Date :	19.10.2016	Document number:	4000852866-30.ASME

This calculation is in accordance with, and verified against ASME VIII div 1 ed. 2015 by BWe / SLo. rev: 20 - 23/03/2016.

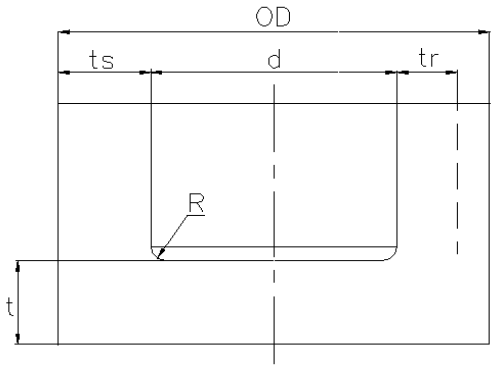
FLAT HEAD

According UG-34(B-2)

trh = d * sqrt(C * P / (S * E))

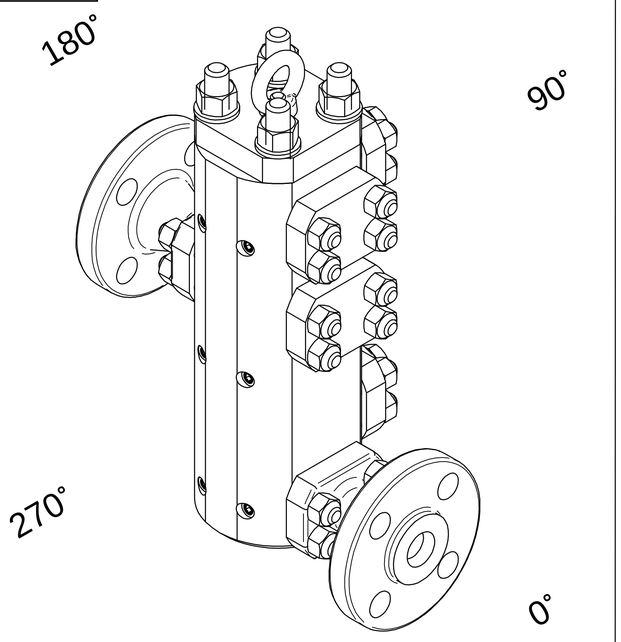
Nominal diameter	dnom	63.00	mm	
Nominal head thickness	t	17.50	mm	0.69 inch
Factor	E	1.00		
Nominal shell thickness	ts	13.30	mm	
		design:		
Required shell thickness	tr	1.96	mm	
corrosion allowance	c1	0.00	mm	
Fabrication tolerance	c2	0.25	mm	
Design pressure	P	8.27	MPa	
Material stress value at T-design	S	138.00	MPa	

d = dnom + 2 * (c1 + c2)		63.50	mm
m = tr / ts		0.15	
C = 0.33 * m (but minimal 0.2)		0.20	
Required thickness	trh	6.95	mm
Total required thickness = trh + c1 + c2 =		7.20	mm
Total required thickness due to test pressure		7.72	mm **O.K.**
If ts <= 38.1 mm, then r =		10	mm



Revision:	0	by :		Initial calculation for approval.	
Drawn :	LKU	Date :	19.10.2016	Document number:	4000852866-30.ASME

This calculation is in accordance with, and verified against ASME VIII div 1 ed. 2015 by BWe / SLo. rev: 20 - 23/03/2016.



REV.	DATE	DRAWN	CHECKED	DESCRIPTION
B	01.11.16	LKU	RHO	ISO VIEW AND VENT DRAIN CHANGED

B

John Crane INDUFIL

Manufacturer	INDUFIL BV. The Netherlands		
Filter type	ISSH 1-00085		
Cartridge	INR-S-00085-BAS-GF3-ED		
Shop number	*		
Year built	**	Vol.	0.16 USG
Design code	ASME VIII DIV.1		
Design temperature	Min. -20 °F		
	Max. 200 °F		
Design pressure	-14.5 / 1200 psi(g)		
Test pressure	1800 psi(g)		
Corrosion allow.	0 "		
Empty weight	40 lb		
Inspection by	NB		
Tag No.	***		

*	**	***
4000852866-30.1	2016	F-201

NAMEPLATE POSITIONS

NAMEPLATE TYPE	ORIENTATION
NAMEPLATE INDUFIL B.V.	**0°**
NAMEPLATE U-STAMP	**90°**

PARTS LIST

DESCRIPTION	GPN
NAMEPLATE INDUFIL B.V.	**87472064 (Small)**
NAMEPLATE U-STAMP	**87472064 (Small)**

DOCUMENT REFERENCE

DOCUMENT TYPE	DOCUMENT NAME
FULL STRUCTURE REFERENCE	**GA-195476-1**
CALCULATION	**4000852866-30.ASME**
VQP	**4000852866-30.VQP**

INDUFIL ORDER NO.: **4000852866-30**	GPN: **89811362**

ORDER INFORMATION		**DESIGN CONDITIONS**	
CLIENT: **JOHN CRANE INC**		DESIGN CODE: **ASME VIII DIV.1**	ALT. DESIGN CODE:
P.O. NUMBER: **849252/LAT/S899823**		PED:	ATEX:
END USER: **LA TURBINE CORPORATION**		INSPECTION: **NB**	
FINAL DESTINATION:		DESIGN PRESS. / MAWP: **1200 psig**	TEST PRESSURE: **1800 psig**
PROJECT: **LAT573**		MIN. TEMP. / MDMT: **-20 °F**	MAX. TEMPERATURE: **200 °F**
APPLICATION: **SEAL GAS**		MEDIUM: **HYDROCARBON GAS**	

FILTER		**BALL VALVE**	
CONFIGURATION: **SINGLE**	FILTER TYPE: **00085**	CONFIGURATION:	BALL TYPE:
MATERIAL: **SA182 / SA479 S31600 / S31603**	INLET/OUTLET: **1"SAE-3KSI**	MATERIAL:	HOUSING SIZE:
SEAL MATERIAL: **VITON-ED**	RESERVOIR CAP.:	SEAT MATERIAL:	EQUALIZING LINE:
NOTE:			

CONNECTIONS					**INSTRUMENTATION**	
	SIZE	CONNECTION	RATING	ORIENTAT.	PDI	**NO**
INLET	**1"**	**ANSI FLANGED**	**600#**	**0°**	LEVEL GAUGE	**NO**
OUTLET	**1"**	**ANSI FLANGED**	**600#**	**180°**	LEVEL SWITCH	**NO**
B VENT	**1/2"**	**NPT-F**		**90°**	LEVEL TRANSM.	**NO**
DRAIN DIRTY					PRESS. SAFETY V.	**NO**
B DRAIN CLEAN	**1/2"**	**NPT-F**		**90°**	FLOW MEASUREM.	**NO**
SIDE CONN.					AUTO DRAIN	**NO**
FLANGE FINISH	**RF**				BASEFRAME	**NO**

FILE TYPE: **CONTRACT DRAWING**	FULL STRUCTURE REFERENCE: **GA-195476-1**

TITLE:

CONTRACT DRAWING

SINGLE FILTER 1-00085

SCALE	DATE	DRAWN	CHECKED	APPROVED	DRG. LOC.	DESIGN AUTH.
	13-10-16	**LKU**	**BWE**		**CZ01**	**NL02**

INDUFIL B.V.®

INDUFIL Copyright

DRAWING No.

4000852866-30

SHEET 1 OF 1

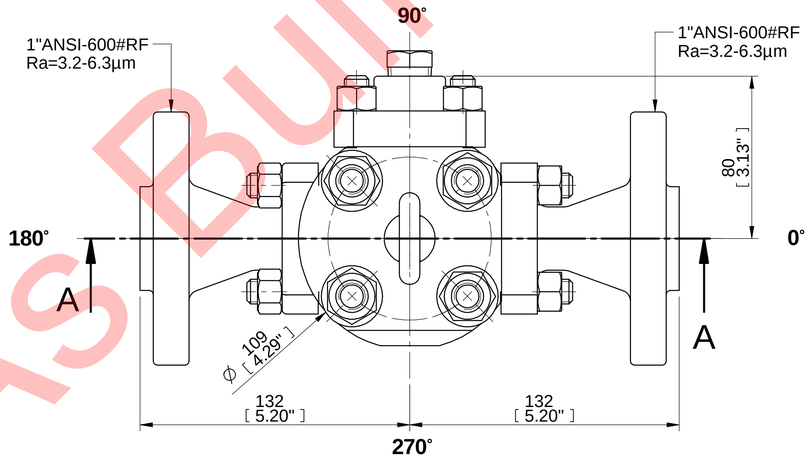
ISSUE **B**

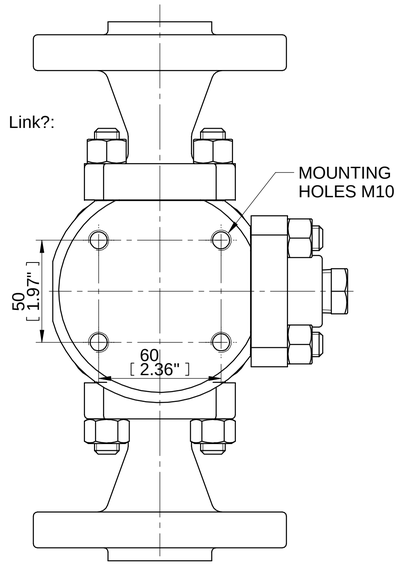
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A1

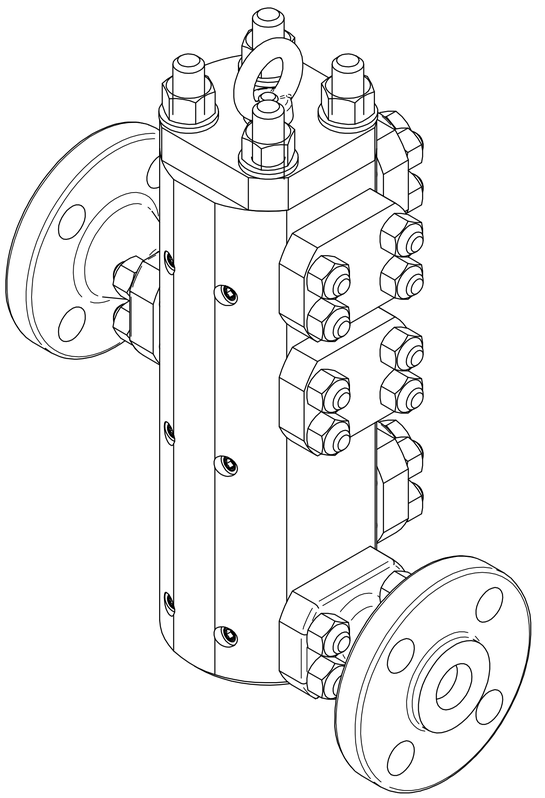
As Built

REV.	DATE	DRAWN	CHECKED	DESCRIPTION
B	1.11.16	LKU	RHO	VENT AND DRAIN CHANGED

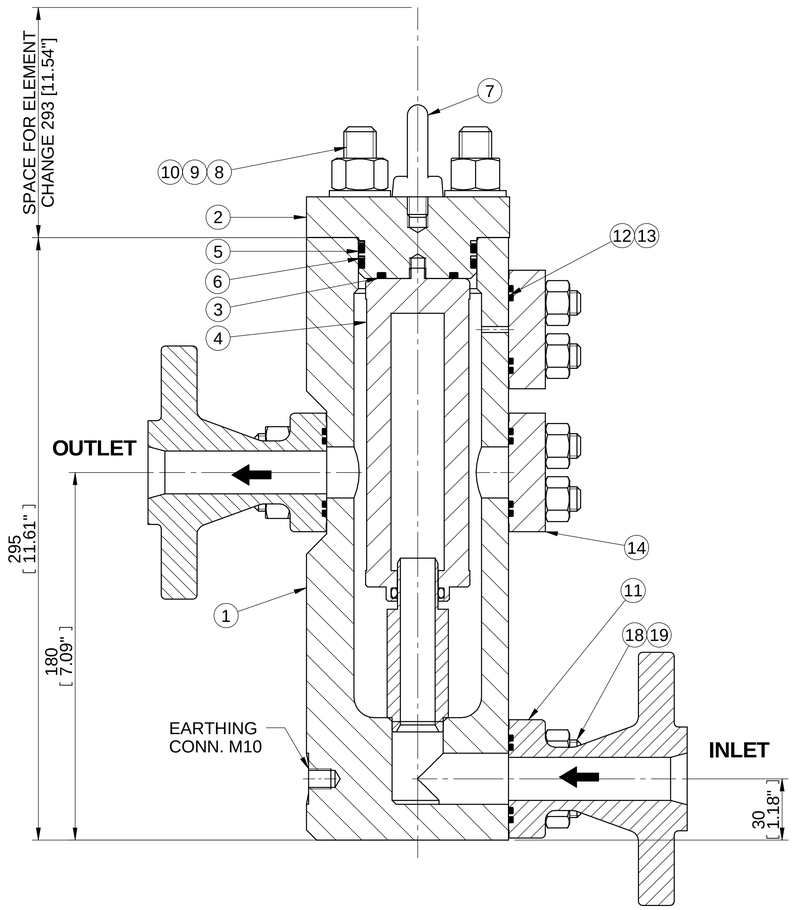


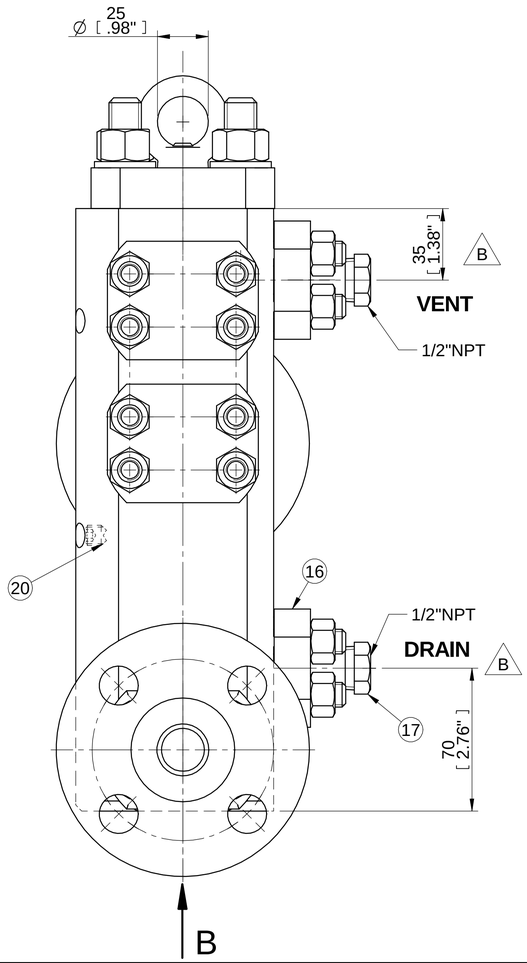


VIEW B-B



SECTION A-A





FILTER		BALL VALVE	
CONFIGURATION: **SINGLE**	FILTER TYPE: **00085**	CONFIGURATION:	BALL TYPE:
MATERIAL: **SA182 / SA479 S31600 / S31603**	INLET/OUTLET: **1"SAE-3KSI**	MATERIAL:	HOUSING SIZE:
SEAL MATERIAL: **VITON-ED**	RESERVOIR CAP.:	SEAT MATERIAL:	EQUALIZING LINE:
NOTE:			

CONNECTIONS					INSTRUMENTATION	
	SIZE	CONNECTION	RATING	ORIENTAT.	PDI	NO
INLET	1"	ANSI FLANGED	600#	0°	LEVEL GAUGE	NO
OUTLET	1"	ANSI FLANGED	600#	180°	LEVEL SWITCH	NO
VENT	1/2"	NPT-F		90°	LEVEL TRANSM.	NO
DRAIN DIRTY					PRESS. SAFETY V.	NO
DRAIN CLEAN	1/2"	NPT-F		90°	FLOW MEASUREM.	NO
SIDE CONN.					AUTO DRAIN	NO
FLANGE FINISH	RF				BASEFRAME	NO
FILE TYPE: **FULL STRUCTURE**			FULL STRUCTURE REFERENCE:			

TITLE:

GENERAL ARRANGEMENT DRAWING

SINGLE FILTER 1-00085

SCALE	DATE	DRAWN	CHECKED	APPROVED	DRG. LOC.	DESIGN AUTH.
1:1.5	13-10-16	LKU	BWE		CZ01	NL02

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DRAWING No.

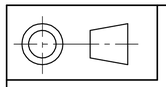
GA-195476-1

SHEET 1 OF 2

ISSUE **B**

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A1



Ref.	CAD Reference	GMC	Description	Material	Dimension	Cert.	Note	Basic/Special	Qty.	GPN	Spares
1	046.05.662.01-A	4469	FILTER HOUS. ASS.	SA182 / SA479 S31600 / S31603	D109 X 295	3.1	1-85 1" SINGLE		1	87487596	
2	046.05.662.01-TC	4469	TOP COVER	SA182 / SA479 S31600 / S31603	D109 X 40	3.1	1-85		1	87488655	
3	0000219	4511	O RING	Viton 90-95H	D32.93 X 3.53 (219)				1	87460856	X
4	INR-S-00085		FILTER ELEMENT	INR-S-00085-BAS-GF3-ED	D54 X 158				1	87486131	X
5	0000226	4511	O RING	Viton 90-95H	D50.40 X 3.53 (226)				2	87460930	X
6	FC-500-1036	7500	BACK-UP RING	PTFE	D58.0 X D51.9 X 1.5				2	87489927	X
7	033.00.006.28	4477	EYE BOLT ASSEMBLY	A4-70 ISO 3506	M10				1	87485619	
8	V1178.0-0058	4482	ENGINEERED STUD	SA193 Grade B8M Cl.2 (S31600)	5/8"-11UNC-5/8" X 3/8" X 1 3/4"	3.1			4	87472382	
9	95160020101	4477	WASHER FLAT	A4-70 ISO 3506	M16 (DIN 125A)				4	87471999	
10	99621102200	5536	NUT HEX. HEAVY	SA194 Grade 8M	5/8"-11UNC (H=D)	3.1	Bright finished		4	87471893	
11	033.00.131.02-L87.5	4469	FLANGE CONNECTION	SA182 / SA479 S31600 / S31603	1"SAE X 1"ANSI-600#RF L=87.5	3.1			2	87491662	
12	0000122	4511	O RING	Viton 90-95H	D28.25 X 2.62 (122)				6	87460828	X
13	0000128	4511	O RING	Viton 90-95H	D37.77 X 2.62 (128)				6	87460879	X
14	033.00.113.08	4469	BLIND FLANGE	SA182 / SA479 S31600 / S31603	1"SAE L=18	3.1			2	87472140	
16	033.00.101.08-L35	4469	FLANGE CONNECTION	SA182 / SA479 S31600 / S31603	1"SAE X 1/2"NPT L=35	3.1			2	87485467	
17	FC-500-0277	4469	HEXAGON PLUG	SA182 / SA479 S31600 / S31603 — Parker	1/2"NPT-6000PSI	3.1			2	87472270	
18	V1178.0-0103	4482	ENGINEERED STUD	SA193 Grade B8M Cl.2 (S31600)	M12-12 X 10 X 25	3.1			24	87472262	
19	99121752201	5536	NUT HEX. HEAVY	SA194 Grade 8M	M12 (H=D)	3.1	Bright finished		24	87472136	
20	61101500010	4477	SET SCREW CUP POINT	A4-70 ISO 3506	M10 X 10 (DIN 916)				6	87477870	

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TITLE:

BILL OF MATERIALS
SINGLE FILTER 1-00085

SCALE	DATE	DRAWN	CHECKED	APPROVED	DRG. LOC.	DESIGN AUTH.
1:1.5	**13-10-16**	**LKU**	**BWE**		**CZ01**	**NL02**

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DRAWING No.

GA-195476-1

SHEET 2 OF 2

ISSUE
B

A1

JACOBY-TARBOX®

A Product Line of The Clark-Reliance Corporation

Over 80 years of Quality!

Full-View Sight Flow Indicator
Flanged Bulls-Eye Models
300 & 600 ASME Class

Section: T100
Bulletin: T100.25
Date: 8/03
Supersedes: T100.25 (00)

Jacoby-Tarbox's full ASME rated line of flanged bulls-eye sight flows have been engineered per the design criteria of the ASME B31.1 & 31.3 Power & Chemical Piping Codes, incorporating all **ASTM** listed materials for the pressure retaining components: bodies, fasteners, and retainers. This standard-setting group of features include full **ASME** code compliance with regards to yield criteria, materials, and pressure/temperature ratings.

STANDARD FEATURES

- Connections per ASME B16.5
- Standard fasteners per ASTM A354 and ASTM A194 complying with most piping specifications.
- Tempered borosilicate glass
- Units are machined and assembled in an ISO-9001 fully automated facility.
- Wetted components meet NACE MR-01-75 requirements
- Stainless steel engraved identification faceplate

FULL-VIEW VISIBILITY

Pipeline view is maximized, in most cases with a diameter that is equal to the nominal pipe size, allowing 100% unobstructed process observation of gases, solids, solutions, and slurries.

CAPACITY

Non-Rotor models offer minimized pressure drops with their non-restricting, smooth, full-bore construction.

APPLICATIONS

Jacoby-Tarbox ASME flanged units are ideal for piping, process, and mechanical engineers that wish to maintain full ASME compliance within their pipelines. Refining, chemical, power, and gas pipeline industries are just a few areas of Jacoby Tarbox's successful code applications. O.E.M.'s specify this series when maximum reliability in harsh operating service is desired.

INDICATOR OPTIONS:

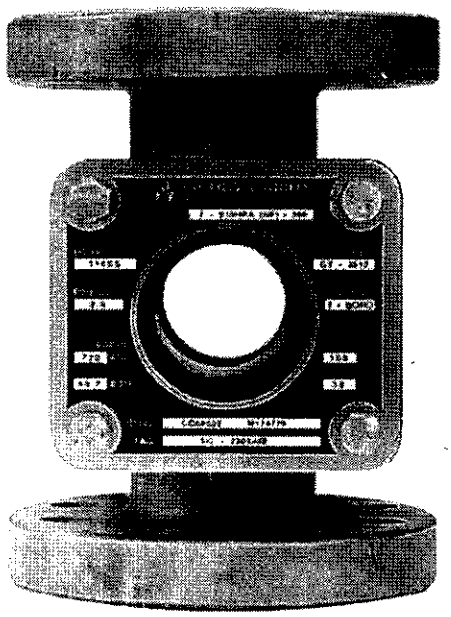
Plain: These units are bi-directional and may be placed in any orientation. Used primarily in processes where spot indication is desired to detect presence of media, or to inspect color, clarity, turbidity, or other critical characteristics.

Drip Tube: Low, intermittent flows are easily detected with this uni-directional style in the horizontal or vertically downwards direction. The drip tube forces the process to collect on the lower lip of the 316 SS tube, allowing it to visibly drip downward.

Flapper: This unit employs a 316 SS hinged weighted flapper to indicate flow of media. The velocity of the flow is indicated by the position of the flapper. Uni-directional, these units are optimal for horizontal or vertically upward flows.

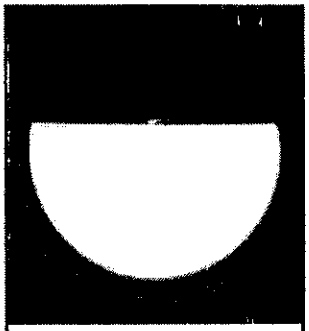
Flutter: The TFE flutter allows for easy uni-directional indication of low flowing gases and liquids. The thin, ribbon type flutter curls into the pipeline, vibrating at the slightest presence of gas or liquid movement. The flow of the media is indicated by the intensity of the fluttering against the window of the unit.

Rotor: The TFE rotor allows for easy bi-directional, multi-orientational flow indication. The speed of the rotor indicates the relative velocity of the media. Ideal for opaque liquids or heavy gases for an easily contrasting detection at far viewing distances. Extra durable stainless rotors are available as an option.

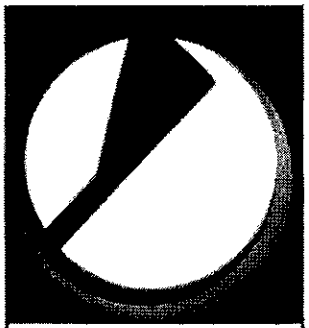


Models
F-910HPA (NF)-300 F-910HPA (NF)-600
Plain

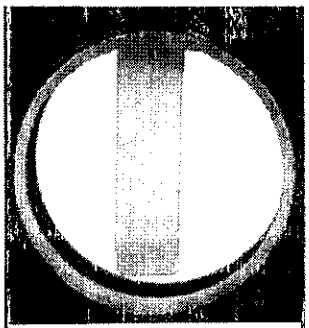
INDICATOR OPTIONS



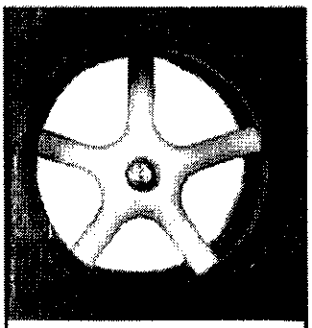
Drip Type Models
F-608HPA-300
F-608HPA-600



Flapper Type Models
F-910HPA-300
F-910HPA-600



Flutter Type Models
F-910HPA-FLTR-300
F-910HPA-FLTR-600



Rotor Type Models
F-960HPA-300
F-960HPA-600

DIMENSIONAL DATA

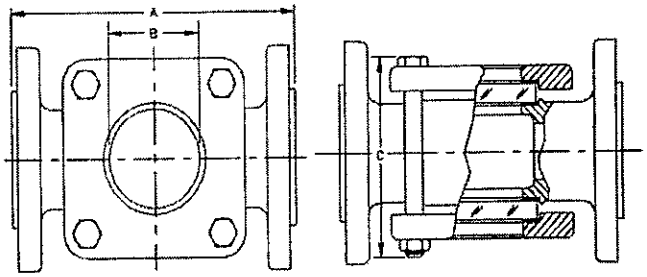
ALL 300 ASME CLASS MODELS									
NOM. SIZE		A		B		C		APPROX. WT.	
IN	DN	IN	mm	IN	mm	IN	mm	LBS.	KGS.
1/2	15	5.88	149	1.00	25	5.25	133	9	4.0
3/4	20	5.88	149	1.00	25	5.25	133	9	4.0
1	25	6.88	175	1.25	32	5.25	133	17	7.7
1-1/2	40	7.50	191	2.00	51	7.38	187	24	10.9
2	50	8.62	219	2.00	51	7.63	193	35	15.9
2-1/2	65	11.38	289	3.19	81	10.63	270	64	29.0
3	80	11.38	289	3.19	81	10.63	270	64	29.0
4	100	13.25	337	4.25	108	13.00	330	135	61.3
6	150	21.38	543	5.50	140	17.13	435	250	113.6
8	200	23.00	584	5.50	140	19.00	483	335	152.2

ALL 600 ASME CLASS MODELS									
NOM. SIZE		A		B		C		APPROX. WT.	
IN	DN	IN	mm	IN	mm	IN	mm	LBS.	KGS.
1/2	15	6.25	159	1.00	25	5.25	133	9	4.0
3/4	20	6.25	159	1.00	25	5.25	133	9	4.0
1	25	7.25	184	1.25	32	5.75	146	17	7.7
1-1/2	40	7.88	200	2.00	51	7.88	200	24	10.9
2	50	9.00	229	2.00	51	8.12	206	35	15.9
2-1/2	65	11.75	298	3.19	81	11.63	295	64	29.0
3	80	11.75	298	3.19	81	11.63	295	64	29.0
4	100	14.25	362	4.25	108	14.25	362	135	61.3
6	150	23.38	594	5.50	140	19.12	486	260	118.1
8	200	25.25	641	5.50	140	21.44	544	350	159.0

PRESSURE/TEMPERATURE RATINGS

ASME CLASS PRESSURE/TEMPERATURE RATINGS					
TEMP	TEMP	CL 300 : psig (Barg)		CL 600 : psig (Barg)	
°F	°C	STEEL	316 SS	STEEL	316SS
-20 TO	-29 TO 38	740 (50.8)	720 (49.4)	1480 (101.6)	1440 (98.9)
150	65	705 (48.4)	670 (46.0)	1415 (97.2)	1340 (92.0)
200	93	675 (46.3)	620 (42.6)	1350 (92.7)	1240 (85.2)
250	121	665 (45.6)	590 (40.5)	1335 (91.7)	1180 (81.0)
300	149	655 (44.9)	560 (38.5)	1315 (90.3)	1120 (76.9)
350	177	645 (44.3)	535 (36.7)	1290 (88.6)	1075 (73.8)
400	204	635 (43.6)	515 (35.4)	1270 (87.2)	1030 (70.7)
450	232	615 (42.2)	495 (34.0)	1235 (84.8)	990 (68.0)
500	260	600 (41.2)	480 (33.0)	1200 (82.4)	955 (65.6)

GASKET OPERATING TEMPERATURES		
MATERIAL	DEGREES F	DEGREES C
NEOPRENE	-20 TO 250	-29 TO 121
FIBER (NON-ASB)	-40 TO 550	-40 TO 287
VITON® A	-65 TO 350	-52 TO 177
SILICONE	-80 TO 450	-62 TO 232
GRAPHITE (OXY PRESENT)	-328 TO 932	-200 TO 500
GRAPHITE (STEAM)	-328 TO 1200	-200 TO 648
GRAPHITE (OXY FREE)	-328 TO 5432	-200 TO 3000
BUNA-N	-20 TO 250	-29 TO 121
EPDM	-20 TO 250	-29 TO 121
TFE/NEO	-20 TO 250	-29 TO 121
TFE/FIBER	-40 TO 450	-40 TO 232
TFE (GYLON®)	-325 TO 500	-198 TO 260



Construction and Materials

Body: Steel: ASTM A216 WCB
316 SS: ASTM A351 CF8M
Optional Alloys: Hastelloy®, Inconel®, 304SS, Alloy 20, Monel®, "L" Grade SS, others upon request

Retainer: Steel: ASTM A516 Gr. 70
Options: ASTM A240 (316 SS)

Fasteners: Steel: ASTM A354-BD
ASTM A194-2H
Option: ASTM A193 B8M CL2 (316SS)
ASTM A194-8M (316 SS)
Special trim required above 800°F (Inquire at Factory)

Connections: Steel: ASME B16.5 CL 300/600 RF
316 SS: ASME B16.5 CL 300/600 RF
Options: DIN PN 25/40 / JIS 20K/40K
RTJ / T&G / 125-250 Ra / <125 Ra

Windows: Tempered Borosilicate
Options: Quartz (above 500°F)
Shields: UniShield® Window Protection, Mica, PFA Teflon®, Kel-F®

Seal Gasket: Neoprene - See Table for Options

Cushion: Compressed Fiber (Non-Asbestos)

Options & Accessories:

3-Way Connections, Side FNPT Probe Taps, Steam Jackets, Epoxy and Offshore Coating Systems, Frost-Free Extensions, Spray Rings, Explosion-Proof Illuminators, Ball Type Indicator, External Impact Shields

Linings: Teflon®, Tefzel®, PVC, Kynar®, Rubber

Safety Window Options (Full ANSI Rated)

- FM® Approved Dual Borosilicate
- UniGlas®
- Dual UniGlas®

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JACOBY·TARBOX®
A Product Line of The Clark•Reliance® Corporation
16633 Foltz Industrial Parkway, Strongsville, OH 44149 USA
Telephone: (440) 572-1500 Fax: (440) 238-8828

ISO 9001 REGISTERED

KECKLEY

Style SA-7

Y-Strainer
Carbon Steel (ASTM A 216, Grade WCB)
150 lb. & 300 lb. Flanged



Cast Carbon Steel Y-Strainer

APPLICATIONS

Steam, water, oil or gas where protection from foreign matter in a pipeline is required.

CONSTRUCTION

The Keckley Style SA-7 stainers are constructed from rugged carbon steel castings and are machined to exacting specifications. These bodies have drilled flanges that are in accordance with ASME B16.5. All flanges come standard with back-faced bolt holes.

FEATURES

The Keckley Style SA-7 strainer features a machined groove in both the body and cover for proper screen alignment and to ensure accurate reseating when servicing is required. The gasket is 304 stainless steel spiral wound and is compressed between the body and cover (for maximum strength and durability) and designed for high pressure and high temperature service. All Keckley Style SA-7 strainers have cap screws and can be furnished with a steel blow-off plug upon request.

Blind covers are available upon request.

SCREENS

Standard perforated 304 stainless steel screens are spot welded along the seam for maximum strength. Different size perforations and meshes are available in stainless steel, monel, and brass to meet specific media requirements. If media is not indicated, screens for *steam* will be supplied.

SELF CLEANING

Self cleaning is accomplished by opening the valve or drain plug connected to the blow-off port. **Warning:** See Maintenance Instructions on page S6 of the Strainer Information Section for additional precautions and detailed information on servicing the strainer.

WORKING PRESSURES - NON SHOCK

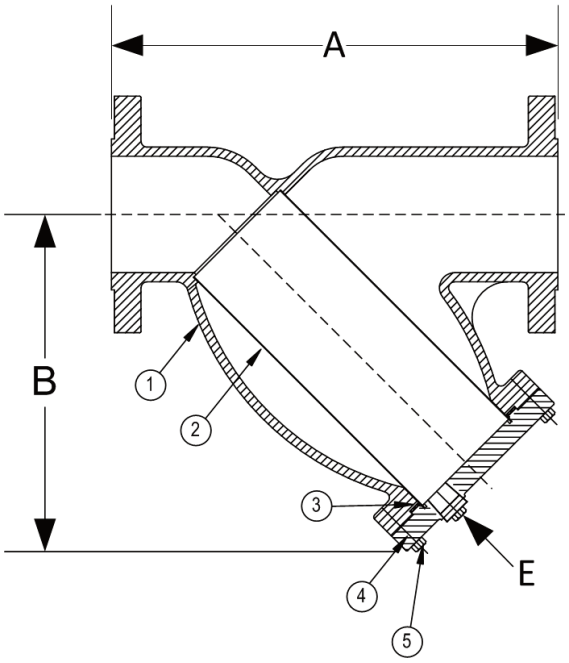
NOM. RATING	MEDIA	1/2" to 14"	15 mm to 350 mm
150# R.F. & D. (STANDARD FLANGE)	STEAM	150 PSI @ 565ºF	1035 KPa @ 296ºC
	W.O.G.	285 PSI @ 100ºF	1966 KPa @ 38ºC
NOM. RATING	**MEDIA**	**1/2" to 14"**	**15 mm to 350 mm**
300# R.F. & D. (EX. HEAVY FLANGE)	STEAM	300 PSI @ 838ºF	2069 KPa @ 448ºC
	W.O.G.	740 PSI @ 100ºF	5104 KPa @ 38ºC

KECKLEY

TECHNICAL DATA
DIMENSIONS AND WEIGHTS

Style SA-7

Y-Strainer, 150 lb. & 300 lb. Flanged
Carbon Steel (ASTM A 216, Grade WCB)



PARTS LIST		
ITEM	DESCRIPTION	MATERIAL
1*	Body	Carbon Steel (ASTM A 216, Grade WCB)
2	Screen	Stainless Steel (304)
3	Gasket	Spiral Wound Stainless Steel (304)
4	Cover	Carbon Steel (ASTM A 216, Grade WCB)
5	Hex Head Cap Screw	Carbon Steel (ASTM A 193, Grade B7)

Optional: Blow-off Plug, Carbon Steel.
*Optional Body Materials Available in LCB, WC6, and WC9.

STANDARD SCREENS SUPPLIED

SIZE		SCREEN GAGE	SCREEN PERFORATION					
			FOR STEAM		OPEN AREA	FOR LIQUID		OPEN AREA
in	mm		in	mm		in	mm	
1/2 to 4	15 to 100	28	3/64	1.2	33%	1/16	1.6	30%
5 to 10	125 to 250	22	3/64	1.2	33%	1/8	3.2	43%
12 & 14	300 & 350	22	1/16	1.6	30%	1/8	3.2	43%

Standard screens supplied are for **steam service**, unless otherwise specified.
Options: Other perforations, meshes, and screen materials are available.

SIZE		DIMENSIONS										WEIGHTS			
		A				B				E					
		150#		300#		150#		300#		150# & 300#		150#		300#	
in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lbs	kgs	lbs	kgs
1/2	15	6-1/2	165	6-1/8	156	3-3/4	95	3-3/4	95	3/8	10	7	3	6	3
3/4	20	7-3/8	187	7-3/4	197	4-1/4	108	4-1/4	108	1/2	15	11	5	13	6
1	25	7-3/8	187	7-7/8	200	4-1/4	108	4-1/4	108	1/2	15	11	5	13	6
1-1/4	32	7	178	8-1/8	206	5-1/8	130	5-1/8	130	1/2	15	12	5	19	9
1-1/2	40	7-1/8	181	8-1/4	210	5-1/8	130	5-1/8	130	1/2	15	14	6	19	9
2	50	7-7/8	200	9-1/2	241	6	152	6	152	1/2	15	22	10	33	15
2-1/2	65	9-3/4	248	10-3/8	264	7	178	7	178	1	25	32	15	44	20
3	80	10-1/16	256	12	305	7-7/16	189	7-5/16	186	1	25	41	19	58	26
4	100	12-1/8	308	14-1/2	368	8-15/16	227	8-15/16	227	1-1/2	40	63	29	90	41
5	125	15-1/2	394	19-5/16	491	13-1/32	331	13-1/32	331	2	50	111	50	180	82
6	150	18-1/2	470	19-5/16	491	13-1/4	337	13-1/4	337	2	50	136	62	180	82
8	200	21-3/8	543	23-3/8	594	15-1/2	394	15-1/2	394	2	50	212	96	304	138
10	250	26	660	27-3/8	695	18-7/16	468	18-7/16	468	2	50	280	127	470	213
12	300	29-7/8	759	32	813	21-5/8	549	21-5/8	549	2	50	460	209	709	322
14	350	34-1/2	876	36	914	25	635	25	635	2	50	980	445	1300	590

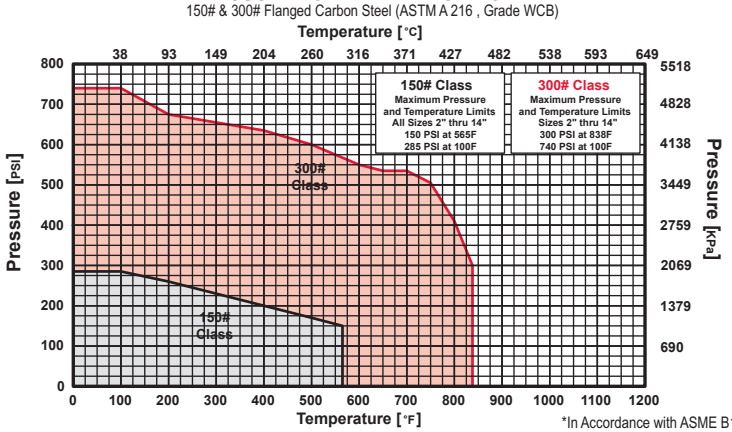
Certified dimensional drawings are available upon request.
†This table reflects only the nearest metric equivalents.

TOTAL SCREEN AREA

Size	(in²)	Size	(in²)	Size	(in²)	Size	(in²)
1/2"	6.46	1-1/2"	18.68	4"	91.89	10"	532.80
3/4"	12.32	2"	30.28	5"	209.41	12"	600.71
1"	12.32	2-1/2"	46.91	6"	241.18	*(Total screen area listed for 150 lb. class only)*	
1-1/4"	18.68	3"	57.62	8"	342.86		

*See DETERMINING RATIOS on page S5 of the Strainer Information Section for calculating NET FREE AREA of the screen to inside pipe area.

PRESSURE vs. TEMPERATURE CHART
150# & 300# Flanged Carbon Steel (ASTM A 216 , Grade WCB)



*In Accordance with ASME B16.5

KECKLEY

PRESSURE DROP CHART

Flanged "Y" Pattern Strainers (Styles A, BA, BA-7, SA, SA-7, SSA and SSA-7)

This pressure drop chart is based on the flow of clean water through the Keckley "Y" strainers listed above with screen perforations ranging from 3/64" through 1/8".

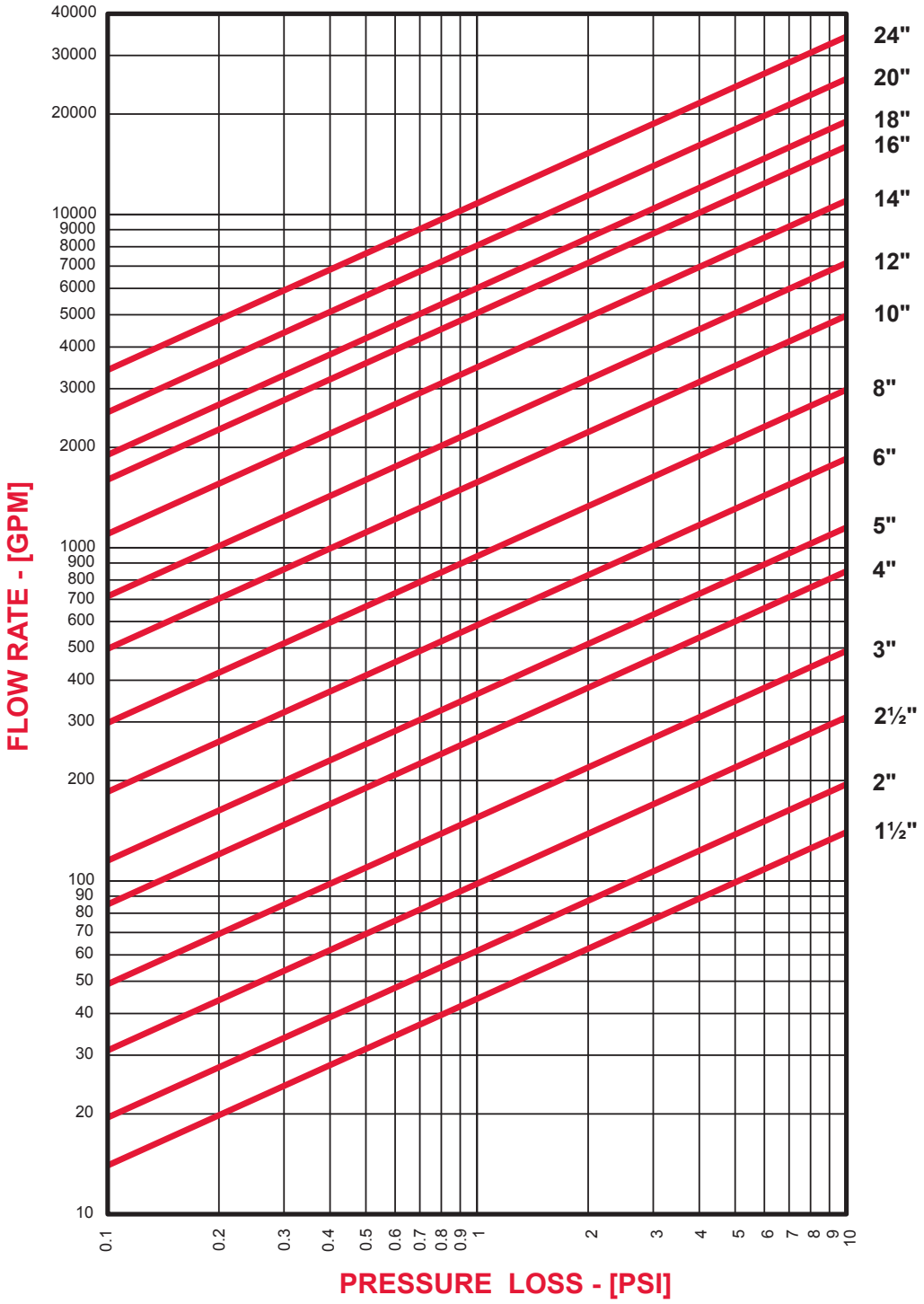
TO USE CHARTS:

Find your desired rate of flow (GPM) on the left hand side of the chart. Follow its corresponding horizontal line to the point where it intersects the diagonal line indicating the strainer pipe size. From this point of intersection, follow the vertical line down to the bottom of the chart to determine the approximate pressure drop.

CORRECTION FACTORS:

For finer mesh screens that are backed with a perforated sheet, multiply the pressure drops shown at right by the following:

40 mesh	x 1.2
60 mesh	x 1.4
80 mesh	x 1.6
100 mesh	x 1.7



Leistritz

INSTRUCTION MANUAL

PUMP MODEL:
L3MG 38/76 IFOGNO-G

L.A. Turbine Corporation
PO#: 23575

LEISTRITZ REFERENCE: S.O: 22991
SERIAL NUMBERS: 013522 & 013523

Leistritz ATC
165 Chestnut Street
Allendale, NJ 07401
Phone: (201) 934-8262
Fax: (201) 934-8266

Date: 12/20/16

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    1) Working Principle
    2) Direction of Rotation
    3) Shaft Seals
    4) Pressure Relief Valve
    5) Operation and Mounting
    6) Drive Requirements
    7) Installation Advice
    8) L3 Seal Cross Sections

2. Operating and Maintenance Instructions for LEISTRITZ Screw Pumps Series L3
    1) Introduction
    2) Design
    3) Pump Conservation and Storage
    4) Mounting the Pump Unit
    5) Hydrostatic Test
    6) Starting-Up
    7) Maintenance
    8) Dismantling the Pump
    9) Reassembling the Pump
    10) Dismantling the Safety Valve
    11) Assembling the Safety Valve
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    13) Assembling Integral Relief Valve
    14) Long-term Stand Still
    15) Spare Parts
    16) Special Operating Manuals
    17) Service
    18) Warranty

3. Scope of Supply
4. Pump Dimension Drawing / Overview
5. Pump Cross Section
6. Pump Data Sheet
7. Pump Nomenclature
8. Motor Drawing / Manual
9. Coupling Drawing / Manual

General Description Instructions for LEISTRITZ Screw Pumps Series L3

1. WORKING PRINCIPLE

The L3 type pumps are self-priming positive displacement rotary screw pumps used for pumping lubricating fluids. The L3 pump has three rotors working as conveying elements. The double threaded power rotor meshes closely with two double threaded idler rotors. This rotor package runs in a surrounding housing which encloses and seals around the three rotors. Due to the specially designed thread profile, separate tight cavities between the rotors and between the rotors and the housing are formed. When rotating, the fluid trapped in the cavities moves continuously, without shear or agitation, axially from the inlet to discharge side of the pumps.

The rotor geometry is chosen so that no axial thrust is brought to the ball bearing which is there simply to keep the rotor package in place. All radial loads are equally distributed to the surrounding housing which serves merely as a sleeve bearing.

Depending on pressure and viscosity the size of the clearance between the balance piston of the idlers and of the power rotor will vary. This clearance, which is self-adjusting, guarantees the hydro-dynamic balance of the rotors and provides lubrication for the bearing and the seal. Due to this balancing feature, a minimum differential pressure of 5-10 psi should be maintained for constant operation.

The area around the bearing and the seal is a low pressure area connected to the suction side of the pump by a gun-drill in the housing.Depending upon the application, the pump is available with an internal bearing (I) for lubricating fluids, or with an external bearing (A) for pumping less lubricating fluids. The external bearing can be either sealed for life or regreaseable.

LEISTRITZ L3 pumps are renowned for their quiet operation and low pulsation. The close meshing of the rotor flanks and the small clearances between the rotors and the housing, guarantee good volumetric efficiency of the pump. The pumps also have an excellent suction capability. It is possible to maintain a full flow discharge under poor NPSH conditions.

Due to the small number of moving parts and also to the fact that the power rotor is hardened and ground over its total length, LEISTRITZ L3 pumps have a long service life.

2. DIRECTION OF ROTATION

The pump is designed for a standard direction of rotation and therefore for a standard flow direction from inlet to outlet. The normal direction of rotation of LEISTRITZ L3 pumps is clockwise when viewed facing the pump shaft end. The pump may not be rotated in reverse, because the hydraulic balance will no longer be maintained.

Pumps for counter clockwise operation are available as an option.

3. SHAFT SEALS

Special consideration has been taken when designing and selecting the shaft seals for LEISTRITZ L3 pumps. Due to the advantage of the hydraulic balancing principle of the LEISTRITZ L3 pumps, the shaft seals are subjected only to the inlet pressure conditions. In this way, the seals are protected against high back pressures. The following types of seals are available:

A. Radial Lip Seal - Type "W"

The most economical type of seal used consists of two radial lip seals (52) (Fig.1) with an intermediate filling of grease. The sealing lips are mounted back to back.

This type of seal can be recommended for operations under normal suction conditions, i.e. inlet pressures of 8 psia to 25 psia, and when pumping reasonably clean fluids. Up to 200ºF the lip seals are made of Buna-N, and between 200°F to 300°F FKM is used.

This type of seal requires no maintenance. When mounting the radial shaft sealing rings, the sealing lips should be protected from damage by oiling the shaft end and covering the keyway slot with adhesive tape.

B. Mechanical Seals - Type "G"

The mechanical seal (62)(Fig.2) consists of a non-rotating seat (stationary element) and a rotating seal head fixed to the rotor, and kept together under a light spring tension. The pumped fluid enters the seal chamber and is recirculated via an internal bore back to the suction chamber of the pump. Thus the seal is only subjected to inlet pressure. A small amount of fluid leaks across the seal faces to provide lubrication.

It is important to ensure that the sealing faces of the mechanical seal are not allowed to run dry, particularly when starting the pump. The temperature of the fluid shall not exceed 350ºF for standard seals. For higher temperatures, specialty seals are available. The material combinations for the rotating and the stationary elements depend on the fluid and the operating conditions.

C. Packing - Type "S"

Pumps with an external bearing (A), can pump fluids which may solidify at lower temperatures. In particularly severe duties, the pump is preferably equipped with an adjustable packing (Fig.3). In order to prevent dry running of the packing on the power rotor, and to prevent air from being sucked in, the drive side cover (45) is equipped with a stuffing box control system (79, 80, 81, 82). By means of the control screw (81) an overpressure of 8 psi max. can be set on the packing. Care should be taken that this control screw is never completely closed, otherwise the internal balance system will not function properly.

4. PRESSURE RELIEF VALVE

In general, all L3 pumps can be equipped with a pressure limiting safety valve to protect the plumbing, pump drive and pump from damage due to excessive pressure. The valve is a directly operated integral relief valve and has a spring loaded poppet, which reacts to the pressure difference over the valve seat (217). If the pressure increases to an amount in excess of which has been set by the spring tension, the poppet (219) is lifted off of the valve seat and the fluid is allowed to flow from the pressure side of the pump to the suction side. The permissible relief pressure can be adjusted, over a small span, by setting the spring tension with the set screw (222).

If the viscosity of the fluid at start up is substantially higher than during normal operation, the valve on Models L3MG and L3MC can be equipped with a bypass handwheel which allows the set pressure to be temporarily reduced to prevent the drive motor from being overloaded. When the pump is started, the bypass handwheel is turned in a clockwise direction, which lifts the poppet (219) from the seat (217). Without interfering with the normal pre-set spring tension, up to 25% of fluid flow is bypassed back into the suction chamber of the pump. The bypass handwheel can then be turned to its normal position once the operating temperature has been reached.

The integral pressure relief valve is a safety valve only and should not be utilized as a system pressure regulating or control valve.

5. OPERATION AND MOUNTING

All L3 pumps are designed for direct drive via a flexible coupling. It is also possible to connect the drive shaft of the pump directly to a power take off. Contact LEISTRITZ for permissible radial shaft load information.

The pumps may run at 4000 RPM depending upon the operating conditions, inlet requirements, pressure and viscosity of the fluid, and the size of the pump. In general, high speeds can be used for smaller pumps and low viscosities whereas lower speeds are selected for larger pumps and higher viscosities (consult Data Tables).

6. DRIVE REQUIREMENTS

The shaft coupling should be bored and installed so that it can be properly aligned. When mounting, care should be taken to ensure that the two coupling halves are aligned. For non-spacer couplings, they should have an axial clearance of between 1/8" and 1" depending upon the type and size of the coupling.

The required torque on the pump shaft is directly proportional to the discharge pressure. When starting the pump against full back pressure, the drive motor must be able to deliver full torque immediately. The drive motor must be sized to handle the toughest conditions, i.e. when the pump is required to operate at maximum pressure with the highest viscosity.

For pumps with electric motor drives, which are continuously run with varying pressure and viscosity, it is recommended to oversize the motor power by 15% to 20% over the BHP values of the Data Tables.

For intermittent operation, the motor may be sized to meet the actual requirements of the pump.

7. INSTALLATION ADVICE

L3 pumps are designed with two mounting options, namely, as free installed pumps for connection to inlet and discharge lines or as vertical tank mounted pumps. The various models and sizes available permit the most suitable and economical pump selection for each individual application.

Non-standard designs are available to meet installations with existing pipe work or foundations.

Inlet and discharge lines shall be mounted in such a way that no excessive pipe loads are transferred to the pump. This is especially important when alternately hot and cold fluids are to be pumped due to longitudinal expansion. The steel base of the unit shall be sturdy and designed to avoid all mechanical stresses, allowing no mis-alignment between the pump and drive during operation.

When heavy oils and other viscous fluids are pumped, the piping must be appropriately sized. High viscosities cause large frictional losses in pipes, which in turn may affect the operation of the entire system.

If the pipe size of the suction line is too small to suit the capacity of the pump, cavitation will occur.

For every type of pump, a required inlet pressure is stated (in psia), dependent upon the pump speed and fluid viscosity. If the available inlet pressure is too low cavitation will take place. As a result, the capacity will be reduced, vibrations will occur and the pump will be noisy. Over time, cavitation may cause damage to the pump internals. In order to prevent pump cavitation, it is recommended that care be taken when planning the piping layout, and that the pressure drop in the suction line be monitored.

When designing the piping layout, it is a good rule to ensure that the flow to the pump is not restricted by too many sharp bends, right-angled valves, check valves, etc. Cross-sectional area variations of the pipes should be carried out as smoothly as possible and sudden changes in flow direction should be avoided.

If the fluid has solidified in the pump, the pump should not be started. Such a starting attempt will result in high, uncontrollable starting forces which can cause damage to the bearings and bearing surfaces. When dealing with fluids which tend to solidify at low temperatures, the pump must be pre-heated before starting. Jacket heating is available with L3 pumps, whereby steam, hot water, thermal oil or electrical heating can be used. The heating jacket is designed for a maximum pressure of the heating media (e.g. steam, thermal oil) of 220 psi at a maximum temperature of 400ºF for cast iron casings, and 600ºF for ductile iron and steel casings.

Additionally, the pump can be provided with a low pressure steam quench. The steam quench pressure should be limited to 15 psi.

All piping, pockets and valves should be carefully cleaned before the pump is installed in order to remove welding slag, i.e. screws and nuts, etc. (e.g. by flushing). Due to the close tolerances between the rotors, liners and the balance pistons, care should be taken to ensure that the fluid contains no foreign matter. This is especially important for pumps equipped with internal bearings.

Suction strainers with the following mesh are recommended:

-150 mesh (100 microns) for fluids with viscosity less than 150 SSU (32 cSt.)

-30 mesh (500 microns) for fluids in the viscosity range between 150 and 700 SSU (32-150 cSt.)

-1/8 inch perforations above 700 SSU (150 cSt.)

L3 Seal Cross Sections

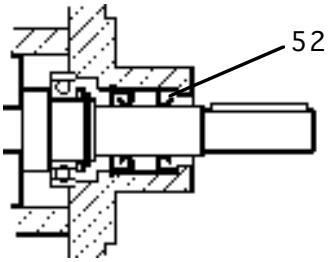


Fig.1 - Type "W" Lip Seal

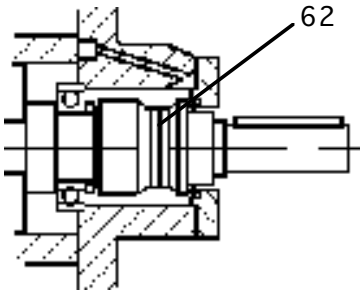


Fig.1 - Type "G" Mechanical Seal

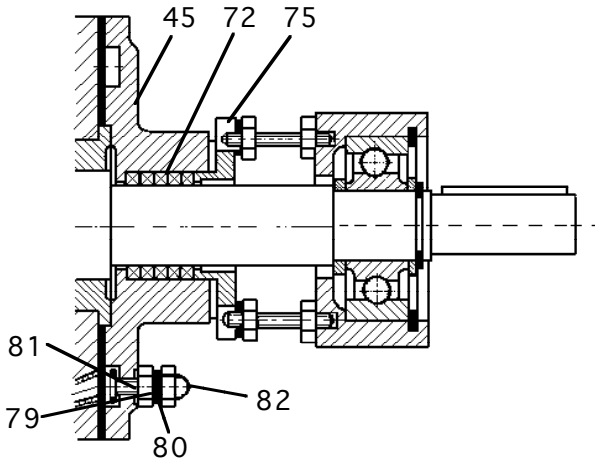


Fig.3 - Type "S" Packing for Pumps with External Bearing

Operating and Maintenance Instructions for LEISTRITZ Screw Pumps Series L3

1. INTRODUCTION

LEISTRITZ Series L3 pumps, with Models L3NG, L3MF, L3HF, L3MG, L3HG, L3MC and L3HC, are self-priming, positive displacement rotary screw pumps used for pumping oils or other lubricating fluids. The L3NG, L3MF and L3HF pumps have an integral liner and casing while the L3MG, L3HG, L3MC and L3HC are cartridge type units with separate liners and casings.

The maximum operating temperature should not exceed 210˚F for models with internal ball bearing (I), or 530˚F for models with external ball bearing (A), in the viscosity range of 33 to 200,000 SSU.

For pumps with steam jacket heating, the maximum steam temperature is 400˚F for models with cast iron housings and 600˚F for models with ductile iron or steel housings. For pumps equipped with heating jackets the maximum steam pressure is 220 psi .

If the pump is provided with a steam quench for the mechanical seal, the steam pressure should be limited to 15 psi.

For sectional views of the individual pump Models, see separate catalog section.

WARNING

Prior to starting the pump, the operator must read all product literature and familiarize himself as much as possible with the product.

In no case should the system be operated without the pump/motor coupling guard in place.

In no case should the pump be operated if signs of leakage or abnormal noise/ vibrations are evident. If such signs appear during operation, the pump should be stopped immediately.

2. DESIGN

Rotor

L3 Pumps have three rotors that mesh together and are hydraulically balanced. The threaded profiles of the rotors form tight cavities together with the surrounding housing, transporting the fluid axially as the rotors run in the liner. The rotors are normally made of nitrided steel, hardened to approx. 60 - 65 HRc with a nitration depth of approx. 0.02”, and finish ground. The idler rotors may also be made of cast iron.

Liner of Models L3NG, L3MF and L3HF

The rotor liner is integral to the pump casing. The suction chamber of the L3MF, which rotates in 90 degree increments, can have different inlet connections, depending on pump size. The L3NG has ANSI flange connections. On the drive side the pumps have an end cover which also serves as the mounting face.

Liner of Models L3MG, L3HG, L3MC and L3HC

The separate rotor liner together with the rotors and end cover, form a cartridge unit which can be built into various types of cast or fabricated casings.

Direction of Rotation

The direction of rotation is normally clockwise when viewed facing the shaft end. Pumps for counter-clockwise rotation are available as an option.

Direction of Flow

For models L3MF and L3HF, the flow direction is from the suction end towards the shaft end.

For models L3NG, L3MC, L3HC, L3MG and L3HG, which have a side in/ side out configuration, the flow direction is from right to left when viewed facing the shaft end. The L3NG, L3MG and L3HG flanges are in-line, while the L3MC and L3HC flanges are staggered. Special designs are available with reverse flow direction or different flange locations.

Shaft Seals

Various shaft seals can be installed in the pumps.

Special importance is put on the selection and design of the shaft seals. Since the seal chamber is connected to the suction side of the pump, the shaft seals of LEISTRITZ L3 Pumps are only subjected to the inlet pressure of the pump. This allows the use of

lip seals and unbalanced mechanical seals throughout the L3 product range. Balanced mechanical seals are also available for inlet pressures over 125 psi. The following types of seals are available:

A. Radial Lip Seals - Type "W":

The simplest type of seal the pump can have consists of Buna-N double lip seals (52) with an intermediate filling of grease.

This type of seal is recommended for inlet pressures above 8 and below 25 psia, and temperatures up to 200°F.

Between 200˚F and 300˚F, the lip seals are made of FKM.

PTFE is also available for higher temperatures.

For special operating conditions other lip seal arrangements are available, e.g. with supporting rings. The space between the sealing rings is filled with grease. The grease filling is sufficient for the expected service life of the lip seal.

B. Mechanical Seals – Type “G”.

Various types of mechanical seals can be installed. The mechanical seal (62) consists of a non-rotating seat (stationary element) and a rotating seal head, kept together under a slight spring tension. The pumped fluid enters the seal chamber and is recirculated via an internal bore back to the suction chamber of the pump. Thus the seal is only subjected to inlet pressure. A small amount of fluid leaks across the seal faces to provide lubrication.

The pumps may be provided with a steam quench connection for the mechanical seal. Steam pressure should be limited to 15 psi.

Care should be taken to ensure that the pump is filled with fluid and properly vented when started. Material combinations for the rotating and stationary element are selected depending on the pumped fluid and the operating conditions. When mounted vertically, insure proper venting of the seal area by using the vent screw on the drive side cover.

C. Packing - Type "S":

Under certain operating conditions, it is possible to use shaft packing with external bearing pumps. In order to prevent dry running of the packing (72) on the power rotor, and to prevent air from being sucked in, the drive side cover (45) is fitted with a stuffing box control system (79, 80, 81, 82). With this system, a slight over pressure of 8 psi max. can be applied to the packing. The set screw (81) can be adjusted if required until the desired pressure is reached.

The set screw must be secured by means of the hex nut (79) and cap nut (82). At positive inlet pressures, the set screw shall be turned counter-clockwise accordingly. When starting the pump, over pressure will occur as the space behind the packing is filled with the pumped fluid. The set screw will be preadjusted at the factory to suit the operating conditions specified. The set screw should only be adjusted during running of the pump and when leakage from the packing gland (75) can be observed.

Care should be taken to insure that the set screw is never completely closed, otherwise the internal balance system will not function properly.

Design and Operation of Relief Valves

WARNING

Pumps must be equipped with a pressure relief valve mounted in or on the pump, or separate in the discharge line. There should be no shut off valves between the pump and the relief valve.

If the pressure increases above the set value, the poppet (219) is lifted from the valve seat (217) and the fluid will pass into the suction chamber of the pump. The set pressure is kept by means of the valve spring (235), and the spring tension is set by the adjusting screw (222). Turning the adjusting screw clockwise will increase the set pressure.

For relief valves mounted to pumps with casings, the valve can also have a by-pass handwheel. By manually turning the handwheel (227) when starting, up to 25% of the fluid can be diverted back into the suction chamber. This manual bypass does not change the normal set pressure of the valve.

The pump should not be allowed to run with the relief valve blocked shut, as this will offset its safety function. This can lead to severe damage of the pump, piping and drive.

If required, the relief valve can be equipped with the return direct to the tank, instead of to the suction chamber.

WARNING

The pressure relief valve is a safety valve and should not be used as a pressure control valve.

3. PUMP CONSERVATION AND STORAGE

All pumps are shipped with a coating of oil on all internal parts, which is usually sufficient for normal storage times before installation. However, if the pumps are to be stored for a long period of time, long time conservation should be requested. Regardless of the type of conservation applied, the pumps should always be stored indoors.

The conservation material can be flushed from the pump with the pumped fluid. If the conservation material could contaminate the product, a suitable solvent such as kerosene, benzene, diesel fuel or alcohol may be used to clean out the pump.

4. MOUNTING THE PUMP UNIT

The pump should be inspected upon receipt to check for any shipping damage. All temporary shipping covers or attachments must be removed before installation. The pump internals should be inspected for any foreign matter or signs of improper storage.

When mounting the pump to the drive, necessary care should be taken to ensure good alignment. The bedplate should be firmly bolted to the foundation before checking alignment. The alignment should be rechecked prior to start-up and after the pump comes up in temperature.

4.1 Proceed according the following.

a) Check the angularity of the shaft coupling:

Check the distance between the facing surfaces of the coupling halves with an indicator while slowly rotating the shaft. Adjust the halves as necessary.

b) Check the parallelism in the shaft coupling:

With a steel ruler bridged between the outer diameters of the two coupling halves, check the alignment at four evenly distributed points. Shim as necessary to obtain acceptable parallelism.

In addition, the instructions of the coupling manufacturer should always be consulted for alignment recommendations.

Acceptable alignment is reached when angularity and parallelism are within 0.008".

4.2 The baseplate, pump and drive should be relieved from all mechanical stresses when the alignment is checked.

4.3 Before the pump is connected to the system, all lines, strainers and valves should be cleaned and flushed. Solid residues may damage internal parts when passing through the pump.

4.4 Inlet and discharge piping should be mounted without stresses to the pump nozzles, and the load on the pump must be unaffected by the thermal expansion of the piping. Care should be taken to insure that the pump is turning in the correct direction (direction of arrow). The L3MC and L3HC are designed for nozzle loads per API 676.

4.5 After assembling, the shaft should be turned by hand and checked that it can rotate freely.

4.6 Pressure and suction gauges should be installed to insure safe pump operation.

4.7 Check that the coupling guard is in place.

WARNING

DO NOT START WITHOUT THE COUPLING GUARD IN PLACE!

4.8 The above procedure is also applicable to pumps mounted to a motor via a bell-housing (horizontal face mounting and vertical mounting), except that the alignment is built into the bell-housing and normally does not need to be adjusted.

4.9 For pumps in hot service (above 200°F), the alignment must be rechecked after the pump comes up to operating temperature.

5. HYDROSTATIC TEST

Isolate the pump if the system is subjected to hydrostatic test, as the seal is only designed for inlet pressure.

6. STARTING-UP

6.1 Before the pump is started for the first time, it must be filled with fluid. This can be done by opening the isolation valves and turning the pump by hand. The pump should be protected from any welding debris and dirt by placing a temporary startup strainer in the suction pipe.

6.2 Check the direction of rotation of the drive motor to verify that it is the same as the pump by briefly bumping the motor. The proper rotation is given by the pump rotation arrow.

6.3 Observe the pump visually for signs of anything that appears to be abnormal. Check for leaks.

6.4 All valves should be fully opened. Insure that any feed pumps are operational and providing the proper feed rates.

6.5 The discharge line should be provided with a venting device and be vented at its highest point. When no more air is present, the fluid will start to flow out of the vents. Once this occurs the vents should be closed.

6.6 Pumps in high pressure service should be started in bypass mode to avoid motor over load. The discharge pressure at startup should be in the range of 300 to 500 psi.

6.7 Run the unit for a short period of time. Due to the pump's balancing feature, a minimum differential pressure of 5-10 psi should be maintained for constant operation. Listen for abnormal noise and watch for excessive vibration. Stop the pump and recheck the alignment. Check for leaks around the flanges and seal area. Remount the coupling guard.

6.8 Restart the pump and let it run for 10-15 minutes. Read the pressure and suction gauges and compare the values with those of the specifications in the order. Read drive motor amperage and flow if possible.

6.9 Check temperature and, if possible, viscosity of the fluid.

6.10 After the pump has run for a short period, all performance readings should be checked and compared to the specifications. Note that a fluid with a higher viscosity than specified will result in a higher power demand, flow rate and net positive inlet pressure required. Check that the required inlet pressure is available, otherwise cavitation will take place.

As a positive displacement pump, the pump flow rate cannot be changed by throttling the discharge. Throttling will only increase the back pressure on the pump and may cause damage. In order to control flow, either the speed of the pump can be changed (if possible) or a bypass line can be used to return part of the flow back to the suction header or tank.

6.11 If an integral pressure relief valve is installed, the opening pressure can be adjusted within a limited span, by turning the adjusting screw (222). **The pressure relief valve is preset on our factory test-bench so that it opens at approx. 10% above the nominal maximum pressure and should not be adjusted unless absolutely necessary.**

6.12 When shutting down the pump, any inlet feed pumps should be shut down at the same time. Shutting down the feed pumps first can cause the pump to run dry and damage the pump.

6.13 For short shutdown periods, the pump may be restarted without any additional preparation. After long shut downs, restarting must be carried out in accordance with the above instructions.

7. MAINTENANCE

LEISTRITZ L3 Pumps require little or no maintenance, providing that the operating instructions are strictly followed and that the fluid does not contain excessive amounts of contaminates. The degree of cleanliness and the lubricating quality of the fluid are directly related to the service life of the pump.

7.1 The following service intervals are recommended:

a) Every 500 running hours, the pump should be checked for abnormal noises or vibrations. The temperature should be measured at the bearing housing and compared to the temperature of the fluid. The difference should not exceed 75-80˚F. (The temperature difference is caused by the temperature rise over the balance pistons, which is normal). Furthermore, the temperature at the safety valve should not be higher than that of the fluid, otherwise it may indicate a valve seat leakage.

b) If the pump is fitted with a regreaseable bearing, the intervals and quantities listed in Annex 1 should be observed.

c) Every 2 to 5 years of operation, depending upon the degree of contaminates in the fluid, the pump should be dismantled and all internal parts inspected for signs of wear. It is especially important that the rolling surfaces of the rotors, faces of the mechanical seal, and surfaces of the rotor liner are inspected for signs of scoring. Light scoring of the surfaces of the rotors and liner can be removed by means of polishing and honing. The amount of scoring indicates the degree of fluid contamination.

7.2 Residues which have accumulated in the lower part of the pump housing should be removed whenever the pump is disassembled.

7.3 All significantly worn parts must be replaced.

8. DISMANTLING THE PUMP

When dismantling a LEISTRITZ L3 Pump, the following should be observed:

8.1 Before dismantling the pump, close the suction and discharge valves. Disconnect and tag out the motor.

8.2 Drain the fluid by opening the drain plugs of the pump. Some L3MF models do not have drain plugs due to the minor amount of liquid in the pump. The pipe connections can then be removed.

8.3 Disconnect the pump from the drive, and lift it from the base. Remove the half of the coupling that is mounted to the pump rotor by means of a gear puller and remove the key (180).

8.4 L3MG, L3HG, L3MC and L3HC:

Unbolt the cartridge face from the casing (1) and slide out the cartridge unit.

8.5 For pumps with internal bearing

('I' designation), proceed as follows:

a) Remove the mounting screws (50) and carefully remove the drive side cover (45), complete with the gasket (46) and the stationary seat of the mechanical seal (or the lip seals). When removing the cover, pull carefully to avoid damage to the seal.

b) If a mechanical seal (62) is fitted, remove it from the power rotor by loosening the set screws and carefully sliding it off of the shaft. Remove the spacer ring (63), if provided.

c) Remove the entire rotor set (150,151) from the casing or liner.

d) Remove the idler rotors (151) from the power rotor (150) and set aside.

e) Remove the snap ring (173) and back ring (172) from the power rotor (150).

f) Remove the bearing (170) from the power rotor (150) by using a gear puller.

g) If a mechanical seal is fitted, remove the stationary seat from the drive side cover (45). If lip seals (52) are fitted, remove the snap ring (53) and then remove the lip seals (52)

8.6 For pumps with external bearing

('A' designation), proceed as follows:

a) Remove the mounting screws (50) and carefully slide the entire rotor package out of the casing or liner, complete with the drive side cover (45).

b) Remove the idler rotors (151) from the power rotor (150) and set aside.

c) Remove the snap ring (173) and the back ring (172), if provided.

d) Place the power rotor/ drive side cover assembly on a table and use a gear puller to remove the drive side cover (45) from the power rotor (150). Support the drive side cover as it is pulled to avoid damaging the seal when the bearing breaks free.

e) Remove the snap ring (174), bearing (170) and back ring (172), if provided, from the drive side cover (45).

f) If a mechanical seal is fitted, remove the stationary seat from the drive side cover (45). If lip seals (52) are fitted, remove the snap ring (53) and then remove the lip seals (52).

g) If a mechanical seal (62) is fitted, remove it from the power rotor by loosening the set screws and carefully sliding it off of the shaft. Remove the spacer ring (63), if provided.

8.7 Models L3MG and L3NG

If needed the gasket (31) and the pedestal (40) (vertical pumps) or non-drive side cover (30) (horizontal pumps) can be removed by removing the mounting screws (32)

9. REASSEMBLING THE PUMP

When reassembling the pump, care should be taken to ensure that all parts have been fully cleaned and reconditioned as necessary.

9.1 For pumps with internal bearing

('I' designation), proceed as follows:

a) Heat only the inner race of the bearing (170) and press onto the power rotor (150). If a press is not available, the bearing can be installed by tapping on the inner race with an appropriate tool.

b) Install the back ring (172) and then the snap ring (173).

c) Mesh the idler rotors (151) with the power rotor (150).

d) Oil the bearing (170) and the entire rotor set (150,151).

e) While holding the entire rotor set in position, carefully slide the rotor set into the casing or liner.

f) If a mechanical seal is fitted, install the stationary seat, complete with O-ring, into the drive side cover (45). Insure that the pin (61) engages the notch on the stationary seat. If lip seals (52) are fitted, install the lip seals (52) and then the snap ring (53). Fill the space between the lips seals with an appropriate grease.

g) If a mechanical seal is fitted, slide the spacer ring (63), if provided, and then the rotating element of the seal onto the power rotor (150).

h) Check the drive side cover gasket (46) and replace if necessary. Lightly coat with grease and fit to the drive side cover (45) so that the balance bore is not covered.

i) Carefully install the drive side cover (45) and secure with mounting bolts (50). Insure that the balance bore on the drive side cover matches the bore on the casing or liner.

9.2 For pumps with external bearing

('A' designation), proceed as follows:

a) If a mechanical seal (62) is fitted, install the spacer ring (63), if provided, and then carefully slide the rotating element of the mechanical seal onto the power rotor. Secure the rotating element to the power rotor by tightening the set screws.

b) If a mechanical seal is fitted, install the stationary seat, complete with O-ring, into the drive side cover (45). Make sure that pin (61) engages the notch in the seat. If lip seals (52) are fitted, install the lip seals (52) and then the snap ring (53). Fill the space between the lip seals with an appropriate grease.

c) Turn the power rotor (150) vertical and place on a flat surface. Carefully fit the drive side cover (45) onto the power rotor (150). Insure that the end of the power rotor (150) does not contact the stationary seat of the mechanical seal, as chipping could occur.

d) Slide the back ring (172), if provided, onto the power rotor (150).

e) Heat only the inner race of the bearing (170) and press onto the power rotor (150). If a press is not available, the bearing can be installed by tapping on the inner race with an appropriate tool. When tapping the bearing, the drive side cover (45) must be held down to keep compression on the mechanical seal and to avoid seal damage.

f) Slide on the back ring (172), if provided, and then install snap ring (173).

g) Install snap ring (174).

h) Check the drive side cover gasket (46) and replace if necessary. Lightly coat with grease and fit to the drive side cover (45) so that the balance bore is not covered.

i) Mesh the idler rotors (151) with the power rotor (150).

j) Oil the entire rotor set (150,151).

k) While holding the entire rotor set in position, carefully slide the rotor set into the casing or liner. Insure that the balance bore on the drive side cover (45) matches the bore on the casing or liner. Secure with mounting bolts (50).

9.3 Models L3MG and L3NG

If removed during disassembly, reinstall gasket (31) and pedestal (40) (vertical pump) or non-drive side cover (30) (horizontal pump) using mounting screws (32)

9.4 Models L3MG, L3HG, L3MC and L3HC:

Slide the cartridge into the pump casing. Avoid using force and grease the O-ring (15) before mounting. Bolt the cartridge unit to the pump casing.

9.5 Install the key (180) into the power rotor (150).

9.6 The coupling halves should be a slip fit. If they are not sliding on freely, the hubs can be heated and then slid onto the shaft. If the coupling is forced too hard on the pump shaft, there is a possibility that the Snap Ring (173) will jump out.

9.7 After assembly, it should be possible to turn the pump freely by hand.

10. DISMANTLING THE SAFETY VALVE

L3MG, L3HG, L3MC and L3HC:

10.1 Remove the mounting screws (27), and remove the valve together with the gasket (26).

10.2 By turning the valve spring set screw (222) counter-clockwise as far as possible, the valve spring (235) will be partially relieved (NOTE NUMBER OF TURNS). As the spring still has tension exerted on the cover (209), continue with the following procedure. Remove two of the screws (211) from opposing positions, and replace with longer socket head screws which should be turned in as far as possible. The remaining screws (211) can now be removed by alternately loosening one after the other. Finally, the two socket head screws can be removed, once again by alternately loosening one after the other. Do not tilt the cover (209). Remove the cover (209) together with the adjustment screw (222) and spring plate (220) from the housing (200). Remove the pressure spring (235) from the housing (200). Remove the gasket (210).

10.3 Remove the adjustment screw (222) from the cover (209).

10.4 Screw the pressure side cover or seal plug (215) out of the housing (200). Remove seal ring (216).

10.5 Push out poppet (219) from the pressure side opening.

10.6 If fitted, remove the handwheel (227) and loosen the stem (225) from the pressure side cover (215).

11. ASSEMBLING THE SAFETY VALVE

L3MG, L3HG, L3MC and L3HC:

11.1 If fitted, install the stem (225) complete with O-ring (226) into the pressure side cover (215). Install handwheel (227).

11.2 Slide the poppet (219) into the housing (200) from the suction side end of the valve.

11.3 Bolt the pressure side cover (215) complete with seal ring (216) onto the valve.

11.4 Place the spring (235) onto the poppet (219) with the front end against the pressure side guide.

11.5 Turn the spring plate (220) on the adjustment screw (222) as far as the shoulder. Oil the shaft of the adjustment screw (222) and thread the shaft into the hole of the cover (209).

11.6 Install the cover (209) complete with adjustment screw (222) and gasket (210) in the housing (200). First, secure with the two long socket head screws, positioned opposite one another. These should be alternately tightened until they are locked. Now screw the two screws (211) evenly in. Finally, remove the two long socket head screws and replace them with the two remaining screws (211).

11.7 Install the housing (200) together with the gasket (26) onto the pump housing (1) with the mounting screws (27).

11.8 Re-setting the relief pressure:

An exact setting of the relief pressure is accurate only if the flow and the pressure can be measured. Otherwise, the safety valve must be returned to the factory for adjustment. However, if during dismantling (see 9.2), the number of turns which were required to relieve the valve spring pressure were noted, then the relief pressure can be set with a similar number of turns in a clockwise direction with the adjustment screw (222). After adjusting, lock in position with the lock nut (281). (This method should not be used when a replacement spring has been fitted, due to the different spring characteristics).

12.DISMANTLING INTEGRAL RELIEF VALVE

The valves should only be disassembled if necessary.

12.1 L3MF:

a) Loosen the lock nut (281). By turning the adjustment screw (222), counter-clockwise as far as possible the valve spring (235) will be partly relieved. (NOTE THE NUMBER OF TURNS!)

b) Open threaded valve head (209) carefully, as it is under spring load, and take out spring plate (220), spring (235) and poppet (219).

12.2 L3NG:

a) Remove end cover (30) with adjusting screw (222) and locknut (281) in place. Remove spring plate (220), spring (235) and poppet (219).

13. ASSEMBLING INTEGRAL RELIEF VALVE

13.1 L3MF:

a) Assemble poppet (219), spring (235) and spring plate (220) and slide them on to stem of adjustment screw (222). Screw in valve head (209) under spring load.

b) Readjust the valve spring by turning the adjustment screw (222) the noted turns clockwise and lock it with the lock nut (201).

13.2 L3NG:

a) Assemble poppet (219), spring (235) and spring plate (220) and place the assembly into casing. Reinstall end cover (30).

14. LONGTERM STAND STILL

14.1 If the pump is to be restarted within roughly three months, no special conservation is necessary. However, if the fluid tends to solidify at low temperatures, the pump should be isolated and drained of all excess fluid.

14.2 If the pump is to remain idle for three to six months, the pump should be filled with pumped fluid and isolated. Again, if the pumped fluid tends to solidify, the pump should be drained of all excess fluid and isolated.

14.3 For stand still periods in excess of six months, the pump should be isolated from the system and filled with a suitable conservation media.

14.4 The pump shaft must be rotated at least once a month during the shut down.

15. SPARE PARTS

All parts are identified by a position number which is the same for all sizes.

15.1 All replacement and spare parts are shown in the sectional drawings and are grouped into:

a) Minor Repair Kit:

Mechanical or lip seals, ball bearing, O-rings and gaskets.

b) Major Repair Kit:

Spare cartridge – if applicable.

15.2 It is always advisable to keep at least one complete minor repair kit in stock.

15.3 When ordering spare parts, it is essential that the following information be given:

Position Number, Pump Model and Size, and the Serial Number of the Pump, which is stamped into the flange and also into the nameplate.

16. SPECIAL OPERATING MANUALS

For pumps that are supplied as a special execution, the relevant Operating Instructions will be supplied.

17. SERVICE

Assuming the pump has been correctly assembled and the Start-Up and Operating Instructions have been followed, Leistritz L3 Pumps are known for long and trouble-free service.

Each pump is factory tested prior to shipment.

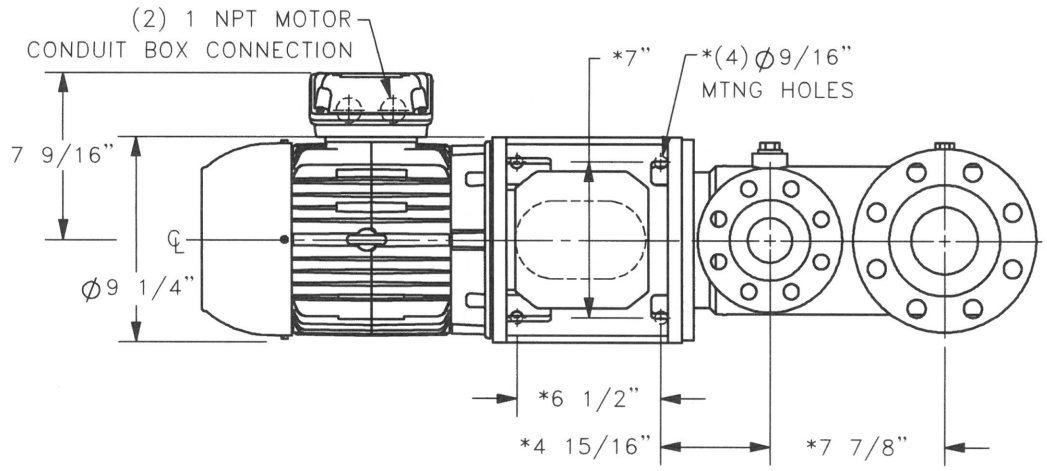
For installation and repairs, experienced specialists are available, on request, from the factory or from any of our authorized distributors.

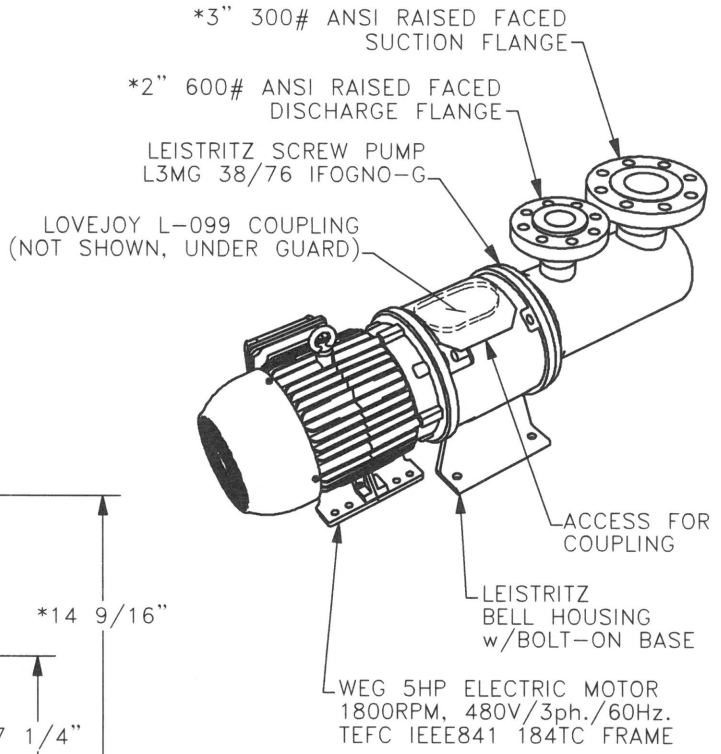
18. WARRANTY

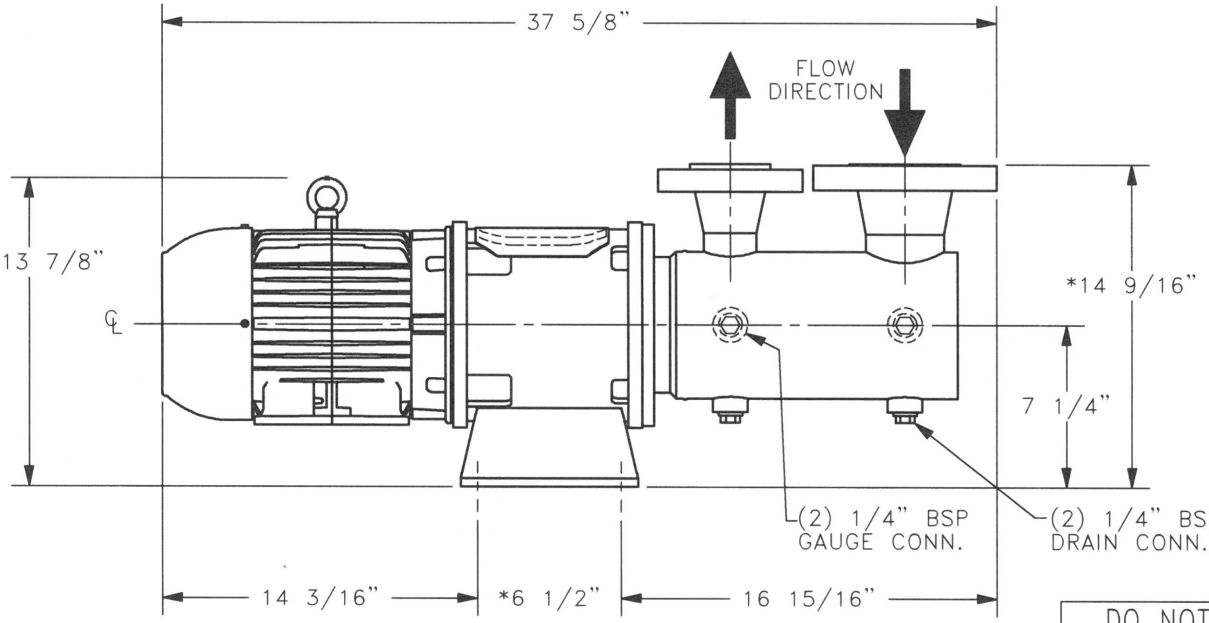
Our liability covering the defects of shipped goods is outlined in our Terms and Conditions of Sale.

No responsibility will be accepted for damages that may occur as a result of non-compliance to the Operating Instructions and Application Conditions. If at a later date, application conditions change, (e.g. other media, viscosity, temperature, speed or inlet flow conditions), the conditions shall be reviewed and acknowledged by LEISTRITZ. If no other agreements have been signed by LEISTRITZ, then delivered pumps shall only be dismantled and /or modified by LEISTRITZ or a qualified LEISTRITZ service representative during the warrant period. Otherwise, the warranty will be null and void.

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	1	CHANGE MOTOR T-BOX SIDE	12/08/16	







*** ALL DIMENSIONS ARE IN INCHES EXCEPT [mm]
ALL DIMENSIONS MARKED WITH * ARE QC VERIFIED
DRAWING MAY BE OUT OF SCALE FOR ANY DIMENSIONS

CONFIDENTIAL
THIS DESIGN IS THE PROPERTY OF LEISTRITZ CORP.; IT MAY NOT BE REPRODUCED FOR FABRICATION OR DISCLOSED TO A THIRD PARTY WITHOUT THE WRITTEN CONSENT OF LEISTRITZ CORP.

DRAWING STANDARD
THIRD ANGLE PROJECTION

DO NOT SCALE

TOLERANCES
FRACT. ±.062
.XX ±.031
.XXX ±.005
∠ ±2°
UNLESS OTHERWISE SPECIFIED

Issued 10/25/16

A

DRAWN BY: AD
APPROVED:
QC VERIFIED:

Leistritz
165 Chestnut Street, Allendale, New Jersey 07401
(201) 934-8262

DWG# 22991-1-A
SCOPE OF SUPPLY DWG
L3MG 38/76 IFOGNO-G
184TC MOTOR

REV: 1

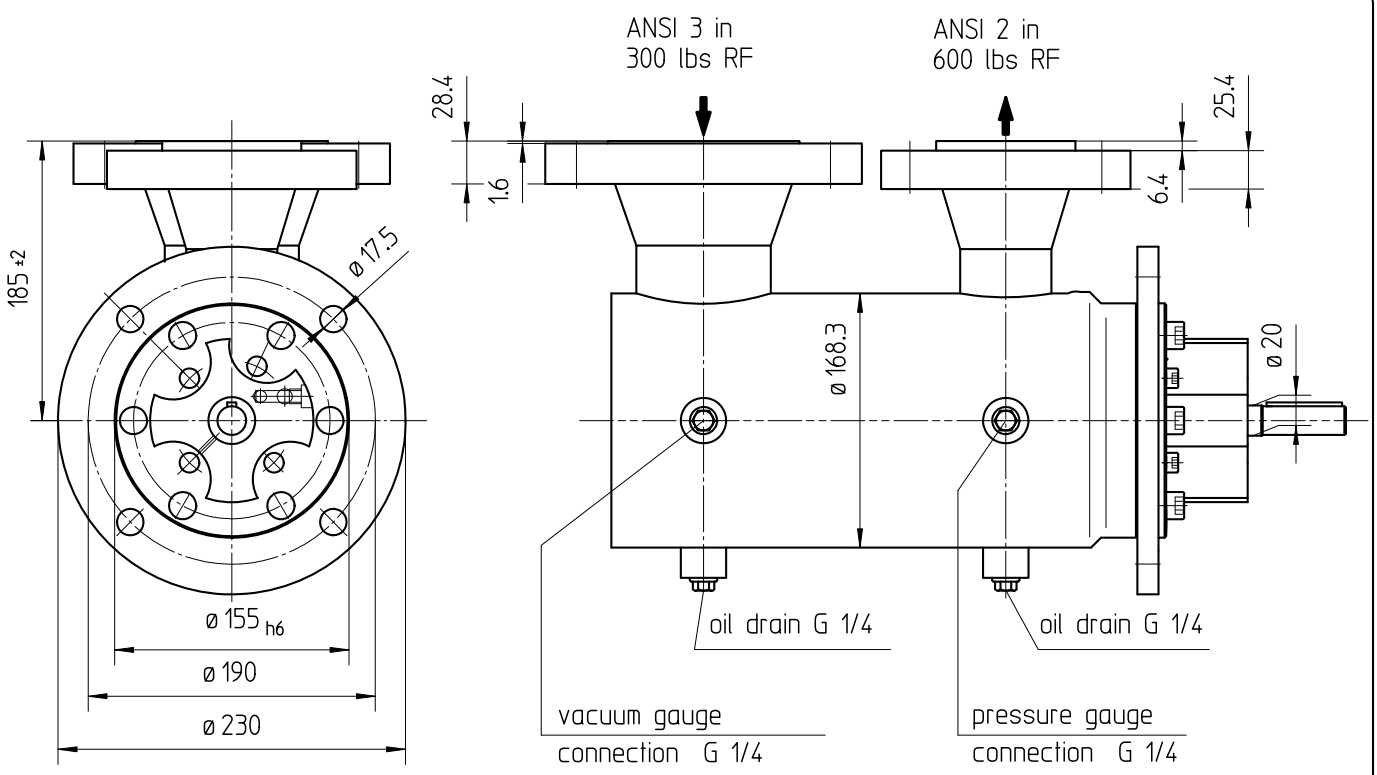
MAT'L: WEIGHT: SHEET

SCREW PUMPS

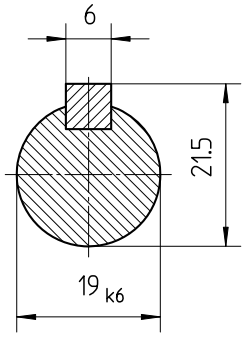
Leistritz

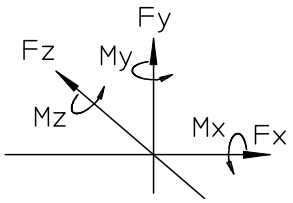
Range	Type	Size	Pitch	Shape	Type of Seal	Identification
L3M	**G**	**38**	**/...**	**IFOGNO**	**G**	3 SPINDLE ENCHASED PUMP FLANGE MOUNTED, CASING WELDED BALL BEARING INSIDE

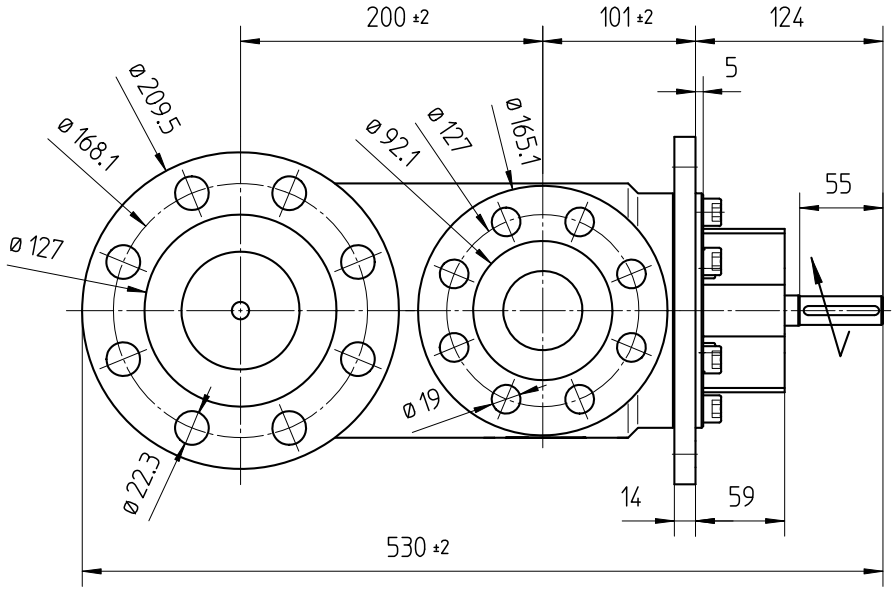
N-41012841



shaft
M 1:1







max. allowable resultant forces and moments on pump nozzles	
suction connection	pressure connection
Fx= 1120N Mx= 560Nm	Fx= 700N Mx= 350Nm
Fy= 1120N My= 560Nm	Fy= 700N My= 350Nm
Fz= 1120N Mz= 560Nm	Fz= 700N Mz= 350Nm

weight: 42 kg

Projektionsmethode 1

measures in mm
scale 1:5

Edition: 04.10.2016 Henning

Subject to modification.

Rev. 000

Leistritz AG Markgrafenstr.36-39 D-90459 Nürnberg, Postfach 3041 D-90014 Nürnberg Tel. (0911)4306-0 Telex 626717 Telefax (0911)4306-490

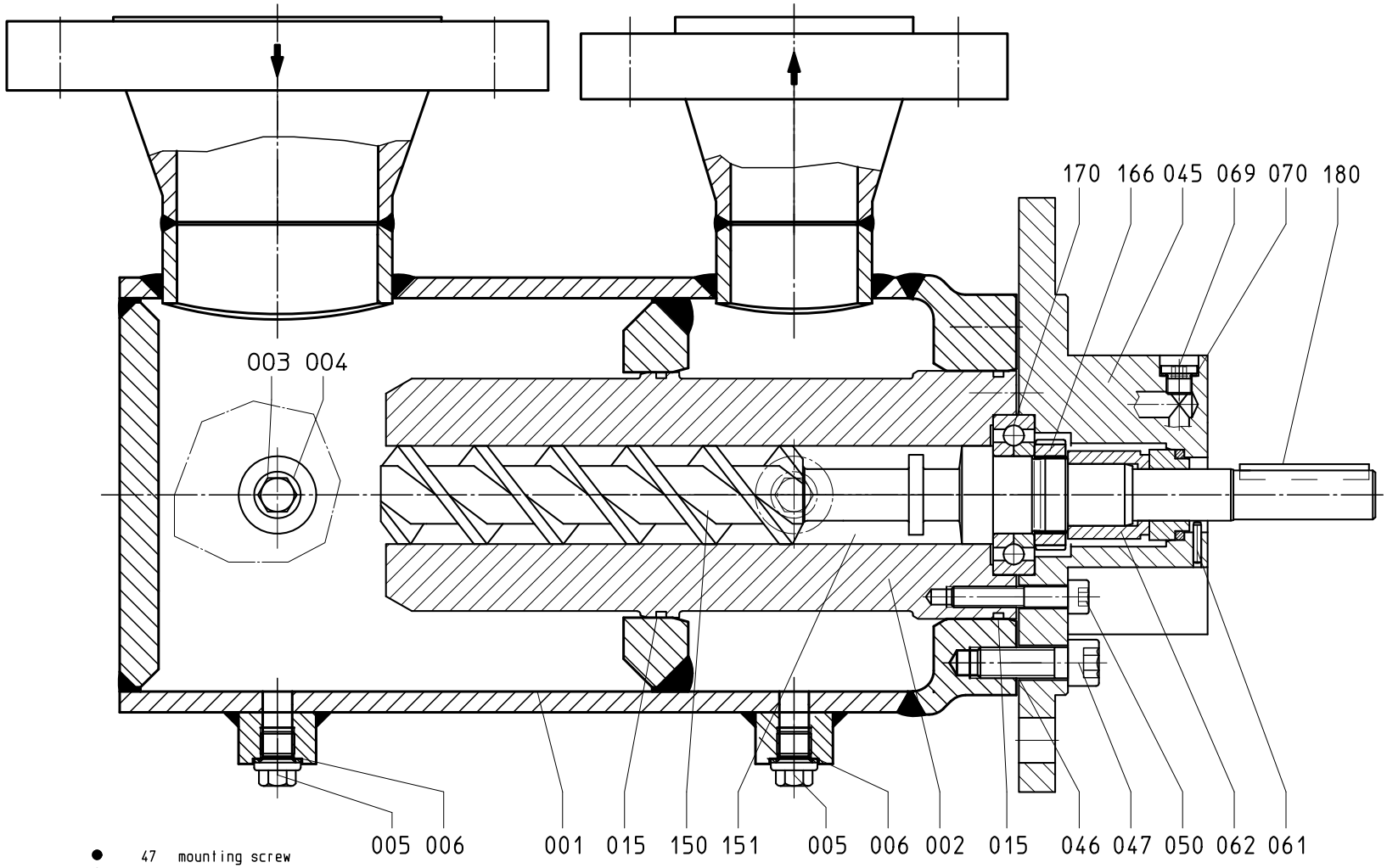
E 168 8435

NOTES:

SCREW PUMPS

Leistritz

Range	Type	Size	Pitch	Shape	Type of Seal	Identification
L3M	G	038	/...	IFOGIO	G	3 SPINDLE ENCASED PUMP, FLANGE FOUR POINT BEARING INSIDE



		1	pump casing
	○	2	casing insert
●		3	locking screw
●	○	4	sealing ring
●		5	locking screw
●	○	6	sealing ring
	○	15	o-ring
		45	cover driving side
	○	46	gasket
●		47	mounting screw
●		50	mounting screw
●	○	61	edged adjusting pin
	○	62	mechanical seal
●		69	locking screw
●	○	70	sealing ring
	○	150	driving spindle
	○	151	idler spindle
●	○	166	castle nut
●	○	170	four point bearing
●	○	180	key

Projektionsmethode 1

● DIN - parts
○ spare-parts

Edition: 05.10.16 Henning Subject to modification.

Rev.000

Leistritz Pumpen GmbH, Markgrafenstr 36-39, D-90459 Nürnberg, Postfach 3041 D-90014 Nürnberg Tel. (0911)4306-0 Telex 626717 Telefax (0911)4306-490

D 160 9828

Customer Name or Project Name:	LA Turbine	Sales Order No.	22991
Customer Job No.	LAT-573	Pump Model	L3MG 38/76 IFOGNO-G
Customer PO No.	23575	Pump Type	3 Screw
Application / Pumped Fluid	ISO VG 32 Lube Oil	Quantity	1

Pump

	Rated	Alt 1	Alt 2	Alt 3	
Temperature	150	100	150	100	deg. F
Viscosity	12	32	12	32	cSt
Capacity	20.5	21.3	19.7	20.8	gpm
Suction Pressure	245	245	160	160	psig
Discharge Pressure	370	370	360	360	psig
Differential Pressure	125	125	200	200	psi
Required Net Positive Inlet Pressure	2.9	3	2.9	3	psia
Required Power	2.1	2.3	3.2	3.4	bhp
Speed	1780	1780	1780	1780	rpm
Overall Efficiency	71.2	67.5	71.8	71.4	%
Estimated Noise Level	58.3	58.3	58.8	58.8	dB(A)
Relief Valve Cracking Pressure					psig
Power Required					bhp

Pump Construction

Casing	Carbon Steel ASTM A106	Orientation	Horizontal	
Liner	Cast Iron, ASTM A48	Mount	Flange	
Rotors	Hardened Steel, ASTM A322-70	Coupling	Direct	
Bearing - Axial	N/A			
Bearing - Radial	Internal Ball Bearing, 4-Point			
Bearing Lubrication	Product	Suction	3" ANSI R.F. 300#	
Mechanical Seal Manufacturer	John Crane	Discharge	2" ANSI R.F. 600#	
Seal Type/Model	Mechanical - 58B	Rotation	CW	
Seal Face Materials	SiC vs. Carbon	Flow direction	NO, Top/Top	(viewed from shaft)
Seal Plan	API Plan 13 (Internal)	Estimated Weight	100 lbs.	
Integral Relief Valve	Not Included			

Motor

Rated Power	5	Hp	Manufacturer	WEG
Speed	1800	rpm	Enclosure	TEFC
Voltage	460	V	Type	Class 1 Div 2 Groups C/D
Phase/Hertz	3/60	Hz	Design	IEEE 841
			Frame	184TC
Service Factor	1.15		Estimated Weight	TBD

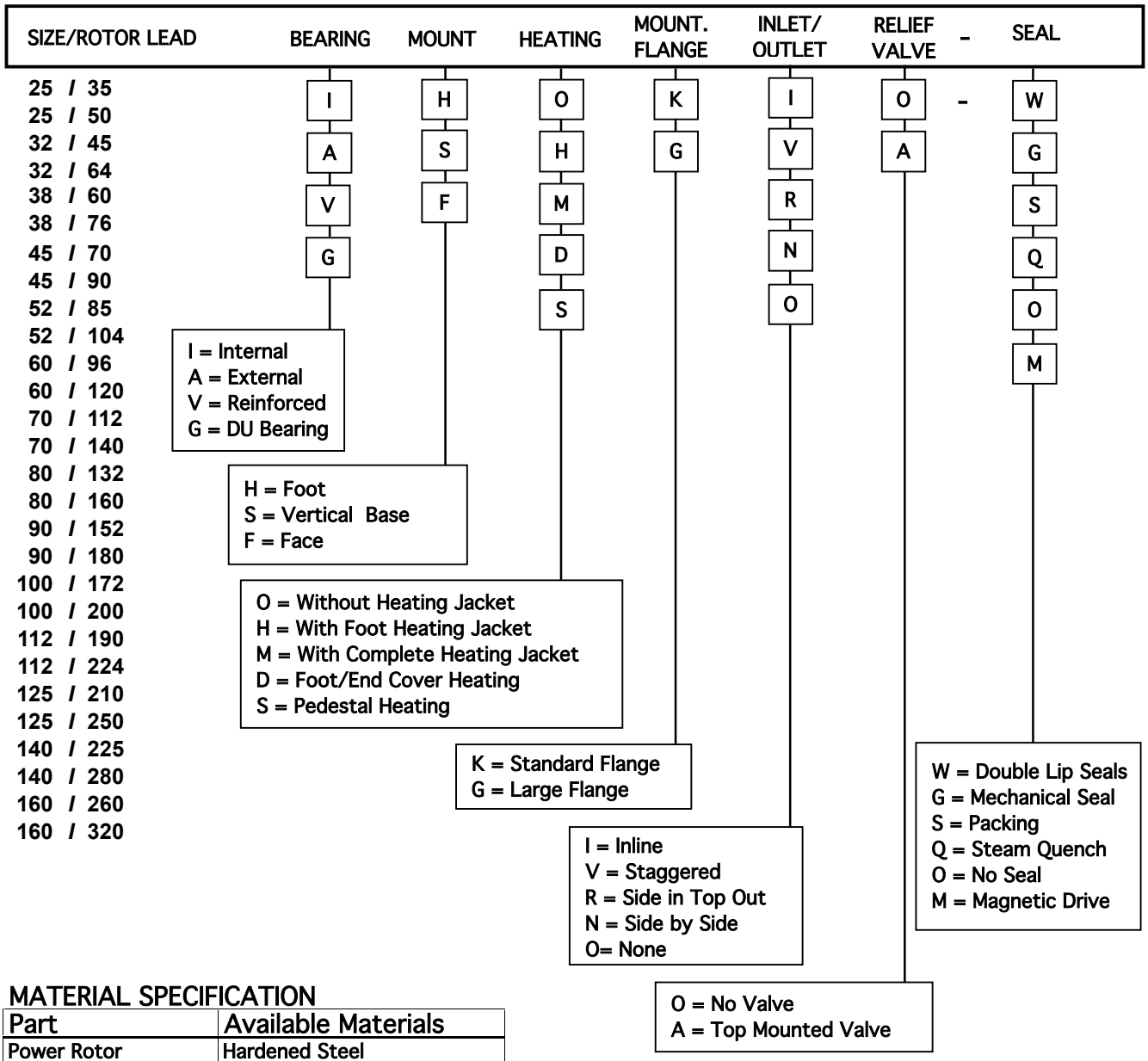
Baseplate and Coupling

Coupling Manufacturer	Lovejoy
Coupling Type / Model	Jaw Type
Additional Description	L-099
Adaptor Type	Leistritz Standard
Additional Description	Pump-Motor with Feet

Notes

1. Pump operating data guaranteed in accordance with VDMA 24284, class II, group II standards.
2. Pump materials built to DIN standards, ASTM equivalents listed above.
3. Leistritz standard paint color is RAL 5021- water blue.
4. All orders are processed in accordance with Leistritz' Quality Control Procedure LC-IP-010, latest revision.
5. Pump is API 676 3rd edition compliant except for the attached comments and exceptions.
6. Leistritz standard testing and 3.1 material test certificates are included(rotors and casing), for additional testing please contact Leistritz.
7. Motor testing includes: routine test report, FM or CSA/US certificate.

MODEL L3MG / L3MC / L3ME



MATERIAL SPECIFICATION

Part	Available Materials
Power Rotor	Hardened Steel
Idler Rotors	Cast Iron (Al Liner Only) Hardened Steel
Rotor Liner	Aluminum Cast Iron Ductile Iron Teflon or Bronze Coated
Casing	Cast Iron Ductile Iron
Seal Housing	Cast Iron Ductile Iron Steel
Elastomers	Buna-N FKM
Inlet Connections	ANSI 150 lbs. or custom
Outlet Connections	ANSI 300 lbs. or custom

DESIGN SPECIFICATON

Max. Pressure	1200 PSI
Capacity	3 - 1100 GPM
Max. Speed	4,000 RPM
Viscosity	33 - 200,000 SSU
Temperature	5°F - 480°F
Rotation	CW Standard

PUMP FEATURES

- Hydrodynamically balanced rotor set
- Optional integral relief valve
- Face, foot or vertical mounting
- Inline or custom ANSI Flanges
- Internal or external ball bearing

Test Report
Three Phase Induction Motor

Motor's Serial Number
1032367029

WEG Equipamentos Elétricos S/A. - Motores | **Quality Control - Electric Laboratory IV**

Av. Pref. Waldemar Grubba, 3000 - 89256-900, Jaragua do Sul - Santa Catarina - Brasil

Customer: WEG ELECTRIC CORPORATION - WEC
Sales Order: 4080834

1. Motor Identification

TAG: -
Material: 11433391
Frame: 182/4TC
Mounting: B34R(D)
Approximate Weight (LBS): 112
Drawing: -

Enclosure: IP55
Altitude (m): 1000
Duty Cycle: S1
Design: B

Insulation Class: F
Temperature Rise (K): 80
Ambient Temperature (°C): 40
Service Factor: 1.25

Voltage (V)	Current (A)	Power (HP)	Freq. (Hz)	Speed (rpm)	P.F.	Eff. (%)
460	6.45	5	60	1755	0.8	89.5

2. Tests

2.1. Electric Resistance

Resistance (Ohms): 2.485 / 2.480 / 2.469
Ambient Temperature (°C): 18.9

Unbalance (%): 0.65
Connection Type: T1-T2-T3

2.2. Vibration

Unfiltered vibration (mm/s peak // in/s peak)*			
Position	**Horizontal**	**Vertical**	**Axial**
DE	0.10 // 0.00	0.15 // 0.01	0.18 // 0.01
NDE	0.14 // 0.01	0.25 // 0.01	-

* Test performed on rigid mounting

2.3. No Load

Voltage (V): 460.0
Frequency (Hz): 60.0

Current (A): 2.95
Speed (rpm): 1800

Power (W): 227.80
Direction of Rotation: Clockwise

2.4. Withstand Voltage AC

Voltage (kV): 1.92

Time (s): 60

Current (mA): 4.20

2.5. Insulation Resistance

Resistance (MOhms): 11000

Time (s): 60

Ambient Temperature (°C): 19.5

3. Result

Test approved in accordance with the requirements of IEEE 841: 2009

NOTES:
00518ST3QIE184TC-W22 modified for F2 mount.
120v space heaters
PES.245491-1-A shown on nameplate

* Confidential report. Reproduction of this document shall not be partial and depends on the written approval of the laboratory;
* The results presented in this document refer exclusively to the electric motor subjected to the specified tests and do not extend to any batch;
* WEG will keep the original document archived for at least five years.

WEG Motors	Customer
Sidnei Borgonovo Test Date: 6/1/2016	Inspector

Test Report
Three Phase Induction Motor

Motor's Serial Number
g1032367030

WEG Equipamentos Elétricos S/A. - Motores | **Quality Control - Electric Laboratory IV**
Av. Pref. Waldemar Grubba, 3000 - 89256-900, Jaragua do Sul - Santa Catarina - Brasil

Customer: WEG ELECTRIC CORPORATION - WEC
Sales Order: 4080834

1. Motor Identification

TAG: -
Material: 11433391
Frame: 182/4TC
Mounting: B34R(D)
Approximate Weight (LBS): 112
Drawing: -

Enclosure: IP55
Altitude (m): 1000
Duty Cycle: S1
Design: B

Insulation Class: F
Temperature Rise (K): 80
Ambient Temperature (°C): 40
Service Factor: 1.25

Voltage (V)	Current (A)	Power (HP)	Freq. (Hz)	Speed (rpm)	P.F.	Eff. (%)
460	6.45	5	60	1755	0.8	89.5

2. Tests

2.1. Electric Resistance

Resistance (Ohms): 2.484 / 2.474 / 2.479
Ambient Temperature (°C): 19.5

Unbalance (%): 0.40
Connection Type: T1-T2-T3

2.2. Vibration

Unfiltered vibration (mm/s peak // in/s peak)*			
Position	**Horizontal**	**Vertical**	**Axial**
DE	0.12 // 0.00	0.24 // 0.01	0.23 // 0.01
NDE	0.29 // 0.01	0.26 // 0.01	-

* Test performed on rigid mounting

2.3. No Load

Voltage (V): 459.9
Frequency (Hz): 60.0

Current (A): 2.93
Speed (rpm): 1800

Power (W): 210.80
Direction of Rotation: Clockwise

2.4. Withstand Voltage AC

Voltage (kV): 1.92

Time (s): 60

Current (mA): 5.10

2.5. Insulation Resistance

Resistance (MOhms): 11000

Time (s): 60

Ambient Temperature (°C): 19.6

3. Result

Test approved in accordance with the requirements of IEEE 841: 2009

NOTES:
00518ST3QIE184TC-W22 modified for F2 mount.
120v space heaters
PES.245491-1-B shown on nameplate

* Confidential report. Reproduction of this document shall not be partial and depends on the written approval of the laboratory;
* The results presented in this document refer exclusively to the electric motor subjected to the specified tests and do not extend to any batch;
* WEG will keep the original document archived for at least five years.

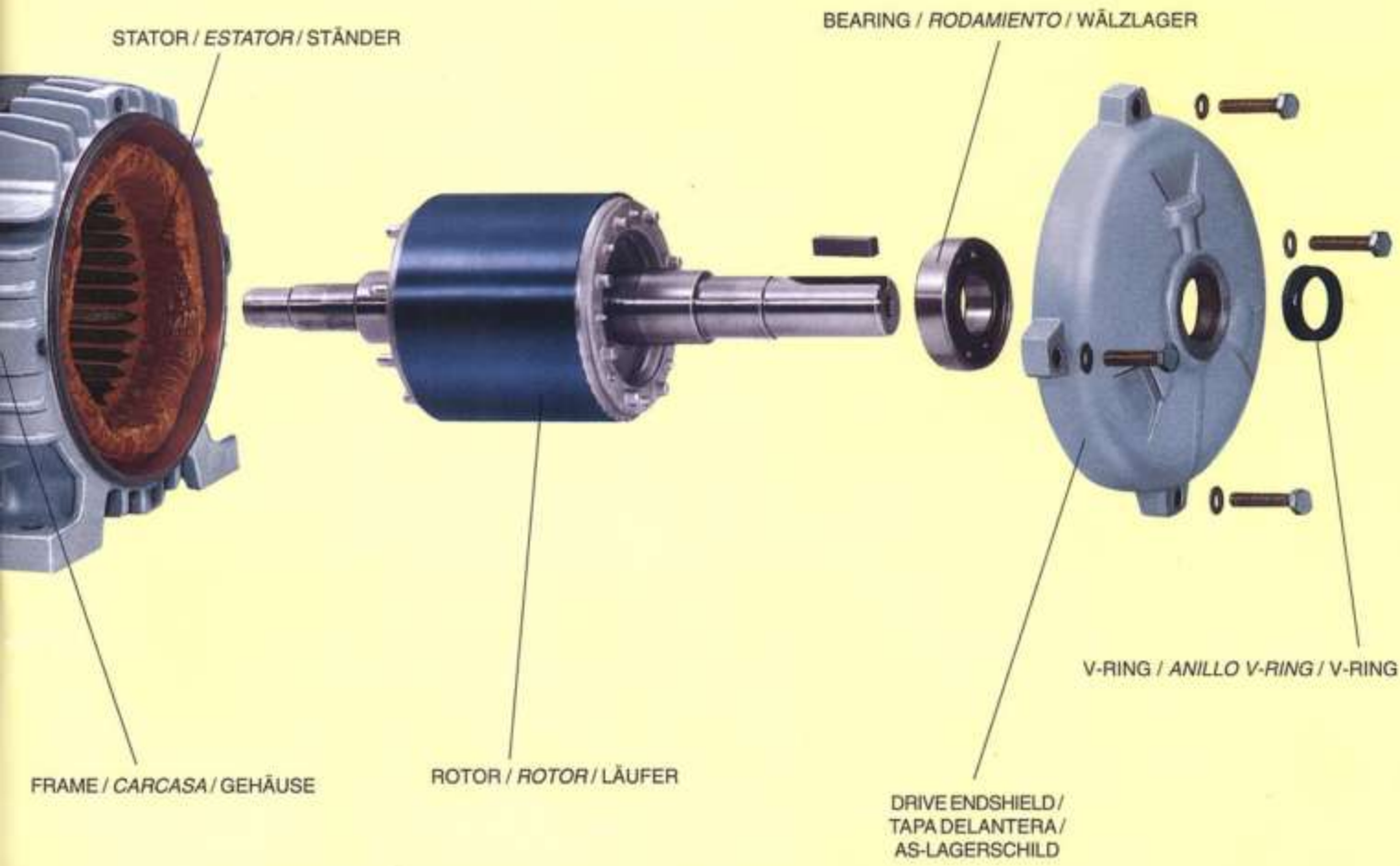
WEG Motors	Customer
Sidnei Borgonovo Test Date: 6/1/2016	Inspector

MOTORS & DRIVES

Installation and Maintenance Manual for Electric Motors

Manual de Instalacion y Mantenimiento de Motores Electricos

Aufstellungs - Und Wartungsanleitungen für Elektrische Motoren



QUALITY SYSTEM ISO 9001 WEG MOTORES



FOREWORD

The electric motor is an equipment widely used by man in the industrial development as most of the machines he has been inventing depend on it.
Taking into consideration the prominent role the electric motor plays on people's life, it must be regarded as a prime power unit embodying features that require special care including its installation and maintenance in order to ensure perfect operation and longer life to the unit. This means that the electric motor should receive particular attention.
The INSTALLATION AND MAINTENANCE MANUAL FOR LOW VOLTAGE THREE-PHASE INDUCTION MOTORS intends to assist those who deal with electric machines facilitating their task to preserve the most important item of the unit:

THE ELECTRIC MOTOR.

WEG

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1 - INTRODUCTION

This manual covers all WEG asynchronous induction squirrel cage motors, that is, three phase motors in frames 63 to 355, and single-phase motors.
The motors mentioned in this manual are subject to continuous improvement. Therefore, any information is subject to change without prior notice.
For further details, please contact WEG.

2 - BASIC INSTRUCTIONS

2.1 - GENERAL INSTRUCTIONS

All personnel involved with electrical equipment, either installation, operation or maintenance should be well-informed and updated concerning the safety norms and principles that govern the work and, furthermore, they are advised to heed them. Before work commences, it is the responsibility of the person in charge to ascertain that these have been duly complied with and to alert his personnel of the inherent hazards of the job in hand.
It is recommended that these tasks be undertaken by qualified personnel.
Fire fighting equipment, and notices concerning first aid should not be lacking at the work site; these should be visible and accessible at all times.

2.2 - DELIVERY

Prior to shipment, motors are factory-tested and dynamically balanced. With half key to ensure perfect operation.
Upon receipt, we recommend careful handling and a physical checking for any damage which may have occured during transportation.
In the event of any damage, both the nearest WEG sales office and the carrier should be informed immediately.

2.3 - STORAGE

Motors should be lifted by their eyebolts and never by the shaft. Raising and lowering must be steady and joltless, otherwise bearings may be damaged.
When motors are not immediately installed, they should be stored in their normal upright position in a dry even temperature place, free of dust, gases and corrosive smoke. Other objects should not be placed on or against them.
Motors stored over long periods are subject to loss of insulation resistance and oxidation of bearings.

Bearings and the lubricant deserve special attention during long periods of storage. Depending on the length and conditions of storage it may be necessary to regrease or change rusted bearings. The weight of the rotor in an inactive motor tends to expel grease from the bearing surfaces thereby removing the protective film that impedes metal-to-metal contact. As a preventive measure against the formation of corrosion by contact, motors should not be stored near machines which cause vibrations, and their shaft should be rotated manually at least once a month.

Recommendations for Storage of Bearings:

- Ambient must be dry with relative humidity not exceeding 60%.
- Clean room with temperature ranging from 10ºC to 30ºC.
- Maximum stacking of 5 boxes.
- Far from chemical products and tubes conducting steams, water and compressed air.
- They should not be stacked over stone floors or against walls.
- Stock should follow the first-in-first-out principle.
- Double shielded bearings should not remain in stock for more than 2 years.

Storage of motors:
- Mounted motors which are kept in stock must have their shaft turned periodically, at least once a month, in order to renew the grease on the bearing races.

It is difficult to prescribe rules for the actual insulation resistance value of a machine as the resistance varies according to the type, size and rated voltage and the state of the insulation material used, method of construction and the machine's insulation antecedents. A lot of experience is necessary to decide when a machine is ready or not to be put into service. Periodical records are useful to take such decision.

The following guidelines show the approximate values that can be expected of a clean and dry machine when, at 40ºC, test voltage is applied over a period of one minute.

Insulation resistance Rm is obtained by the formula:

$$Rm = Un + 1$$

where: Rm - minimum recommended insulation resistance in MΩ with winding at 40ºC.
Un - machine rated voltage in kV.

In case that the test is carried out at a temperature other that 40ºC, the reading must be corrected to 40ºC using a curve of insulation resistance vs. temperature for the particular machine. If such curve is not available, an approximation is possible with the aid of Figure 2.1; it is possible to verify that resistance practically doubles every 10ºC that insulating temperature is lowered.

On new machines, lower values are often attained due to solvents present in the insulating varnishes that later evaporate during normal operation. This does not necessarily mean that the machine is not operational, since insulating resistance will increase after a period of service.

On motors which have been in service for a period of time, much larger values are often attained. A comparison of the values recorded in previous tests on the same machine, under similar load, temperature and humidity conditions, serves as a better indication of insulation condition than that of the value coming from a single test. Any substantial or sudden reduction is suspect.

Insulation resistance is usually measured with a MEGGER. In the event that insulation resistance be inferior to the values coming from the above formula, motors should be submitted to a drying process.

This drying process should be carried out in a stove, where the rate of temperature rise should not exceed 5ºC per hour and the temperature should not exceed 110ºC.

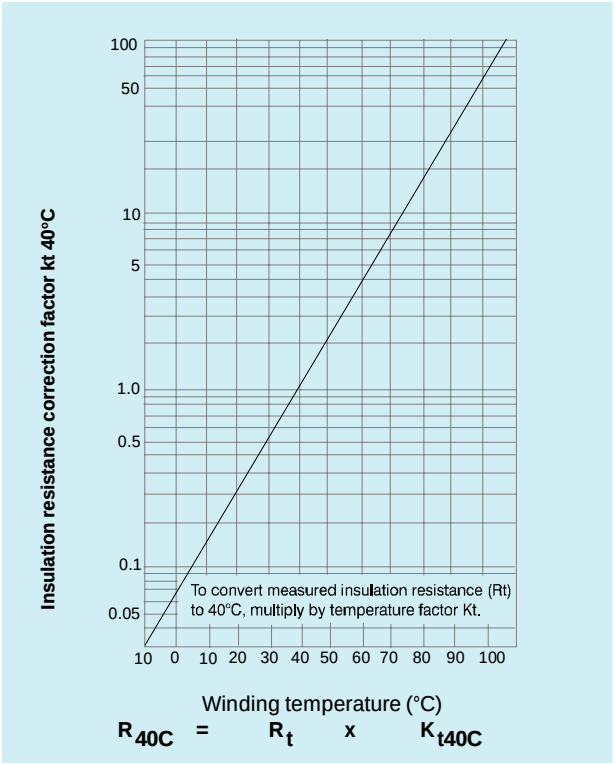


Fig. 2.1 Approximate calculation curve of the insulation resistance.

3 - INSTALLATION

Electric machines should be installed in such a way to allow easy access for inspection and maintenance. Should the surrounding atmosphere be humid, corrosive or containing flammable substance or particles, it is essential to ensure an adequate degree of protection.
The installation of motors on ambients where there are steams, gases or dusts, flammable or combustible materials, subject to fire or explosion, should be undertaken according to appropriate and governing codes, such as ABNT/IEC 7914, NBR 5418, VDE 0165, NEC-ART. 500, UL-674.
Under no circumstances motors can be enclosed in boxes or covered with materials which may impede or reduce the free circulation of cooling air.
Machines fitted with external ventilation should be at least 50cm far from the wall to permit air movement.
The place of installation should allow for air renewal at a rate of 20 cubic meter per minute for each 100kW of motor output considering ambient temperature of 40ºC and altitude of 1000 m.a.s.l.

3.1 - MECHANICAL ASPECTS

3.1.1 - FOUNDATION

The motor base must be level and as far as possible free of vibrations.
A concrete foundation is recommended for motors over 100 HP (75kW).
The choice of base will depend upon the nature of the soil at the place of installation or of the floor capacity in the case of buildings.
When designing the motor base, keep in mind that the motor may ocasionally be run at a torque above that of the rated full load torque.
Based upon Figure 3.1, foundation stresses can be calculated by using the following formula:

$$F1 = 0.5.g.G - \frac{4\ Tmax}{A} \qquad F2 = 0.5.g.G + \frac{4\ Tmax}{A}$$

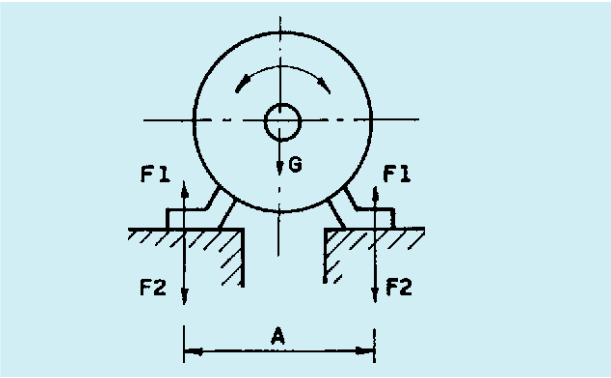


Fig. 3.1 - Base Stresses

Where:
F1 and F2 - Lateral Stress (N)
g - Gravity Force (9.8m/s²)
G - Motor Weight (kg)
Tmax - Breakdown torque (Nm)
A - Obtained from the dimensional drawing of the motor(m)

Sunken bolts or metallic base plates should be used to secure the motor to the base.

3.1.2 - TYPES OF BASES

a) Slide Rails

When motor drive is by pulleys the motor should be mounted on slide rails and the lower part of the belt should be pulling to avoid belt sleppage during operation and also to avoid the belts to operate sidewise causing damage to bearing shoulders.
The rail nearest the drive pulley is positioned in such a way that the adjusting bolt be between the motor and the driven machine. The other rail should be placed with the bolt in the opposite position, as shown in Fig. 3.2.

The motor is bolted to the rails and set on the base. Drive and driven pulley centers must be correctly aligned on the same way, motor and driven machine shafts must be parallel.

The belt should not be overly stretched, see Fig. 3.10.
After the alignment, the rails are fixed, as shown below:

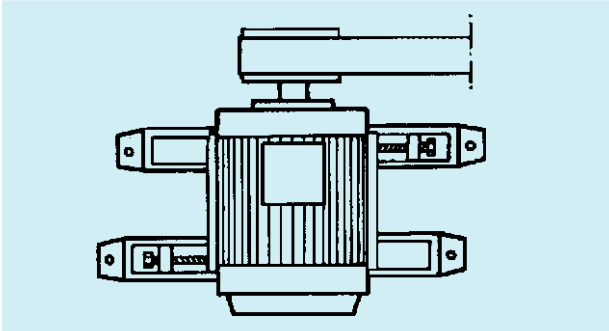


Fig. 3.2 - Positioning of slide rails for motor alignment.

b) Foundation Studs

Very often, particularly when drive is by flexible coupling, motor is anchored directly to the base with foundation studs.
This type of coupling does not allow any thrust over the bearings and it is of low cost.
Foundation studs should neither be painted nor rusted as both interfere with the adherence of the concrete, and bring about loosening.

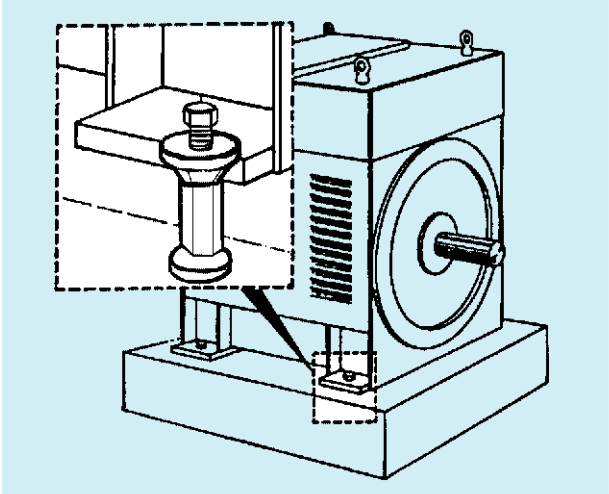


Fig. 3.3 - Motor mounted on a concrete base with foundation studs.

c) Metallic Base

Motor-generator sets are assembled and tested at the factory prior to delivery. However, before putting into service at site, coupling alignment should be carefully checked as the metallic base could have suffered displacement during transit due to internal stresses of the material.
The metallic base is susceptible to distortion if secured to a foundation that is not completely flat.
Machines should not be removed from their common metallic base for alignment; the metallic base should be level on the actual foundation with the aid of a spirit level (or similar instrument).
When a metallic base is used to adjust the height of the motor shaft end with the machine shaft end, the latter should be level on the concrete base.
After the base has been levelled, foundation, studs tightened, and the coupling checked, the metal base and the studs are cemented.

3.1.3- ALIGNMENT

The electric motor should be accurately aligned with the driven machine, particularly in cases of direct coupling. An incorrect alignment can cause bearing failure, vibrations and even shaft rupture.
The best way to ensure correct alignment is to use dial gauges

placed on each coupling half, one reading radially and the other axially.
Thus, simultaneous readings are possible and allow checking for any parallel (Fig. 3.4) and concentricity deviations (Fig. 3.5) by rotating the shafts one turn.
Gauge readings should not exceed 0.05 mm.

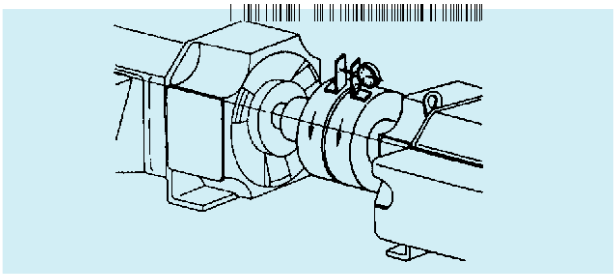


Fig. 3.4 - Deviation from parallelism

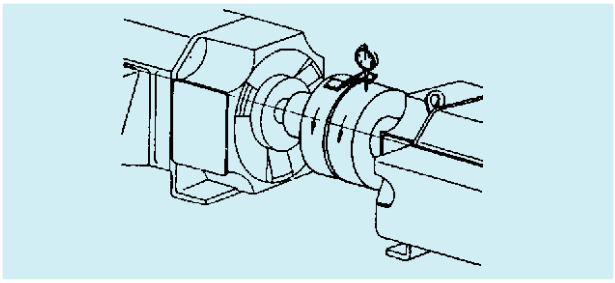


Fig. 3.5 - Deviation from concentricity

3.1.4- COUPLING

a) Direct Coupling

Direct coupling is always preferable due to low cost, space economy, no belt slippage and lower accident risk.
In cases of speed ratio drives, it is also common to use a direct coupling with a reducer (gear box).
CAUTION: Carefully align the shaft ends using, whenever feasible, a flexible coupling, leaving a minimum tolerance of 3 mm between the couplings (GAP).

b) Gear Coupling

Poorly aligned gear couplings are the cause of jerking motions which cause vibrations on the actual drive and on the motor.
Therefore, due care must be taken for perfect shaft alignment: exactly parallel in the case of straight gears and at the correct angle for bevel or helical gears.
Perfect gear engagement can be checked by the insertion of a strip of paper on which the teeth marks will be traced after a single rotation.

c) Belt and Pulley Coupling

Belt coupling is most commonly used when a speed ratio is required.
Assembly of Pulleys: To assemble pulleys on shaft ends with a keyway and threaded end holes the pulley should be inserted halfway up the keyway merely by manual pressure.
On shafts without threaded end holes, the heating of the pulley to about 80ºC is recommended, or alternatively, the devices illustrated in Figure 3.6 may be employed.

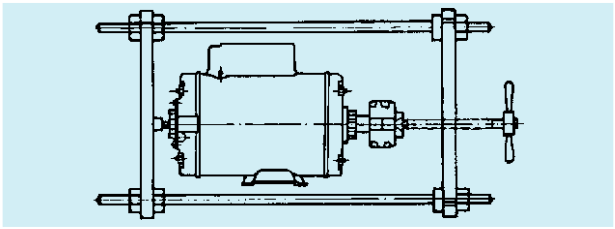


Fig. 3.6 - Pulley mounting device

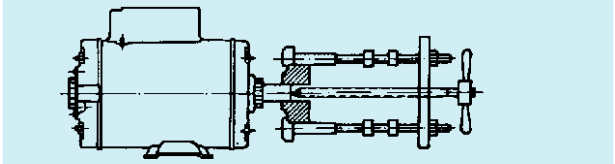


Fig. 3.7 - Pulley extractor

Hammers should be avoided during the fitting of pulleys and bearings. The fitting of bearings with the aid of hammers leaves blemishes on the bearing races. These initially small flaws increase with usage and can develop to a stage that completely impairs the bearing.
The correct positioning of a pulley is shown in Figure 3.8.

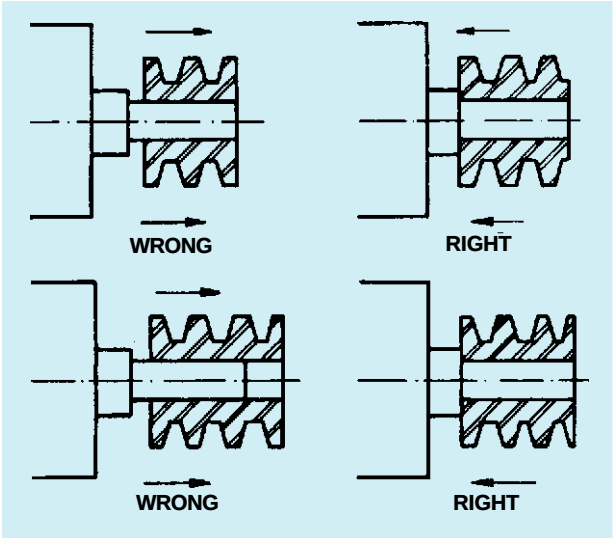


Fig. 3.8 - Correct positioning of pulley on the shaft.

RUNNING: To avoid needless radial stresses on the bearings it is imperative that shafts are parallel and the pulleys perfectly aligned. (Figure 3.9).

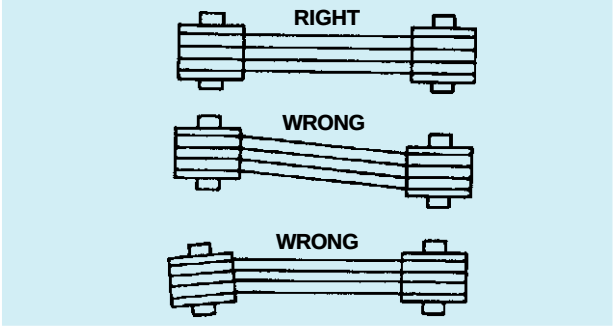


Fig. 3.9 - Correct pulley alignment

Pulleys that are too small should be avoided; these cause shaft flexion because belt traction increases in proportion to a decrease in the pulley size. Table 1 determines minimum pulley diameters, and Table 2 and 3 refer to the maximum stresses acceptable on motor bearings up to frame 355.

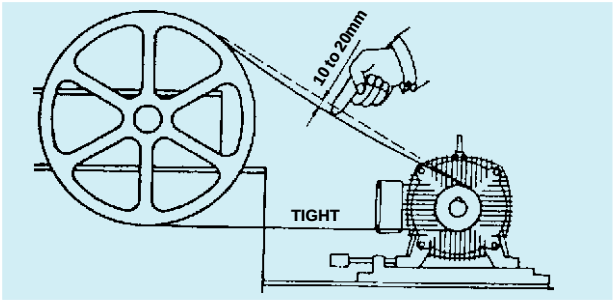


Fig. 3.10 - Belt tensions

Laterally misaligned pulleys, when running, transmit alternating knocks to the rotor and can damage the bearing housing. Belt slippage can be avoided by applying a resin (rosin for example).
Belt tension should be sufficient to avoid slippage during operation.

TABLE 1

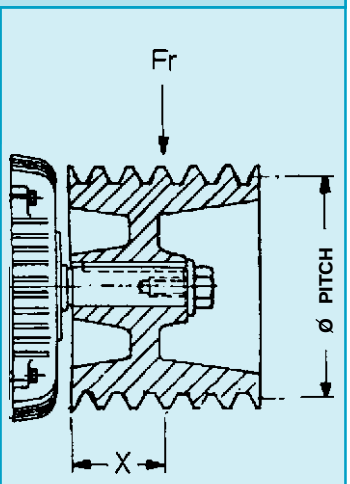
MINIMUM PITCH DIAMETER OF PULLEYS								
Frame	BALL BEARINGS							
	Bearing	Size X (mm)						
		20	40	60	80	100	120	
63	6201-ZZ	40	---	---	---	---	---	
71	6203-ZZ	40	40	---	---	---	---	
80	6204-ZZ	40	40	---	---	---	---	
90	6205-ZZ	63	71	80	---	---	---	
100	6206-ZZ	71	80	90	---	---	---	
112	6307-ZZ	71	80	90	---	---	---	
132	6308-ZZ	---	100	112	125	---	---	
160	6309-Z-C3	---	140	160	180	200	---	
180	6311-Z-C3	---	---	160	180	200	224	
200	6312-Z-C3	---	---	200	224	250	280	

TABLE 1.1

Frame	Poles	BALL BEARINGS				
		Bearing	Size X (mm)			
			50	80	110	140
225	IV-VI-VIII	6314	250	265	280	300
250	IV-VI-VIII	6314	375	400	425	450
280	IV-VI-VIII	6316	500	530	560	600
315	IV-VI-VIII	6319	-----	-----	-----	-----
355	IV-VI-VIII	6322	-----	-----	-----	-----

For II pole motors, contact Weg.

TABLE 1.2

Frame	Poles	Roller Bearings						
		Bearing	Size x (mm)					
			50	80	100	140	170	210
225	IV-VI-VIII	NU 314	77	80	110	136	-----	-----
250	IV-VI-VIII	NU 314	105	115	145	175	-----	-----
280	IV-VI-VIII	NU 316	135	140	170	210	-----	-----
315	IV-VI-VIII	NU 319	-----	170	185	225	285	-----
355	IV-VI-VIII	NU 322	-----	-----	345	410	455	565

TABLE 2

MAXIMUM ACCEPTABLE RADIAL LOAD (N) - IP55 MOTORS - 60Hz				
FRAME	POLES			
	II	IV	VI	VIII
63	245	294	-----	-----
71	294	392	-----	----
80	343	491	-----	-----
90	392	540	589	687
100	589	785	883	981
112	1040	1275	1472	1668
132	1275	1570	1864	1962
160	1570	1962	2256	2551
180	2060	2649	3041	3434
200	2354	3139	3630	4120
225	3041	4120	4415	5003
250	2845	3728	4316	4807
280	3532	4513	5101	5690
315	3335	4905	5690	6475
355	----	15402	15402	15402

MAXIMUM ACCEPTABLE RADIAL LOAD (N) - IP55 MOTORS - 50Hz				
FRAME	POLES			
	II	IV	VI	VIII
63	245	294	-----	-----
71	294	392	-----	----
80	343	491	-----	-----
90	392	589	638	687
100	589	834	932	1079
112	1079	1373	1570	1766
132	1373	1668	1962	2060
160	1668	2060	2403	2698
180	2158	2796	3237	3630
200	2502	3335	3826	4365
225	3237	4365	4709	5297
250	3041	3924	4611	5101
280	3728	4807	5396	5984
315	3532	5199	5984	6867
355	----	16285	16285	16285

TABLE 2.1

MAXIMUM ACCEPTABLE RADIAL LOAD (Kgf) - 60Hz AND 50Hz				
NEMA 56 MOTORS (SINGLE-PHASE)				
FRAME	RADIAL FORCE (N)			
	POLES			
	II	IV	VI	VIII
56 A	245	343	-----	-----
56 B	294	343	-----	-----
56 D	343	441	-----	-----
SAW ARBOR MOTORS (THREE-PHASE)				
80 S - MS	981	-----	-----	-----
80 H - MS	981	-----	-----	-----
80 L - MS	981	-----	-----	-----
90 L - MS	1275	1570	-----	-----

Concerning ODP NEMA 48 & 56 fractional motors, these have the following features:

- Rotor: Squirrel cage
- Protection: Open drip proof
- Insulation: Class “B” (130ºC) - IEC 34
- Cooling system: internal
- Bearings: Ball
- Standards: NEMA MG-1
- Voltage: Single phase: 110/220V
  Three phase: 220/380V
- Frequency: 60Hz and 50Hz

For more information referring to motor features, please contact WEG.

TABLE 3

MAXIMUM ACCEPTABLE AXIAL LOAD (N) - f = 60 Hz TOTALLY ENCLOSED FAN COOLED MOTORS - IP55																
FRAME	POSITION / MOUNTING CONFIGURATION															
																
	II	IV	VI	VIII	II	IV	VI	VIII	II	IV	VI	VIII	II	IV	VI	VIII
63	275	363	422	-	275	363	422	-	265	343	412	-	265	343	412	-
71	294	402	471	530	363	491	579	647	284	383	451	520	353	481	559	638
80	353	481	559	638	471	647	755	844	334	451	530	608	461	618	726	824
90	451	618	746	834	491	667	824	922	422	569	706	785	461	628	775	873
100	481	657	795	903	687	932	1128	1275	432	589	726	834	638	873	1069	1207
112	677	912	1109	1275	1197	1628	1972	2227	608	824	1020	1187	1138	1540	1874	2139
132	834	1158	1383	1570	1422	1982	2364	2659	706	1010	1207	1364	1305	1825	2178	2453
160	1197	1648	1884	2168	2040	2747	3178	3620	952	1383	1560	1884	1795	2482	2855	3335
180	-	2178	2492	2815	-	3718	4307	4846	-	1825	1991	2315	-	3375	3806	4365
200	1668	2207	2659	3041	3129	4130	4895	5552	1197	1579	2040	2472	2659	3483	4277	4983
225	3983	5278	6200	6985	3983	5278	6200	6985	3335	4454	5297	6082	3335	4454	5297	6082
250	3895	5180	6053	6828	3895	5180	6053	6828	3129	4169	4876	5651	3129	4169	4876	5651
280	3747	5964	7073	7985	3747	5964	7073	7985	2541	4424	5307	6239	2541	4424	5307	6239
315	3424	5562	6622	7514	3424	5562	6622	7514	1579	3208	3924	4836	1579	3208	3924	4836
355	3120	6259	7338	8299	3120	6259	7338	8299	451	2109	2443	2659	451	2109	2443	2659

MAXIMUM ACCEPTABLE AXIAL LOAD (N) - f = 50 Hz TOTALLY ENCLOSED FAN COOLED MOTORS - IP55																
FRAME	POSITION / MOUNTING CONFIGURATION															
																
	II	IV	VI	VIII	II	IV	VI	VIII	II	IV	VI	VIII	II	IV	VI	VIII
63	294	392	441	-	294	392	441	-	284	363	441	-	294	392	441	-
71	314	432	491	559	392	520	618	687	304	402	481	549	373	510	589	677
80	373	510	589	677	491	687	785	893	353	481	559	647	491	657	765	873
90	481	657	785	883	520	706	873	981	441	618	746	834	491	667	824	922
100	510	697	844	961	726	981	1197	1354	461	628	765	883	677	922	1128	1275
112	716	961	1177	1354	1275	1727	2090	2354	647	873	1079	1256	1207	1628	1982	2266
132	883	1226	1472	1668	1511	2080	2502	2815	765	1069	1275	1442	1383	1933	2305	2600
160	1275	1746	1991	2296	2158	2914	3375	3836	1010	1472	1658	1991	1903	2629	3021	3532
180	-	2305	2649	2982	-	3944	4562	5131	-	1933	2109	2453	-	3581	4032	4630
200	1766	2335	2815	3227	3316	4375	5189	5886	1275	1668	2158	2619	2815	3689	4532	5278
225	4218	5592	6573	7407	4218	5592	6573	7407	3532	4719	5611	6445	3532	4719	5611	6445
250	4120	5494	6416	7230	4120	5494	6416	7230	3316	4415	5160	5984	3316	4415	5160	5984
280	3973	6318	7505	8466	3973	6318	7505	8466	2688	4689	5621	6612	2688	4689	5621	6612
315	3630	5886	7014	7966	3630	5886	7014	7966	1668	3404	4159	5121	1668	3404	4159	5121
355	3306	6632	7779	8790	3306	6632	7779	8790	481	2237	2590	2815	481	2237	2590	2815

TABLE 3.1

MAXIMUM ACCEPTABLE AXIAL LOAD (N) - f = 60 Hz and 50Hz								
FRAME	POSITION / MOUNTING CONFIGURATION FRAME							
	 Fa1 Fa2		 Fa1 Fa2		 Fa1  Fa1		 Fa2  Fa2	
	II	IV	II	IV	II	IV	II	IV
56 A	294	392	363	491	275	373	343	471
56 B	294	392	353	481	275	363	343	461
56 D	275	383	461	638	255	353	441	608

3.2 - ELECTRICAL ASPECTS

3.2.1- POWER SUPPLY SYSTEM

Proper electric power supply is very important. The choice of motor feed conductors, whether branch or distribution circuits, should be based on the rated current of the motors as per IEC 34 Standard.

NOTE: In the case of variable speed motors, the highest value among the rated currents should be considered. When motor operation is intermittent the conductors should have a current carrying capacity equal or greater, to the product of the motor rated current times the running cycle factor shown in Table 4.

IMPORTANT: For a correct choice of motor feed conductors, we recommend to check the standards requirements for industrial installations.

TABLE 4

Service Duty Factor				
Motor Rated Service Time / Classification	5 min.	15 min.	30 to 60 min.	Continuous
Short (valve operation, contact operation, etc.)	1.10	1.20	1.50	-
Intermittent (load or building elevators, tools, pumps, rolling bridges, etc.)	0.85	0.85	0.90	1.40
Periodical (Rolling mill, mining machines, etc.)	0.85	0.90	0.95	1.40
Variable	1.10	1.20	1.50	2.00

3.2.2 - STARTING OF ELECTRIC MOTORS

Induction motors can be started by the following methods:

DIRECT STARTING

Whenever possible a three phase motor with a squirrel cage should be started directly at full voltage supply by means of contactors. It has to be taken into account that for a certain motor, torque and current curves are fixed, independently of the load, for constant voltage.

In cases where motor starting current is high, this can cause interference to the following:

a) Significant voltage drop in the power supply feeding system. As a consequence, other equipment connected to the same system can suffer interference.

b) The protection system (cables and contactors) must be overdesigned leading to a high cost.

c) Power supply utilities will limit the supply voltage drop.

In cases where DOL starting is not feasible due to above given reasons, then indirect system can be used in order to reduce the starting current such as:
- Star-delta starting
- Starting with compensating switch (auto-transformer starting)
- Series-parallel starting
- Electronic starting (soft-start)

STAR-DELTA STARTING

It is fundamental for star-delta starting that three phase motor have the required number of leads to allow connection on both voltages, that is, 220/380V, 380/660V or 440/760V.
These motors should have at least 6 connecting leads. The starting has to be made at no load. The star-delta starting can be used when the motor torque curve is sufficiently high to guarantee acceleration of the load at reduced voltage. At star connection, current is reduced to 25% to 30% of the starting current in comparison to delta connection.
Torque curve is also reduced proportionally. For this reason, every time a star-delta starting is required, a high torque curve motor must be used.
WEG motors have high starting and breakdown torque. Hence, they are suitable in most cases for star-delta starting.
The load resistant torque can not exceed the motor starting torque, neither the current when switching to delta connection can not be of an unacceptable value.
There are cases where this starting method can not be used. For example, when the resistant torque is too high. If the starting is made at star, motor will accelerate the load up to approximately 85% of the rated speed. In this point, the switch must be connected at delta. In this case, the current which is about the rated current jumps, suddenly, which is in fact not advantageous, as the purpose is to reduce the starting current.
Table 5 shows the most common multiple rated voltages for three phase motors and their use to the usual power supply voltages.
The DOL or compensating switch starting is applicable to all cases of table 5.

TABLE 5

Normal connections for three phase motors		
Winding design	**Operation Voltage**	**Star-delta starting**
220V/380V	220 V 380 V	yes no
220/440/230/460	220V/230V 440V/760V	no yes
380V/660V	380V	yes
220/380/440/760	220V 380V 440V	yes no yes

STARTING WITH COMPENSATING SWITCH (AUTO-TRANSFORMER)

This starting method can be used to start motors hooked to the load. It reduces the starting current avoiding in this way overload giving the motor enough torque for the starting and acceleration. The voltage in the compensating switch is reduced through an auto-transformer which normally has TAPS of 50, 65 and 80% of the rated voltage.

SERIES - PARALLEL STARTING

For series-parallel starting, motor must allow reconnection for two voltages:
The lowest to be equal to the power supply voltage and the other twice higher.
This starting method requires 9 connecting leads in the motor, and the most common voltage is 220/440V, that is, during the starting, motor is series connected until it reaches the rated speed and then it is switched to parallel connection.

ELECTRONIC STARTING (SOFT START)

The advance of the electronics has allowed creation of the solid state starting switch which is composed of a set of pairs of tiristors (SCR) (or combination of tiristors/diodes), one on each motor output borne.
The trigger angle of each pair of tiristors is controlled electronically to apply a variable voltage to the motor terminals during the acceleration. At the final moment of the starting, typically adjusted between 2 and 30 seconds, voltage reaches its full load value after a smooth acceleration or an increasing ramp, instead of being submitted to increasing or sudden jumps.
Due to that it is possible to keep the starting current (in the power supply) close to the rated current and with slight variation.
Besides the advantage of controlling the voltage (current) during the starting, the electronic switch has also the advantage of not having moving parts or those that generate arc, as it happens with mechanical switches. This is a strong point of the electronic switches as their useful life is extended.

3.2.3 - MOTOR PROTECTION

Motors in continuous use should be protected from overloads by means of a device incorporated into the motor, or by an independent device, usually a fixed or adjustable thermal relay equal or less than to the value originated from the multiplication of the rated feed current at full load by:
- 1.25 for motors with a service factor equal or superior to 1.15; or
- 1.15 for motors with service factor equal to 1.0 (IEC 34)

Some motors are optionally fitted with overheating protective devices such as thermoresistances, thermistors, thermostats or thermal protectors.
The type of temperature detector to be used are selected taking into consideration the motor insulation temperature, type of motor and customer requirement.

THERMOSTAT (THERMAL PROBE)

They are bimetallic thermal detectors with normally closed silver contacts. They open as the temperature increases and then return to the original position as soon as the temperature acting on the bimetallic decreases, allowing new closing of the contacts.
Thermostats can be used for alarm, tripping systems or both (alarm and tripping) of three phase electric motors when requested by the customer. Thermostats are series connected directly to the contactor coil circuit.
Depending on the safety level and customer requirement, three thermostats (one per phase) or six thermostats (two per phase) can be installed. In order to operate as alarm and tripping (two thermostats per phase), the alarm thermostats must be suitable to act at the motor predetermined temperature, while the tripping thermostats must act at the maximum temperature of the insulating material.
Thermostats are also used on special applications of single phase motors. On these applications, the thermostat can be series connected with the motor power supply as long as the motor current does not exceed the maximum acceptable current of the thermostat.
If this occurs, connect the thermostat in series with the contactor coil.
Thermostats are installed in the coil heads of different phases.

THERMISTORS (PTC and NTC)

These are semi-conductor heat detectors which sharply change their resistance upon reading a set temperature.
PTC - Positive temperature coeficient.
NTC - Negative temperature coeficient.
The PTC type is a thermistor whose resistance increases sharply to a temperature defined value specified for each type. This sudden variation of the resistance interrupts the current in the PTC by acting an outlet relay which switches off the main circuit. It can also be used for alarm and tripping systems (two per phase).
NTC thermistors, which act adversily of PTC's, are not normally used on WEG motors as the control electronic circuits available commonly apply to PTC's.
Thermistors have reduced size, do not suffer mechanical wear and act quicker in relation to other temperature detectors.
Fitted with control electronic circuits, thermistors give complete protection for overheating, overload, sub or overvoltages or frequent reversing or on - off operations.
It is a low cost device, similar to a PT-100, but it requires a commanding relay for alarm or operation.

RESISTANCE TEMPERATURE DETECTORS (RTD) PT-100

The RTD operates on the principle that the electrical resistance of a metallic conductor varies linearly with the temperature. It is an element usually made of copper, platinum or nickel which allows a continuous follow up of the motor heating process through a control panel of high precision and acting sensibility. Highly used in the industry in general where temperature measuring and automation techniques are required. Also widely used on applications that require irregular intermittent duty.
A single detector can be used for alarm and tripping purposes.

THERMAL PROTECTORS

These are bimetallic thermal detectors with normally closed silver contacts. Mainly used as protection of single phase motors against overheating caused by overloads, locked rotor, voltage drop, etc. They are normally fitted in the motors when requested by the customer. The basic components are a bimetallic disc, two flexible contacts, a resistance and a pair of fixed contacts.
It is series connected with the supply voltage and, due to a thermal dissipation caused by the current pass through its internal resistance, the disc is deformed enough to open the contacts, and then motor feeding is interrupted. As soon as the temperature comes down, the protector should react.
Based on the resetting, there are two types of thermal protectors:

a) Automatic overload protector where the resetting is done automatically.

b) Manual overload protector when the resetting is done through a manual release.

Table 6 shows a comparison between motor protection systems.

TABLE 6

COMPARISON BETWEEN MOTOR PROTECTION SYSTEMS			
Causes of overheating	**Current-based protection**		**Protection with probe thermistor in motor**
	Fuse only	**Fuse and thermal protector**	
Overload with 1.2 times rated current	○	●	●
Duty cycles S1 to S10	○	◑	●
Brakings, reversals and frequent starts	○	◑	●
Operation with more than 15 starts p/hour	○	◑	●
Locked rotor	◑	◑	●
Fault on one phase	○	◑	●
Excessive voltage fluctuation	○	●	●
Frequency fluctuation on main supply	○	●	●
Excessive ambient temperature	○	●	●
External heating caused by bearings, belts, pulleys, etc.	○	○	●
Obstructed ventilation	○	○	●

CAPTION ○ *Unprotected*
◑ *Partially protected*
● *Totally protected*

3.3 - START-UP

3.3.1 - PRELIMINARY INSPECTION

Before starting a motor for the first time, check the following:

a) Remove all locking devices and blocks used in transit and chek that the motor rotates freely;
b) Check if the motor is firmly secured and that coupling elements are correctly mounted and aligned;
c) Ascertain that voltage and frequency correspond to those indicated on the nameplate. Motor performance will be satisfactory as long as voltage and frequency remain in the range determined by IEC Standard.
d) Check if connections are in accordance with the connection diagram shown on the nameplate and be sure that all terminal screws and nuts are tight;
e) Check the motor for proper grounding. Providing that there are no specifications calling for ground-insulated installation, the motor must be grounded in accordance with prevalent standard for grounding electrical machines. The screw identified by the symbol (⏚) should be used for this purpose. This screw is generally to be found in the terminal box or on the motor foot.
f) Check if motor leads correspond with the main supply as well as the control wires, and the overload protection device are in accordance with IEC Standards;
g) If the motor has been stored in a humid place, or has been stopped for some time, measure the insulating resistance as recommended under the item covering storage instructions;
h) Start the motor uncoupled to ascertain that it is running freely and in the desired direction.
To reverse the rotation of a three-phase motor, invert two terminal leads of the main power supply.
Medium voltage motors having an arrow on the frame indicating rotation direction can only turn in the direction shown;

3.3.2 - THE FIRST START-UP

THREE-PHASE MOTOR WITH SQUIRREL CAGE ROTOR

After careful checking of the motor, follow the normal sequence of starting operations listed in the control instructions for the initial start-up.

BEARING SPECIFICATION BY MOTOR TYPE

TABLE 7

FRAMES	Mounting Config.	BEARINGS	
		DE	**ODE**
TEFC motors			
63	all mounting configurations	6201-ZZ	6201-ZZ
71		6203-ZZ	6202-ZZ
80		6204-ZZ	6203-ZZ
90 S		6205-ZZ	6204-ZZ
90 L		6205-ZZ	6204-ZZ
100 L		6206-ZZ	6205-ZZ
112 M		6307-ZZ	6206-ZZ
132 S		6308-ZZ	6207-ZZ
132 M		6308-ZZ	6207-ZZ
160 M		6309-Z-C3	6209-Z-C3
160 L		6309-Z-C3	6209-Z-C3
180 M		6311-Z-C3	6211-Z-C3
180 L		6311-Z-C3	6211 -Z-C3
200 L		6312-Z-C3	6212-Z-C3
200 M		6312-Z-C3	6212-Z-C3
225 S/M		6314-C3	6314-C3
250 S/M		6314-C3	6314-C3
280 S/M		6314-C3**	6314-C3
		6316-C3	6316-C3
315 S/M		6314-C3**	6314-C3
		6319-C3	6316-C3
355 M/L		6314-C3	6314-C3
		NU322-C3	6319-C3

*** Only valid for 2 pole motors.*

3.3.3 - OPERATION

Drive the motor coupled to the load for a period of at least one hour while watching for abnormal noises or signs of overheating.
Compare the line current with the value shown on the nameplate. Under continuous running conditions without load fluctuations, this should not exceed the rated current times the service factor, also shown on the nameplate.
All measuring and control instruments and apparatus should be continuously checked for any deviation and any irregularities corrected.

3.3.4 - STOPPING

Warning:

To touch any moving part of a running motor, even though disconnected, is a danger to life and limb.

Three-phase motor with squirrel cage rotor:
Open the stator circuits switch. With the motor at a complete stop, reset the auto-transformer, if any, to the “start” position.

BEARING SPECIFICATION BY MOTOR TYPE

TABLE 8

FRAMES	Mounting Config.	BEARINGS	
		DE	ODE
TEFC motors			
143 T	all mounting configurations	6205-ZZ	6204-ZZ
145 T		6205-ZZ	6204-ZZ
182 T		6307-ZZ	6206-ZZ
184 T		6307-ZZ	6206-ZZ
213 T		6308-ZZ	6207-ZZ
215 T		6308-ZZ	6207-ZZ
254 T		6309-C3	6209-C3
256 T		6309-C3	6209-C3
284 T / TS		6311-C3	6211-C3
286 T / TS		6311-C3	6211-C3
324 T / TS		6312-C3	6212-C3
326 T / TS		6312-C3	6212-C3
364 T / TS		6314-C3	6314-C3
365 T / TS		6314- C3	6314-C3
404 T		6314-C3	6314-C3
405 TS		6314-C3	6314-C3
444 T		6316-C3	6316-C3
444 TS		6314-C3**	6314-C3
445 T		6316-C3	6316-C3
445 TS		6314-C3**	6314-C3
504 Z		6319-C3	6316-C3
505 U		6314-C3**	6314-C3
505 Z		6319-C3	6316-C3
586 T		6314-C3	6314-C3
587 T		NU 322-C3	6319-C3

*** Only valid for 2 pole motors.*

BEARING SPECIFICATION BY MOTOR TYPE

BEARINGS FOR SAW ARBOR MOTORS

TABLE 8A

SAW ARBOR	Mounting Config.	BEARINGS	
		DE	ODE
80 S MS	B 3	6307-ZZ	6207-ZZ
80 M MS		6307-ZZ	6207-ZZ
80 L MS		6307-ZZ	6207-ZZ
90 L MS		6308-ZZ	6208-ZZ

NEMA FRAME MOTORS

TABLE 8B

NEMA Frames	Mounting Config.	BEARINGS	
		DE	ODE
ODP motors			
48B	all mounting configurations	6203-ZZ	6202-ZZ
56 A		6203-ZZ	6202-ZZ
56 B		6203-ZZ	6202-ZZ
56 D		6204-ZZ	6202-ZZ
56 H		6204-ZZ	6202-ZZ

BEARING LUBRICATION INTERVALS AND AMOUNT OF GREASE

TABLE 9

BALL BEARINGS - SERIES 62/63													
Relubrication intervals (running hours - horizontal position)													
	II pole		IV pole		VI pole		VIII pole		X pole		XII pole		Amount of grease
Serie 62													
Bearing	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	(g)
6209	18400	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	9
6211	14200	16500	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	11
6212	12100	14400	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	13
Serie 63													
Bearing	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	(g)
6309	15700	18100	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	13
6311	11500	13700	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	18
6312	9800	11900	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	21
6314	3600	4500	9700	11600	14200	16400	17300	19700	19700	20000	20000	20000	27
6316	-	-	8500	10400	12800	14900	15900	18700	18700	20000	20000	20000	34
6319	-	-	7000	9000	11000	13000	14000	17400	17400	18600	18600	20000	45
6322	-	-	5100	7200	9200	10800	11800	15100	15100	15500	15500	19300	60

TABLE 10

ROLLER BEARINGS - SERIES NU 3													
Relubrication intervals (running hours - horizontal position)													
	II pole		IV pole		VI pole		VIII pole		X pole		XII pole		Amount of grease
Bearing	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	(g)
NU 309	9800	13300	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	13
NU 311	6400	9200	19100	20000	20000	20000	20000	20000	20000	20000	20000	20000	18
NU 312	5100	7600	17200	20000	20000	20000	20000	20000	20000	20000	20000	20000	21
NU 314	1600	2500	7100	8900	11000	13100	15100	16900	16900	19300	19300	20000	27
NU 316	-	-	6000	7600	9500	11600	13800	15500	15500	17800	17800	20000	34
NU 319	-	-	4700	6000	7600	9800	12200	13700	13700	15700	15700	20000	45
NU 322	-	-	3300	4400	5900	7800	10700	11500	11500	13400	13400	17300	60
NU 324	-	-	2400	3500	5000	6600	10000	10200	10200	12100	12100	15000	72

Notes:
- The ZZ bearings from 6201 to 6307 do not require relubrication as its life time is about 20,000 hours.
- Tables 9 and 10 are intended for the lubrication period under bearing temperature of 70°C (for bearings up to 6312 and NU 312) and temperature of 85°C (for bearings 6314 and NU 314 and larger).
- For each 15°C of temperature rise, the relubrication period is reduced by half.
- The relubrication periods given above are for those cases applying Polyrex® EM grease.
- When motors are used on the vertical position, their relubrication interval is reduced by half if compared to horizontal position motors.

Compatibility of Polyrex® EM grease with other types of grease:

Containing polyurea thickener and mineral oil, the Polyrex® EM grease is compatible with other types of grease that contain:
- Lithium base or complex of lithium or polyurea and highly refined mineral oil.
- Inhibitor additive against corrosion, rust and anti-oxidant additive.

Notes:
- Although Polyrex® EM is compatible with types of grease given above, we do no recommended to mix it with any other greases.
- If you intend to use a type of grease different than those recommended above , first contact WEG.
- On applications (with high or low temperatures, speed variation, etc), the type of grease and relubrification interval are given on an dditional nameplate attached to the motor.

4 - MAINTENANCE

A well-designed maintenance program for electric motors, when correctly used, can be summed up as: periodical inspection of insulation levels, temperature rise, wear, bearing lubrication at the occasional checking of fan air flow.
Inspection cycles depend upon the type of motor and the conditions under which it operates.

4.1 - CLEANLINESS

Motors should be kept clean, free of dust, debris and oil. Soft brushes or clean cotton rags should be used for cleaning. A jet of compressed air should be used to remove non-abrasive dust from the fan cover and any accumulated grime from the fan and cooling fins.
Terminal boxes fitted to motors with IP-55 protection should be cleaned; their terminals should be free of oxidation, in perfect mechanical condition, and all unused space dust-free.
Motors with IP(W) 55 protection are recommended for use under unfavourable ambient conditions.

4.2 - LUBRICATION

Motors made up to frame 160 are not fitted with grease fitting, while larger frames up to frame 200 this device is optional.
For frame 225 to 355 grease fitting is supplied as standard.
Proper Lubrication extends bearing life.
Lubrication Maintenance Includes:

a) Attention to the overall state of the bearings;
b) Cleaning and lubrication;
c) Careful inspection of the bearings.

Bearing temperature control is also part of routine maintenance. The temperature of bearings lubricated with suitable grease as recommended under item 4.2.2 should not exceed 70°C.
Constant temperature control is possible with the aid of external thermometers or by embedded thermal elements. WEG motors are normally equipped with grease lubricated ball or roller bearings.
Bearings should be lubricated to avoid the metallic contact of the moving parts, and also for protection against corrosion and wear.
Lubricant properties deteriorate in the course of time and mechanical operation and, furthermore, all lubricants are subject to contamination under working conditions.
For this reason, lubricants must be renewed and any lubricant consumed needs replacing from time to time.

4.2.1 - LUBRICATION INTERVALS

To apply correct amount of grease is an important aspect for a good lubrication.
Relubrication must be made based on the relubrication intervals Table. However, when a motor is fitted with a lubrication instructions plate, these instructions must be followed.
For an efficient initial bearing lubrication, the motor manual or the Lubrication Table must be followed. If this information is not available, the bearing must be greased up to its half (only the empty space between the moving parts).
When performing these tasks, care and cleanliness are recommended in order to avoid penetration of dust into the bearings.

4.2.2 - QUALITY AND QUANTITY OF GREASE

Correct lubrication is important!
Grease must be applied correctly and in sufficient quantity as both insufficient or excessive greasing are harmful.
Excessive greasing causes overheating brought about by the greater resistance caused on the rotating parts and, in particular, by the compacting of the lubricant and its eventual loss of lubricating qualities.
This can cause seepage with the grease penetrating the motor and dripping on the coils or other motor components.
A lithium based grease is commonly used for the lubrication of electric motor bearings as it has good mechanical stability, insoluble in water.

Greases for standard motors

Type	Supplier	Frame
Polyrex®EM	Esso	63 to 355M/L

This grease should never be mixed with different base greases.
More details about the greases mentioned above can be obtained at an authorized service agent or you can contact WEG directly.
For special greases, please contact WEG.

4.2.3. LUBRICATION INSTRUCTIONS

- Inject about half the estimated amount of grease and run the motor at full speed for approximately a minute; switch off the motor and inject the remaining grease.
The injection of all the grease with the motor at rest could cause penetration of a portion of the lubricant through the internal seal of the bearing case and hence into the motor.
Nipples must be clean prior to introduction of grease to avoid entry of any alien bodies into the bearing.
For lubricating, use only a manual grease gun.

BEARING LUBRICATION STEPS

1. Clean the area around the grease nipples with clean cotton fabric.
2. With the motor running, add grease with a manual grease gun until the quantity of grease recommended in Tables 9 or 10 has been applied.
3. Allow the motor to run long enough to eject all excess of grease.

4.2.4 - REPLACEMENT OF BEARINGS

The opening of a motor to replace a bearing should only be carried out by qualified personnel.
Damage to the core after the removal of the bearing cover is avoided by filling the gap between the rotor and the stator with stiff paper of a proper thickness.
Providing suitable tooling is employed, disassembly of a bearing is not difficult (Bearing Extractor).
The extractor grips should be applied to the sidewall of the inner ring to the stripped, or to an adjacent part.

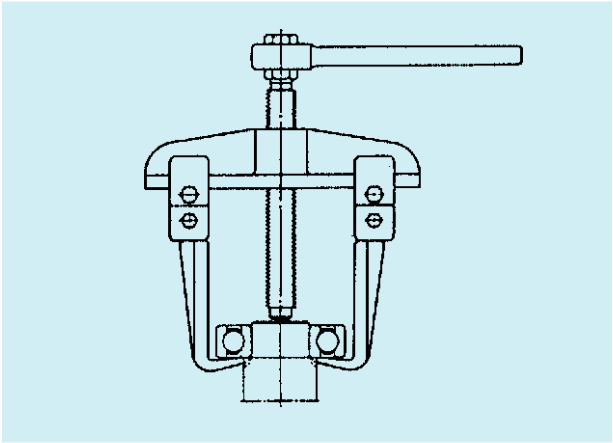


Fig. 4.2 - Bearing Extractor

To ensure perfect functioning and no injury to the bearing parts, it is essential that the assembly be undertaken under conditions of

complete cleanliness and by competent personnel.
New bearings should not be removed from their packages until the moment of assembly.
Prior to fitting a new bearing, ascertain that the shaft has no rough edges or signs of hammering.
During assembly bearings cannot be subjected to direct blows. The aid used to press or strike the bearing should be applied to the inner ring.
Protect all machined parts against oxidation by applying a coating of vaseline or oil immediately after cleaning.

STRIPPING OF WINDINGS - This step requires great care to avoid knocking and/or denting of enclosure joints and, when removing the sealing compound from the terminal box, damage or cracking of the frame.

IMPREGNATION - Protect all frame threads by using appropriate bolts, and terminal box support fitting with a non-adhesive varnish (ISO 287 - ISOLASIL).
Protective varnish on machined parts should be removed soon after treating with impregnation varnish. This operation should be carried out manually without using tools.

ASSEMBLY - Inspect all parts for defects, such as cracks, joint incrustations, damaged threads and other potential problems.
Assemble using a rubber headed mallet and a bronze bushing after ascertaining that all parts are perfect by fitted.
Bolts should be positioned with corresponding spring washers and evenly tightened.

TESTING - Rotate the shaft by hand while examining for any drag problems on covers or fastening rings.

MOUNTING THE TERMINAL BOX - Prior to fitting the terminal box all cable outled on the frame should be sealed with a self estinguishible sponge compound (1st layer) and on Explosion Proof Motors an Epoxy resin (ISO 340) mixed with ground quartz (2nd layer).

Drying time for this mixture is two hours during which the frame should not be handled and cable outlets should be upwards.
When dry, see that the outlets and areas around the cables are perfectly sealed.
Mount the terminal box and paint the motor.

4.3- MISCELLANEOUS RECOMMENDATIONS

- Any damaged parts (cracks, pittings in machined surfaces, defective threads) must be replaced and under no circumstances should attempt be made to recover them.

- Upon reassembling explosion proof motors IP(W) 55, the replacement of all seals is mandatory.

SINGLE PHASE MOTORS

SINGLE PHASE ASYNCHRONOUS INDUCTION MOTORS:

ADVANTAGES:
WEG single phase motors, totally enclosed fan cooled (degree of protection IP55) are highly resistant to bad weather, any external contamination and action and penetration of rodents, and they offer more additional advantages in relation to standard motors.
The capacitors - start and run-supply superior power factor and high efficiency, offering significant energy saving.
The energy saving obtained by using this new single phase motors can be calculated comparing the efficiency and power factor curves in order to know the investment payback.
These motors are built with an efficient starting method. The centrifugal switch mounted on a ridig base is fitted with special steel helicoidal springs, resistant to fatigue, driven by counter-weights designed in such a way to ensure the closing and opening under minimum and maximum established speeds.

FRACTIONAL MOTORS

FRACTIONAL ODP NEMA 48 AND 56 MOTORS:

SINGLE PHASE: Built with high starting torque which are suitable for heavy loads.
They are supplied with starting capacitor.

APPLICATIONS: Compressors, pumps, industrial air conditioning equipment, general machines and tooling, other industrial and commercial components requiring high starting torque.

THREE PHASE: Designed with torque suitable to drive industrial machines as well as optimized breakdown torques to operate under instantaneous overload conditions.

APPLICATIONS: Compressors, pumps, fans, chippers and general use machines powered by three phase network and continuous duty.

THREE PHASE ODP FRACTIONAL MOTOR "JET PUMP"

This type of motor can be used where three phase power supply is applicable. It has high starting torque, and breakdown torque approximately 3 times the rated current.

FRACTIONAL ODP "JET PUMP" MOTOR - START CAPACITOR

It is a single phase motor designed with a main winding and a capacitor series connected with the auxiliary winding.
The centrifugal switch disconnects the auxiliary winding when motor reaches about 80% of the synchronous speed. Then the motor operates continuously with the main winding.
The start capacitor motors present high torques. The starting torque varies between 200 and 350% of the rated torque, and the breakdown torque between 200% and 300% of the rated torque.
Based on these features, this type of motor is recommended for heavy starting load and it is used for the range of output up to 3HP (2.2kW).

APPLICATIONS: Water pumping systems by jet pumps, commercial and industrial pumps, domestic use pumps, centrifugal pumps and hydraulic pumps.

FRACTIONAL ODP MOTOR "JET PUMP PLUS" - SPLIT PHASE

It is a single phase motor built with two windings: main and starting auxiliary. The centrifugal switch disconnects the auxiliary winding when the motor reaches about 70% of the synchronous speed. Then the motor operates continuously with the main winding.
The "Jet Pump Plus - Split Phase" has moderated torques. The starting torque varies between 150% and 200% of the rated torque, and the breakdown torque between 200% and 300% of the rated torque.
It is a type of motor recommended for applications that require few starts and low starting torque.

These are the mechanical characteristics for this line of motors:
- Squirrel cage rotor
- Ball bearings
- 1045 steel shaft or stainless steel (optional)
- Feet and thermal protector (optional)
- CCW rotation direction
- Voltages:single-phase: 110V, 220V or 110/220V
  split-phase: without capacitor
- Standard painting is Red Oxid Primer.
- Degree of Protection is IP21.

THREE PHASE MOTOR - PREMIUM HIGH EFFICIENCY

Standard Features:
- Frequency: 60Hz and 50Hz
- Voltages: 220/380V, 380/660V, 440/760V or 220/380/440V
- Service Factor: 1.0
- Class of insulation: "F"
- Degree of Protection: IP55
- Design N (IEC 85)
- Speeds: 60Hz: 3600, 1800, 1200 and 900 rpm
  50Hz: 3000,1500,1000 and 750 rpm
- Temperature rise: below 80ºC

Optional Features:
- Class of insulation: "H"
- Degree of Protection: IP(W)55
- Thermal protection: Thermostats or thermistors
- Space heaters
- Routine and type test (IEC 34-2), witnessed or not.

Optional Features on Request:
- Design: H
- Hazardous location motors
- Explosion proof motors
- Increased safety
- Marine duty motors

THREE PHASE BRAKE MOTORS -*Single Disc*

GENERAL DESCRIPTION:

The brake motor is composed of an induction motor coupled to a single disc brake forming an integral and compact unit.

The induction motor is a totally enclosed fan cooled motor with the same mechanical and electrical performance of the WEG standard motors.

The brake is built with few movable parts which gives long life with reduced maintenance. The two faces of the brake pads create a large contact area which reduces the pressure over them, reduces the heating and the wear is minimum.

Besides, the brake is cooled by the same motor cooling.

The electromagnet drive coil, protected with epoxy resin, operates continuously with voltages varying 10% above and below the rated voltage. It is DC powered, supplied by a bridge rectifier made of silicon diodes and varistors which avoid sudden voltage peaks and allow a quick current switching off.

The DC power supply gives the brake a quicker and uniform operation.

APPLICATIONS:

Brake motors are commonly used on: tooling-machines, sewing machines, packing machines, conveyors, bottle washing machines, winding machines, folding machines, hoists, rolling bridges, elevators, printing machines and others. In general terms, on equipment requiring quick stops based on safety, positioning and time saving factors.

BRAKE OPERATION:

When motor is switched off from power supply, the control also interrupts the coil current and then the electromagnet stops operating. The pressure springs force the armature towards the motor non drive endshield. The braking pads, which are fitted in the braking disc, are compressed between the two friction surfaces, the armature and the endshield braking the motor until it stops.

The armature is pulled against the electromagnet frame by eliminating the spring resistance. Once they are free, the braking pads move axially in their fittings and they stay out of the friction area.

In this way, the braking is finished permitting the motor to start freely.

As an option, WEG can supply lining braking disc.

INSTALLATION:

Brake motors can be mounted in any position as long as it is not subject to penetration of water, oil, abrasive dust, etc through the air inlet.

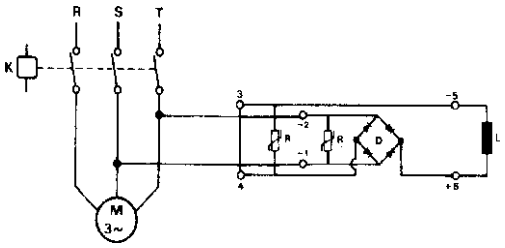
When normally mounted, the brake motor complies with Degree of Protection IP54 of IEC.

CONNECTION DIAGRAM

The WEG Brakemotor allows 3 types of connection diagram supplying slow, medium and quick brakings.

a) Slow Braking

The feeding of the brake coil bridge rectifier is done directly from the motor terminals, without interruption, as shown below:

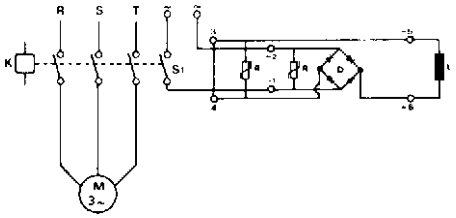


D - Bridge rectifier
R - Varistors
L - Electromagnet coil
K - Contactor

Fig. 1 - Connection diagram for slow braking

b) Medium Braking:

In this case a contact for interruption of the bridge rectifier feeding current in the AC circuit is fitted. It is essential that this be a NO auxiliar contact of the contactor itself or motor magnetic switch in order to allow switch on and off of brake and motor simultaneously.



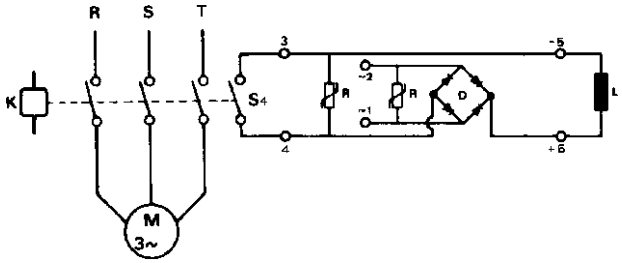
D- Bridge rectifier
R- Varistors
L- Electromagnet coil
K- Contactor
S1- NO auxiliary contact.

Fig 2 - Connection diagram for medium braking.

c) Quick Braking:

A contact for interruption is directly fitted in one of the coil feeding cables in the DC circuit.

It is essential that this is a NO auxiliary contact of the contactor itself or motor magnetic switch.



D - Bridge rectifier
R - Varistors
L - Electromagnet coil
K - Contactor
S1 - NO auxiliary contact

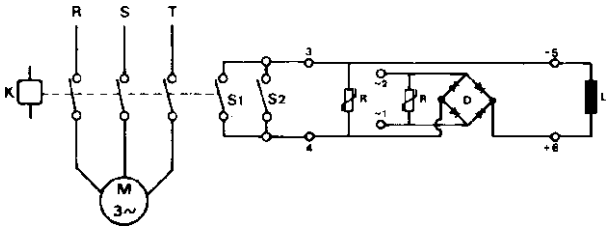
Fig. 3 - Connection Diagram for quick braking.

BRAKE COIL FEEDING:

The medium and quick braking allow two feeding alternatives:

a) Through motor terminals:
Motor 220/380V: Connect motor terminals 2 and 6 to terminals 1 and 2 of the bridge rectifier.
Motor 220/380/440/760V: connect motor terminals 1 and 4 to terminals 1 and 2 of the bridge rectifier.
Two speed motor 220V.
- High Speed: Connect motor terminals 4 and 6 to terminals 1 and 2 of the bridge rectifier.
- Low Speed: Connect motor terminals 1 and 2 to terminals 1 and 2 of the bridge rectifier.
- Motor 440V: Connect two of the motor terminals to terminals 1 and 2 of the bridge rectifier.

b) Independent Feeding:
For motor built for other voltages, connect the brake coil terminals to the independent 24ADC power supply. However, always with simultaneous interruption with motor feeding. With independent feeding it is possible to electrically release the brake, as shown in Fig. 4.
D - Bridge rectifier



R - Varistors
L - Electromagnet coil
K - Contactor
S1 - NO auxiliary contact
S2 - Electric release switch

Fig. 4 - Connection Diagram for independent feeding.

BRAKING TORQUE

It is possible to obtain a smoother motor stop by reducing the braking torque value. This is done by removing the brake pressure springs.

IMPORTANT:

The springs must be removed in such a way the remaining ones stay symmetrically disposed, avoiding in this way any friction even after operating the motor, and uneven wear of the braking pads.

BRAKE MAINTENANCE

As they are of simple construction, brake motors require low maintenance. What it is required to do is a periodical airgap adjustment.
It is recommended to clean internally the brake motor in cases of penetration of water, dust, etc. or at the time motor periodical maintenance is carried out.

AIRGAP ADJUSTMENT

WEG brake motors are supplied with an initial factory set air gap, that is, a gap between the armature and the frame with the brake energized, pre-adjusted at the factory to the minimum value as indicated in Table 1.

TABLE 1

FRAME	Initial (factory set) Air gap (mm)	Maximum air gap (mm)
71	0.2 - 0.3	0.6
80	0.2 - 0.3	0.6
90 S - 90 L	0.2 - 0.3	0.6
100 L	0.2 - 0.3	0.6
112 M	0.2 - 0.3	0.6
132 S - 132 M	0.3 - 0.4	0.8
160M - 160L	0,3 - 0,4	0,8

Due to the natural wear of the braking pads, the size of the air gap gradually increases without affecting the performance of the brake until it reaches the maximum value shown on Table 1.
To adjust the air gap to its initial value, proceed as follows:
a - Unfasten the bolts and remove the fan cover
b - Remove the protective band
c - Measure the air gap in three places, near the adjustment screws, using a set of feeler gauges.
d - If the width of the gap is equal to or greater than the maximum indicated, or if the three readings are not the same, proceed to adjust as follows:
1) Loosen the fixing bolts and the adjustment screws.
2) Adjust the air gap to the initial value indicated in Table 1 by equally adjusting the three adjustment screws.
   The value of the air gap must be uniform at the three measured points, and be such that the feeler gauge corresponding to the minimum gap, moves freely and the feeler gauge corresponding to the maximum gap cannot be introduced to any of the measured points.
3) Adjust the adjustment screws until the ends touch the motor endshield. Do not adjust any further.
4) Tighten the fixing bolts.
5) Re-check the air gap to ensure the measurements are as per Point 2 above.
6) Replace the protective band.
7) Replace the fan cover

Periodical Inspection and Re-adjustment of the air gap

The time interval between periodical adjustments of the air gap, that is, the number of braking operations until the wear of pads leads the air gap to it maximum value depends on the load, the frequency of operations, and the condition of the working environment, etc. The ideal interval can only be determined by closely observing the performance of the brake motor during the first months of its operating under actual working conditions. As a guide, Table 2 indicates the typical values which can be expected under normal working conditions. The wear of the brake linings depends on the moment of inertia of the load.

EXPLOSION PROOF MOTORS

The motors are designed to operate in ambients considered as dangerous.
These are areas where inflamable gases, steams or combustible gas are or can be in the environment continuous, intermittent or periodically in amount enough to produce explosive mixture or inflamable originated from seepage, repairs or maintenance.
Due to this, the design and manufacturing criteria of the motor components are differentiated from standard motor lines, specially in reference to mechanical aspects.
This motor line follows the recommendations of the following standards: ABNT (Brazilian Association of Technical Standards), IEC (International Electrical Code), UL (Underwriters Laboratories Inc.), CSA (Canadian Standards Association).
The special features of an explosion proof motor are the following:
- Mechanical resistance strong enough to withstand the impact of an internal explosion.
- Dimensional geometric tolerances and controlled rugosity level to avoid passage of flames to the outside and to control the amount of

gases exchanged between inside and outside of the motor. Below you will find an explanation of the features which make a motor to become explosion proof:

CONSTRUCTION FEATURES:

The features described above, by themselves, do not guarantee that the motor meets the Standard specifications. Then suitable procedures and tools are required.
Therefore, explosion proof motors can not be assembled or serviced by personnel not authorized.

MECHANICAL RESISTANCE	- Cast iron rugged construction (walls are thicker); corrosion resistant. - Fixation of endshields made with tempered internally haxangled bolts, with high resistance to traction. - More bolts to fix the endshield
TIGHNESS	- Use of epoxy base sealing compound between frame and terminal box - Fitting between endshields and frame with larger dimensions in comparison to standard motors, as per IEC 34-7 Standard. - Use of an internal DE and NDE bearing cap. - Touching surface between T-box and frame and T-box and endshield are machined (which does not require rubber sealing ring).

WARNING:
The operation place of an electric explosion proof motor is harmful to life.

5 - ABNORMAL SITUATIONS DURING OPERATION

ANALYSIS OF SOME ABNORMAL SITUATIONS AND POSSIBLE CAUSES ON ELECTRIC MOTORS:

ABNORMAL SITUATION	POSSIBLE CAUSES
MOTOR DOES NOT START	- Lack of voltage on motor terminals - Low feeding voltage - Wrong connection - Incorrect numbering of leads - Excessive load - Open stationary switch - Damaged capacitor - Auxiliary coil interrupted
LOW STARTING TORQUE	- Incorrect internal connection - Failed rotor - Rotor out of center - Voltage below the rated voltage - Frequency below the rated frequency - Frequency above the rated frequency - Capacitance below that specified - Capacitors series connected instead of parallel
LOW BREAKDOWN TORQUE	- Failed rotor - Rotor with bar inclination above that specified - Rotor out of center - Voltage below the rated voltage - Run capacitor below that specified
HIGH NO LOAD CURRENT	- Air gap above that specified - Voltage above that specified - Frequency below that specified - Wrong internal connection - Rotor out of center - Rotor rubbing on the stator - Defective bearing - Endbells fitted under pressure or badly fitted - Steel magnetic lamination without treatment - Run capacitor out of that specified - Stationary/centrifugal switch do not open
HIGH CURRENT UNDER LOAD	- Voltage out of the rated voltage - Overload - Frequency out of the rated frequency - Belts excessively tightened - Rotor rubbing on the stator
LOW INSULATION RESISTANCE	- Damaged slot insulating materials - Cut leads - Coil head touching the motor frame - Humidity or chemical agents present - Dust on the winding

ABNORMAL SITUATION	POSSIBLE CAUSES
BEARING HEATING	- Excessive amount of grease - Excessive axial thrust or radial force of the belt - Bent shaft - Loose endbells or out of center - Lack of grease - Foreign bodies in the grease
MOTOR OVERHEATING	- Obstructed ventilation - Smaller size fan - Voltage or frequency out of that specified - Rotor rubbing on the shaft - Failed rotor - Stator with insufficient impregnation - Overload - Defective bearing - Consecutive starts - Air gap below that specified - Improper run capacitor - Wrong connections
HIGH NOISE LEVEL	- Unbalancing - Bent shaft - Incorrect alignment - Rotor out of center - Wrong connections - Foreign bodies in the air gap - Foreign bodies between fan and fan cover - Worn bearings - Improper slots combination - Inadequate aerodynamic
EXCESSIVE VIBRATION	- Rotor out of center - Unbalance power supply voltage - Failed rotor - Wrong connections - Unbalanced rotor - Bearing housing with excessive clearance - Rotor rubbing on the stator - Bent shaft - Stator laminations loose - Use of fractional groups on run capacitor single-phase winding

SERVICE

Leaving the factory in perfect conditions is not enough for the electric motor. Although the high quality standard assured by Weg for several years of operation, there will be a day when the motor will require service: This can be corrective, preventive or orientative.

Weg gives great inportance to service as this makes part of a successful sale.

Weg service is immediate and efficient.

At the moment you buy a Weg electric motor, you are also receiving an uncomparable know-how developed in the company and you will count on our authorized services during the whole motor operating life, carefully selected and strategically located in more than fifty countries.

Jaw

In This Section:

- L Type
- LC Type
- Al Type - Aluminum
- SS Type - Stainless
- RRS and RRSC Types - Spacer
- C and H Type - Medium / Heavy Duty
- RRC Type - Spacer



Jaw

⚠ Safety Warning

When using Lovejoy products, you must follow these instructions and take the following precautions. Failure to do so may cause the power transmission product to break and parts to be thrown with sufficient force to cause severe injury or death.

Refer to this Lovejoy Catalog for proper selection, sizing, horsepower, torque range, and speed range of power transmission products, including elastomeric elements for couplings. Follow the installation instructions included with the product, and in the individual product catalogs for proper installation of power transmission products. Do not exceed catalog ratings.

During start up and operation of power transmission product, avoid sudden shock loads. Coupling assembly should operate quietly and smoothly. If coupling assembly vibrates or makes beating sound, shut down immediately, and recheck alignment. Shortly after initial operation and periodically thereafter, where applicable, inspect coupling assembly for: alignment, wear of elastomeric element, bolt torques, and flexing elements for signs of fatigue. Do not operate coupling assembly if alignment is improper, or where applicable, if elastomeric element is damaged, or worn to less than 75% of its original thickness.

Do not use any of these power transmission products for elevators, man lifts, or other devices that carry people. If the power transmission product fails, the lift device could fall resulting in severe injury or death.

For all power transmission products, you must install suitable guards in accordance with OSHA and American Society of Mechanical Engineers Standards. Do not start power transmission product before suitable guards are in place. Failure to properly guard these products may result in severe injury or death from personnel contacting moving parts or from parts being thrown from assembly in the event the power transmission product fails.

If you have any questions, contact the Lovejoy Engineering Department at 1-630-852-0500.

Jaw

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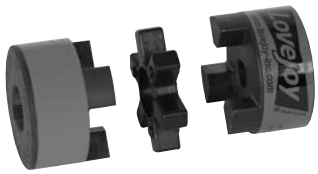
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Jaw Type Couplings

The Jaw Type couplings from Lovejoy are offered in the industry's largest variety of stock bore/keyway combinations. These couplings require no lubrication and provide highly reliable service for light, medium, and heavy duty electrical motor and internal combustion power transmission applications.

Features

- Fail-safe – will still perform if elastomer fails
- No metal to metal contact
- Resistant to oil, dirt, sand, moisture and grease
- More than 850,000 combinations of bore sizes
- Most types available from stock in 24 hours



L Type



LC Type

Applications include power transmission to industrial equipment such as pumps, gear boxes, compressors, blowers, mixers, and conveyors. Lovejoy's Jaw Type couplings are available in 24 sizes from a minimum torque rating of 3.5 in–lbs to a maximum torque rating of 170,004 in–lbs and a bore range of .125 inches to 7 inches. Lovejoy's standard bore program covers AGMA, SAE, and DIN bore/keyway and spline bore combinations.

The Lovejoy Jaw Type coupling is available in a variety of metal hub and insert materials. Hubs are offered in sintered metal, aluminum, bronze, steel, stainless steel, and ductile iron.



AL Type Jaw



SS Type

L Type

- Coupling offers standard shaft-to-shaft connection for general industrial duty applications
- Standard L Type coupling hub materials are either sintered iron (L035-L190) or cast iron (L225-L276)

LC Type

- Uses the standard L Type hubs with a snap wrap spider and retaining ring
- Suited for applications over 1,750 RPM

AL Type

- Aluminum hubs offer light weight with low overhung load and low inertia
- Excellent resistance to atmospheric conditions, perfect for corrosive environment applications



RSS Type

SS Type

- The SS Type coupling provides maximum protection against harsh environmental conditions
- Sizes SS075-SS150 available from stock, other sizes available on request

RRS Type

- Center "drop out" section of this coupling provides proper shaft separation, while also allowing easy elastomer installation without disturbing the hubs or requiring the realignment of shafts
- Accommodates American and European industry standard pump/motor shaft separations
- The spacer is made of glass reinforced plastic, cast iron, or aluminum



SW Type



C & H Types

SW Type

- Standard L Type coupling with a snap wrap elastomer with retaining ring
- Well suited for standard shaft to shaft connection in general industrial purpose applications under 1,750 RPM

C & H Types

- Couplings provide standard shaft-to-shaft connection for medium (C) and Heavy (H) duty range applications
- Standard C coupling hub is made of cast iron, while the H is constructed of ductile iron

Elastomers In Compression

Lovejoy offers four types of elastomer designs to allow for additional flexibility in addressing specific application requirements. One piece designs are used in the "L" and "AL" models (referred to as spiders) and multiple part "load cushions" are used in the "C" and "H" model couplings. The load cushions are in sets of 6 to 14 pieces depending on coupling size.

Solid Center Spider

- The solid center design is commonly used design when shafts of the driver and driven equipment can be kept separate by a standard gap

Open Center Spider

- The open center design allows for the shafts of the driver and driven to be positioned within a short distance
- Open center spiders offer shaft positioning flexibility but have a lower RPM capacity (1,750 RPM maximum for NBR, 3,600 maximum for Urethane/Hytrel®)

Cushions

- Used exclusively for the C and H Type couplings
- Load cushions are held in place radially by a steel collar which is attached to one of the hubs

Snap Wrap Flexible Spider

- Design allows for easy removal of the spider without moving the hubs
- Allows for close shaft separation all the way up to the hubs maximum bore
- Maximum RPM is 1,750 RPM with the retaining ring, but if used with the LC Type (with collar) the normal RPM rating of the coupling applies
- Style is available in NBR and Urethane only, and in limited sizes

Note: ■ Complete technical data for the new Jaw In-Shear elastomer is contained in the next section of this catalog, labeled "JIS" on the page tabs.



Spider Materials

SOX (NBR) Rubber

- The standard material that is highly flexible material that is oil resistant
- Resembles natural rubber in resilience and elasticity, and operates effectively in temperature ranges of -40° to 450° F (-40° to 232° C)

Urethane

- Has 1.5 times greater torque capacity than NBR
- Good resistance to oil and chemicals
- Material provides less dampening effect and operates at a temperature range of -30° to 160° F

Hytrel

- Flexible elastomer designed for high torque and high temperature operations
- Operates in temperatures of -60° to 250° F (-51° to 121° C)

Bronze

- Rigid, porous, oil-impregnated metal insert exclusively for low speed (max 250 RPM) applications requiring high torque capabilities
- Not affected by water, oil, dirt, or extreme temperatures – operates in temperatures of -40° to 450° F (-40° to 232° C)

⚠ WARNING

You must refer to page JW-2 (Page 14) for Important Safety Instructions and Precautions for the selection and use of these products. Failure to follow the instructions and precautions can result in severe injury or death.

Jaw Type Coupling Selection Process

The selection process for determining the proper jaw coupling size and elastomer requires using the charts shown on the following pages. There are three components to be selected, two hubs and one elastomer. When the shaft size of the driver and driven of the application are of the same diameter, the hubs selected will be the same. When shaft diameters differ, hubs selected will differ accordingly.

Information necessary before a coupling can be selected:

- HP (or KW) and RPM or Torque of driver
- Shaft sizes of driver and driven equipment and corresponding keyways
- Application description
- Environmental conditions (i.e. extreme temperature, corrosive conditions, space limitations)

List of Charts provided for Selection:

- Chart 1 – Application Service Factors (page JW-8)
- Chart 2 – Spider Performance Data (page JW-9)
- Chart 3 – Jaw Nominal Rated Torque (page JW-9)
- Jaw Type Performance Ratings (page JW-22)

Formulas:

$$\text{Nominal Torque} = \text{in-lb} = \frac{(HP \times 63025)}{RPM}$$

$$\text{Nm} = \frac{(KW \times 9550)}{RPM}$$

Design Torque = Nominal Torque x Application Service Factor

Steps In Selecting A Jaw Coupling

Step 1: Determine the Nominal Torque of your application by using the following formula:

$$\text{Nominal Torque} = \text{in-lb} = \frac{(HP \times 63025)}{RPM}$$

$$\text{Nm} = \frac{(KW \times 9550)}{RPM}$$

Step 2: Using the Application Service Factors Chart 1 (page JW-8) select the service factor which best corresponds to your application.

Step 3: Calculate the Design Torque of your application by multiplying the Nominal Torque calculated in Step 1 by the Application Service Factor determined in Step 2.

Design Torque = Nominal Torque x Application Service Factor

Step 4: Using the Spider Performance Data Chart 2 (page JW-9), select the elastomer material which best corresponds to your application.

Step 5: Using the Jaw Nominal Rated Torque Chart 3 (page JW-9), locate the appropriate elastomer material column for the elastomer selected in Step 4.

Scan down this column to the first entry where the Torque Value in the appropriate column is greater than or equal to the Design Torque calculated in Step 3.

Once this value is located, refer to the corresponding coupling size in the first column of the Jaw Nominal Rated Torque Chart 3 (page JW-9).

Refer to the maximum RPM value (page JW-22) for this elastomer torque capability to ensure that the application requirements are met. If the requirement is not satisfied at this point, another type of coupling may be required for the application. Please consult Lovejoy engineering for assistance.

Step 6: Compare the application driver/driven shaft sizes to the maximum bore size available on the coupling selected. If coupling bore size is not large enough for the shaft diameter, select the next largest coupling that will accommodate the driver/driven shaft diameters. Refer to Chart 3 (page JW-9).

Step 7: Using the UPC number selection table (pages JW-11 or JW-12), find the appropriate Bore and Keyway sizes required and locate the Lovejoy UPC number.

Selection Example

A coupling is needed to connect a 20 HP standard electric motor rated at 1,800 RPM to a rotary pump. The shaft size of the electric motor (driver) is 2.0 inches and the pump (driven) is 1.75 inches. There are no special environmental conditions and the general operating temperature is normal room temperature of 72° F. Less than 1° of misalignment is expected.

Step 1: Determine the Nominal Torque:

$$\text{Nominal Torque} = \frac{(\text{HP} \times 63025)}{\text{RPM}}$$

$$= \frac{(20 \times 63025)}{1800}$$

$$= 700.28 \text{ in-lb}$$

Step 2: Using the Application Service Factors Chart 1 (page JW-8), select the service factor which best corresponds to your application. The Application Service Factor for an electric motor with standard torque driving a rotary pump is 1.25. The value of 1.25 is found under the application category Pumps, Rotary, column: Electric Motor w/Standard Torque in Chart 1.

Step 3: Calculate the Design Torque of your application:

Design Torque = Nominal Torque x Application Service Factor
= 700.28 x 1.25
= 875.35 in-lb

Step 4: Using the Spider Performance Data Chart 2 (page JW-9), select the elastomer material which best corresponds to your application. Since there are no special environmental conditions, the operating temperature is 72° F and less than 1° of angular misalignment is required, the NBR elastomer material is selected.

Step 5: Using the Jaw Nominal Rated Torque Chart 3 (page JW-9), the NBR elastomer column is used to determine the proper coupling size. Scanning down the NBR column, the first entry to accommodate the Design Torque value of 875.35 in-lb is the size L150 with a nominal torque rating of 1,240 in-lb. Referring to page JW-20, the maximum RPM of 1,800 on the electric motor of the application does not exceed the 5,000 RPM maximum allowed for the L150 size coupling with an NBR elastomer.

Step 6: Compare the application driver/driven shaft size to the maximum bore available in the coupling selected (page JW-9). The electric motor (driver) of this application has a shaft size of 2.0 inches and the pump (driven) has a shaft size of 1.75 inches. The L150 coupling has a maximum bore less than the driver shaft size. Continuing down the Maximum Bore column, in Chart 3 (page JW-9), the L190 size is found to have a maximum bore size of 2.125 and is able to accommodate the driver/driven shaft sizes. Therefore, the proper coupling size for this application is a Lovejoy L190 with an NBR elastomer.

Step 7: Using the UPC number Selection table, locate the appropriate Lovejoy UPC numbers. The L Type Spider Table (page JW-10), and the L Type hub table (page JW-11), provides easy reference to the Lovejoy UPC numbers.

Locate the L Type Spider Table (page JW-10).

The spider is selected by scanning down the type column and locating the NBR (Solid) entry. Read across to the L190 column and locate the Lovejoy UPC number of 12274. This number should be prefixed with the Lovejoy UPC number of 685144.

Locate the L Type Hub Table (page JW-11).

The first bore size to be located is for the 2 inch shaft on the electric motor. Scan down the Bore/Keyway column to the 2 inch bore entry. Read across to the L190 column to locate the Lovejoy UPC number of 12303. This number should be prefixed with the Lovejoy UPC number of 685144.

The second bore size to be located is for the 1.75 inch shaft on the pump. Scan down the Bore/Keyway column to the 1-3/4 inch bore entry. Read across to the L190 column to locate the Lovejoy UPC number of 12299. This number should be prefixed with the Lovejoy UPC number of 685144.

Application Service Factors

Chart 1

	Service Factors				
	Electric Motor w/ Standard Torque	Electric Motor w/ High Torque	Steam Turbines & Engines w4 or more cyl*	Reciprocating Engines*	
				1-Cyl	2-Cyl
Agitators	1.00	1.25	1.00	1.7	1.3
Band Resaw (lumber)	1.50	1.75	1.50	2.2	1.8
Barge Haul Puller	2.00	2.25	2.00	2.7	2.3
Beaters	1.50	1.75	1.50	2.2	1.8
Blowers					
Centrifugal	1.00	1.25	1.00	1.7	1.3
Lobe, Vane	1.25	1.50	1.25	2.0	1.6
Bottling Machinery	1.25	1.50	1.25	2.0	1.6
Brew Kettles (distilling)	1.25	1.50	1.25	2.0	1.6
Can Filling Machinery	1.00	1.25	1.00	1.7	1.3
Car Dumpers	2.50	2.75	2.50	3.2	2.8
Car Pullers	1.50	1.75	1.50	2.2	1.8
Card Machine	1.75	2.00	1.75	2.5	2.0
Chiller (oil)	1.50	2.00	1.25	2.0	2.0
Compressors					
Centrifugal	1.00	1.25	1.00	1.7	1.3
Screw, Lobe	1.25	1.50	1.25	2.0	1.6
Reciprocating	See Note				
Conveyors, Uniformly Fed					
Assembly, Belt, Screw	1.00	1.25	1.00	1.7	1.3
Bucket, Sawdust	1.25	1.50	1.25	2.0	1.6
Live Roll, Shaker, Reciprocating	3.00	3.25	3.00	3.7	3.3
Conveyors, Not Uniformly Fed					
Assembly, Belt, Oven, Screw	1.20	1.45	1.20	1.9	1.5
Reciprocating	2.50	2.75	2.50	3.2	2.8
Shaker	3.00	3.25	3.00	3.7	3.3
Cookers—Brewing, Distilling, Food	1.25	1.50	1.25	2.0	1.6
Cranes & Hoist[1]	2.00	2.25	2.00	2.7	2.3
Crushers—Cane (sugar), Stone, or Ore	3.00	3.25	3.00	3.7	3.3
Dredges					
Cable reels	2.00	2.25	2.00	2.7	2.3
Conveyors, Pumps, Maneuvering Winches	1.50	1.75	1.50	2.2	1.8
Cutter Head Drives	2.50	2.75	2.50	3.2	2.8
Dynamometer	1.50	1.75	1.50	2.2	1.8
Evaporators	1.00	1.25	1.00	1.7	1.3
Fans					
Centrifugal	1.00	1.25	1.00	1.7	1.3
Cooling Towers	2.00	2.25	2.00	2.7	2.3
Forced Draft, Propeller	1.50	1.75	1.50	2.2	1.8
Induced draft w/damper control	2.00	2.25	2.00	2.7	2.3
Induced draft w/o damper control	1.25	1.50	1.25	2.0	1.6
Feeders					
Belt, Screw	1.00	1.25	1.00	1.7	1.3
Reciprocating	2.50	2.75	2.50	3.2	2.8
Filter, Press-oil	1.50	1.75	1.50	2.2	1.8
Generators					
Not Welding	1.00	1.25	1.00	1.7	1.3
Welding	2.00	2.25	2.00	2.7	2.3
Hoist	1.50	1.75	1.50	2.2	1.8
Hammermills	2.00	2.25	2.00	2.7	2.3
Kilns	1.50	1.75	1.50	2.2	1.8
Laundry Washers —					
Reversing	2.00	2.25	2.00	2.7	2.3
Lumber Machinery					
Barkers, Edger Feeder, Live Roll	2.00	2.25	2.00	2.7	2.3
Planer, Slab Conveyor	2.00	2.25	2.00	2.7	2.3
Machine Tools					
Punch Press-gear Driven, Plate Planer	2.00	2.25	2.00	2.7	2.3
Tapping Machinery, Bending Roll	2.00	2.25	2.00	2.7	2.3
Main Drive	1.50	1.75	1.50	2.2	1.8
Auxiliary Drives	1.00	1.25	1.00	1.7	1.3
Metal Forming Machines					
Draw Bench-carriage & Main Drive	2.00	2.25	2.00	2.7	2.3
Extruder, Forming Machine, Wire Drawing	2.00	2.25	2.00	2.7	2.3
Table Conveyors	2.50	2.75	2.50	3.2	2.8
Wire Winding, Coilers, Slitters	1.50	1.75	1.50	2.2	1.8
Mills, Rotary Type					
Ball, Kilns, Pebble, Rolling, Tube	2.00	2.25	2.00	2.7	2.3
Cement Kilns, Dryers, Coolers	2.00	2.25	2.00	2.7	2.3
Tumbling	1.50	1.75	1.50	2.2	1.8
Mixers					
Concrete, continuous	1.75	2.00	1.75	2.5	2.0
Muller	1.50	1.75	1.50	2.2	1.8
Paper Mills					
Agitator (mixers), Reel, Winder	1.20	1.45	1.20	1.9	1.5
Winder	1.20	1.45	1.20	1.9	1.5
Barker (mechanical), Log Haul, Chipper	2.00	2.25	2.00	2.7	2.3
Barking Drum (spur gear)	2.50	2.75	2.50	3.2	2.8
Beater, Pulper, Jordans, Dresses	2.00	2.25	2.00	2.7	2.3
Calenders, Dryers, Washers, Thickener	1.50	1.75	1.50	2.2	1.8
Converting Machines, Conveyors	1.20	1.45	1.20	1.9	1.5
Printing Presses	1.50	1.75	1.50	1.7	1.3
Pug Mill	1.75	2.00	1.75	2.0	1.6
Pumps					
Centrifugal	1.00	1.25	1.00	1.7	1.3
Gear, Rotary, Vane	1.25	1.50	1.25	2.0	1.6
Reciprocating:					
1–Cyl. Single or Double Acting	2.00	2.25	2.00	2.7	2.3
2–Cyl. Single Acting	2.00	2.25	2.00	2.7	2.3
2–Cyl. Double Acting	1.75	2.00	1.75	2.5	2.0
3 or more Cyl.	1.50	1.75	1.50	2.2	1.8
Rubber Machinery					
Mixers	2.50	2.75	2.50	3.2	2.8
Rubber Calender	2.00	2.25	2.00	2.7	2.3
Screens					
Air washing, Water	1.00	1.25	1.00	1.7	1.3
Rotary—stone or gravel, Dewatering	1.50	1.75	1.50	2.2	1.8
Vibrating	2.50	2.75	2.50	3.2	2.8
Grizzly	2.00	2.25	2.00	2.7	2.3
Shredders	1.50	1.75	1.50	2.2	1.8
Steering Gears	1.00	1.25	1.00	1.7	1.3
Stokers	1.00	1.25	1.00	1.7	1.3
Suction Roll (paper)	1.50	1.75	1.50	2.2	1.8
Textile Machinery					
Dryers, Dyeing Machinery, Mangle	1.20	1.45	1.20	2.0	1.6
Loom, Spinner, Tenter frames	1.50	1.75	1.50	2.2	1.8
Tumbling Barrels	1.75	2.00	1.75	2.5	2.0
Windlass	2.00	2.25	2.00	2.7	2.3
Woodworking Mach.	1.00	1.25	1.00	1.7	1.3

Caution: Applications involving reciprocating engines and reciprocating driven devices are subject to critical rotational speeds which may damage the coupling and/or connected equipment. Contact Lovejoy Engineering with specific requirements.

Note: ■ 1 indicates: If people are transported, Lovejoy does not recommend and will not warranty the use of the coupling.

Spider Performance Data

Chart 2

Characteristics	Temperature Range	Misalignment		Shore Hardness[1]	Dampening Capacity	Chemical Resistance[2]	Color
		Angular Degree	Parallel Inch				
SOX (NBR) Rubber – Nitrile Butadiene (Buna N) Rubber is a flexible elastomer material that is oil resistant, resembles natural rubber in resilience and elasticity and operates effectively in temperature range of -40° to 212° F (-40° to 100° C). Good resistance to oil. Standard elastomer. (Also applies to SXB Cushions.)	-40° to 212° F -40° to 100° C	1°	.015	80A	HIGH	GOOD	BLACK
URETHANE – Urethane has greater torque capability than NBR (1.5 times), provides less dampening effect, and operates at a temperature range of -30° to 160° F (-34° to 71° C). Good resistance to oil and chemicals. Not recommended for cyclic or start/stop applications.	-30° to 160° F -34° to 71° C	1°	.015	55D L050-L110 90-95A L150-L225	LOW	VERY GOOD	BLUE
HYTREL® – Hytrel is a flexible elastomer designed for high torque and high temperature operations. Hytrel can operate in temperatures of -60° to 250° F (-51° to 121° C) and has an excellent resistance to oil and chemicals. Not recommended for cyclic or start/stop applications.	-60° to 250° F -51° to 121° C	1/2°	.015	55D	LOW	EXCELLENT	TAN
BRONZE – Bronze is a rigid, porous oil-impregnated metal insert exclusively for slow speed (maximum 250 RPM) applications requiring high torque capabilities. Bronze operations are not affected by extreme temperatures, water, oil, or dirt.	-40° to 450° F -40° to 232° C	1/2°	.010	—	NONE	EXCELLENT	BRONZE

Notes: ■ 1 indicates: NBR standard shore hardness is 80A ±5A – Except L035=60A. Other softer or harder designs are available in NBR material; consult Lovejoy.
■ 2 indicates: Chemical Resistance chart shown in Engineering Data Section (page ED-9).

Jaw Nominal Rated Torque Data

Chart 3

Size	Max Bore		Spider Material							
			SOX (NBR) Torque		Urethane Torque		Hytrel Torque		Bronze Torque	
	in	mm	in-lbs	Nm	in-lbs	Nm	in-lbs	Nm	in-lbs	Nm
L035	0.375	9	3.5	0.4	—	—	—	—	—	—
L/AL050	0.625	16	26.3	3.0	39	4.5	50	5.60	50	5.60
L/AL070	0.750	19	43.2	4.9	65	7.3	114	12.90	114	12.90
L/AL075	0.875	22	90.0	10.2	135	15.3	227	25.60	227	25.60
L/AL090	1.000	25	144.0	16.3	216	24.4	401	45.30	401	45.30
L/AL095	1.125	28	194.0	21.9	291	32.9	561	63.40	561	63.40
L/AL099	1.188	30	318.0	35.9	477	53.9	792	89.50	792	89.50
L/AL100	1.375	35	417.0	47.1	626	70.7	1,134	128.00	1,134	128.00
L/AL110	1.625	42	792.0	89.5	1,188	134.0	2,268	256.00	2,268	256.00
L150	1.875	48	1,240.0	140.0	1,860	210.0	3,708	419.00	3,706	419.00
AL150	1.875	48	1,450.0	163.8	—	—	—	—	—	—
L190	2.125	55	1,728.0	195.0	2,592	293.0	4,680	529.00	4,680	529.00
L225	2.625	65	2,340.0	264.0	3,510	397.0	6,228	704.00	6,228	704.00
L276	2.875	73	4,716.0	533.0	—	—	—	—	12,500	1 412.00
C226	2.500	64	2,988.0	338.0	—	—	5,940	671.00	5,940	671.00
C276	2.875	73	4,716.0	533.0	—	—	9,432	1 066.00	—	—
C280	3.000	76	7,560.0	854.0	—	—	13,866	1 567.00	—	—
C285	4.000	102	9,182.0	1 038.0	—	—	16,680	1 882.00	—	—
C2955	3.500	89	11,340.0	1 281.0	—	—	22,680	2 563.00	22,680	2 563.00
C2955	4.000	102	18,900.0	2 136.0	—	—	37,800	4 271.00	37,800	4 271.00
H3067	4.500	114	33,395.0	3 774.0	—	—	47,196	5 333.00	47,196	5 333.00
H3567	5.000	127	46,632.0	5 269.0	—	—	63,000	7 119.00	63,000	7 119.00
H3667	5.629	143	64,812.0	7 323.0	—	—	88,200	9 966.00	88,200	9 966.00
H4067	6.250	159	88,224.0	9 969.0	—	—	126,000	14 237.00	126,000	14 237.00
H4567	7.000	178	119,700.0	13 525.0	—	—	170,004	19 209.00	170,000	19 209.00

Note: ■ Bronze has a maximum RPM capability of 250 RPM.

L Type Coupling

- Sizes range from L035 to L0276
- Ordering requires selecting UPC numbers for two standard L hubs and one standard open or solid center elastomer (spider)



SW Type Coupling

- Sizes range from L090 to L190
- Ordering requires selecting UPC numbers for two standard L hubs and one snap wrap spider with snap ring
- Both L and SW Type couplings, select hubs from the standard bore and keyway chart (pages JW-11 and JW-12) maximum RPM for SW + Ring is 1,750 RPM
- LC coupling uses a snap wrap spider with a collar instead of a retaining ring

Jaw In-Shear Coupling

- Ordering requires selecting item numbers for two standard hubs, one In-Shear elastomer and one In-Shear ring. See pages JIS-1 through JIS-4

L Type Spider UPC Number Selection Table

	Coupling Size										
Spider Type	**L035**	**L050**	**L075**	**L075**	**L090/095**	**L099/100**	**L110**	**L150**	**L190**	**L225**	**L276**
SOX (NBR) (Solid)	10118	10194	10406	10621	11070	10494	11724	12001	12274	12409	—
SOX (NBR) (open center)	—	—	10393	10620	10968	11492	11711	37880	37881	12406	12612
Urethane (Solid)	—	37786	10395	—	—	—	—	—	—	—	—
Urethane (open center)	—	—	10411	10626	11075	11499	11729	12006	12280	12417	—
Hytrel® (Solid)	—	25307	—	—	—	—	11717	11993	12265	12401	—
Hytrel® (open center)	—	—	25308	25309	25310	11486	38097	38098	38099	12400	—
Bronze (open center)	—	10198	10409	10624	11073	11497	11727	12004	12277	34517	25767
Snap Wrap (NBR) w/ring	—	—	—	—	24669	24670	24671	24672	24673	—	—
Snap Wrap (NBR) w/o ring	—	—	—	—	11071	11495	11725	12002	12275	—	—
SOX (NBR) Bulk - pk 25	50115	50116	50117	50118	50119	—	—	—	—	—	—
SOX (NBR) Bulk - pk 10	—	—	—	—	—	51020	50121	50122	—	—	—
Snap Wrap Urethane - solid ring	—	—	—	—	—	41170	41171	—	28284	26093	—
In-Shear Elastomer	—	—	—	—	67576	67577	67578	67579	67580	68559	67581
In-Shear Ring	—	—	—	—	67584	67585	67586	67587	67588	68560	67589

Note: ■ When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

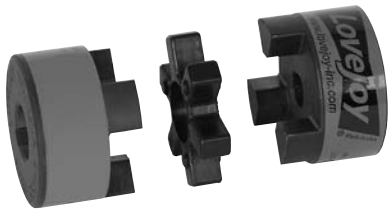
L Type Hub - Spline Bore UPC Number Selection Table

Teeth	Pitch	SAE	Spline Bore Diameters		Major	Coupling Size								
			Major	Minor	Dia	L090	L095	L099	L100	L110	L150	L190	L225	L276
9	16/32	A	0.651	0.509	0.625	38568	37900	38571	37904	—	—	—	—	—
11	16/32		0.776	0.631	0.750	38569	37901	38572	37905	37909	37917	37925	—	—
13	16/32	B	0.901	0.754	0.875	38570	37902	38573	37906	37910	37918	37926	37935	—
13	8/16	D, E	1.798	1.506	1.750	—	—	—	—	37915	37923	37931	37940	38576
14	12/24	C	1.289	1.087	1.250	—	—	—	—	37912	37920	37928	37937	38577
15	16/32	BB	1.026	0.877	1.000	—	—	38574	37907	37911	37919	37927	37936	38578
21	16/32		1.401	1.250	1.375	—	—	—	—	37913	37921	37929	37938	—
23	16/32		1.526	1.375	1.500	—	—	—	—	37914	37922	37930	37939	—
27	16/32		1.776	1.625	1.750	—	—	—	—	37916	37924	37932	37941	38579
15	8/16	F	2.048	1.753	2.000	—	—	—	—	—	—	37933	37942	—

Notes: ■ All pressure angles on above splines = 30°. Class 5 fit is standard, unless otherwise specified.
■ All stock spline bore hubs are supplied standard with Lovejoy's exclusive L-LOC Clamping Feature. See page T-7 for description.
■ When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

Jaw
L Type Inch Bore / Keyway
Item Selection

The L Type coupling consists of two standard L Type hubs and one spider. Refer to pages JW-11, JW-12, and JW-10.

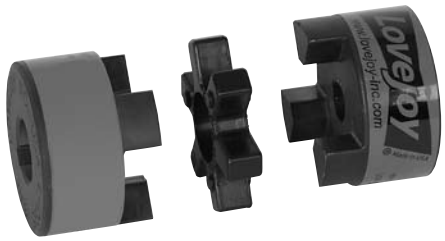




Bore	Keyway	L035	L050	L075	L075	L090	L095	L099	L100	L110	L150	L190	L225	L276
1/8	No Keyway	10124	—	—	—	—	—	—	—	—	—	—	—	—
3/16	No Keyway	10126	—	—	—	—	—	—	—	—	—	—	—	—
1/4	No Keyway	10127	10206	10416	10680	10766	—	—	—	—	—	—	—	—
1/4	1/8 x 1/16	—	—	—	35744	—	—	—	—	—	—	—	—	—
5/16	No Keyway	10128	10207	10417	10681	26209	—	—	—	—	—	—	—	—
3/8	No Keyway	24687	10208	10418	10682	10767	—	—	—	—	—	—	—	—
3/8	3/32 x 3/64	—	46121	41985	37234	37235	—	—	—	—	—	—	—	—
3/8	1/8 x 1/16	—	44136	48829	35745	37236	—	—	—	—	—	—	—	—
7/16	No Keyway	—	10209	10419	10683	10768	11082	31297	11505	—	—	—	—	—
7/16	3/32 x 3/64	—	44713	44007	28089	28877	27613	38198	37237	—	—	—	—	—
7/16	1/8 x 1/16	—	—	44066	28875	28878	28879	38199	37238	—	—	—	—	—
1/2	No Keyway	—	10210	10420	10684	10769	11083	11333	11506	—	—	—	—	—
1/2	1/8 x 1/16	—	10211	10421	10685	26087	26088	11334	26089	—	—	—	—	—
9/16	No Keyway	—	10212	52338	10686	24976	37239	11335	11508	—	—	—	—	—
9/16	1/8 x 1/16	—	10213	10423	10687	28876	11084	38200	11509	—	—	—	—	—
5/8	No Keyway	—	10214	24771	44322	46052	41911	44174	44291	11733	12101	—	—	—
5/8	5/32 x 5/64	—	—	51104	37240	37241	37242	38201	37243	37244	37245	—	—	—
5/8	3/16 x 3/32	—	—	10424	10688	10771	11085	11336	11510	26211	26212	—	—	—
11/16	3/16 x 3/32	—	—	10425	10689	10772	11086	11337	11511	11734	12102	—	—	—
3/4	No Keyway	—	—	46116	56140	54282	56887	49705	45212	—	—	12285	12422	—
3/4	1/8 x 1/16	—	—	51719	35881	37246	37074	38202	37247	37248	37249	37250	—	—
3/4	3/16 x 3/32	—	—	10426	10690	10773	11087	11338	11512	11735	12103	38468	35882	—
13/16	3/16 x 3/32	—	—	—	10691	10774	11088	11339	11513	11736	12104	37252	37255	—
7/8	No Keyway	—	—	—	56941	—	—	59063	—	—	—	—	—	12582
7/8	3/16 x 3/32	—	—	—	10692	10775	11089	11340	11514	11737	12105	12286	12423	12585
7/8	1/4 x 1/8	—	—	—	—	38188	35747	38203	35686	35749	35750	37256	35753	54883
15/16	1/4 x 1/8	—	—	—	—	32332	11090	11341	11515	11738	12160	12287	12424	—
1	1/4 x 1/8	—	—	—	—	31296	11091	11342	11516	11739	12107	12288	12425	12586
1	3/16 x 3/32	—	—	—	—	37257	37258	38204	37259	37260	37261	37262	37263	—
1-1/16	1/4 x 1/8	—	—	—	—	—	11092	11343	11517	11740	12108	12289	12426	—
1-1/8	1/4 x 1/8	—	—	—	—	—	11093	11344	11518	11741	12109	12290	12427	12587
1-3/16	1/4 x 1/8	—	—	—	—	—	—	11345	11519	11742	12110	12291	12428	—
1-1/4	1/4 x 1/8	—	—	—	—	—	—	—	11520	11743	12111	12292	12429	12588
1-1/4	5/16 x 5/32	—	—	—	—	—	—	—	35748	35752	35751	37294	35754	12589
1-5/16	5/16 x 5/32	—	—	—	—	—	—	—	11521	11744	12112	12293	26090	—
1-3/8	5/16 x 5/32	—	—	—	—	—	—	—	11522	11745	12113	12294	12430	12590
1-3/8	3/8 x 3/16	—	—	—	—	—	—	—	44348	37265	37266	37267	37568	46758
1-7/16	3/8 x 3/16	—	—	—	—	—	—	—	—	11746	12114	12295	12431	12591
1-1/2	5/16 x 5/32	—	—	—	—	—	—	—	—	37269	37270	37271	37272	—
1-1/2	3/8 x 3/16	—	—	—	—	—	—	—	—	11747	12115	12296	12432	12592
1-9/16	3/8 x 3/16	—	—	—	—	—	—	—	—	11748	12116	37273	12433	45689
1-5/16	3/8 x 3/16	—	—	—	—	—	—	—	—	11749	12117	12297	12434	12593
1-11/16	3/8 x 3/16	—	—	—	—	—	—	—	—	—	12118	12298	12435	60057
1-3/4	3/8 x 3/16	—	—	—	—	—	—	—	—	—	12119	12299	13436	12594
1-3/4	7/16 x 7/32	—	—	—	—	—	—	—	—	—	37274	37275	37276	48250
1-13/16	1/2 x 1/4	—	—	—	—	—	—	—	—	—	12120	12300	26091	—
1-7/8	1/2 x 1/4	—	—	—	—	—	—	—	—	—	12121	12301	12437	12595
1-15/16	1/2 x 1/4	—	—	—	—	—	—	—	—	—	—	12302	12438	49762
2	1/2 x 1/4	—	—	—	—	—	—	—	—	—	—	12303	12439	12596
2-1/16	1/2 x 1/4	—	—	—	—	—	—	—	—	—	—	12304	26092	—
2-1/8	1/2 x 1/4	—	—	—	—	—	—	—	—	—	—	12305	12440	12597
2-3/16	1/2 x 1/4	—	—	—	—	—	—	—	—	—	—	—	12441	12598
2-1/4	1/2 x 1/4	—	—	—	—	—	—	—	—	—	—	—	12442	12599
2-3/8	5/8 x 5/16	—	—	—	—	—	—	—	—	—	—	—	12443	12602
2-5/8	5/8 x 5/16	—	—	—	—	—	—	—	—	—	—	—	41809	12605
2-7/8	3/4 x 3/8	—	—	—	—	—	—	—	—	—	—	—	—	12607

Notes:
- Tolerances for bore and keyways are found in Engineering Data section (pages ED-10 and ED-11). All hubs supplied standard with one set screw.
- Non-standard bores available – consult Lovejoy Engineering.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

The L Type coupling consists of two standard L Type hubs and one spider. Refer to pages JW-10, JW-12, and JW-10.





L Type Hub - Metric Bore and Keyway UPC Number Selection Table

Bore	Keyway	L035	L050	L075	L075	L090	L095	L099	L100	L110	L150	L190	L225	L276
4	No Keyway	41850	—	—	—	—	—	—	—	—	—	—	—	—
5	No Keyway	47419	46214	—	—	—	—	—	—	—	—	—	—	—
6	No Keyway	45872	50351	—	—	—	—	—	—	—	—	—	—	—
7	No Keyway	60679	10215	58803	—	—	—	—	—	—	—	—	—	—
8	No Keyway	55169	41460	46151	—	60945	—	—	—	—	—	—	—	—
9	3 x 1.4	—	41313	56177	44298	—	—	—	—	—	—	—	—	—
10	No Keyway	—	10216	41452	41456	—	—	—	—	—	—	—	—	—
10	3 x 1.4	—	41450	49870	41457	52828	—	—	—	—	—	—	—	—
11	4 x 1.8	—	41314	41453	50811	—	49424	—	—	—	—	—	—	—
12	No Keyway	—	48510	51562	—	48276	—	—	—	—	—	—	—	—
12	4 x 1.8	—	41315	41454	44153	44329	44832	—	55195	—	—	—	—	—
14	No Keyway	—	58036	47505	—	41461	41465	—	—	—	—	—	—	—
14	5 x 2.3	—	41316	41317	41321	51231	41466	60094	45101	—	—	—	—	—
15	No Keyway	—	60708	—	10693	—	46561	52697	41469	—	—	—	—	—
15	5 x 2.3	—	41451	41455	41454	52096	45778	46972	47123	—	—	—	—	—
16	5 x 2.3	—	56176	41318	41322	49198	41325	52098	55534	52092	52471	—	—	—
17	5 x 2.3	—	—	45333	49398	—	49704	—	56178	60067	60156	—	—	—
18	6 x 2.8	—	—	59724	41884	46433	46626	44647	41926	44288	—	—	—	—
19	No Keyway	—	—	—	—	10777	—	—	—	41471	—	—	—	—
19	6 x 2.8	—	—	41319	41323	41462	41326	44157	14329	49700	48821	46717	—	—
20	6 x 2.8	—	—	—	41459	41925	41467	47122	52093	41804	61218	61497	—	—
22	6 x 2.8	—	—	—	58246	41968	44827	41959	44467	45214	44720	—	—	—
24	8 x 3.3	—	—	—	—	41463	41327	41990	41330	48301	48182	59109	—	—
25	8 x 3.3	—	—	—	—	41464	41468	45055	41470	41906	46751	52153	—	—
28	No Keyway	—	—	—	—	—	—	—	—	—	56179	56182	—	—
28	8 x 3.3	—	—	—	—	—	41328	50103	41331	41333	45679	52976	—	—
30	8 x 3.3	—	—	—	—	—	—	47132	48317	45681	41738	44471	48982	—
32	No Keyway	—	—	—	—	—	—	—	—	—	41472	41473	48319	56232
32	10 x 3.3	—	—	—	—	—	—	—	—	—	41873	45562	41849	41885
35	No Keyway	—	—	—	—	—	—	—	41332	41334	56180	56183	56184	—
35	10 x 3.3	—	—	—	—	—	—	—	—	—	46562	58035	52197	—
38	10 x 3.3	—	—	—	—	—	—	—	49925	45682	41337	41474	49664	52961
40	12 x 3.3	—	—	—	—	—	—	—	—	41335	48318	48320	49605	59308
42	12 x 3.3	—	—	—	—	—	—	—	—	45683	41338	41475	47492	45609
45	14 x 3.8	—	—	—	—	—	—	—	—	41336	45102	56017	52674	50292
48	No Keyway	—	—	—	—	—	—	—	—	—	56181	—	—	—
48	14 x 3.8	—	—	—	—	—	—	—	—	—	56227	48322	47569	61202
50	No Keyway	—	—	—	—	—	—	—	—	—	—	56228	56230	56233
50	14 x 3.8	—	—	—	—	—	—	—	—	—	—	44392	48797	45062
55	No Keyway	—	—	—	—	—	—	—	—	—	—	56229	56231	56234
55	16 x 4.3	—	—	—	—	—	—	—	—	—	—	47006	44089	56067
60	No Keyway	—	—	—	—	—	—	—	—	—	—	—	56185	56235
60	18 x 4.4	—	—	—	—	—	—	—	—	—	—	—	44598	56236
65	No Keyway	—	—	—	—	—	—	—	—	—	—	—	—	56237
65	18 x 4.4	—	—	—	—	—	—	—	—	—	—	—	56544	50102
70	20 x 4.9	—	—	—	—	—	—	—	—	—	—	—	—	58268

Notes:
- Tolerances for bore and keyways are found in Engineering Data section (page ED-17 and ED-18). All hubs supplied standard with one set screw.
- Non-standard bores available – consult Lovejoy Engineering.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

LC Type Couplings

The LC Type coupling consists of one standard L Type hub (without collar attachment), one LC Type hub (provides collar attachment), one standard snap wrap center and one collar with screws. Refer to pages JW-11, JW-12 and JW-13 for details.



Features

- Radially removable insert
- Collar allows for maximum speed of 3,600 RPM
- Collar manufactured from 1018 Steel

LC Type Hub - Inch Bore and Keyway UPC Number Selection Table

Bore	Keyway	LC090	LC095	LC099	LC100	LC110	LC150	LC190	LC225
1/4	No Keyway	45321	—	—	—	—	—	—	—
3/8	No Keyway	45322	—	—	—	—	—	—	—
1/2	No Keyway	45323	11133	—	11575	—	—	—	—
1/2	1/8 x 1/16	—	—	—	48768	—	—	—	—
5/8	No Keyway	—	—	—	—	11828	45412	—	—
5/8	3/16 x 3/32	45324	11134	48886	11577	—	—	—	—
3/4	No Keyway	—	—	—	—	—	—	12322	12456
3/4	1/8 x 1/16	—	—	—	55466	—	—	—	—
3/4	3/16 x 3/32	45325	11135	—	41920	11829	—	12323	—
13/16	3/16 x 3/32	—	11136	—	—	11830	—	—	—
7/8	3/16 x 3/32	45326	11137	—	11578	11832	—	—	—
7/8	1/4 x 1/8	—	—	56567	49553	56566	60343	—	—
15/16	1/4 x 1/8	—	11138	—	—	11834	—	—	—
1	1/4 x 1/8	45327	11139	52825	11579	11836	12069	44161	50125
1	3/16 x 3/32	—	—	—	—	55552	—	—	—
1-1/8	1/4 x 1/8	—	44156	—	11580	11838	12071	44160	50126
1-3/16	1/4 x 1/8	—	11140	—	—	11840	—	—	—
1-1/4	1/4 x 1/8	—	—	—	11581	11841	12073	12327	12462
1-1/4	5/16 x 5/32	—	—	—	59046	—	48273	—	—
1-3/8	5/16 x 5/32	—	—	—	45257	11842	12075	12329	50127
1-7/16	3/8 x 3/16	—	—	—	—	11844	—	—	12465
1-1/2	5/16 x 5/32	—	—	—	—	—	12077	—	—
1-1/2	3/8 x 3/16	—	—	—	—	11846	—	12332	12466
1-9/16	3/8 x 3/16	—	—	—	—	11848	—	12332	—
1-5/8	3/8 x 3/16	—	—	—	—	11849	12079	12334	12468
1-3/4	3/8 x 3/16	—	—	—	—	—	44159	12336	46818
1-7/8	1/2 x 1/4	—	—	—	—	—	12082	12337	12472
1-15/16	1/2 x 1/4	—	—	—	—	—	—	12339	—
2	1/2 x 1/4	—	—	—	—	—	—	12341	14276
2-1/8	1/2 x 1/4	—	—	—	—	—	—	44064	12477
2-1/4	1/2 x 1/4	—	—	—	—	—	—	—	12480
2-3/8	5/8 x 5/16	—	—	—	—	—	—	—	12482

Notes:
- These "LC" hubs are drilled and tapped to accept collar mounting screws but the collar and hardware are not included.
- See L Type (inch or metric) coupling chart for standard hub.
- Tolerances for bore and keyways are found in Engineering Data section (pages ED-10 and ED-11).
- All hubs are supplied standard with one set screw.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

LC Type Couplings

The LC Type coupling consists of one standard L Type hub (without collar attachment), one LC Type hub (provides collar attachment), one standard snap wrap center and one collar with screws. Refer to pages JW-11, JW-12 and JW-13 for details.



Features

- Radially removable insert
- Collar allows for maximum speed of 3,600 RPM
- Collar manufactured from 1018 Steel

LC Type Wrap Spider / Collar UPC Number Selection Table

	LC090	LC095	LC099	LC100	LC110	LC150	LC190	LC225
Snap Wrap Spider/No Ring	11071	11071	11495	11495	11725	12002	12275	26093[1]
Collar Only w/Screws	48340	48340	45258	45258	47932	47933	47934	47935

Notes:
- 1 indicates: L225 snap wrap spider is urethane, solid ring.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

LC Type Hub - Metric Bore and Keyway UPC Number Selection Table

Bore	Keyway	LC090	LC095	LC099	LC100	LC110	LC150	LC190	LC225
12	No Keyway	58596	—	—	—	—	—	—	—
12	4 x 1.8	58597	—	—	—	—	—	—	—
14	No Keyway	58598	58592	—	—	—	—	—	—
14	5 x 2.3	58556	58559	—	—	—	—	—	—
15	5 x 2.3	58599	—	—	—	—	—	—	—
16	5 x 2.3	—	58593	—	—	—	—	—	—
19	6 x 2.8	58557	58560	56197	58563	58566	—	—	—
20	6 x 2.8	—	58594	—	—	—	—	—	—
24	8 x 3.3	58558	58561	58588	58564	58567	—	—	—
25	8 x 3.3	58600	58595	58589	—	—	—	—	—
28	8 x 3.3	—	58562	58590	58565	58568	58571	58575	—
32	10 x 3.3	—	—	—	52806	58587	58585	58586	—
38	10 x 3.3	—	—	—	—	58569	58572	58576	58580
42	12 x 3.3	—	—	—	—	58570	58573	58577	58581
48	14 x 3.8	—	—	—	—	—	58574	58578	58582
55	16 x 4.3	—	—	—	—	—	—	58579	58583
65	No Keyway	—	—	—	—	—	—	—	58584

Notes:
- These “LC” hubs are drilled and tapped to accept collar mounting screws but the collar and hardware are not included.
- See L Type (inch or metric) UPC Number Selection Table for standard hub (pages JW-11 or JW-10).
- Tolerances for bore and keyways are found in Engineering Data section (pages ED-17 and ED-18).
- All hubs are supplied with one set screw.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

AL and SS Type Couplings



The AL Type coupling consists of two hubs and one spider.

Features

- Interchangeable with all hub sizes standard for the L-Line and AL-Line products
- Available in a variety of different finished bore and keyway combinations
- Finished bores passivated for additional rust protection

AL Type Hub - Inch Bore and Keyway UPC Number Selection Table

Bore	Keyway	AL050	AL070	AL075	AL090	AL095	AL099	AL100	AL110	AL150
1/4	No Keyway	10252	10463	10630	10791	—	—	—	—	—
5/16	No Keyway	10253	10464	10631	10792	—	—	—	—	—
3/8	No Keyway	10254	10466	10632	10793	—	—	—	—	—
7/16	No Keyway	10256	10469	10633	10794	—	—	—	—	—
1/2	No Keyway	10257	10471	10634	10795	17847	17880	17914	—	—
1/2	1/8 x 1/16	49706	10473	10635	10796	17848	17881	17915	—	—
9/16	No Keyway	—	—	10638	10797	—	—	56473	—	—
9/16	1/8 x 1/16	—	—	61817	4412	37994	44323	17917	—	—
5/8	No Keyway	10259	10480	10639	44004	—	—	—	17977	18035
5/8	3/16 x 3/32	—	10482	45227	10798	17855	17882	17918	38888	44828
11/16	3/16 x 3/32	—	—	47835	10799	17851	45494	17919	44059	46642
3/4	1/8 x 1/16	—	—	10640	47725	46295	—	—	—	—
3/4	3/16 x 3/32	—	10491	10641	10800	17852	17883	17920	17978	18036
13/16	3/16 x 3/32	—	—	10642	10801	17853	17884	17921	—	—
7/8	3/16 x 3/32	—	—	—	10802	17854	17885	17922	17979	18037
15/16	1/4 x 1/8	—	—	—	—	17855	17886	17923	17980	18038
1	1/4 x 1/8	—	—	—	—	17856	17887	17924	17981	18039
1-1/16	1/4 x 1/8	—	—	—	—	17857	17888	17925	26094	18040
1-1/8	1/4 x 1/8	—	—	—	—	17858	17889	17926	17982	18041
1-3/16	1/4 x 1/8	—	—	—	—	—	17890	17927	17983	18042
1-1/4	1/4 x 1/8	—	—	—	—	—	—	17928	17984	18043
1-5/16	5/16 x 5/32	—	—	—	—	—	—	17929	17985	18044
1-3/8	5/16 x 5/32	—	—	—	—	—	—	17930	17986	18045
1-7/16	3/8 x 3/16	—	—	—	—	—	—	45508	17987	18046
1-1/2	3/8 x 3/16	—	—	—	—	—	—	—	17988	18047
1-9/16	3/8 x 3/16	—	—	—	—	—	—	—	17989	18048
1-5/8	3/8 x 3/16	—	—	—	—	—	—	—	17990	18049
1-11/16	3/8 x 3/16	—	—	—	—	—	—	—	—	18050
1-3/4	3/8 x 3/16	—	—	—	—	—	—	—	—	18051
1-13/16	1/2 x 1/4	—	—	—	—	—	—	—	—	18052
1-7/8	1/2 x 1/4	—	—	—	—	—	—	—	—	18053

Notes:
- Tolerances for bore and keyways are found in Engineering Data section (page ED-10).
- Lovejoy does not recommend reboring AL hubs.
- All hubs are supplied standard with one set screw, except the AL150 which is provided with two set screws.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

SS Type Hub - Inch Bore and Keyway UPC Number Selection Table



Size	RSB	1/4	1/2	5/8	3/4	7/8	1	1-1/8	1-3/8	1-1/2
SS075	70001	70006	70007	70008	70009	70010	—	—	—	—
SS095	70002	70011	70011	70012	70013	70014	70015	70016	—	—
SS100	70003	—	—	—	70017	70018	70019	70020	70022	—
SS110	70004	—	—	—	—	—	70023	70024	70026	70027
SS150	70005	—	—	—	—	—	70029	70030	70032	70033

Note:
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

AL Type Couplings



The AL Type coupling consists of two hubs and one spider. Refer to page JW-10 for spider details.

Features

- Aluminum material is corrosion resistant
- Lightweight
- Hubs compatible with standard Lovejoy hub design (except AL150)

AL Type Spider UPC Number Selection Table

Spider Type	AL050	AL070	AL075	AL090/095	AL099/100	AL110	AL150
SOX (NBR) (solid)	10194	10406	10621	11070	11494	11724	18027
SOX (NBR) (open center)	—	10393	10620	10968	11492	11711	—
Urethane (solid)	37786	10395	—	—	—	—	—
Urethane (open center)	—	10411	10626	11075	11499	11729	—
Hytrel (solid)	25307	—	—	—	—	11717	—
Hytrel (open center)	—	25308	25309	25310	11486	38097	—
Bronze (open center)	10198	10409	10624	11073	11497	11727	—
Snap Wrap w/ring	—	—	—	24669	24670	24671	—
Snap Wrap no ring	—	—	—	11071	11495	11725	—

Notes:
- AL Type couplings use the same spiders as L Type couplings, except AL150 which has four jaws instead of three.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

AL Type Hub - Metric Bore and Keyway UPC Number Selection Table

Bore	Keyway	AL050	AL070	AL075	AL090	AL095	AL099	AL100	AL110	AL150
8	No Keyway	—	—	48973	—	—	—	—	—	—
10	3 x 1.4	—	—	41924	56514	—	—	—	—	—
11	4 x 1.8	—	65694	51098	58620	—	—	—	—	—
12	4 x 1.8	—	56487	64655	60429	—	—	—	—	—
14	5 x 2.3	—	65696	47302	58621	56800	58624	—	—	—
15	5 x 2.3	—	62906	49633	58622	56801	—	49629	—	—
16	5 x 2.3	—	—	52221	—	47014	—	45012	—	—
17	5 x 2.3	—	—	—	60887	44712	—	59164	—	—
19	6 x 2.8	—	65698	47427	44679	47012	58625	47253	59064	—
20	No Keyway	—	—	56137	—	—	—	—	—	—
20	6 x 2.8	—	—	59394	61478	48347	49634	49630	49631	60878
22	6 x 2.8	—	—	—	—	47013	—	—	—	—
24	8 x 3.3	—	—	—	—	45736	58626	44058	45690	64634
25	8 x 3.3	—	—	—	—	65469	49709	55687	45933	64633
28	8 x 3.3	—	—	—	—	47015	58627	47393	45463	—
30	8 x 3.3	—	—	—	—	—	52048	58266	49632	45063
32	10 x 3.3	—	—	—	—	—	—	—	54417	44347
35	10 x 3.3	—	—	—	—	—	—	—	46215	64803
36	10 x 3.3	—	—	—	—	—	—	—	—	51737
38	10 x 3.3	—	—	—	—	—	—	—	52692	58215
42	12 x 3.3	—	—	—	—	—	—	—	—	45404
46	14 x 3.8	—	—	—	—	—	—	—	—	64119

Notes:
- Tolerances for bore and keyways are found in Engineering Data section (page ED-17).
- Lovejoy does not recommend reboring AL hubs.
- All hubs are supplied standard with one set screw, except the AL150 which is provided with two set screws.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

RRS and RRSC Type Radially Removable Spacer Couplings



RRS Type couplings range from sizes RRS090 to RRS225. The RRS Type coupling consists of:

RRS090 – RRS110:

2 Standard RRS Hubs
1 Spacer Assembly consisting of:
- 2 snap wrap spiders w/o ring
- 2 collars with screws
- 1 spacer

RRS150 – RRS225:

1 Standard RRS Hub
1 Standard RRSC Hub – Drilled for collar
1 Spacer Assembly consisting of:
- 2 snap wrap spiders w/o ring
- 2 collars with screws
- 1 spacer

RRS Type Hub - Inch Bore and Keyway UPC Number Selection Table

Bore	Keyway	RRS090	RRS095	RRS099	RRS100	RRS110	RRS150	RRS190	RRS225
7/16	No Keyway	—	41229	52184	41231	—	—	—	—
1/2	No Keyway	41227	50357	41230	52199	—	—	—	—
1/2	1/8 x 1/16	56512	38145	—	38151	—	—	—	—
9/16	3/16 x 3/32	—	44474	—	—	—	—	—	—
5/8	No Keyway	—	—	—	—	38159	45265	—	—
5/8	3/16 x 3/32	38143	38146	38168	38152	—	50163	—	—
3/4	No Keyway	—	—	—	—	—	—	45273	45290
3/4	3/16 x 3/32	38144	38147	38169	38153	38160	45266	—	45292
7/8	1/4 x 1/8	—	—	—	52966	—	—	—	—
7/8	3/16 x 3/32	41228	38148	38170	38154	38161	45267	45274	45291
1	1/4 x 1/8	51672	38149	38171	38155	38162	45268	45275	45294
1-1/8	1/4 x 1/8	—	38150	38172	38156	38163	45153	45276	45295
1-1/8	5/16 x 5/32	—	—	—	—	—	48104	—	—
1-1/4	1/4 x 1/8	—	—	—	38157	38164	45392	48503	50743
1-3/8	5/16 x 5/32	—	—	—	38158	38165	44002	44725	45296
1-7/16	3/8 x 3/16	—	—	—	—	51579	49659	48933	49658
1-1/2	3/8 x 3/16	—	—	—	—	40816	49638	46628	45297
1-5/8	3/8 x 3/16	—	—	—	—	38166	41880	45277	45298
1-3/4	3/8 x 3/16	—	—	—	—	—	45162	45278	45299
1-7/8	1/2 x 1/4	—	—	—	—	—	44214	45279	41953
2	1/2 x 1/4	—	—	—	—	—	—	45280	45300
2-1/8	1/2 x 1/4	—	—	—	—	—	—	—	44724
2-3/8	5/8 x 5/16	—	—	—	—	—	—	—	45106

Notes:
- RRS inch hubs are standard with two set screws, including those with no keyway.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

RRS / RRSC Type Hub - Metric Bore and Keyway UPC Number Selection Table

Bore	Keyway	RRSC150	RRSC190	RRSC225
32	No Keyway	55675	55679	55683
38	10 x 3.3	55676	55680	—
40	12 x 3.3	55677	55681	—
42	12 x 3.3	55678	55682	—

Notes:
- RRS inch hubs are standard with two set screws and are drilled to accept retaining collar. Collars are supplied with spacers.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

RRS / RRSC Type Hub - Inch Bore and Keyway UPC Number Selection Table

Bore	Keyway	RRSC150	RRSC190	RRSC225
5/8	No Keyway	45269	—	—
3/4	No Keyway	—	45281	45301
3/4	3/16 x 3/32	45312	—	45303
7/8	3/16 x 3/32	45270	45282	45293
1	1/4 x 1/8	45271	45283	45305
1-1/8	1/4 x 1/8	44779	45284	45105
1-3/8	5/16 x 5/32	44006	45285	45306
1-1/2	3/8 x 3/16	46939	—	45307
1-5/8	3/8 x 3/16	14881	45286	45308
1-3/4	3/8 x 3/16	—	45287	45309
1-7/8	1/2 x 1/4	45272	45288	41954
2	1/2 x 1/4	—	45289	45310
2-1/8	1/2 x 1/4	—	—	45311

Notes:
- RRS inch hubs are standard with two set screws and are drilled to accept retaining collar. Collars are supplied with spacers.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

RRS Type Radially Removable Spacer Couplings



RRS Type couplings range from sizes RRS090 to RRS225.
The RRS Type coupling consists of:

RRS090 – RRS110:
2 Standard RRS Hubs
1 Spacer Assembly consisting of:
- 2 snap wrap spiders w/o ring
- 2 collars with screws
- 1 spacer

RRS150 – RRS225:
1 Standard RRS Hub
1 Standard RRSC Hub – Drilled for collar
1 Spacer Assembly consisting of:
- 2 snap wrap spiders w/o ring
- 2 collars with screws
- 1 spacer

Note: ■ RRS Type Inch Hubs provided standard with two set screws at 90°
Metric Hubs provided standard with one set screw.

Features
- Standard API based spacers available
- Radially removable inserts
- Standard Lovejoy hub design with additional set screw at 90°

RRS Type Spacer UPC Number Selection Table

Description		RRS090	RRS095	RRS099	RRS100	RRS110	RRS150	RRS190	RRS225
3-1/2 in	Spacer Assembly	12620	12620	12630	12630	12644	12660	12676	12685
5 in	Spacer Assembly	26119	26119	26123	26123	26128	26770	27046	27041
7 in	Spacer Assembly	26120	26120	26124	26124	26129	27044	27043	27039
100mm	Spacer Assembly	55563	55563	55567	55567	55570	61056	61057	61058
140mm	Spacer Assembly	55281	55281	55569	55569	55571	55572	55573	55574
180mm	Spacer Assembly	61055	61055	55575	55575	55576	55577	55578	55579

Notes: ■ Spacer length denotes separation between shaft ends. Assembly includes spacer, two snap wrap spiders w/o ring, and two collars with screws. See page JW-10 for ordering information on spiders.
■ When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

RRS Type Hub - Metric Bore and Keyway UPC Number Selection Table

Bore	Keyway	RRS090	RRS095	RRS099	RRS100	RRS110	RRS150	RRS190	RRS225
12	No Keyway	48276	—	—	—	—	—	—	—
14	No Keyway	41461	41465	—	—	—	—	—	—
14	5 x 2.3	51231	41466	60094	45101	—	—	—	—
15	No Keyway	—	46561	52697	41469	—	—	—	—
15	5 x 2.3	52096	45778	46972	47123	—	—	—	—
16	5 x 2.3	49198	41325	52098	55534	52092	52471	—	—
19	No Keyway	10777	—	—	—	41471	—	—	—
19	6 x 2.8	41462	41326	44157	41329	49700	48821	46717	—
20	6 x 2.8	41925	41467	47122	52093	41804	—	61497	—
23	8 x 3.3	50135	—	—	—	—	—	—	—
24	8 x 3.3	41463	41327	41990	41330	48301	48182	59109	—
25	8 x 3.3	41464	41468	45055	41470	41906	46751	52153	—
28	8 x 3.3	—	41328	50103	41331	41333	45679	52976	—
30	8 x 3.3	—	—	47132	48317	45681	41738	44471	48982
32	No Keyway	—	—	—	—	—	41472	41473	48319
32	10 x 3.3	—	—	—	41332	41334	41873	45562	41849
35	10 x 3.3	—	—	—	49925	45682	46562	58035	52197
38	10 x 3.3	—	—	—	—	41335	41337	41474	49664
40	12 x 3.3	—	—	—	—	45683	48318	48320	49605
42	12 x 3.3	—	—	—	—	41336	41338	41475	47492

Notes: ■ DIN Metric Hubs are standard with one set screw only.
■ When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

C Type Couplings

The C Type coupling consists of two standard hubs, one cushion set and collar with hardware.



Features

- Greater torque and bore capacity than the L-Line series jaw coupling
- Elastomeric cushions are radially removable
- Cushions available in SXB rubber and Hytrel

C Type Cushions / Collar UPC Number Selection Table

Size	C226	C276	C280	C285	C295	C2955
Number of Cushions	6	6	6	6	6	10
SXB (NBR) cushion set	14547	14633	14712	14771	14805	14856
Hytrel® cushion set	27529	14637	14716	14774	14808	14859
Bronze cushion set	14545	—	—	—	51914	51915
Collar with hardware	40122	40123	40124	40292	40293	40293

Notes:
- Chemical resistance and compatibility for cushions is described in Engineering Data section (page ED-9).
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

C Type Hub - Inch Bore and Keyway UPC Number Selection Table

Bore	Keyway	C226	C276	C280	C285	C295	C2955
7/8 RSB	No Keyway	40125	40126	—	—	—	—
1-1/8	1/4 x 1/8	26036	26050	—	—	—	—
1-1/4 RSB	No Keyway	—	—	20607	41036	—	—
1-1/4	1/4 x 1/8	26037	26051	48988	47173	—	—
1-3/8	5/16 x 5/32	26038	26052	46278	55546	—	—
1-7/16	3/8 x 3/16	26039	—	—	—	—	—
1-1/2 RSB	No Keyway	—	—	—	—	41037	—
1-1/2	3/8 x 3/16	26040	26053	46277	48366	44824	—
1-5/8	3/8 x 3/16	26041	26054	46194	41892	56078	—
1-3/4 RSB	No Keyway	—	—	—	—	—	41038
1-3/4	3/8 x 3/16	26042	26055	44011	52311	45780	—
1-7/8	1/2 x 1/4	26043	26056	44012	51533	47080	49075
2	1/2 x 1/4	26044	26057	48194	—	—	—
2-1/8	1/2 x 1/4	26045	26058	44370	49809	44711	—
2-1/4	1/2 x 1/4	26046	44547	—	—	—	—
2-3/8	5/8 x 5/16	26047	26060	44014	47288	44825	52703
2-1/2	5/8 x 5/16	26048	46120	51998	56779	45249	48454
2-5/8	5/8 x 5/16	—	46755	44013	—	50145	54549
2-7/8	3/4 x 3/8	—	26064	51525	49456	52702	48108
3	3/4 x 3/8	—	—	48193	—	—	—
3-3/8	7/8 x 7/16	—	—	—	47171	45402	49077
3-1/2	7/8 x 7/16	—	—	—	46844	52988	44545
3-5/8	7/8 x 7/16	—	—	—	—	—	50106
3-3/4	7/8 x 7/16	—	—	—	—	—	58378
3-7/8	1 x 1/2	—	—	—	48247	—	49351
4	1 x 1/2	—	—	—	—	—	55016

Notes:
- RSB (Rough Stock Bore) hub has no keyway or set screw hole, it is not useable as shown and must be machined to proper bore tolerances. Hub includes inside sleeve and is drilled and tapped for collar bolts. Non-standard bores available – consult Lovejoy Engineering.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

C Type Hub - Metric Bore and Keyway UPC Number Selection Table

Bore	Keyway	C226	C276	C280	C285	C295	C2955
30	8 x 3.3	62792	—	—	—	—	—
35	10 x 3.3	60243	47386	—	—	—	—
38	10 x 3.3	45348	62160	—	—	—	—
40	12 x 3.3	49379	54037	—	—	—	—
42	12 x 3.3	—	45219	—	—	—	—
45	14 x 3.8	52550	44723	58265	—	—	—
48	14 x 3.8	54288	—	52205	—	—	—
55	16 x 4.3	58011	58444	49012	—	—	—
60	18 x 4.4	—	47265	49378	—	—	—
65	18 x 4.4	—	52008	—	—	—	58676
70	20 x 4.9	—	59032	—	56794	54355	58677
75	22 x 5.4	—	—	—	—	47913	58678
80	22 x 5.4	—	—	—	44487	58675	58679
90	25 x 5.4	—	—	—	54363	—	—
95	25 x 5.4	—	—	—	—	—	62695

Notes:
- RSB (Rough Stock Bore) hub has no keyway or set screw hole, it is not useable as shown and must be machined to proper bore tolerances. Hub includes inside sleeve and is drilled and tapped for collar bolts. Non-standard bores available – consult Lovejoy Engineering. For RSB hub part numbers see the C Type Inch Hub table.
- When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

H Type Couplings

The H Type coupling consists of two hubs, two inside sleeves, one cushion set and one collar with hardware. H Type coupling hubs are supplied with an inside sleeve. For technical assistance, please contact Lovejoy Engineering.



Features

- Greater torque and bore capacity than the C-Line series jaw coupling
- Elastomeric cushions are radially removable
- Cushions available in SXB rubber and Hytrel

H Type Cushions / Collar UPC Number Selection Table

Size	H3067	H3567	H3667	H4067	H4567
Number of Cushions	14	14	14	14	14
SXB cushion set	15365	15386	15419	15457	15473
Hytrel® cushion set	15367	15388	45223	15459	55475
Collar with hardware	15361	15381	15411	55472	55476

Note: ■ When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

H Type Hubs - Rough Stock Inch Bore UPC Number Selection Table

Bore	H3067	H3567	H3667	H4067	H4567
2-1/8 RSB	48070	—	—	—	—
2-5/8 RSB	—	50883	—	—	—
3 RSB	—	—	47878	—	—
3-1/4 RSB	—	—	—	55473	—
3-1/2 RSB	—	—	—	—	55477

Notes: ■ RSB (Rough Stock Bore) hub has no keyway or set screw hole.
■ RSB bores should not be used as shown and may need additional machinign to reach proper tolerances.
■ When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

RRC Type Radially Removable Spacer Coupling

RRC Type couplings range from sizes RRC226to RRC2955. The RRC Type coupling consists of:

2 RRC Hub Adapters (includes bolts)
1 Spacer assembly consisting of:
- 2 RRC Jaw rings
- 1 collar with hardware
- 1 set of SXB (NBR) cushions

RRC Type Spacer UPC Number Selection Table

Description		RRC226	RRC276	RRC280	RRC285	RRC295	RRC2955
3-1/2 in	Spacer Assembly	55709	55712	55715	55718	—	—
4 in	Spacer Assembly	—	—	—	—	55721	55724
5 in	Spacer Assembly	55710	55713	55716	55719	55722	55751
7 in	Spacer Assembly	55711	55174	55717	55720	55723	55752

Note: ■ When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

RRC Type Adapter Hubs - Rough Stock Inch Bore UPC Number Selection Table

Bore	RRC226	RRC276	RRC280	RRC285	RRC295	RRC2955
7/8 RSB	55770	55771	—	—	—	—
1-1/4 RSB	—	—	52030	55772	—	—
1-1/2 RSB	—	—	—	—	55773	—
1-3/4 RSB	—	—	—	—	—	55774

Note: ■ When referencing the Lovejoy UPC number in this table, include 685144 as a prefix to the number shown.

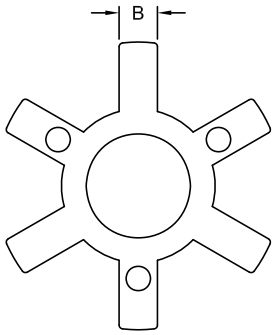
Jaw Type Performance Ratings

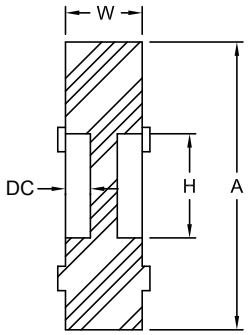
Size	Elastomeric Member	Number of Jaws	Basic HP Ratings @ Varying RPM				Torque Rating		Max Bore		Max x1000
			100	1200	1800	3600	in-lbs	Nm	in	mm	RPM
L, AL & LC Type											
L035	SOX (NBR)	2	0.006	0.07	0.10	0.22	3.5	0.40	0.375	9	31.0
L050/AL050	SOX (NBR)	2	0.042	0.50	0.75	1.51	26.3	2.97	0.625	16	18.0
L050/AL050	Hytrel®	2	0.080	0.96	1.43	2.88	50.0	5.65	0.625	16	18.0
L070/AL070	SOX (NBR)	2	0.070	0.84	1.23	2.52	43.2	4.88	0.750	19	14.0
L070/AL070	Hytrel	2	0.180	2.16	3.26	6.48	114.0	12.88	0.750	19	3.6
L075/AL075	SOX (NBR)	3	0.140	1.68	2.57	5.04	90.0	10.17	0.875	22	11.0
L075/AL075	Hytrel	3	0.360	4.32	6.48	12.96	227.0	25.65	0.875	22	3.6
L090/AL090/LC090	SOX (NBR)	3	0.230	2.76	4.11	8.28	144.0	16.27	1.000	25	9.0
L090/AL090	Hytrel	3	0.640	7.68	11.50	23.04	401.0	42.31	1.000	25	3.6
L095/AL095/LC095	SOX (NBR)	3	0.310	3.72	5.50	11.16	194.0	21.92	1.120	28	9.0
L095/AL095	Hytrel	3	0.890	10.68	16.00	32.04	561.0	63.38	1.120	28	3.6
L099/AL099/LC099	SOX (NBR)	3	0.500	6.00	9.10	18.00	318.0	35.93	1.180	30	7.0
L099/AL099	Hytrel	3	1.260	15.12	22.60	45.36	792.0	89.48	1.180	30	3.6
L100/AL100/LC100	SOX (NBR)	3	0.660	7.92	11.90	23.76	417.0	47.11	1.380	35	7.0
L100/AL100	Hytrel	3	1.800	21.60	32.40	64.80	1,134.0	128.12	1.380	35	3.6
L110/AL110/LC110	SOX (NBR)	3	1.260	15.12	23.00	45.36	792.0	89.48	1.620	42	5.0
L110/AL110	Hytrel	3	3.600	43.20	65.00	129.60	2,268.0	256.25	1.620	42	5.0
L150/LC150	SOX (NBR)	3	2.000	24.00	35.00	72.00	1,240.0	140.10	1.880	48	5.0
L150	Hytrel	3	5.900	70.80	106.00	212.40	3,708.0	418.95	1.880	48	5.0
AL-150	SOX (NBR)	4	2.300	27.60	41.40	82.80	14.50.0	163.83	1.880	48	5.0
L190/LC190	SOX (NBR)	3	2.700	32.40	49.00	97.20	1,728.0	195.24	2.120	55	5.0
L190	Hytrel	3	7.400	88.80	134.00	266.40	4,680.0	528.77	2.120	55	5.0
L225/LC225	SOX (NBR)	3	3.700	44.40	67.00	133.20	2,340.0	264.38	2.620	65	4.2
L225	Hytrel	3	9.900	118.80	178.00	356.40	6,228.0	703.67	2.620	65	4.2
L276	SOX (NBR)	3	7.500	90.00	135.00	+	4,716.0	532.84	2.880	73	1.8
C Type											
C226	SXB (NBR)	3	4.700	56.40	85.00	169.20	2,988.0	337.60	2.500	64	4.8
C226	Hytrel	3	9.400	112.80	170.00	338.40	5,940.0	671.13	2.500	64	4.8
C276	SXB (NBR)	3	7.500	90.00	135.00	270.00	4,716.0	532.84	2.880	73	4.2
C276	Hytrel	3	15.000	180.00	269.00	540.00	9,432.0	1065.67	2.880	73	4.2
C280	SXB (NBR)	3	12.000	114.00	216.00	+	7,560.0	854.17	3.000	76	3.5
C280	Hytrel	3	22.000	264.00	396.00	+	13,866.0	1 566.65	3.000	76	3.5
C285	SXB (NBR)	3	14.600	175.20	262.00	+	9,182.0	1 037.43	4.000	102	3.2
C285	Hytrel	3	26.000	312.00	476.00	+	16,660.0	1 882.33	4.000	102	3.2
C295	SXB (NBR)	3	18.000	216.00	324.00	+	1,134.0	1 281.25	3.500	89	2.3
C295	Hytrel	3	36.000	432.00	648.00	+	22,680.0	2 562.50	3.500	89	2.3
C2955	SXB (NBR)	5	30.000	360.00	540.00	+	18,900.0	2 135.42	4.000	102	2.3
C2955	Hytrel	5	60.000	720.00	1,080.00	+	37,800.0	4 270.83	4.000	102	2.3
H Type											
H3067	SXB (NBR)	7	53.000	639.00	954.00	+	33,396.0	3 773.25	4.500	114	2.3
H3067	Hytrel	7	75.000	900.00	1,348.00	+	47,196.0	5 332.44	4.000	102	2.3
H3567	SXB (NBR)	7	74.000	888.00	1,332.00	+	46,632.0	5 268.72	5.000	127	2.1
H3567	Hytrel	7	100.000	1,200.00	1,799.00	+	63,000.0	7 118.06	4.500	114	2.1
H3667	SXB (NBR)	7	103.000	1,236.00	1,851.00	+	64,812.0	7 322.78	5.620	146	1.9
H3667	Hytrel	7	140.000	1,680.00	2,519.00	+	88,200.0	9 965.28	5.000	127	1.9
H4067	SXB (NBR)	7	140.000	1,680.00	2,520.00	+	88,224.0	9 967.99	6.250	159	1.8
H4067	Hytrel	7	200.000	2,400.00	3,600.00	+	126,000.0	14 236.11	5.500	140	1.8
H4567	SXB (NBR)	7	190.000	2,280.00	+	+	119,700.0	13 524.30	7.000	178	1.5
H4567	Hytrel	7	270.000	3,240.00	+	+	170,000.0	19 207.45	6.000	152	1.5
RRS Type											
RRS090	SOX (NBR)	3	0.230	2.76	4.11	8.28	144.0	16.27	1.000	25	3.6
RRS095	SOX (NBR)	3	0.310	3.72	5.50	11.16	194.0	21.92	1.120	28	3.6
RRS099	SOX (NBR)	3	0.500	6.00	9.10	18.00	318.0	35.93	1.180	30	3.6
RRS100	SOX (NBR)	3	0.660	7.92	11.90	23.76	417.0	47.11	1.380	35	3.6
RRS110	SOX (NBR)	3	1.260	15.12	23.00	45.36	792.0	89.48	1.620	42	3.6
RRS150	SOX (NBR)	3	2.000	24.00	35.00	72.00	1,240.0	140.10	1.880	48	3.6
RRS190	SOX (NBR)	3	2.700	32.40	49.00	97.20	1,728.0	195.24	2.120	55	3.6

Notes: ■ + indicates: exceeds RPM capacity.

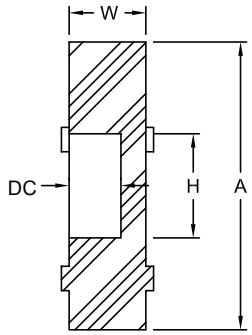
■ See Chart on page JW-9 for Bronze and Urethane ratings.

Elastomers In Compression (Spiders)

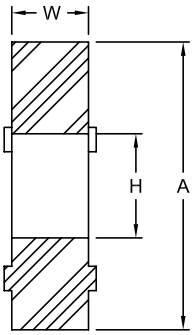




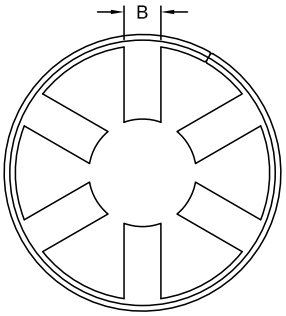
Solid Center

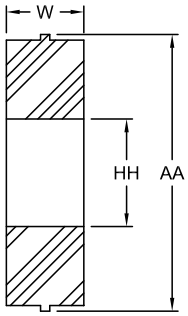


L095 & L225 NBR Only



Open Center





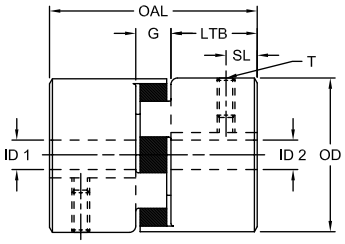
Snap Wrap

Elatomers In Compression (Spiders) Dimensional Data

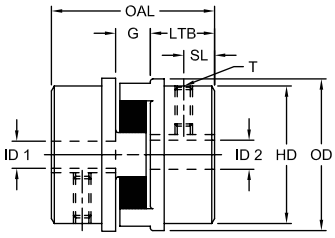
					A	DC	H					A	H				AA	HH	W	B
	Solid Center Spiders							Open Center Spiders									Snap Wrap Spiders		All	
	Material Available							Material Available												
Size	NBR SOX	Urethane URE	Hytrel® HYT	Bronze BRZ	in	in	in	NBR SOX	Urethane URE	Hytrel® HYT	Bronze BRZ	in	NBR in	URE in	HYT in	BRZ in	Material NBR	in	in	in	in
L035	X	—	—	—	0.62	—	—	—	—	—	—	—	—	—	—		N/A	—	—	0.28	0.21
L050	X	X	X	—	1.07	—	—	—	—	—	X	1.07	0.31			0.31	N/A	—	—	0.42	0.27
L070	X	X	—	—	1.38	—	—	X	X	X	X	1.38	0.50			0.50	N/A	—	—	0.42	0.27
L075	X	—	—	—	1.75	—	—	X	X	X	X	1.75	0.75			0.75	N/A	—	—	0.44	0.27
L090/L095	X	—	—	—	2.12	0.18	0.88	X	X	X	X	2.12	0.88			0.75	X	2.56	1.06	0.44	0.36
L099/L100	X	—	—	—	2.54	0.25	1.03	X	X	X	X	2.54	1.03			1.03	X	3.08	1.37	0.61	0.43
L110	X	—	X	—	3.31	NBR .25 HYT .18	1.19	X	X	X	X	3.31	1.18			1.38	X	3.87	1.50	0.75	0.45
L150	X	—	X	—	3.75	NBR .31 HYT .21	1.25	X	X	X	X	3.75	1.25			1.25	X	4.56	1.75	0.88	0.59
L190	X	—	X	—	4.50	NBR .31 HYT .18	1.38	X	X	X	X	4.50	1.38			1.38	X	5.18	2.25	0.88	0.60
L225	X	—	X	—	4.98	NBR .38 HYT .18	1.75	X	X	X	X	4.98	1.75			1.75	URE	5.44	2.75	0.88	0.73
L276	—	—	—	—	—	—	—	X	—	—	X	6.19	1.75			1.75	N/A	—	—	1.45	0.75

Notes: ■ X indicates: Not Applicable.
■ See pages JW-5 and JW-9 for more information on spiders.

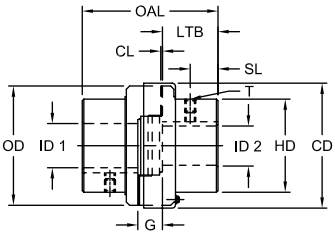
L, C and H Type Couplings



Style 1



Style 2



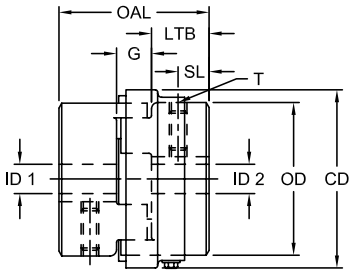
Style 3

L Type, C Type & H Type Dimensional Data

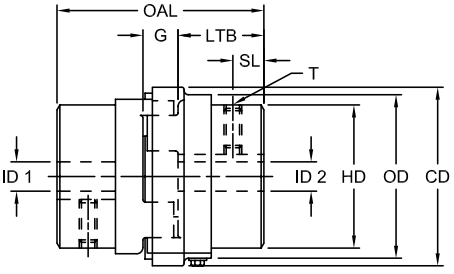
Size	Style No	OAL	G	LTB	SL	CL	T	ID1 - ID2 Min Bore		ID1 - ID2 Max Bore		OD	CD	HD	Weight Min Bore	Weight Max Bore	Moment of Inertia (Solid) WR^2
		in	in	in	in	in	in	in	mm	in	mm	in	in	in	lbs	lbs	lb-in²
L Type																	
L035	1	0.81	0.28	0.27	0.13	N/A	#6-32	0.125	3	0.375	10	0.63	N/A	0.63	0.10	0.10	0.003
L050	1	1.71	0.48	0.62	0.31	N/A	1/4-20	0.250	6	0.625*	16	1.08	N/A	1.08	0.30	0.20	0.054
L070	1	1.98	0.48	0.75	0.38	N/A	1/4-20	0.250	6	0.750	19	1.36	N/A	1.36	0.60	0.40	0.115
L075	1	2.13	0.50	0.82	0.31	N/A	1/4-20	0.250	6	0.875	22	1.75	N/A	1.75	1.00	0.80	0.388
L090	1	2.15	0.52	0.82	0.44	N/A	1/4-20	0.250	6	1.000	25	2.11	N/A	2.11	1.50	1.20	0.772
L095	1	2.51	0.52	1.00	0.44	N/A	5/16-18	0.437	11	1.125	29	2.11	N/A	2.11	1.80	1.30	0.890
L099	1	2.84	0.71	1.06	0.44	N/A	5/16-18	0.437	11	1.188	30	2.54	N/A	2.54	2.50	2.00	2.048
L100	1	3.48	0.71	1.38	0.44	N/A	5/16-18	0.437	11	1.375	35	2.54	N/A	2.54	3.20	2.40	2.783
L110	1	4.22	0.88	1.68	0.75	N/A	3/8-16	0.625	16	1.625	41	3.32	N/A	3.32	6.60	5.30	8.993
L150	1	4.50	1.00	1.75	0.75	N/A	3/8-16	0.625	16	1.875	48	3.75	N/A	3.75	8.80	7.00	11.477
L190	2	4.86	1.00	1.94	0.88	N/A	1/2-13	0.750	19	2.125	54	4.50	N/A	4.00	15.30	12.30	39.256
L225	2	5.34	1.00	2.18	1.00	N/A	1/2-13	0.750	19	2.625	67	5.00	N/A	4.25	19.60	15.00	65.000
L276	2	7.82	1.58	3.12	1.56	N/A	1/2-13	0.875	22	2.875	73	6.18	N/A	5.00	40.00	30.50	188.000
C Type																	
C226	3	7.00	1.50	2.75	1.38	0.12	1/2-13	0.875	22	2.500	64	5.15	5.50	4.12	29.00	22.00	74.000
C276	3	7.87	1.63	3.12	1.56	0.12	1/2-13	0.875	22	2.875	73	6.18	6.53	5.00	47.00	36.00	188.000
C280	3	7.87	1.63	3.12	1.56	0.12	1/2-13	1.250	32	3.000	76	7.50	7.81	5.50	61.00	49.00	362.000
C285	3	9.13	1.63	3.75	1.75	0.12	5/8-11	1.250	32	4.000	102	8.50	8.88	6.50	87.00	68.00	642.000
C295	3	9.38	1.88	3.75	1.88	0.12	5/8-11	1.500	38	3.500	89	9.12	9.62	6.25	97.00	78.00	862.000
C2955	3	10.38	1.88	4.25	2.12	0.12	5/8-11	1.750	44	4.000	102	9.12	9.62	7.12	117.00	90.00	932.000
H Type																	
H3067																	
SXB(NBR)	3	11.62	2.12	4.75	2.37	0.12	5/8-11	2.125	54	4.500	114	10.00	10.68	7.00	162.00	123.00	1,485.000
HYTREL®		11.62	2.12	4.75	2.37	0.12	5/8-11	2.125	54	4.000	102	10.00	10.68	7.00	162.00	123.00	1,485.000
H3567																	
SXB(NBR)	3	12.38	2.38	5.00	2.50	0.12	5/8-11	2.625	67	5.000	127	11.00	11.68	7.75	246.00	195.00	2,174.000
HYTREL		12.38	2.38	5.00	2.50	0.12	5/8-11	2.625	67	4.500	114	11.00	11.68	7.75	246.00	195.00	2,174.000
H3667																	
SXB(NBR)	3	13.88	2.62	5.63	2.81	0.12	3/4-10	3.000	76	5.625	143	12.00	12.45	8.75	262.00	190.00	3,591.000
HYTREL		13.88	2.62	5.63	2.81	0.12	3/4-10	3.000	76	5.000	127	12.00	12.45	8.75	262.00	190.00	3,591.000
H4067																	
SXB(NBR)	3	15.38	2.88	6.25	3.12	0.12	3/4-10	3.250	83	6.250	159	13.25	14.00	9.75	390.00	291.00	6,287.000
HYTREL		15.38	2.88	6.25	3.12	0.12	3/4-10	3.250	83	5.500	140	13.25	14.00	9.75	390.00	291.00	6,287.000
H4567																	
SXB(NBR)	3	17.12	3.12	7.00	3.50	0.12	3/4-10	3.500	89	7.000	178	14.50	15.75	10.75	575.00	435.00	10,565.000
HYTREL		17.12	3.12	7.00	3.50	0.12	3/4-10	3.500	89	6.000	152	14.50	15.75	10.75	575.00	435.00	10,565.000

Notes:
- * indicates: Without keyway.
- 2 indicates: Maximum bore is less for H Type couplings with Hytrel due to increased torque capacity.
- N/A indicates: Not Applicable.
- Jaw coupling hubs are standard with one set screw, for two set screws see RRS & RRC sections.
- See pages JW-9 and JW-22 for Performance Data.

LC and AL Type Couplings



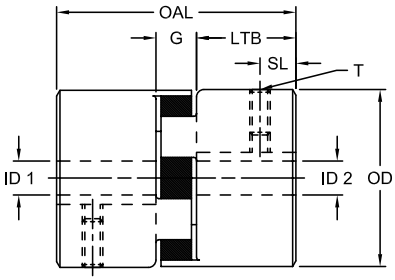
Style 1



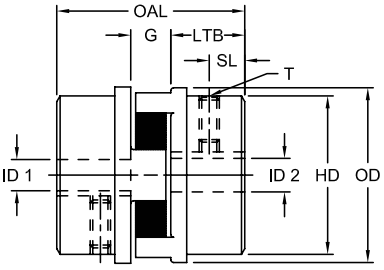
Style 2

LC Type Dimensional Data

Size	Style No	OAL	G	LTB	SL	T	ID1 - ID2 Min Bore		ID1 - ID2 Max Bore		CD	OD	HD	Weight Solid	Weight Max Bore	Moment of Inertia (Solid) WR²
		in	in	in	in	in	in	mm	in	mm	in	in	in	lbs	lbs	lb-in²
LC090	1	2.12	0.50	0.81	0.44	1/4-20	0.250	6	1.00	25	2.54	2.11	2.11	1.5	1.2	0.772
LC095	1	2.50	0.50	1.00	0.44	5/16-18	0.437	11	1.12	29	2.54	2.11	2.11	1.8	1.3	0.890
LC099	1	2.87	0.75	1.06	0.44	5/16-18	0.437	11	1.18	30	3.11	2.53	2.53	2.5	2.0	2.048
LC100	1	3.50	0.75	1.38	0.44	5/16-18	0.437	11	1.37	35	3.11	2.53	2.53	3.5	2.5	2.783
LC110	1	4.25	0.87	1.69	0.75	3/8-16	0.625	16	1.62	41	3.81	3.31	3.31	6.6	5.0	8.993
LC150	1	4.50	1.00	1.75	0.75	3/8-16	0.625	16	1.88	48	4.41	3.75	3.75	9.1	7.0	11.477
LC190	2	4.88	1.00	1.94	0.88	1/2-13	0.750	19	2.12	54	5.01	4.50	4.00	17.0	13.0	39.256
LC225	2	5.38	1.00	2.19	1.00	1/2-13	0.875	22	2.62	67	5.61	5.00	4.25	23.0	18.0	62.003



Style 1

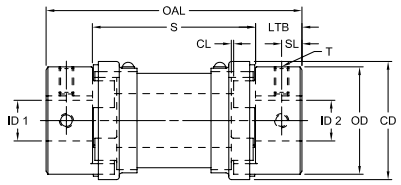


Style 2

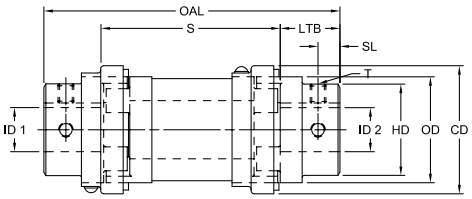
AL Type Dimensional Data

Size	Style No	OAL	G	LTB	SL	T	ID1 - ID2 Min Bore		ID1 - ID2 Max Bore		CD	OD	HD	Weight Solid	Weight Max Bore	Moment of Inertia (Solid) WR²
		in	in	in	in	in	in	mm	in	mm	in	in	in	lbs	lbs	lb-in²
AL050	1	1.71	0.48	0.62	0.31	1/4-20	0.250	6	0.625	16	N/A	1.08	1.08	0.2	0.2	0.020
AL070	1	2.00	0.50	0.75	0.38	1/4-20	0.250	6	0.750	19	N/A	1.36	1.36	0.3	0.2	0.040
AL075	2	2.12	0.50	0.81	0.31	1/4-20	0.250	6	0.875	22	N/A	1.75	1.53	0.4	0.3	0.121
AL090	2	2.34	0.52	0.91	0.34	1/4-20	0.500	13	0.875	22	N/A	2.12	1.53	0.5	0.4	0.271
AL095	1	2.50	0.50	1.00	0.44	5/16-18	0.500	13	1.125	29	N/A	2.12	2.12	0.8	0.6	0.336
AL099	2	2.81	0.75	1.03	0.44	5/16-18	0.500	13	1.187	30	N/A	2.53	2.06	1.0	0.8	0.644
AL100	2	3.50	0.75	1.37	0.44	5/16-18	0.500	13	1.375	35	N/A	2.53	2.41	1.5	1.1	1.207
AL110	1	4.25	0.87	1.69	0.75	5/16-18	0.625	16	1.625	41	N/A	3.31	3.31	2.7	2.1	3.531
AL1502	2	4.50	1.00	1.75	0.63	5/16-18	0.625	16	1.875	48	N/A	4.25	3.19	3.7	2.8	7.002

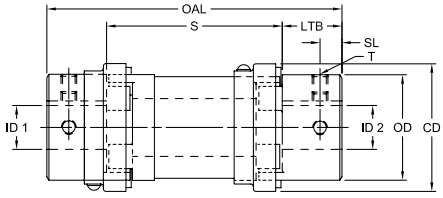
Notes:
- 2 indicates: Maximum bore is less for H Type couplings with Hytrel® due to increased torque capacity.
- N/A indicates: Not Applicable.
- See pages JW-9 and JW-22 for Performance Data.



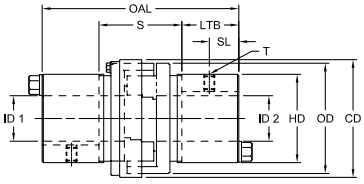
Style 1



Style 2



Style 3



Style 4

RRS & RRC Type Dimensional Data

Size	Style No	OAL in	S in	LTB in	SL in	CL in	T in	ID1 - ID2 Min Bore in	ID1 - ID2 Min Bore mm	ID1 - ID2 Max Bore in	ID1 - ID2 Max Bore mm	CD in	OD in	HD in	Weight lbs
RRS090	1	5.12	3.5	0.81	0.43	0.09	1/4-20	0.250	6	1.000	25	2.50	2.11	—	1.7
		6.62	5.0												1.8
		8.62	7.0												1.9
RRS095	1	5.50	3.5	1.00	0.43	0.09	5/16-18	0.437	11	1.125	29	2.50	2.11	—	1.9
		7.00	5.0												2.0
		9.00	7.0												2.1
RRS099	1	5.62	3.5	1.06	0.44	0.12	5/16-18	0.437	11	1.187	30	3.12	2.53	—	2.2
		7.12	5.0												2.5
		9.12	7.0												2.8
RRS100	1	6.25	3.5	1.38	0.44	0.12	5/16-18	0.437	11	1.375	35	3.12	2.53	—	3.2
		7.75	5.0												3.5
		9.75	7.0												3.8
RRS110	1	6.88	3.5	1.68	0.75	0.12	5/16-18	0.625	16	1.625	41	3.81	3.31	—	6.2
		8.36	5.0												6.6
		10.36	7.0												7.2
RRS150	2	7.00	3.5	1.75	0.62	0.12	3/8-16	0.625	16	1.875	48	4.44	3.75	—	12.2
		8.50	5.0												15.7
		10.50	7.0												20.3
RRS190	3	7.38	3.5	1.94	0.88	0.12	1/2-13	0.750	19	2.125	54	5.00	4.50	4.00	23.0
		8.88	5.0												28.2
		10.88	7.0												35.0
RRS225	4	7.88	3.5	2.18	1.00	0.12	1/2-13	0.750	19	2.625	67	5.62	5.00	4.25	26.5
		9.38	5.0												33.0
		11.38	7.0												41.4
RRC226	4	9.19	3.5	2.84	1.38	N/A	1/2-13	0.875	22	2.125	54	5.50	5.16	4.12	37.0
		10.68	5.0												43.0
		12.68	7.0												49.0
RRC276	4	8.60	3.5	2.47	1.00	N/A	1/2-13	0.875	22	2.875	73	6.50	6.18	5.00	52.0
		9.94	5.0												59.0
		11.94	7.0												69.0
RRC280	4	5.50	3.5	2.47	1.00	N/A	1/2-13	1.250	32	3.375	86	7.81	7.50	5.50	66.0
		9.94	5.0												75.0
		11.94	7.0												87.0
RRC285	4	9.31	3.5	2.87	1.00	N/A	1/2-13	1.250	32	4.125	105	8.88	8.50	6.50	92.0
		10.75	5.0												104.0
		12.75	7.0												121.0
RRC295	4	9.50	4.0	2.75	1.38	N/A	1/2-13	1.500	38	4.125	105	9.56	9.12	6.50	100.0
		10.50	5.0												112.0
		12.50	7.0												128.0
RRC2955	4	9.50	4.0	2.75	1.88	N/A	5/8-11	1.750	44	4.125	105	9.56	9.12	6.50	96.0
		10.50	5.0												111.0
		12.50	7.0												132.0

Notes: ■ N/A indicates: Not Applicable.
■ See pages JW-9 and JW-22 for Performance Data.

RRS Type - Metric Spacer Dimensional Data

Size	Style No	ID1 - ID2 Min Bore in	ID1 - ID2 Min Bore mm	ID1 - ID2 Max Bore in	ID1 - ID2 Max Bore mm	S mm	OAL mm	Spacer Weight lbs	Spacer Weight Kg
RRS090	1	0.250	11	1.000	25	100	141	0.83	0.38
						140	181	1.21	0.55
						180	221	1.59	0.79
RRS095	1	0.437	11	1.125	28	100	151	0.83	0.38
						140	191	1.21	0.55
						180	231	1.59	0.79
RRS099	1	0.437	11	1.188	30	100	154	1.08	0.49
						140	194	1.63	0.74
						180	234	2.17	0.98
RRS100	1	0.437	11	1.375	35	100	170	1.08	0.49
						140	210	1.63	0.74
						180	250	2.17	0.98
RRS110	1	0.625	16	1.625	41	100	186	1.64	0.74
						140	226	2.55	1.16
						180	266	3.48	1.58
RRS150	2	0.625	16	1.875	48	100	189	5.92	2.69
						140	229	9.54	4.33
						180	269	13.19	5.98
RRS190	2	0.750	19	2.125	54	100	199	8.75	3.97
						140	239	14.00	6.35
						180	277	19.26	8.74
RRS225	2	0.750	19	2.625	67	100	221	10.83	4.91
						140	261	17.49	7.93
						180	291	24.18	10.97

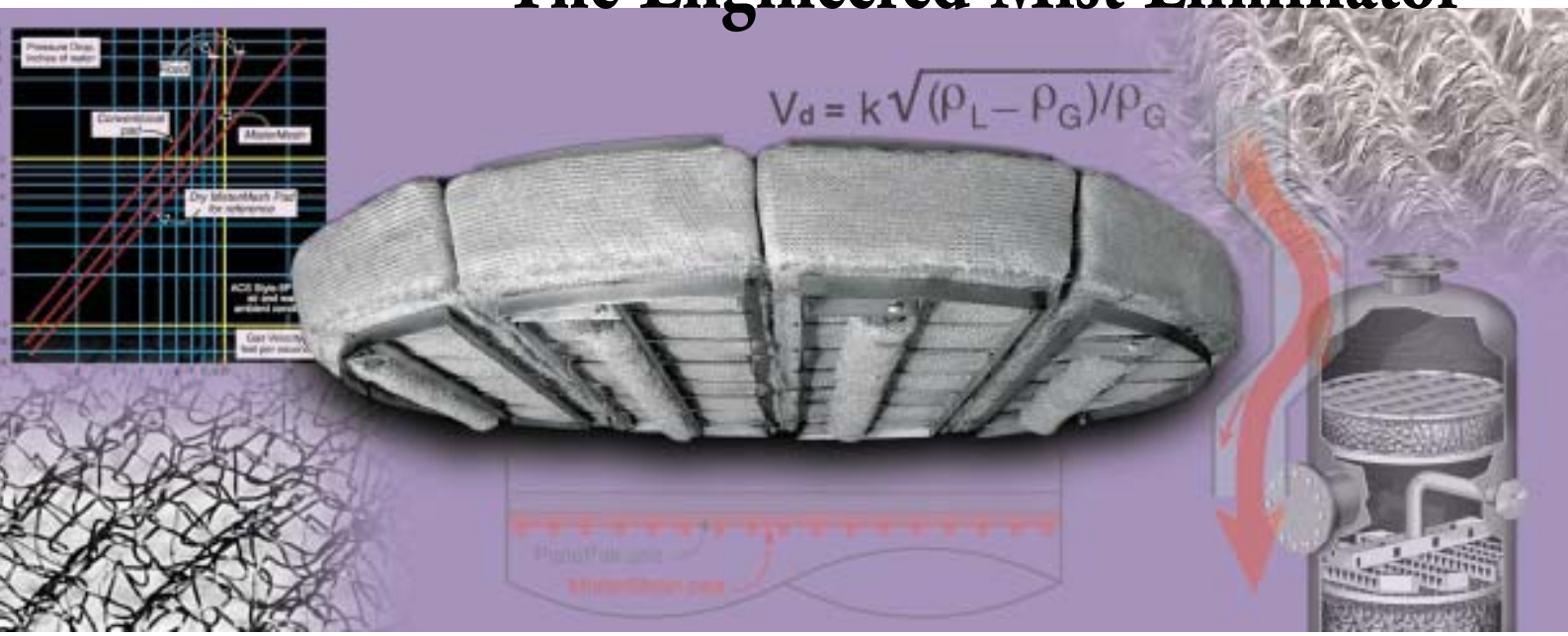
Note: ■ See pages JW-9 and JW-22 for Performance Data.

L Type Hubs - Special Lengths

Size	OAL Standard Dimensions Complete Couplings Overall Length in	LTB Standard Dimensions Hub Length Thru Bore in	OAL Special Dimensions Complete Couplings Overall Length in	LTB Special Dimensions Hub Length Thru Bore in
L050	1.720	0.620	1.10	0.31
			1.34	0.43
			2.24	0.88
L070	2.000	0.750	1.23	0.38
			3.00	1.25
L095	2.500	1.000	3.86	1.68
L100	3.500	1.375	7.99	3.62
L110	4.250	1.690	2.37	0.75
			2.47	0.80
			6.63	2.88

Notes: ■ For ordering information on any special length jaw hub, please contact Lovejoy Customer Service.
■ The Overall Length is calculated using two hubs with the same length thru bore.

The Engineered Mist Eliminator



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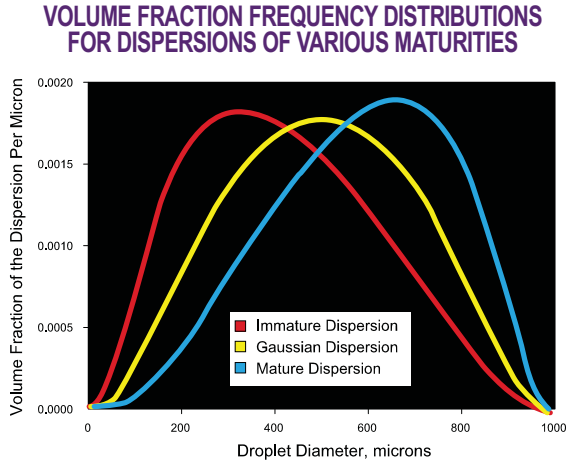
The Engineered Mist Eliminator

Mist elimination, or the removal of entrained liquid droplets from a vapor stream, is one of the most commonly encountered processes regardless of unit operation. Unfortunately, mist eliminators are often considered commodity items and are specified without attention to available technologies and design approaches. The engineered mist eliminator may reduce liquid carryover by a factor of one hundred or more relative to a standard unit, drop head losses by 50% or more, or increase capacity by factors of three or four. This manual summarizes cost effective approaches to reducing solvent losses or emissions, extending equipment life and maintenance cycles using proven and cost effective technologies and techniques.

Droplet Formation and Size Distributions

Entrained liquid does not consist of same-sized droplets, but as a broad range of droplet sizes that may be characterized with a Normal or Bell Distribution centered about some mean or average. The average droplet size depends very much on the mechanism by which they are generated. Sizing equations are expressed in terms of the probability of removing a droplet of a given diameter, and mist eliminator performance is the integration or cumulative sum of individual removal efficiencies. It is therefore critical to know the approximate droplet size distribution in order to properly design a mist elimination system. Figure 1 show some typical size distribution curves from different sources.

FIGURE 1



In practice, designers or engineers do not quantify or measure droplet size distributions, rather they are assumed based on empirical data or experience. Fortunately, an experienced engineer can assume an approximate distribution based on the means or mechanism by which the droplets are generated. Typical examples from common mist sources are given to illustrate these concepts.

Fine droplet distributions, often called *fogs* (<3 µm diameter particles with an average typically in the submicron range), occur in high speed metal stamping in which cycles of extreme frictional heating and shock condensation of lubricating oils form droplets in the submicron range, so-called "blue smoke". This smoke is removed to comply with health and environmental regulations.

Fog is also produced when gas phase reactions form a liquid product as in the case of vapor phase SO_3 and water yielding H_2SO_4. Downstream

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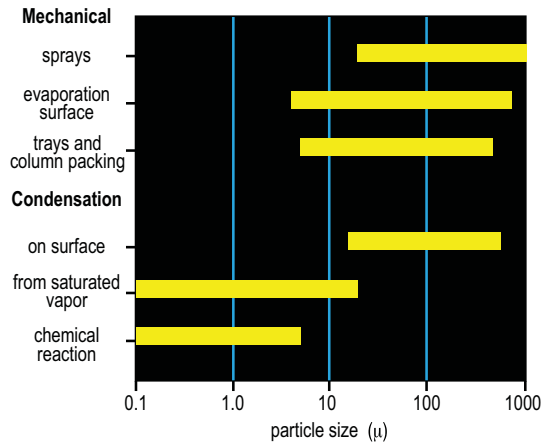
equipment corrodes rapidly without the removal of this liquid. Similar concerns are found in ammonia prill towers, many chlorine applications, as well as phosphoric and nitric acid plants.

A *mist* consists of droplets in the range of 3µm and greater, though distributions with average diameters 20 µm and greater are termed *Sprays*. Mist coming off the top of packing or trays, or generated by surface evaporation, are typically in the broad range of 5-800 µm. In towers used in glycol dehydration and amine sweetening in which mists are a major source of costly solvent losses, removal of droplets down to 5 µm is recommended.

Hydraulic spray nozzles generate particles of diameters greater than 50 µm and pneumatic nozzles greater than 10 µm, with upper limits reaching 1000 µm.

The first step in engineering a mist eliminator is to determine the mechanism by which the droplets are generated and assume an average droplet size. Figure 2 summarizes typical particle size distributions caused by various mechanisms:

FIGURE 2

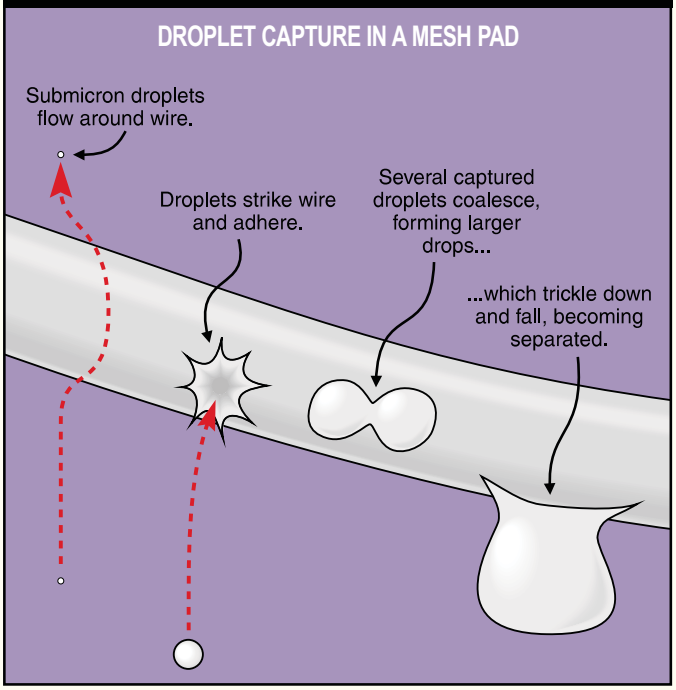


This manual contains basic design concepts used by engineers to remove droplets greater than 3 µm in diameter, so called mists and sprays.

Mechanisms of Droplet Removal

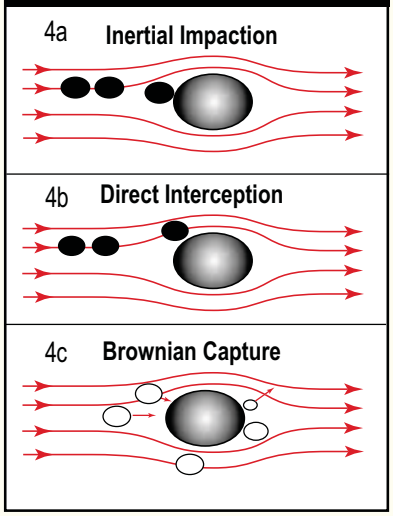
Droplets are removed from a vapor stream through a series of three stages: collision & adherence to a target, coalescence into larger droplets, and drainage from the impingement element. Knowing the size distributions as explained above is important because empirical evidence shows that the target size - important in the first step of removal - must be in the order of magnitude as the particles to be removed. These steps are shown schematically in Figure 3 for mist elimination using a wire mesh mist elimination.

FIGURE 3



For fogs in which the bulk of the droplets are characterized with submicron diameters, the energy to bring about the collision with the target is derived from Brownian Diffusion, the random motion of fine liquid particles as they are pushed about by molecular action as shown in Figure 4c. Fog elimination with so-called fiberbed technology is beyond the scope of this manual.

FIGURE 4

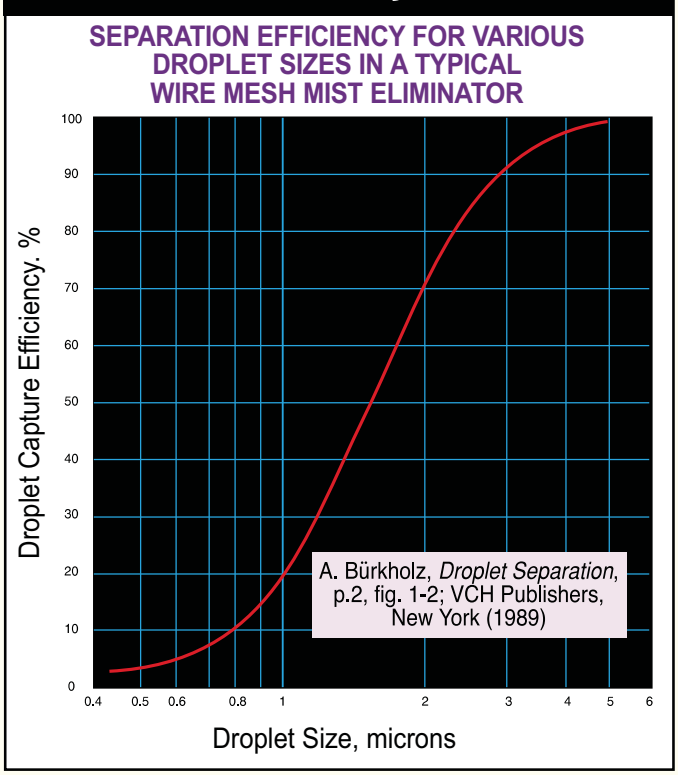


For particles in the mist region between 3-20 µm, knitted wire mesh is most common type of mist eliminator used and Interception is the

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primary mechanism. Consider a droplet approaching a mesh filament of much larger diameter as shown in Figure 4b. The more dense the droplet relative to the gas, the larger the droplet relative to the filament, and the higher the gas velocity, the more likely it is that the droplet will strike the filament. If the velocity is too low, or the droplet too small or too light compared to the gas, the droplet will simply flow around the filament with the gas. If the velocity is too high, liquid clinging to the filaments will be re-entrained, mostly as larger droplets, and carried away by the gas. Re-entrainment is also promoted by low relative liquid density (making it easier for the gas to pick up a droplet) and low liquid surface tension (as less energy is required to break up a film or droplet). The engineered wire mesh mist eliminator may remove 99.9% of particles 2 µm and greater diameter. Figure 5 shows a typical removal efficiency vs droplet size distribution for a wire mesh mist eliminator.

FIGURE 5



Droplets ~20 µm and greater are primarily collected by means of Inertial Impaction whereby the target is directly in the path of the streamline, as shown in Figure 4a. Figure 6 depicts a profile of the ACS PlatePak™ vane. The entrained droplets, due to their momentum, tend to move in straight lines. By studying this figure, it is easy to understand why in the design equations to follow the removal efficiency is directly proportional to the difference in densities of the liquid droplet and carrying gas. With each change in direction of the gas, some droplets collide with the surface and adhere, eventually coalescing into larger droplets which then drain by gravity. Properly designed vane mist eliminators can remove 99% of particles as low as 10 µm in diameter, especially at lower pressures.

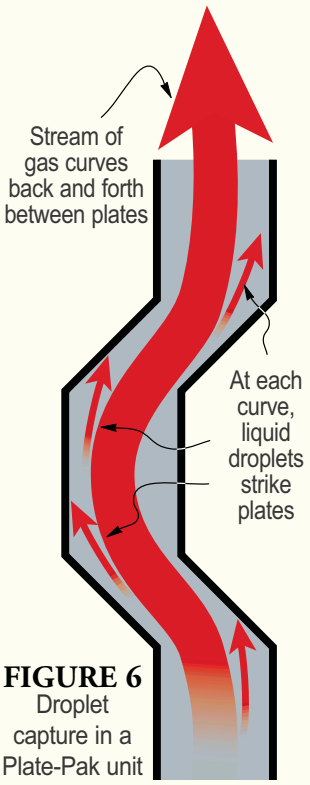


FIGURE 6
Droplet capture in a Plate-Pak unit

Figure 7 illustrates typical wire mesh and PlatePak™ vane mist eliminators, and Figure 8 shows some typical performance curves for both mesh and vane mist eliminators.

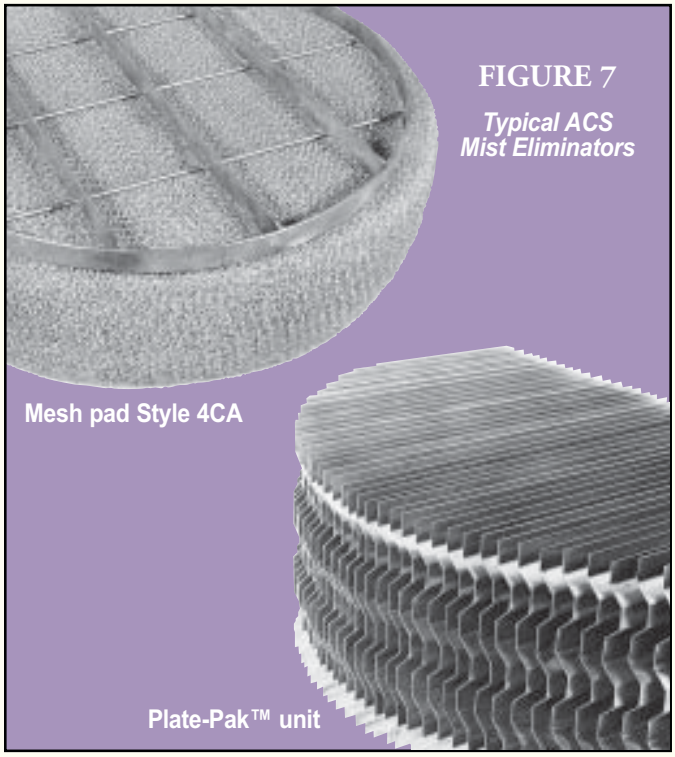
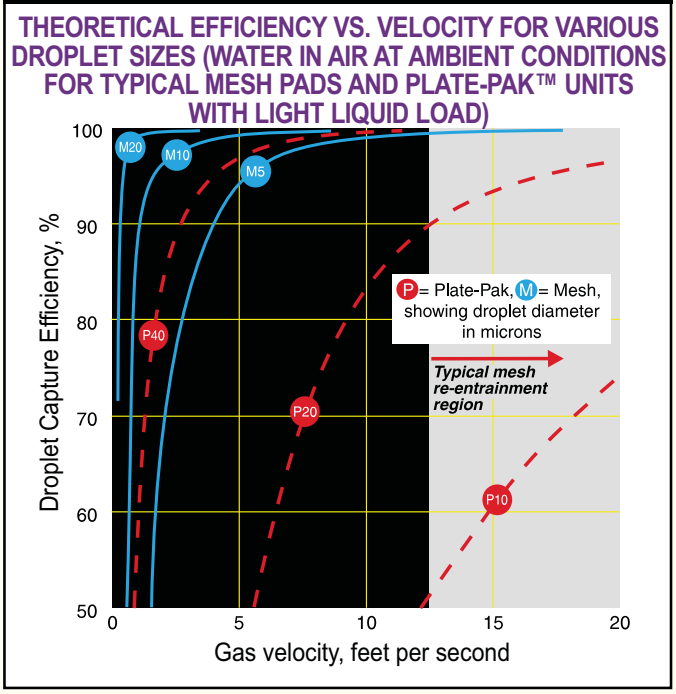


FIGURE 7
Typical ACS Mist Eliminators

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FIGURE 8

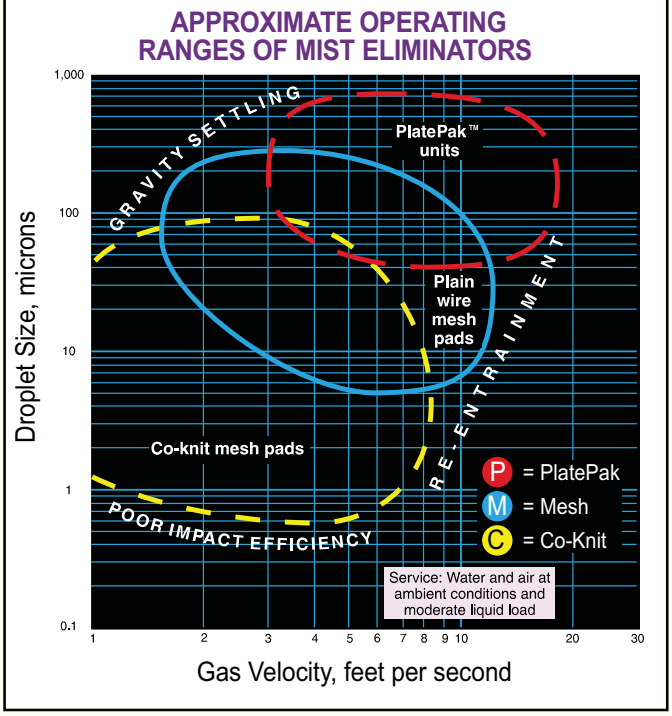


It is worthwhile to discuss Fig. 8 and mist eliminator performance. The dotted curves correspond to different styles of vanes and the solid to wire mesh styles. Note first of all that vanes can be engineered to operate at higher gas velocities and flow rates relative to mesh, but that mesh mist eliminators can approach 100% removal efficiency at smaller droplet sizes. This agrees with the discussions above on Interception and Inertial Impaction removal mechanisms. Note the drastic efficiency drop off at low velocities, in which droplets drift around the filaments or vane blades without striking them. This phenomenon defines the lower operating range of a mist eliminator. The other extreme is when the velocity is too high. In this case, the droplets are captured but the velocity of the gas provides sufficient energy to tear-off and re-entrain droplets. It is in the context of re-entrainment that the design equations which follow show that the removal efficiency is directly proportional to the surface tension of the liquid. As the surface tension increases, so it requires greater kinetic energy (i.e. gas velocity) to break the bond between droplet and target, and the droplets collect and coalesce until drainage by gravity. Re-entrainment defines the upper capacity limit of a mist eliminator.

Operating range is also affected by the liquid loading (proportion of liquid) of the gas. If too great, the mist eliminator becomes choked with liquid, a condition called flooding. Flooding is often noticed by high pressure drops or massive carryover of liquids. Typical wire mesh mist eliminators accommodate liquid loads up to about one US gallon per square foot and vanes twice as much.

The key operating ranges and suitability of mesh and vane mist eliminators is summarized in Figure 9. It emphasizes that vanes are more effective at higher velocities and greater droplet sizes while mesh is more suitable for removing smaller particles at lower velocities. Gravity settling alone is sufficient for very large particles, and co-knit mesh pads, discussed below, for particles in the range of sizes from 2-8 µm. Finally, fiberbed technology is used for submicron fogs.

FIGURE 9



Types of Mist Eliminator Mesh Styles & Materials

Most designers believe that all wire mesh mist eliminators behave basically the same in terms of capacity and removal efficiency. It is true that for meshes of same filament diameter, the denser mesh offers superior removal efficiency. For meshes with differing filament diameters, a lighter (less dense) mesh may offer considerably better removal efficiency. The key is that the working part of the mesh is the target density, not

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the mass density. For example, the most common 9-lb density mesh, ACS style 4CA, exhibits ~85 sq-ft/cu-ft of surface area. Compare this to the co-knit of a metal with fiberglass (ACS style 6BE) which also exhibits 9-lb mass density but exhibits a specific surface area approaching 3,700 sq-ft/cu-ft, some 40X greater targets per unit volume.

Table 1 shows a few of the more common mesh styles available, together with mesh density and void fraction, and most importantly, the diameter and specific surface area (i.e. the target density) of filaments used.

TABLE 1 • *Wire and Plastic Mesh Styles*

Mesh Style	Density lbs/ft³	Diameter D, inches	Surface, S, ft²/ft³	Percent Voids, ε
Metal mesh				
7CA	5.0	0.011	45	99.0
5CA	7.0	0.011	65	98.6
4CA	9.0	0.011	85	98.2
4BA	12.0	0.011	115	97.6
3BF	7.2	0.006	120	98.6
3BA	12.0	0.006	200	97.6
Plastic mesh				
8P	4.0	0.011	130	92.0
8K	4.0	0.011	160	96.3
8T	4.0	0.011	130	97.0

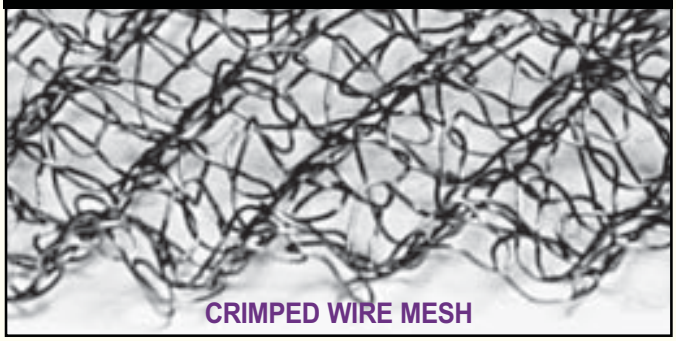
Mesh Style	Density lbs/ft³	Diameter D, inches	Surface, S, ft²/ft³	Percent Voids, ε
Metal mesh				
8D	9	0.0008	485	99.0
8TMW11	12	0.0008	485	99.0
6BE	9	0.00036	3725	99.0
Plastic mesh				
8PP	3	0.001	530	99.0
8TT	5	0.0008	530	99.0

It is the amount of targets per unit volume which influences removal efficiency, not the density of mesh (the greater the number of targets the greater the probability of a successful collision).

In a co-knit such as a metal alloy and fiberglass, the alloy provides a skeleton for structural support and prevents the high specific surface media from collapsing on itself.

As far back as the 1950's researchers (C. LeRoy Carpenter et al) determined that specific surface area and target or filament diameter play a great role in removal efficiency. Target or filament diameter must be on the order of magnitude as the smallest droplets to be removed. Due to limitations in metal wire ductility and corrosion considerations, co-knits provide finer targets and hence remove finer droplets. Figures 8 and 9 are enlarged images of crimped wire mesh and a co-knit with fiberglass respectively.

FIGURE 8



CRIMPED WIRE MESH

FIGURE 9



CO-KNIT MESH WITH FIBERGLASS YARN

In summary, it is important to report mesh styles in terms of the specific surface area - a measure of the target density, and filament diameter -a measure of the smallest droplet size that can be removed with high efficiency. The mass density is only relevant insofar that a metal mesh of density 12-lb exhibits a greater specific surface area than one of density 7-lb provided the wire diameter remains constant.

Selecting the material of mesh style(s) is also important. Corrosion rates as low as 0.005"/year is not serious in vessel walls but will quickly destroy 0.006" or 0.011" wire mesh. Table 2 gives preliminary guidelines, but ACS draws wire and knits mesh with any ductile metal for special applications.

When applying non-metal materials operating temperature limits must be considered.

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TABLE 2
Mesh Corrosion & Temp. Considerations

Material	Spec. Grav.	Max. Op. Temp., °F	Typical Surface
304 SS	1.00	---	Petroleum, aqueous
304L	1.00	---	Petroleum, aqueous
316L	1.00	---	Sulfuric acid
410 SS	1.00	---	Mild chemicals
Monel®	1.12	---	Corrosive chemicals
Nickel	1.13	---	Caustic evaporators
Alloy 20	1.00	---	Sulfuric acid
Glass	2.52	---	Mild aqueous chemicals
Hasteloy®	1.14	---	Hydrochloric & other acids
Dacron®	1.38	350	Co-knit applications
Kynar®	1.75	300	Acid, alkali
Polypropylene	0.90	160	Water, acid, alkali
Teflon®	2.15	400	Hot sulfuric acid up tp 300ßF
Tefzel®	1.70	380	Acid, alkali

Design Equations

To determine mist eliminator cross-sectional area (and hence vessel size) and predict performance in terms of removal efficiency, the optimum design gas velocity is determined first. The Souders-Brown equation is used to determine this velocity based on the physical properties of the liquid droplets and carrying vapor:

$$V_d = k(\rho L - \rho G/\rho G)^{1/2} \qquad (1)$$

where V_d = design gas velocity (ft/sec)
k = Capacity Factor (ft/sec)
ρL = Liquid Density
ρG = Vapor Density

The capacity factor is determined through experience and for each application, and is influenced by type and style of mesh or vane targets used, the geometry of the targets (vertical or horizontal relative to the vapor flow), as well as by properties such as operating pressure, fluid viscosities, and liquid surface tension.

The design velocity V_d for a given application is the value that produces the best performance in terms of capturing droplets and avoiding re-entrainment. Referring to Figure 8, this ideal velocity* for a given class of mist eliminators would be somewhere toward the upper end of the range: about 10 fps for plain wire mesh pads, about 8.5 fps for co-knits, and 14 fps for PlatePak™ elements. As discussed, effectiveness drops off at lower velocities as the droplets have sufficiently low momentum to negotiate paths through the targets, and at higher velocities because the vapor carried sufficient kinetic energy to re-entrain droplets. For typical designs, acceptable velocities range between 25% to 125% of the ideal value.

The Capacity Factor may be thought of as an indication of ability of a mist eliminator to drain liquids and avoid re-entrainment under various conditions. See Table 3 for some typical baseline values.

TABLE 3
Standard Souders-Brown Coefficients (k factors) for mesh and Plate-Pak™ Units

	Pad Arrangement	k, ft/sec
1.	Horizontal Style 4CA pad	0.35
2.	Style 4CA MisterMesh® Pad	0.42
3.	Horizontal Plate-Pak™ Unit *With or without MisterMesh below*	0.50
4.	Vertical Plate-Pak™ Unit *With or without Mesh ahead*	0.65

NOTE: Water and air, room temperature, pressure below 100 psia

Note that Souders-Brown equation provides correction for only gas and liquid densities. Should any conditions exist which affects drainage or re-entrainment, the Capacity Factor must be pro-rated as appropriate.

After selecting the appropriate Capacity Factor and calculating the ideal vapor velocity, the cross-sectional area of mist eliminator is readily determined by dividing the volumetric flow rate by the velocity.

Having established this design velocity for the application, you can now predict the efficiency of a mesh pad for droplets of a particular size. This procedure is laborious and therefore well suited for a computer. The ACS MistXpert® software uses the method described below.

First, calculate the inertial parameter K as follows, using consistent units of measurement:

* For Air Water at ambient temperature and atmospheric pressure

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$$K = K = [(\rho L - \rho G)Vd^2] / 9\mu D \qquad (2)$$

Where K = dimensionless inertial parameter
V =gas velocity in fps
d =Liquid droplet diameter in ft
μ =Gas viscosity in lb/ft s
D =Wire or filament diameter in ft

Use this calculated K value with Figure 10 to find the corresponding value of the impaction efficiency fraction E. From Table 1, find S, the specific surface area for the mesh style of interest.
And determine SO, of the mist eliminator perpendicular to vapor flow and with a correction factor of 0.67 to remove that portion of the knitted wire not perpendicular to the gas flow:

SO = Specific Surface Area x $1/\pi$ x Thickness (ft) x 0.67
Using these values and T, the thickness of the pad, calculate the capture efficiency:

$$\text{Efficiency \%} = 100-(100/e^{0.213^{ESO}})$$

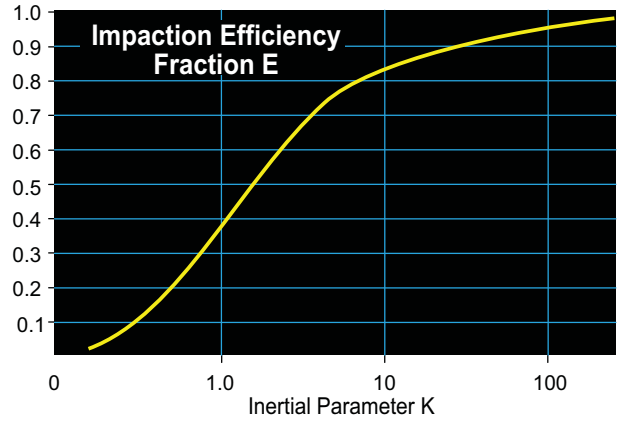
Where S0 = Corrected Pad Specific Surface Area

E = Impaction efficiency fraction

This efficiency is the percent of all incoming droplets of the given diameter which will be captured rather than passing through the mist eliminator. The percentage will be higher for larger droplets and lower for smaller.

FIGURE 10

DETERMINING IMPACTION EFFICIENCY FRACTION E USING INERTIAL PARAMETER K



Predicting Pressure Drop

Although the operating pressure differential across a properly sized mesh pad or vane is never more than a few inches of water, pressure drop is an important design consideration in certain applications, particularly vacuum systems or larger columns requiring the movement of great quantities of gas. It has been shown that each inch of head loss requires some 0.16 hp/scfm. A simple correlation has been developed to describe the pressure drop through a dry mist eliminator (no mist):

$$\Delta P_{dry} = 0.4Vd^2 \rho_G ST/g_c \varepsilon \rho_w \qquad (3)$$

Where gc =gravitational constant
ε =Mesh Void Fraction
ρ_w =Ambient water density

The overall pressure drop is the sum of the head loss incurred as the gas travels through the mesh, as well as that due to the resistance to captured liquids. Liquid accumulates as a pool in the bottom of the mist eliminator. If the liquid loading and velocity are such that a 2" deep pool accumulates in the bottom of the mesh pad, this amount must be added to that calculated using Equation 3. Figure 11 summarizes pressure drop and velocity test data collected on the ACS pilot plant for light and medium liquid loading.

With due consideration given to the mist eliminator itself, the flow of fluid to and from it requires the same attention.

Inlet Diffusers

At high flow rates, primary removal of bulk liquids upstream of the mist eliminator is very important to prevent flooding. This is typically done in a cost effective manner by using a simple inlet diverter as shown in Fig. 12.

With this design, liquids impinge upon the diverters, the flow is forced to flow laterally to allow bulk liquids to escape by gravity and eliminate the countercurrent momentum of the gas.

The *Force of Inertia*, expressed as ρv^2, is typically used to quantify the flow entering a vessel to determine whether a simple baffle will suffice ACS recommends inlet diverters to a Force of Inertia up to 2,500 lb/ft s^2. Above this, more sophisticated distributors are recommended.

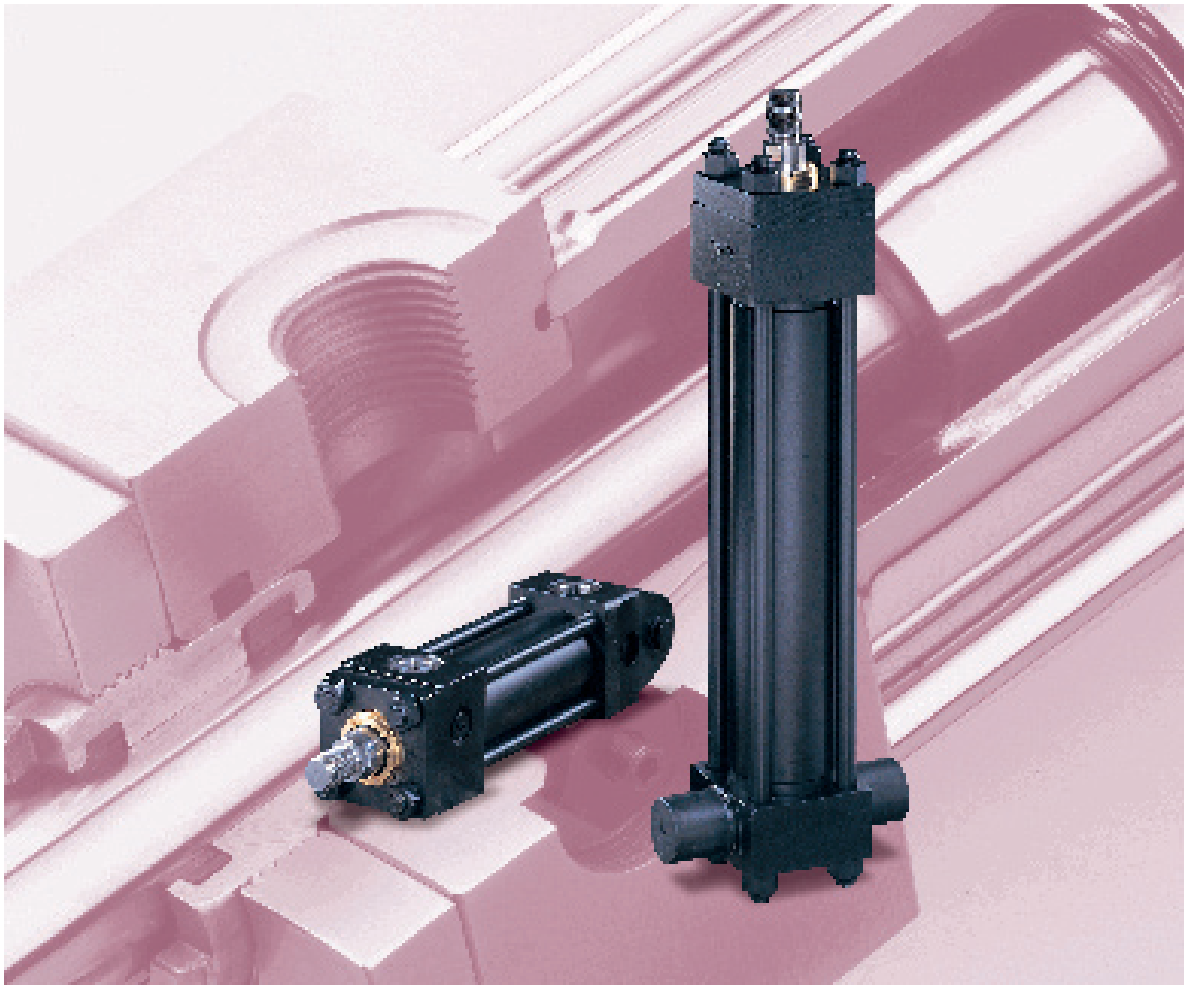
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2H Tie Rod Cylinders

Heavy Duty NFPA Hydraulic Cylinders

for working pressures up to 210 bar

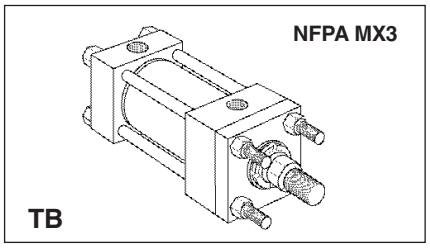
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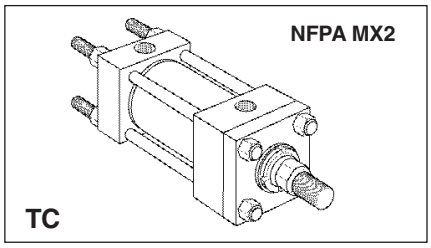


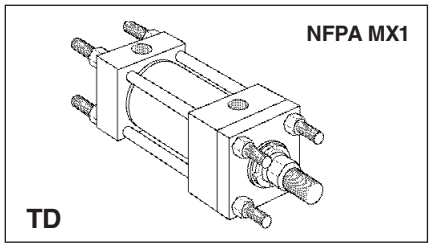
2H Cylinder Mounting Styles

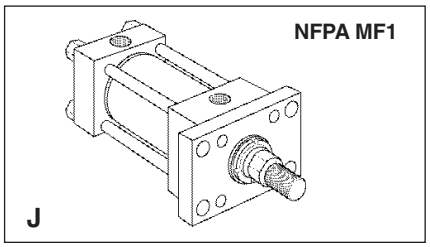
The standard range of Parker 2H cylinders comprises 17 mounting styles. Dimensional information for each mounting style is shown on pages 10-21 for 38.1mm to 203.2mm ($1^1/_2$" to 8") bore sizes, and on pages 22-25 for 254mm and 304.8mm (10" and 12") bore sizes.

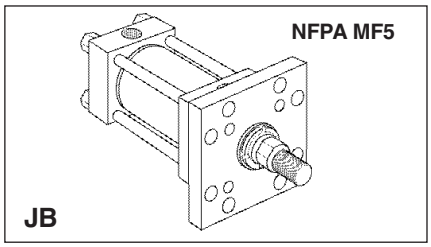
Application-specific mounting information is shown on pages 30-31.
Where a non-standard mounting style is required, please contact the factory for details.

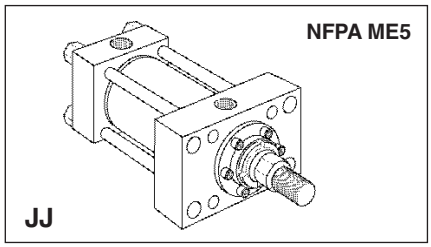


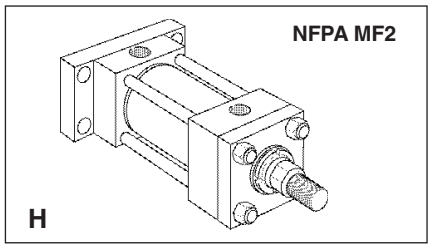


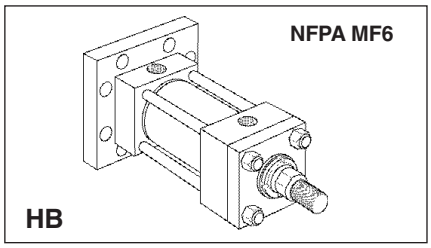


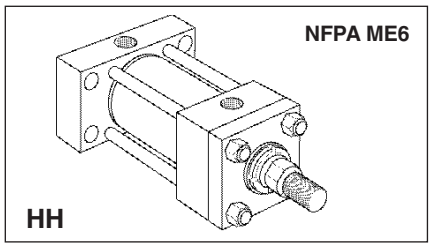


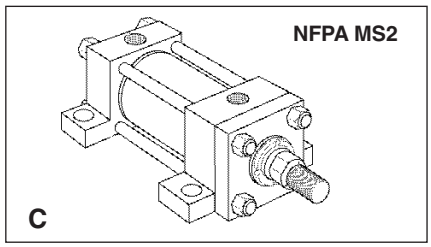


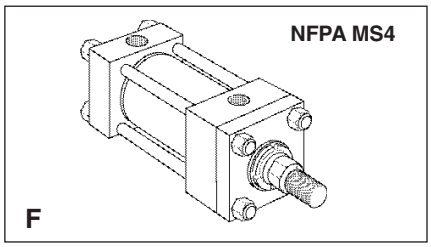


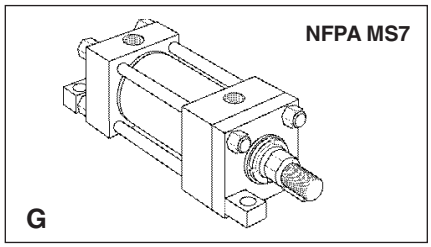


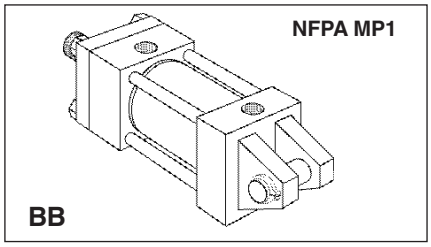


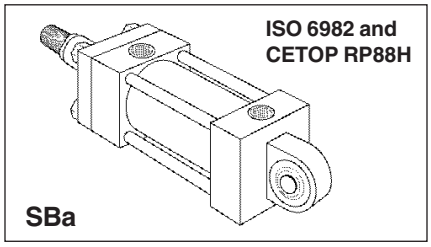


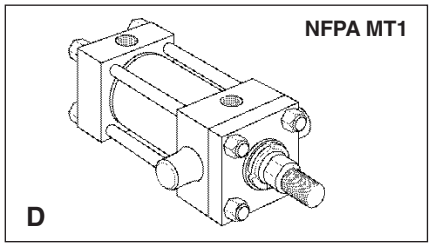


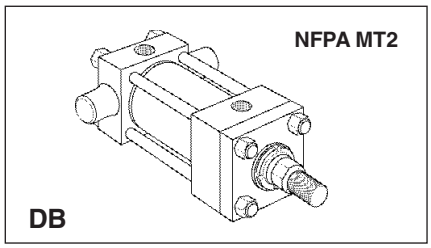


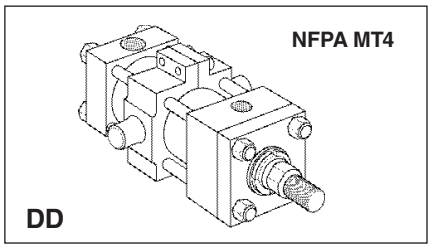


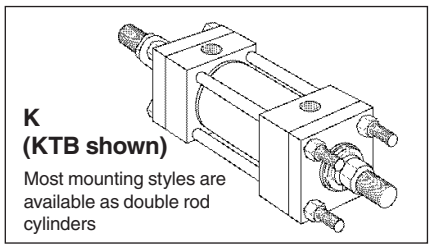






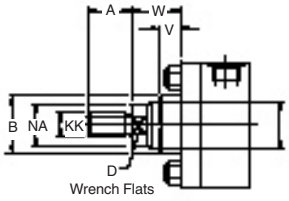




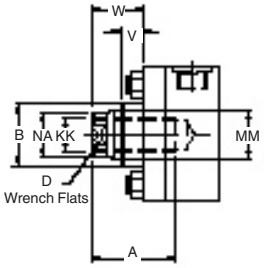


38.1mm to 203.2mm (1½" to 8") Bores Only

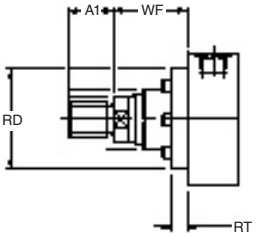
Rod End Styles 4, 7 & 8 – All Except JJ Mount



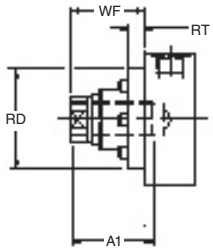
Rod End Style 9 – All Except JJ Mount



Rod End Styles 4, 7 & 8 – JJ Mount Only



Rod End Style 9 – JJ Mount Only



Rod End Styles 4 & 8

The standard rod end, Style 4, is recommended for all applications in which the work piece is secured against the rod shoulder. Where the work piece is not shouldered, Style 8 rod ends are recommended.

Rod End Style 9

For applications where a female thread is required.

Rod End Style 3

Non-standard piston rod ends are designated 'Style 3'. A dimensional sketch or description should accompany the order. Please specify dimensions KK and A.

Rod End Style 7

Style 7 rod ends apply to rod eyes with spherical bearings only (see pages 27 and 29). The Style 7 rod end with spherical bearing allows the same diameter pivot pin to be used at both the head and cap ends of the cylinder. For Style 7 rod end thread lengths, please refer to dimension A1 in the table below.

Style JJ

Dimensions which are not shown are identical to those shown for the equivalent non-JJ design.

Rod End Dimensions – 38.1mm to 203.2mm (1½" to 8") bore sizes only

Bore Ø	Rod No.	MM Rod Diameter	Style 4 & 9		Style 8		Style 7 [2]		A	B +0.00 -0.05	D	NA	V	W	JJ Mount Only		
			KK Metric	KK UNF[1]	KK Metric	KK UNF	KK Metric	A1							RD max.	RT	WF
38.1 (1½")	1	15.9 (⅝")	M10x1.5	7/16 - 20	M12x1.5	½ - 20	–	21	19.0	28.55	13	14.3	6.4	15.9	54.0	9.5	25.4
	2	25.4 (1")	M20x1.5	¾ - 16	M22x1.5	⅞ - 14	M16x1.5		28.6	38.07	22	23.8	12.7	25.4	63.5	9.5	35.0
50.8 (2")	1	25.4 (1")	M20x1.5	¾ - 16	M22x1.5	⅞ - 14	M20x1.5	27	28.6	38.07	22	23.8	6.4	19.1	63.5	9.5	35.0
	2	34.9 (1⅜")	M26x1.5	1 - 14	M30x2	1¼ - 12	M20x1.5		41.3	50.77	30	33.3	9.5	25.4	76.2	9.5	41.3
63.5 (2½")	1	25.4 (1")	M20x1.5	¾ - 16	M22x1.5	⅞ - 14	–	35	28.6	38.07	22	23.8	6.4	19.1	63.5	9.5	35.0
	2	44.5 (1¾")	M33x2	1¼ - 12	M39x2	1½ - 12	M27x2		50.8	60.30	36	42.9	12.7	31.8	88.9	9.5	47.7
	3	34.9 (1⅜")	M26x1.5	1 - 14	M30x2	1¼ - 12	M27x2		41.3	50.77	30	33.3	9.5	25.4	76.2	9.5	41.3
82.6 (3¼")	1	34.9 (1⅜")	M26x1.5	1 - 14	M30x2	1¼ - 12	–	44	41.3	50.77	30	33.3	6.4	22.2	76.2	9.5	41.3
	2	50.8 (2")	M39x2	1½ - 12	M45x2	1¾ - 12	M33x2		57.1	66.65	41	49.2	9.5	31.8	101.6	15.9	50.8
	3	44.5 (1¾")	M33x2	1¼ - 12	M39x2	1½ - 12	M33x2		50.8	60.30	36	42.9	9.5	28.6	88.9	9.5	47.7
101.6 (4")	1	44.5 (1¾")	M33x2	1¼ - 12	M39x2	1½ - 12	–	55	50.8	60.30	36	42.9	6.4	25.4	88.9	9.5	47.7
	2	63.5 (2½")	M48x2	1⅞ - 12	M56x2	2¼ - 12	M42x2		76.2	79.35	55	60.3	9.5	34.9	114.3	15.9	57.2
	3	50.8 (2")	M39x2	1½ - 12	M45x2	1¾ - 12	M42x2		57.1	66.65	41	49.2	6.4	28.6	101.6	15.9	50.8
127.0 (5")	1	50.8 (2")	M39x2	1½ - 12	M45x2	1¾ - 12	–	62	57.1	66.65	41	49.2	6.4	28.6	101.6	15.9	50.8
	2	88.9 (3½")	M64x2	2½ - 12	M76x2	3¼ - 12	M48x2		88.9	107.92	75	85.7	9.5	34.9	146.1	15.9	57.2
	3	63.5 (2½")	M48x2	1⅞ - 12	M56x2	2¼ - 12	M48x2		76.2	79.35	55	60.3	9.5	34.9	114.3	15.9	57.2
	4	76.2 (3")	M58x2	2¼ - 12	M68x2	2¾ - 12	–		88.9	95.22	65	73.0	9.5	34.9	133.4	15.9	57.2
152.4 (6")	1	63.5 (2½")	M48x2	1⅞ - 12	M56x2	2¼ - 12	–	84	76.2	79.35	55	60.3	6.4	31.8	114.3	15.9	57.2
	2	101.6 (4")	M76x2	3 - 12	M95x2	3¾ - 12	M64x3		101.6	120.62	85	98.4	6.4	31.8	165.1	19.1	57.2
	3	76.2 (3")	M58x2	2¼ - 12	M68x2	2¾ - 12	–		88.9	95.22	65	73.0	6.4	31.8	133.4	15.9	57.2
	4	88.9 (3½")	M64x2	2½ - 12	M76x2	3¼ - 12	M64x3		88.9	107.92	75	85.7	6.4	31.8	146.1	15.9	57.2
177.8 (7")	1	76.2 (3")	M58x2	2¼ - 12	M68x2	2¾ - 12	–	–	88.9	95.22	65	73.0	6.4	31.8	133.4	15.9	57.2
	2	127.0 (5")	M90x2	3½ - 12	M110x2	4¾ - 12	–		127.0	146.02	110	123.8	6.4	31.8	190.5	25.4	57.2
	3	88.9 (3½")	M64x2	2½ - 12	M76x2	3¼ - 12	–		88.9	107.92	75	85.7	6.4	31.8	146.1	15.9	57.2
	4	101.6 (4")	M76x2	3 - 12	M95x2	3¾ - 12	–		101.6	120.62	85	98.4	6.4	31.8	165.1	19.1	57.2
203.2 (8")	1	88.9 (3½")	M64.2	2½ - 12	M76x2	3¼ - 12	–	–	88.9	107.92	75	85.7	6.4	31.8	146.1	15.9	57.2
	2	139.7 (5½")	M100x2	4 - 12	M130x2	5¼ - 12	–		139.7	158.72	120	136.5	6.4	31.8	209.6	19.1	57.2
	3	101.6 (4")	M76x2	3 - 12	M95x2	3¾ - 12	–		101.6	120.62	85	98.4	6.4	31.8	165.1	19.1	57.2
	5	127.0 (5")	M90x2	3½ - 12	M110x2	4¾ - 12	–		127.0	146.02	110	123.8	6.4	31.8	190.5	25.4	57.2

All dimensions are in millimetres unless otherwise stated.

[1] All rod threads are UNF except 1" - 14 which is UNS.
[2] Style 7 threads apply to spherical rod eyes only, see page 29.

Parker Hannifin plc
Cylinder Division
Watford, Herts.

Storage

When cylinders must be stored for a period of time, the following procedures are recommended:

1. Store the cylinders in an indoor area which has a dry, clean and non-corrosive atmosphere. Take care to protect the cylinder from both internal corrosion and external damage.
2. Whenever possible, cylinders should be stored in a vertical position (piston rod up). This will minimize corrosion due to possible condensation which could occur inside the cylinder.
3. Port protector plugs should be left in the cylinder until the time of installation.

Installation

1. Cleanliness is an important consideration, and Parker cylinders are shipped with the ports plugged to protect them from contaminants entering the ports. These plugs should not be removed until the piping is to be installed. Before making the connection to the cylinder ports, piping should be thoroughly cleaned to remove all chips or burrs which might have resulted from threading or flaring operations.
2. Cylinders operating in an environment where air drying materials are present such as fast-drying chemicals, paint, or weld splatter, or other hazardous conditions such as excessive heat, should have shields installed to prevent damage to the piston rod and piston rod seals.
3. Correct alignment of the cylinder piston rod and its mating component on the machine should be checked in both the extended and retracted positions. Incorrect alignment will result in excessive rod gland and/or cylinder bore wear, shortening the life of the cylinder.

Warranty

Defective Work or Material Every effort is made to ensure sound material and good workmanship, but the Seller gives no warranty, expressed or implied, of material, workmanship, or fitness of goods for any particular purpose, whether such purpose be known to the Seller or not. In the event of any material or workmanship proving defective the Seller is prepared to rectify or replace such material at the place of delivery and in the condition originally specified, or if rectification or replacement is not practicable, will credit the value of the goods at the invoice price, if required in writing to do so, provided always that the claim is made and admitted and the material is returned within six months from date of invoice. The Seller's liability in respect of or consequent upon any such defect whether in original or replaced material or workmanship, is limited as aforesaid and does not extend in any circumstances to cover any other expenditure incurred nor any consequential damages or loss of profit.

Masses – Series 2H Cylinders

To determine the mass of the cylinder, first select the basic mass for zero stroke, then calculate the mass for the cylinder stroke and add the result to the basic mass.

Bore Ø	Rod No.	Single Rod Cylinders			Double Rod Cylinders		
		Mass at Zero Stroke		Mass per 10mm Stroke kg	Mass at Zero Stroke		Mass per 10mm Stroke kg
		Mounting Styles			Mounting Styles		
		TB, TC, TD, J, JB, H, HB, F kg	JJ, HH, D, DB, DD, C, G, SBa, BB kg		TB, TD, J, JB, F kg	JJ, C, G, D, DD kg	
38.1 (1½")	1	3.6	4.7	0.09	4.1	5.23	0.10
	2	3.7	4.9	0.11	4.4	5.53	0.15
50.8 (2")	1	5.7	7.5	0.14	6.9	8.74	0.18
	2	6.0	7.8	0.18	7.5	9.34	0.25
63.5 (2½")	1	7.9	10.1	0.19	9.4	11.7	0.23
	2	8.7	11.0	0.27	11.0	13.3	0.39
	3	8.2	10.8	0.22	10.0	12.7	0.30
82.6 (3¼")	1	15.2	19.4	0.31	18.2	22.5	0.39
	2	16.1	20.4	0.39	20.0	24.3	0.55
	3	15.7	19.9	0.36	19.2	23.5	0.48
101.6 (4")	1	20.4	25.7	0.39	25	31	0.51
	2	22.2	27.5	0.51	29	35	0.76
	3	20.8	26	0.42	26	32	0.58
127.0 (5")	1	36	44	0.59	43	52	0.75
	2	41	49	0.92	53	62	1.40
	3	37	46	0.68	46	55	0.93
	4	39	47	0.79	49	58	1.20
152.4 (6")	1	58	71	0.92	68	82	1.2
	2	64	77	1.3	80	94	2.0
	3	60	73	1.1	71	85	1.4
	4	62	75	1.2	74	88	1.7
177.8 (7")	1	86	105	1.2	99	119	1.5
	2	97	116	1.8	122	142	2.8
	3	88	107	1.3	103	123	1.8
	4	90	109	1.4	108	128	2.1
203.2 (8")	1	120	145	1.6	137	163	2.1
	2	135	160	2.3	166	192	3.5
	3	123	148	1.8	142	168	2.4
	5	130	155	2.1	157	183	3.1
254.0 (10")	1	275	328	3.0	325	378	4.0
	2	291	344	4.0	357	410	5.9
304.8 (12")	1	444	527	3.9	519	603	5.1
	2	474	557	5.6	579	663	8.4

Masses for accessories are shown on pages 27 to 29.

All dimensions are in millimetres unless otherwise stated.

Parker Hannifin plc
Cylinder Division
Watford, Herts.

Parker Offers the Widest Range of Industrial Cylinders

High Productivity – Low Cost of Ownership

Parker Hannifin's Cylinder Division is the world's largest supplier of hydraulic cylinders for industrial applications.

Parker manufactures a vast range of standard and special tie rod, roundline and 'mill' type cylinders to suit all types of industrial cylinder applications. Our cylinders are available to ISO, DIN, NFPA, ANSI and JIC standards, with other certifications available on request. All Parker hydraulic cylinders are designed to deliver long, efficient service with low maintenance requirements, guaranteeing high productivity year after year.

About Parker Hannifin

Parker Hannifin Corporation is a world leader in the manufacture of components and systems for motion control. Parker has more than 800 product lines for hydraulic, pneumatic and electro-mechanical applications in some 1200 industrial and aerospace markets. With more than 50,000 employees and some 210 manufacturing plants and administrative offices around the world, Parker provides customers with technical excellence and first class customer service.

Visit us at www.parker.com/uk



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The 2H Cylinder Range

The 2H cylinders described in this catalogue are heavy duty hydraulic cylinders, rated for use at working pressures up to 210 bar depending on the rod end and type of service.

In addition to the standard cylinders featured in this catalogue, 2H cylinders can be designed to suit customer requirements. Our engineers will be pleased to advise on unique designs to suit specific applications.

inPHorm and 3-D CAD

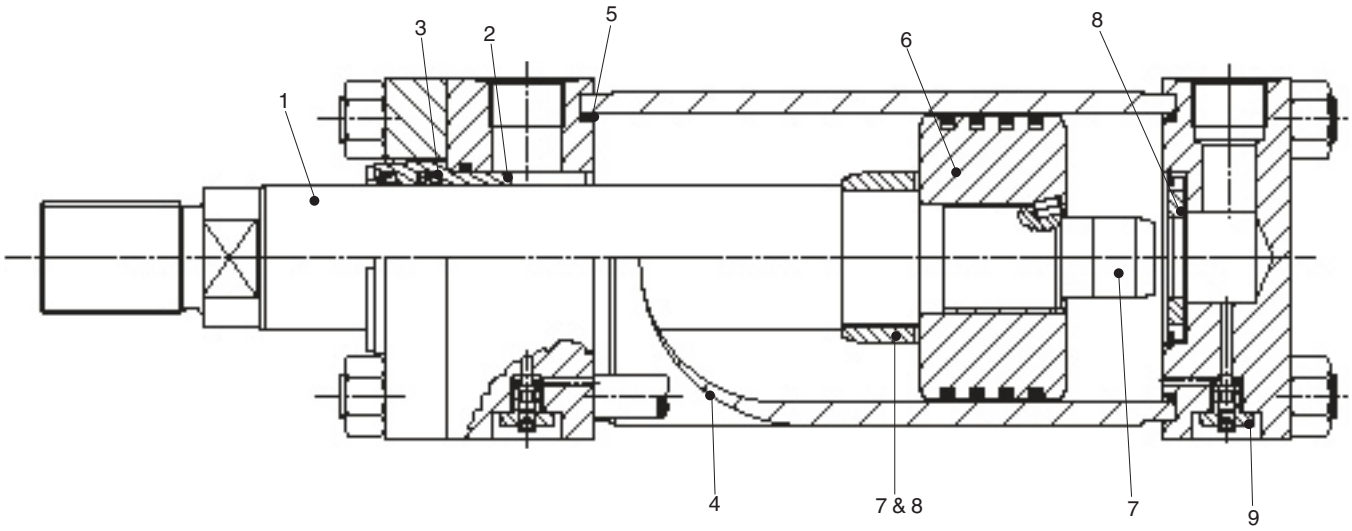
Parker offers easy-to-use software to simplify the cylinder selection process, saving your time and ensuring the accuracy of designs and drawings. InPHorm selection software and new 3-D CAD modelling software can be downloaded from our European Cylinder Division website. Please visit us at www.parker.com/eu or contact your local Sales Office for more information.

Standard Specifications

- Heavy-duty service – ANSI B93.15-1987 and NFPA specifications
- Standard construction – square end - tie rod design
- Standard pressure – 210 bar
- Standard fluid – hydraulic mineral oil
- Standard temperature – -20°C to 80°C (-4°F to 176°F)
- Bore sizes – 38.1mm (1½") to 304.8mm (12")
- Piston rod diameters – 15.9mm (⅝") to 215.9mm (8½")
- Mounting styles – 17 standard styles
- Strokes – available in any practical stroke length
- Cushions – optional at either end or both ends of stroke
- Rod ends – three standard choices – specials to order

Note: In line with our policy of continuing product improvement, specifications in this catalogue are subject to change without notice.

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Watford, Herts.



1 Piston Rod

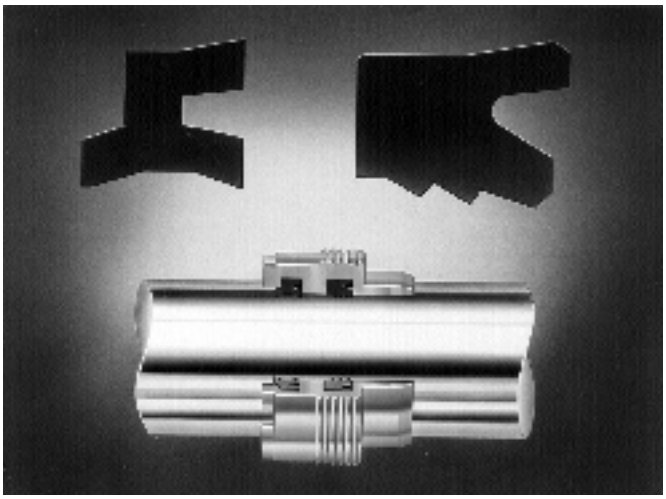
Gland seal life is maximised by manufacturing piston rods from precision ground, high tensile carbon alloy steel, hard chrome plated and polished to 0.2µm max. Piston rods are induction case hardened to Rockwell C54 minimum before chrome plating, resulting in a dent-resistant surface.

2 Parker's Rod Gland

Continuous lubrication, and therefore longer gland life, are provided by the long bearing surface inboard of the lipseal. The gland, complete with rod seals, can easily be removed without dismantling the cylinder, so servicing is quicker – and therefore more economical.

3 Rod Seals

The serrated lipseal has a series of sealing edges which take over successively as pressure increases, providing efficient sealing under all operating conditions. On the return stroke the serrations act as a check valve, allowing the oil adhering to the rod to pass back into the cylinder.



The double lip wiperseal acts as a secondary seal, trapping excess lubricating film in the chamber between the wiper and lip seals and preventing the ingress of dirt into the cylinder, extending the life of gland and seals. Standard lipseals are manufactured from an enhanced polyurethane, giving efficient retention of fluid and a life of up to five times that of traditional seal materials. Standard seals are suitable for speeds up to 0.5m/s – special seal combinations are available for higher speed applications.

4 Cylinder Body

Strict quality control standards and precision manufacture ensure that all tubes meet rigid standards of straightness, roundness and surface finish. The steel tubing is surface finished to minimise internal friction and prolong seal life.

5 Cylinder Body Seals

To ensure that the cylinder body remains leak free, even under pressure shock conditions, Parker fits pressure-energised body seals.

6 Piston

Wear-resistant cast iron piston rings pistons are fitted as standard to 2H cylinders. Lipseal and Hi-Load pistons are available to suit different applications – see 'Piston Seals' opposite. All pistons are of one-piece type, and feature wide bearing surfaces to resist side loading. Long thread engagement secures the piston to the piston rod and, for additional safety, the piston is secured by thread-locking adhesive and a locking pin.

7 Cushioning

Progressive deceleration is available by using stepped cushions at the head and cap – see page 35 for details. The head and cap end cushions are self centring. The polished cap end spear is an integral part of the piston rod.

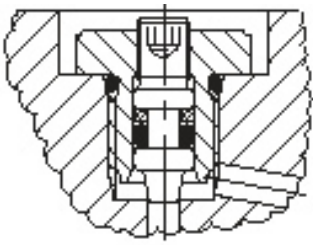
8 Floating Cushion Bushes & Sleeves

Closer tolerances – and therefore more effective cushioning – are permitted by the use of a floating cushion sleeve at the head end of the cylinder, and a floating cushion bush at the cap end. A specially designed cushion sleeve on bore sizes up to 101.6mm (4") operates as a check valve. On larger bore sizes a conventional ball check valve is used. The use of a check valve in the head and lifting of the bronze cushion bush in the cap, provides minimum fluid flow restriction at the start of the return stroke. This allows full pressure to be applied over the whole area of the piston, to provide full power and fast cycle times.

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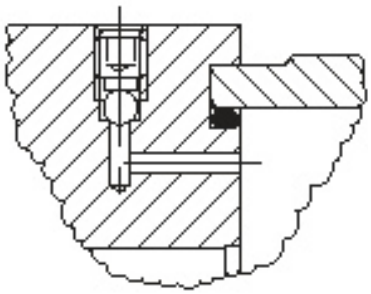
9 Cushion Adjustment

Needle valves are provided at both ends of the cylinder for precise cushion adjustment, and retained within the head and cap so that they cannot be inadvertently removed. The cartridge type needle valve illustrated below is fitted to cylinders of up to 63.5mm ($2^1/_2$") bore – see page 37.



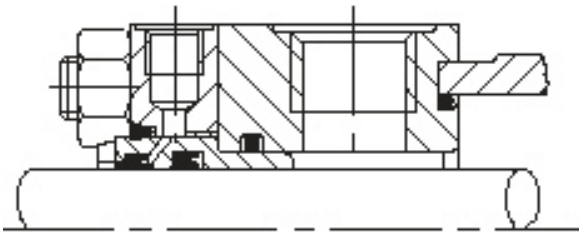
Air Bleeds

Available as an option at both ends, the air bleeds are recessed into the head and cap and retained so that they cannot be inadvertently removed. See Optional Features, page 39.



Gland Drains

The accumulation of fluid behind the gland wiperseal of long stroke cylinders, or cylinders with constant back pressure, can be relieved by specifying the option of a gland drain. A port between the wiperseal and lipseal allows fluid to be piped back to a reservoir. By fitting a transparent tube between the port and the reservoir, fluid loss from concealed or inaccessible cylinders can be monitored to provide an early indication of the need for gland servicing. Gland drains are described in greater detail on page 39.



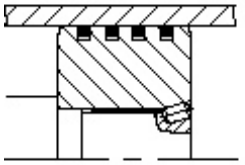
Special Designs

Parker's design and engineering staff are available to produce special designs to meet customer's specific requirements. Alternative sealing arrangements, special mounting styles, different bores and rod sizes are just a few of the custom features which can be supplied.

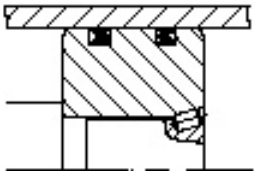
Piston Seals

A variety of piston seal options is available, to suit different applications. The seal option should be specified at the time of order as a seal type cannot be changed unless the piston is also changed.

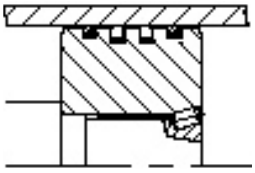
Cast Iron Piston Rings are extremely durable but allow some leakage across the piston and cannot therefore hold a load in position. Piston rings are fitted as standard on series 2H hydraulic cylinders.



Lipseal Pistons can hold a load in position, but they are not as durable as piston rings. Lipseal pistons are optional on series 2H hydraulic cylinders.



Hi-Load Pistons resist side loading and are recommended for long stroke cylinders, especially when pivot mounted. Special wear rings prevent metal to metal contact between the piston and tube and thereby extend the life of the cylinder.



Seal Classes

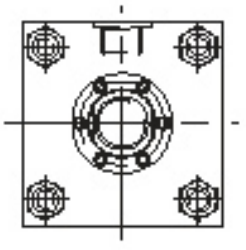
To accommodate the many types of fluid and the varying temperature ranges used in industry, Parker offers a range of rod gland, piston and body seals moulded in different profiles and from different materials. These are described in detail on page 38.

Low Friction Seals

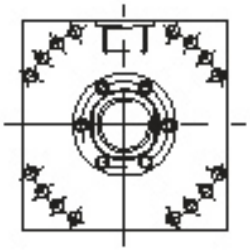
Low friction seals are also available. Please consult the factory.

Cylinder Construction

The dimensional drawings on pages 22-25 show 254mm (10") bore models only, but can also be used to determine all pertinent dimensional data for 304.8mm (12") bore models which are designed with 16 tie rods.



254mm (10") Bore Design
4 Tie Rod Construction



304.8mm (12") Bore Design
16 Tie Rod Construction

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Check List

The following check list indicates the principal factors which should be considered when selecting a hydraulic cylinder for a particular application. Further information is available on the pages shown. If more detailed information is required about any aspect of a cylinder's specification, please contact our design engineers who will be happy to assist.

1 Establish System Parameters ..... **Series 2H**
- – Weight to be moved and force required
- – Nominal operating pressure and range
- – Distance to be travelled
- – Average and maximum piston speed
- – Fluid medium and temperature

2 Mounting Style ..... **Page 9**
Select the appropriate style for the specific application

3 Cylinder Bore and Operating Pressure ..... **Pages 32, 36**
Determine the bore and system pressure required to provide the necessary force

4 Piston Rod ..... **Pages 3, 26, 33, 36, 42**
Single or double rod?
Determine the minimum rod diameter required to withstand buckling forces
Is a stop tube required?
Select a suitable rod end and rod end thread
Check pressure rating of selected cylinder and piston rod

5 Piston ..... **Page 7**
Does seal type suit application?

6 Cushioning ..... **Page 35**
Select cushioning requirements if applicable

7 Ports ..... **Pages 36, 37**
Select suitable ports
Are they capable of the speed required?
Are the standard positions acceptable?

8 Seals ..... **Pages 7, 38**
Select seals to suit the chosen fluid medium and temperature range

9 Rod and Cap End Accessories ..... **Pages 27, 28, 29**
Are rod end and/or cap end accessories required?

10 Optional Features ..... **Page 39**
Air bleeds, gland drains, rod end bellows etc.

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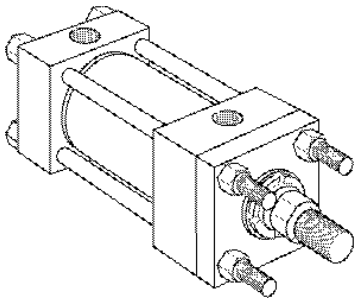
Mounting Styles and Where to Use Them

See also application-specific mounting information on pages 30-31.

Extended Tie Rod Mountings – Styles TB, TC and TD

Application
- straight line force transfer
- compression (push) – use cap end mountings TC or TD
- tension (pull) – use head end mountings TB or TD

Benefits
- ease of mounting where space is limited
- high efficiency – force is absorbed on cylinder's centreline
- TD double-ended mounting allows brackets or switches to be attached to cylinder



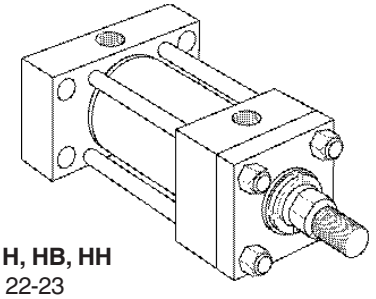
Styles TB, TC, TD
See pages 10-11

TB

Flange Mountings – Styles J, JB, JJ, H, HB and HH

Application
- straight line force transfer
- compression (push) – use cap end mounting H, HB or HH
- tension (pull) – use head end mounting J, JB or JJ

Benefits
- exceptionally rigid mounting due to large flange area
- high efficiency – force is absorbed on cylinder's centreline



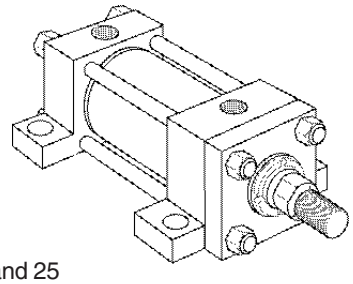
Styles J, JB, JJ, H, HB, HH
See pages 12-15, 22-23

HH

Foot Mountings – Style C, F, G

Application
- straight line force transfer
- suitable for push or pull applications
- force is **not** absorbed on centreline – secure attachment, eg: a thrust key (page 30) and effective load guidance are vital

Benefits
- ease of mounting and adjustment



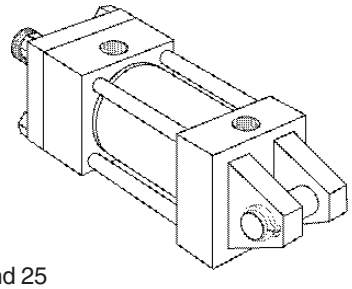
Styles C, F, G
See pages 16-17 and 25

C

Pivot Mountings – Styles BB and SBa

Application
- curved path force transfer
- movement in a single plane – use fixed clevis style BB
- movement in more than one plane – use spherical bearing style SBd

Benefits
- ease of attachment – use with plain or spherical bearing at rod end
- greater flexibility for the machine designer
- self-alignment resists wear of cylinder's bearing surfaces



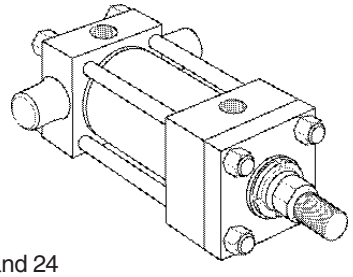
Styles BB, SBa
See pages 18-19 and 25

BB

Trunnion Mountings – Styles D, DB and DD

Application
- curved path force transfer
- movement in a single plane
- compression (push) – use DB or DD mountings
- tension (pull) – use D or DD mountings

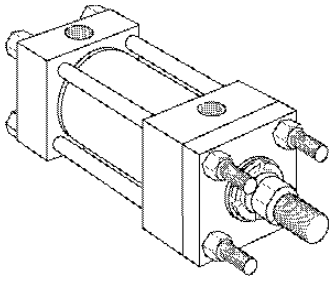
Benefits
- greater flexibility for the machine designer
- self-alignment resists wear of cylinder's bearing surfaces
- high efficiency – force is absorbed on cylinder's centreline
- ease of attachment – use with pivot mounting at rod end



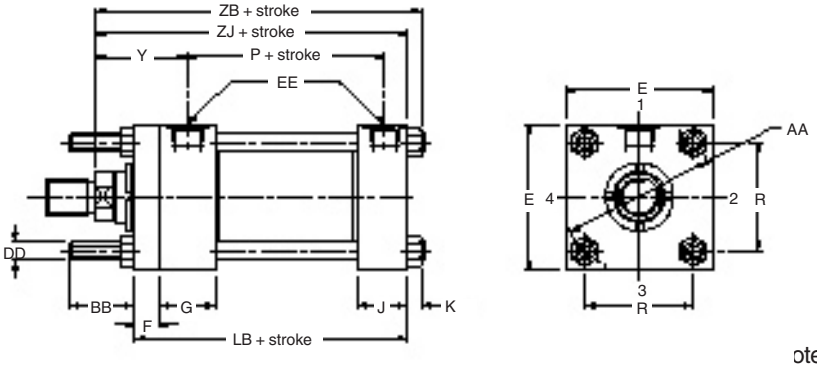
Styles D, DB, DD
See pages 20-21 and 24

DB

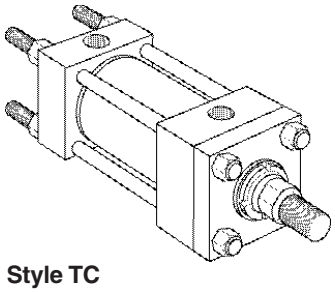
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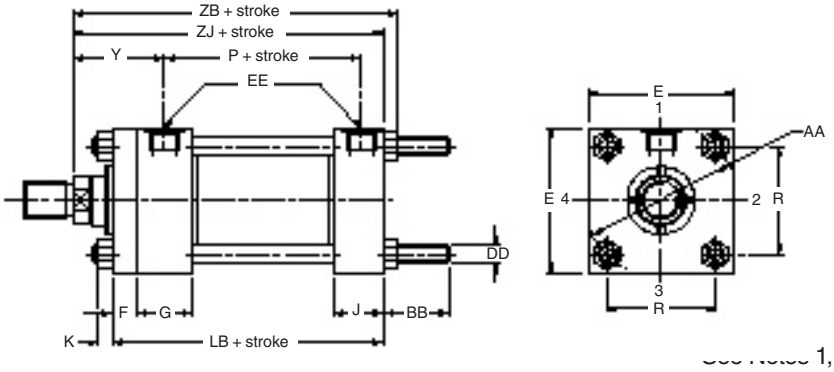
Style TB
Tie Rods Extended Head End
(NFPA Style MX3)



otes 1, 2



Style TC
Tie Rods Extended Cap End
(NFPA Style MX2)



1, 2

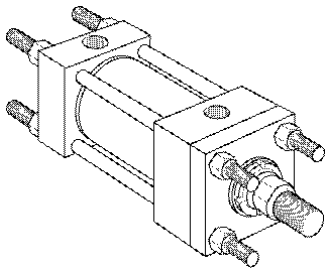
Dimensions TB, TC & TD

See also Dimensions, page 3 & Mounting Information, page 30

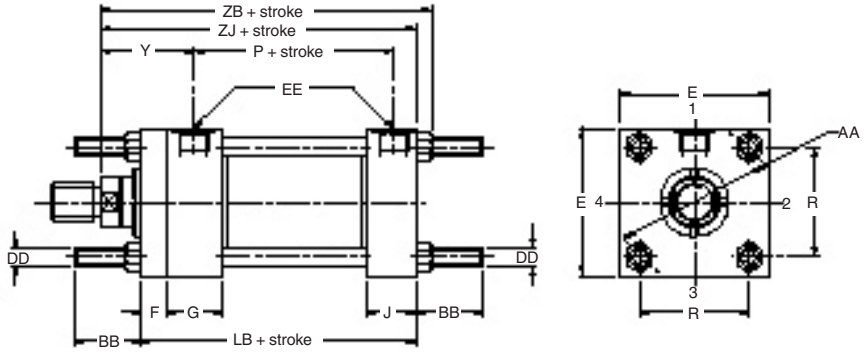
Bore Ø	Rod No.	AA	BB	DD [1]	E	EE (BSPP)	F	G	J
38.1 (1½")	1 2	58.4	34.9	⅜ - 24	63.5	G½	9.5	44.5	38.1
50.8 (2")	1 2	73.7	46.0	½ - 20	76.2	G½	15.9	44.5	38.1
63.5 (2½")	1 2 3	91.4	46.0	½ - 20	88.9	G½	15.9	44.5	38.1
82.6 (3¼")	1 2 3	116.8	58.7	⅝ - 18	114.3	G¾	19.1	50.8	44.5
101.6 (4")	1 2 3	137.2	58.7	⅝ - 18	127.0	G¾	22.2	50.8	44.5
127.0 (5")	1 2 3 4	177.8	81.0	⅞ - 14	165.1	G¾	22.2	50.8	44.5
152.4 (6")	1 2 3 4	205.7	92.1	1 - 14	190.5	G1	25.4	57.2	57.2
177.8 (7")	1 2 3 4	236.2	104.8	1⅛ - 12	215.9	G1¼	25.4	69.9	69.9
203.2 (8")	1 2 3 5	269.2	114.3	1¼ - 12	241.3	G1½	25.4	76.2	76.2

All dimensions are in millimetres unless otherwise stated.

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Style TD
Tie Rods Extended Both Ends
(NFPA Style MX1)



See Notes 1, 2

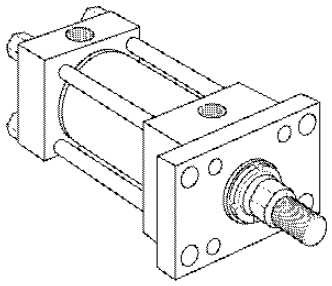
Notes
1 All tie rod threads (dimension DD) are UNF, with the exception of 1" - 14 which is UNS
2 Mounting nuts should be tightened to the torque values shown for tie rod nuts – see page 31

Dimensions TB, TC & TD Continued

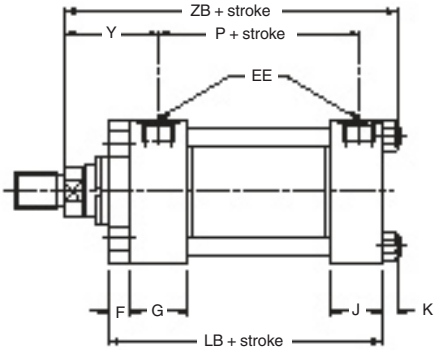
Bore Ø	Rod No.	K max	R	Y	+ Stroke			
					LB	P	ZB max	ZJ
38.1 (1½")	1	10	41.4	49	127.0	75	152.4	142.9
	2			59			161.9	152.4
50.8 (2")	1	13	52.1	59	133.4	75	163.5	152.4
	2			65			169.9	158.8
63.5 (2½")	1	13	64.8	59	136.5	78	166.7	156.6
	2			71			179.4	168.3
	3			65			173.3	161.9
82.6 (3¼")	1	16	82.6	68	158.8	90	195.3	181.0
	2			79			204.8	190.5
	3			76			201.6	187.3
101.6 (4")	1	16	97.0	76	168.3	97	208.0	193.7
	2			86			217.5	203.2
	3			79			211.1	196.9
127.0 (5")	1	19	125.7	79	181.0	110	230.2	209.6
	2			86			236.5	215.9
	3			86			236.5	215.9
	4			86			236.5	215.9
152.4 (6")	1	23	145.5	86	212.7	130	266.7	244.5
	2							
	3							
	4							
177.8 (7")	1	26	167.1	92	241.3	146	298.5	273.0
	2							
	3							
	4							
203.2 (8")	1	28	190.5	94	266.7	168	325.4	298.4
	2							
	3							
	5							

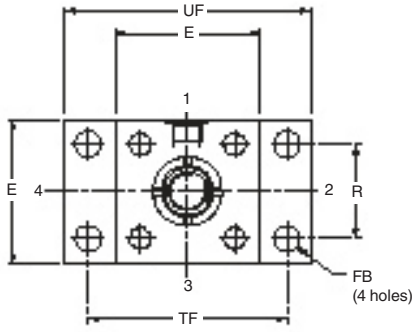
All dimensions are in millimetres unless otherwise stated.

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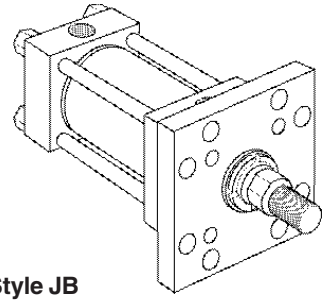


Style J
Head Rectangular Flange
(NFPA Style MF1)

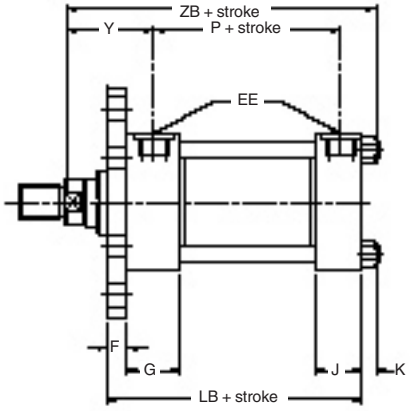


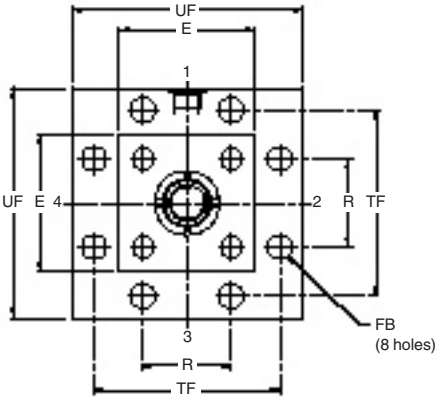


See Note 1



Style JB
Head Square Flange
(NFPA Style MF5)



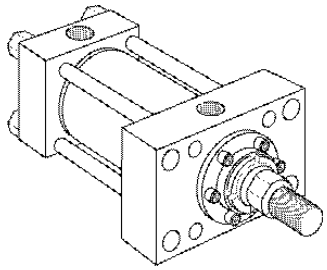


Dimensions J, JB & JJ See also Dimensions, page 3 & Mounting Information, pages 30 & 36

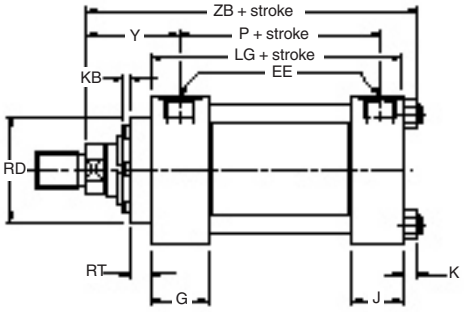
Bore Ø	Rod No.	E	EE (BSPP)	F	FB	G	J	K	KB	R
38.1 (1½")	1 2	63.5	G½	9.5	11.1	44.5	38.1	10	0.0	41.4
50.8 (2")	1 2	76.2	G½	15.9	14.3	44.5	38.1	13	0.0 6.4	52.1
63.5 (2½")	1 2 3	88.9	G½	15.9	14.3	44.5	38.1	13	0.0 6.4 6.4	64.8
82.6 (3¼")	1 2 3	114.3	G¾	19.1	17.5	50.8	44.5	16	6.4 3.2 6.4	82.6
101.6 (4")	1 2 3	127.0	G¾	22.2	17.5	50.8	44.5	16	6.4 6.4 3.2	97.0
127.0 (5")	1 2 3 4	165.1	G¾	22.2	23.8	50.8	44.5	19	3.2 6.4 6.4 6.4	125.7
152.4 (6")	1 2 3 4	190.5	G1	25.4	27.0	57.2	57.2	22	6.4 6.4 6.4 6.4	145.5
177.8 (7")	1 2 3 4	215.9	G1¼	25.4	30.2	69.9	69.9	24	6.4 0.0 6.4 6.4	167.1
203.2 (8")	1 2 3 5	241.3	G1½	25.4	33.3	76.2	76.2	27	6.4 6.4 6.4 0.0	190.5

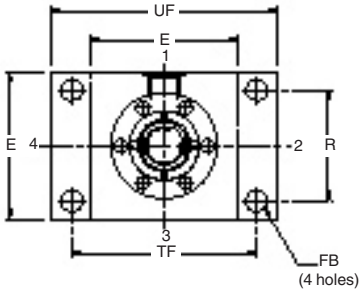
All dimensions are in millimetres unless otherwise stated.

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Cylinder Division
Watford, Herts.



Style JJ
Rectangular Head
(NFPA Style ME5)





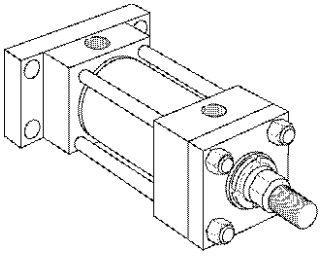
Notes
1 For maximum pressure ratings in push applications, see page 36

Dimensions J, JB & JJ Continued

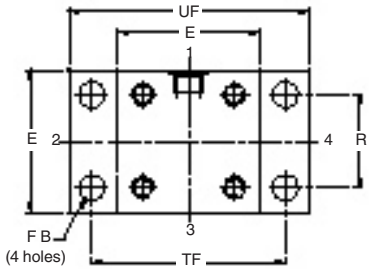
Bore Ø	Rod No.	RD max	RT	TF	UF	Y	+ Stroke			
							LB	LG	P	ZB max
38.1 (1½")	1	54.0	9.5	87.3	108.0	49	127.0	117.5	75	152.4
	2	63.5	9.5			59				161.9
50.8 (2")	1	63.5	9.5	104.8	130.2	59	133.4	117.5	75	163.5
	2	76.2	9.5			65				169.9
63.5 (2½")	1	63.5	9.5	117.5	142.9	59	136.5	120.7	78	166.7
	2	88.9	9.5			71				179.4
	3	76.2	9.5			65				173.3
82.6 (3¼")	1	76.2	9.5	149.2	181.0	68	158.8	139.7	90	195.3
	2	101.6	15.9			79				204.8
	3	88.9	9.5			76				201.6
101.6 (4")	1	88.9	9.5	161.9	193.7	76	168.3	146.1	97	208.0
	2	114.3	15.9			86				217.5
	3	101.6	15.9			79				211.1
127.0 (5")	1	101.6	15.9	208.0	247.7	79	181.0	158.8	110	230.2
	2	146.1	15.9			86				236.5
	3	114.3	15.9			86				236.5
	4	133.4	15.9			86				236.5
152.4 (6")	1	114.3	15.9	239.7	285.8	86	212.7	187.3	130	266.7
	2	165.1	19.1							
	3	133.4	15.9							
	4	146.1	15.9							
177.8 (7")	1	133.4	15.9	269.9	320.7	92	241.3	215.9	146	298.5
	2	190.5	25.4							
	3	146.1	15.9							
	4	165.1	19.1							
203.2 (8")	1	146.1	15.9	300.0	355.6	94	266.7	241.3	168	325.4
	2	209.6	19.1							
	3	165.1	19.1							
	5	190.5	25.4							

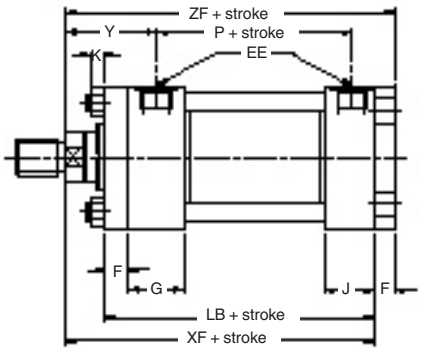
All dimensions are in millimetres unless otherwise stated.

Parker Hannifin plc
Cylinder Division
Watford, Herts.

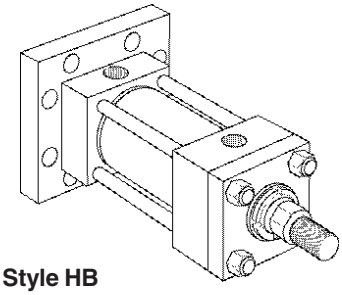


Style H
Cap Rectangular Flange
(NFPA Style MF2)

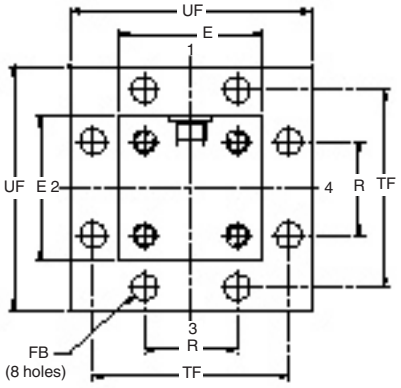


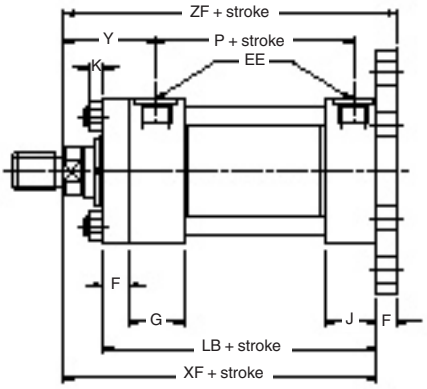


lote 1



Style HB
Cap Square Flange
(NFPA Style MF6)



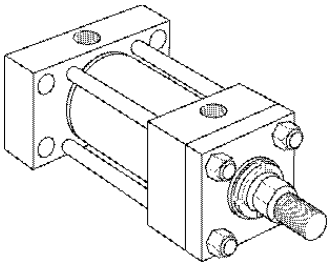


Dimensions H, HB & HH See also Dimensions, page 3 & Mounting Information, pages 30 & 36

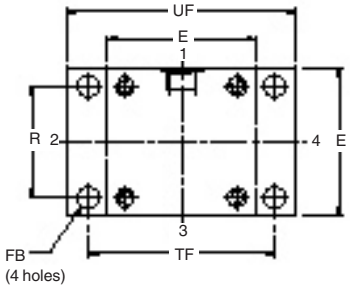
Bore Ø	Rod No.	E	EE (BSPP)	F	FB	G	J	K	R
38.1 (1½")	1 2	63.5	G½	9.5	11.1	44.5	38.1	10	41.4
50.8 (2")	1 2	76.2	G½	15.9	14.3	44.5	38.1	13	52.1
63.5 (2½")	1 2 3	88.9	G½	15.9	14.3	44.5	38.1	13	64.8
82.6 (3¼")	1 2 3	114.3	G¾	19.1	17.5	50.8	44.5	16	82.6
101.6 (4")	1 2 3	127.0	G¾	22.2	17.5	50.8	44.5	16	97.0
127.0 (5")	1 2 3 4	165.1	G¾	22.2	23.8	50.8	44.5	19	125.7
152.4 (6")	1 2 3 4	190.5	G1	25.4	27.0	57.2	57.2	22	145.5
177.8 (7")	1 2 3 4	215.9	G1¼	25.4	30.2	69.9	69.9	24	167.1
203.2 (8")	1 2 3 5	241.3	G1½	25.4	33.3	76.2	76.2	27	190.5

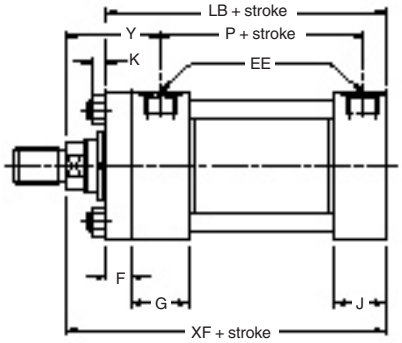
All dimensions are in millimetres unless otherwise stated.

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Cylinder Division
Watford, Herts.



Style HH
Rectangular Cap
(NFPA Style ME6)





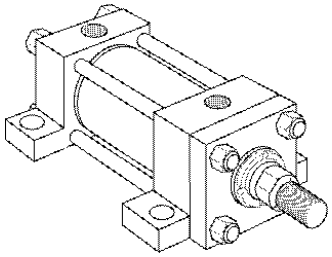
Notes
1 For maximum pressure ratings in pull applications, see page 36

Dimensions H, HB & HH Continued

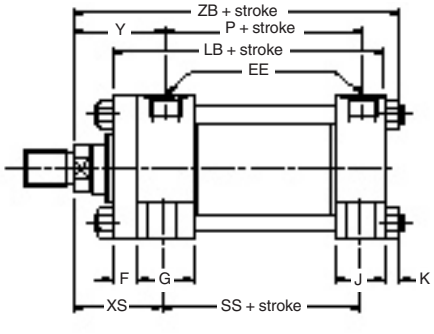
Bore Ø	Rod No.	TF	UF	Y	+ Stroke			
					LB	P	XF	ZF
38.1 (1½")	1	87.3	108.0	49	127.0	75	142.9	152.4
	2			59			152.4	161.9
50.8 (2")	1	104.8	130.2	59	133.4	75	152.4	168.3
	2			65			158.8	174.6
63.5 (2½")	1	117.5	142.9	59	136.5	78	156.6	171.5
	2			71			168.3	184.2
	3			65			161.9	177.8
82.6 (3¼")	1	149.2	181.0	68	158.8	90	181.0	200.0
	2			79			190.5	209.6
	3			76			187.3	206.4
101.6 (4")	1	161.9	193.7	76	168.3	97	193.7	215.9
	2			86			203.2	225.4
	3			79			196.9	219.1
127.0 (5")	1	208.0	247.7	79	181.0	110	209.6	231.8
	2			86			215.9	238.1
	3			86			215.9	238.1
	4			86			215.9	238.1
152.4 (6")	1	239.7	285.8	86	212.7	130	244.5	269.9
	2							
	3							
	4							
177.8 (7")	1	269.9	320.7	92	241.3	146	273.0	298.5
	2							
	3							
	4							
203.2 (8")	1	300.0	355.6	94	266.7	168	298.5	323.9
	2							
	3							
	5							

All dimensions are in millimetres unless otherwise stated.

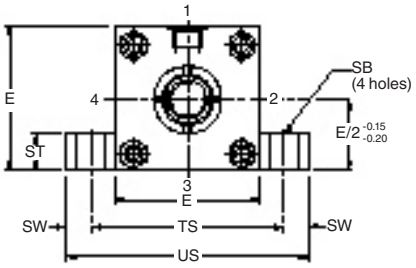
Parker Hannifin plc
Cylinder Division
Watford, Herts.

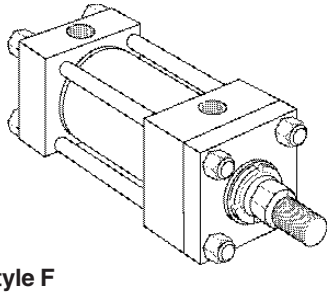


Style C
Side Lug Mounting
(NFPA Style MS2)

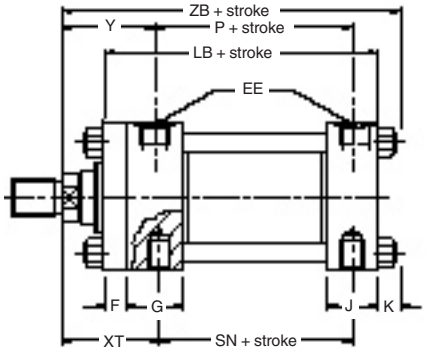


1, 3, 4

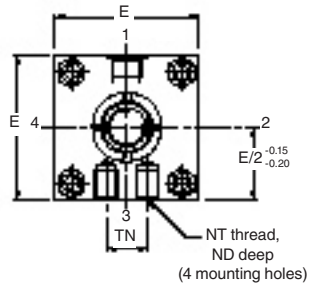




Style F
Side Tapped Mounting
(NFPA Style MS4)



ɔtes 1, 2

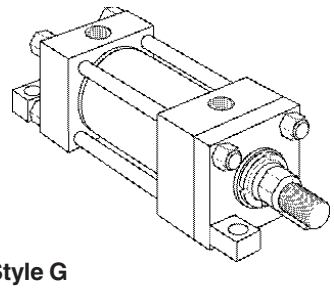


Dimensions C, F & G See also Dimensions, page 3 & Mounting Information, page 30

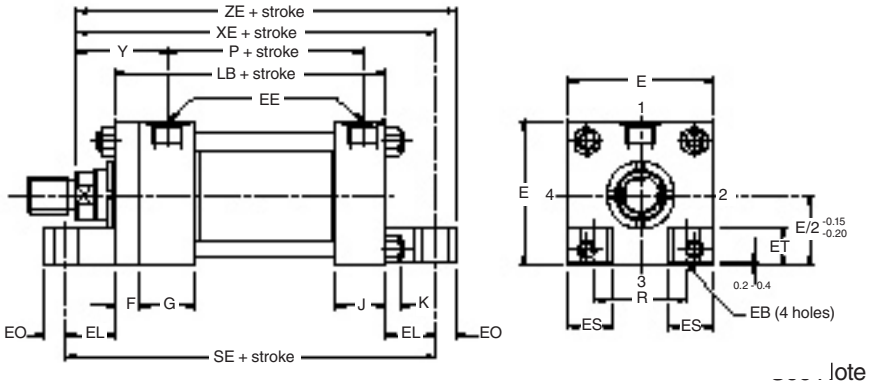
Bore Ø	Rod No.	E	EB	EE (BSPP)	EL	EO	ES	ET	F	G	J	K	ND	NT [2]	R	SB [3]	ST
38.1 (1½")	1 2	63.5	11.5	G½	22.2	9.5	24	21	9.5	44.5	38.1	10	12 12	M10	41.4	11	12.7
50.8 (2")	1 2	76.2	14.3	G½	23.8	12.7	24	24	15.9	44.5	38.1	13	15 11	M12	52.1	14	19.1
63.5 (2½")	1 2 3	88.9	14.3	G½	23.8	12.7	24	24	15.9	44.5	38.1	13	14 12 14	M16	64.8	22	25.4
82.6 (3¼")	1 2 3	114.3	17.5	G¾	28.6	15.9	32	31	19.1	50.8	44.5	16	22 17 22	M20	82.6	22	25.4
101.6 (4")	1 2 3	127.0	17.5	G¾	28.6	15.9	32	29	22.2	50.8	44.5	16	25 17 25	M24	97.0	26	31.8
127.0 (5")	1 2 3 4	165.1	23.8	G¾	38.1	19.1	38	38	22.2	50.8	44.5	19	28 25 28 28	M24	125.7	26	31.8
152.4 (6")	1 2 3 4	190.5	27.0	G1	42.9	22.2	45	45	25.4	57.2	57.2	22	44 31 44 38	M30	145.5	33	38.1
177.8 (7")	1 2 3 4	215.9	30.2	G1¼	46.0	25.4	50	48	25.4	69.9	69.9	24	54 28 54 44	M42	167.1	39	44.5
203.2 (8")	1 2 3 5	241.3	33.3	G1½	50.8	28.6	50	48	25.4	76.2	76.2	27	57 38 57 44	M42	190.5	39	44.5

All dimensions are in millimetres unless otherwise stated.

Parker Hannifin plc
Cylinder Division
Watford, Herts.



Style G
Side End Lug
(NFPA Style MS7)



lote 1

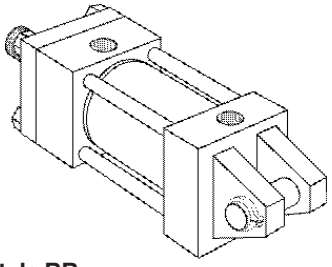
Notes
1 Consider the use of a thrust key with this mounting – see page 30
2 Tapped mounting holes are metric (coarse pitch series)
3 Upper surfaces of lugs are machined for socket head screws
4 Style C cylinders can be supplied with the cylinder ports arranged for mounting and sealing to a manifold surface – see page 31

Dimensions C, F & G Continued

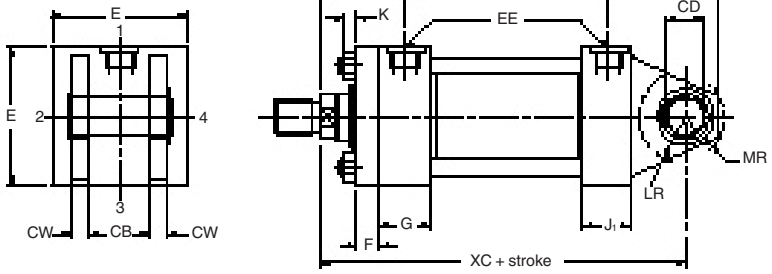
Bore Ø	Rod No.	SW	TN	TS	US	XS	XT	Y	+ Stroke							
									LB	P	SE	SN	SS	XE	ZB max	ZE
38.1 (1½")	1	9.5	18.0	82.6	101.6	34.9	50.8	49	127.0	75	171.5	73.0	98.4	165.1	152.4	174.6
	2					44.5	60.3	59						174.6	161.9	184.2
50.8 (2")	1	12.7	23.8	101.6	127.0	47.6	60.3	59	133.4	75	181.0	73.0	92.1	176.2	163.5	188.9
	2					54.0	66.7	65						182.6	169.9	195.3
63.5 (2½")	1	17.5	32.0	123.8	158.8	52.4	60.3	59	136.5	78	184.2	76.2	85.7	179.4	166.7	192.1
	2					65.1	73.0	71						192.1	179.4	204.8
	3					58.7	66.7	65						185.7	173.3	198.4
82.6 (3¼")	1	17.5	38.1	149.2	184.2	58.7	69.9	68	158.8	90	215.9	88.9	104.8	209.6	195.3	225.4
	2					68.3	79.4	79						219.1	204.8	235.0
	3					65.1	76.2	76						215.9	201.6	231.8
101.6 (4")	1	22.2	52.4	171.5	215.9	69.9	76.2	76	168.3	97	225.4	95.3	101.6	222.3	208.0	238.1
	2					79.4	85.7	86						231.8	217.5	247.7
	3					73.0	79.4	79						225.4	211.1	241.3
127.0 (5")	1	22.2	74.6	209.6	254.0	73.0	79.4	79	181.0	110	257.2	108.0	114.3	247.7	230.2	266.7
	2					79.4	85.7	86						254.0	236.5	273.1
	3					79.4	85.7	86						254.0	236.5	273.1
	4					79.4	85.7	86						254.0	236.5	273.1
152.4 (6")	1	28.6	84.1	247.7	304.8	85.7	88.9	86	212.7	130	298.5	130.2	130.2	287.3	266.7	309.6
	2															
	3															
	4															
177.8 (7")	1	34.9	90.0	285.8	355.6	92.1	96.8	92	241.3	146	333.4	149.2	146.1	319.1	298.5	344.5
	2															
	3															
	4															
203.2 (8")	1	34.9	105.0	311.2	381.0	92.1	100.0	94	266.7	168	368.3	168.3	171.5	349.3	325.4	377.8
	2															
	3															
	5															

All dimensions are in millimetres unless otherwise stated.

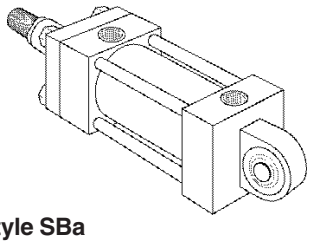
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Cylinder Division
Watford, Herts.



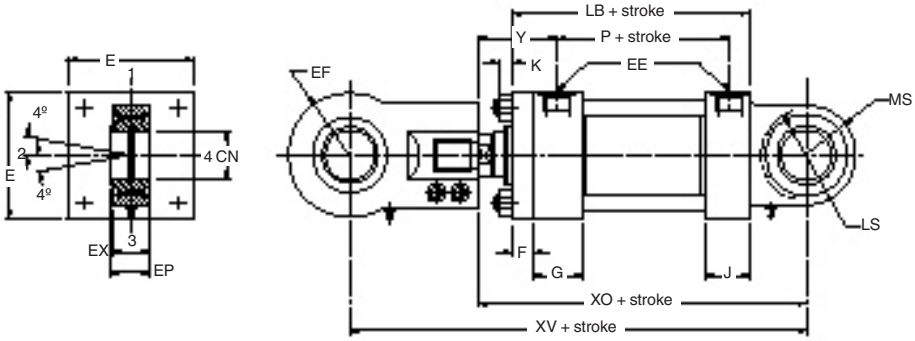
Style BB
Cap Fixed Clevis
(NFPA Style MP1)



See Note 1



Style SBa
Spherical Bearing
(ISO 6982 and CETOP RP88H)



See Notes 2, 3, 4, 5

Dimensions BB & SBa See also Dimensions, page 3 & Mounting Information, page 30

Bore Ø	Rod No.	CB	CD +0.00 -0.05	CN H7	CW	E	EE (BSPP)	EF max	EP	EX	F	G	J	J_1
38.1 (1½")	1 2	19.8	12.73	20	12.7	63.5	G½	25	20	18	9.5	44.5	38.1	42
50.8 (2")	1 2	32.5	19.08	25	15.9	76.2	G½	31	25	22	15.9	44.5	38.1	42
63.5 (2½")	1 2 3	32.5	19.08	32	15.9	88.9	G½	38	32	28	15.9	44.5	38.1	42
82.6 (3¼")	1 2 3	38.9	25.43	40	19.1	114.3	G¾	49	40	35	19.1	50.8	44.5	50
101.6 (4")	1 2 3	51.6	34.95	50	25.4	127.0	G¾	59	50	40	22.2	50.8	44.5	50
127.0 (5")	1 2 3 4	65.0	44.48	63	31.8	165.1	G¾	71	63	52	22.2	50.8	44.5	50
152.4 (6")	1 2 3 4	65.0	50.83	80	31.8	190.5	G1	90	80	60	25.4	57.2	57.2	61
177.8 (7")	1 2 3 4	77.8	63.53	–	38.1	215.9	G1¼	–	–	–	25.4	69.9	69.9	74
203.2 (8")	1 2 3 5	77.8	76.23	–	38.1	241.3	G1½	–	–	–	25.4	76.2	76.2	78

All dimensions are in millimetres unless otherwise stated.

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Cylinder Division
Watford, Herts.

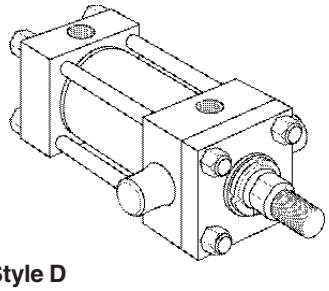
Notes
1 Supplied complete with pivot pin
2 Maximum pressure rating 160 bar
3 For matching pin sizes specify rod end Style 7, see pages 3 and 29
4 Pivot pin not supplied
5 For spherical bearing mountings on cylinders above 152.4mm (6") bore, please consult the factory

Dimensions BB & SBa Continued

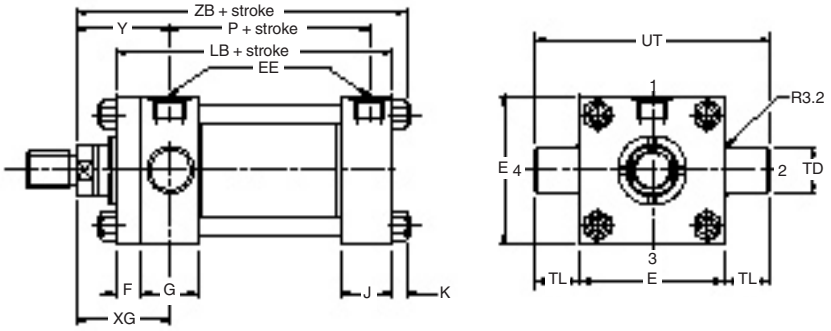
Bore Ø	Rod No.	K	LR	LS	MR	MS max	Y	+ Stroke					
								LB	P	XC	XO [5]	XV	ZC
38.1 (1½")	1	10	14.3	23	15.9	25	49	127.0	75	161.9	–	–	177.8
	2						59			171.5	182.5	234.5	187.4
50.8 (2")	1	13	25.4	26	23.8	31	59	133.4	75	184.2	182.5	247.5	208.0
	2						65			190.5	188.8	253.8	214.3
63.5 (2½")	1	13	23.8	32	23.8	38	59	136.5	78	187.3	–	–	211.1
	2						71			200.0	217.2	297.2	223.8
	3						65			193.7	210.8	290.8	217.5
82.6 (3¼")	1	16	31.8	41	30.2	50	68	158.8	90	219.1	–	–	249.3
	2						79			228.6	240.6	337.6	258.8
	3						76			225.4	237.4	334.4	255.6
101.6 (4")	1	16	44.5	50	41.3	61	76	168.3	97	247.7	–	–	289.0
	2						86			257.2	266.2	386.2	298.4
	3						79			250.8	259.9	379.9	292.1
127.0 (5")	1	19	52.4	62	54.0	71	79	181.0	110	266.7	–	–	320.7
	2						86			273.1	282.9	422.9	327.1
	3						86			273.1	282.9	422.9	327.1
	4						86			273.1	–	–	327.1
152.4 (6")	1	22	58.7	78	60.3	93	86	212.7	130	308.0	–	–	368.3
	2										358.3	538.3	
	3										–	–	
	4										358.3	538.3	
177.8 (7")	1	24	69.9	–	73.0	–	92	241.3	146	349.3	–	–	422.3
	2												
	3												
	4												
203.2 (8")	1	27	82.6	–	79.4	–	94	266.7	168	381.0	–	–	460.4
	2												
	3												
	5												

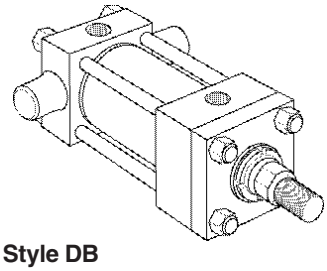
All dimensions are in millimetres unless otherwise stated.

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Watford, Herts.

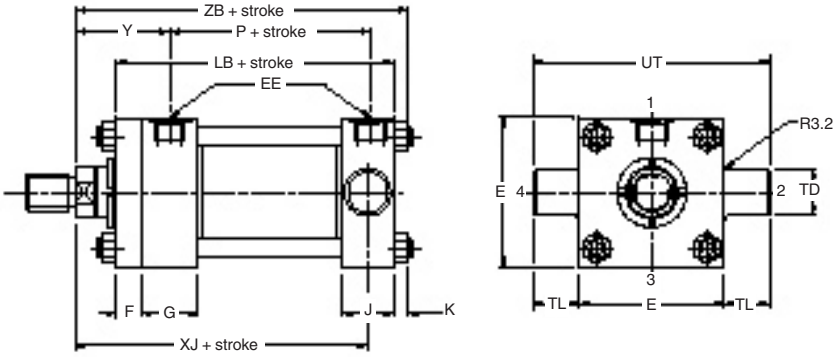


Style D
Head Trunnion
(NFPA Style MT1)





Style DB
Cap Trunnion
(NFPA Style MT2)

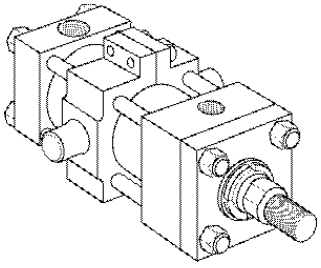


Dimensions D, DB & DD See also Dimensions, page 3 & Mounting Information, page 30

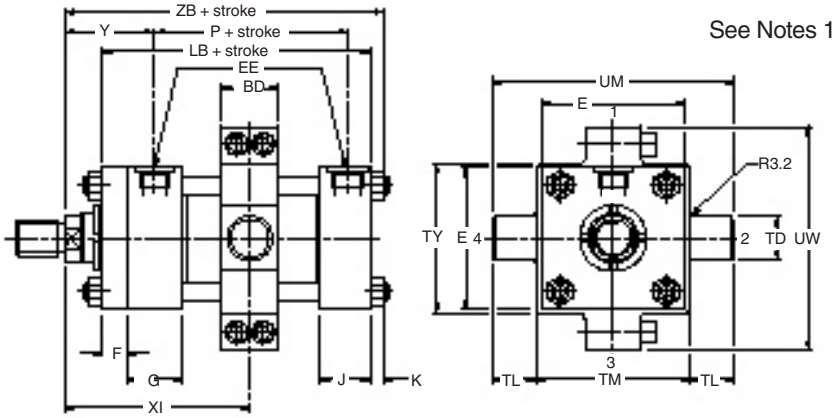
Bore Ø	Rod No.	BD	E	EE (BSPP)	F	G	J	K	TD +0.00 -0.03	TL	TM	TY
38.1 (1½")	1 2	31.8	63.5	G1½	9.5	44.5	38.1	10	25.40	25.4	76.2	69.9
50.8 (2")	1 2	38.1	76.2	G1½	15.9	44.5	38.1	13	34.93	34.9	88.9	82.6
63.5 (2½")	1 2 3	38.1	88.9	G1½	15.9	44.5	38.1	13	34.93	34.9	101.6	95.2
82.6 (3¼")	1 2 3	50.8	114.3	G3/4	19.1	50.8	44.5	16	44.45	44.5	127.0	120.7
101.6 (4")	1 2 3	50.8	127.0	G3/4	22.2	50.8	44.5	16	44.45	44.5	139.7	133.4
127.0 (5")	1 2 3 4	50.8	165.1	G3/4	22.2	50.8	44.5	19	44.45	44.5	177.8	171.5
152.4 (6")	1 2 3 4	76.2	190.5	G1	25.4	57.2	57.2	22	50.8	50.8	215.9	196.9
177.8 (7")	1 2 3 4	76.2	215.9	G1¼	25.4	69.9	69.9	24	63.5	63.5	247.7	222.3
203.2 (8")	1 2 3 5	88.9	241.3	G1½	25.4	76.2	76.2	27	76.2	76.2	279.4	247.7

All dimensions are in millimetres unless otherwise stated.

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Style DD
Intermediate Fixed Trunnion
(NFPA Style MT4)



See Notes 1, 2, 3

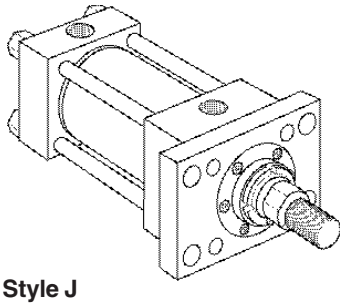
Notes
1 Note the minimum strokes from the table below
2 XI dimension to be specified by customer, note minimum dimension
3 A one-piece trunnion is fitted to 38.1mm (1½"), 50.8mm (2") and 63.5mm (2½") bore cylinders

Dimensions D, DB & DD Continued

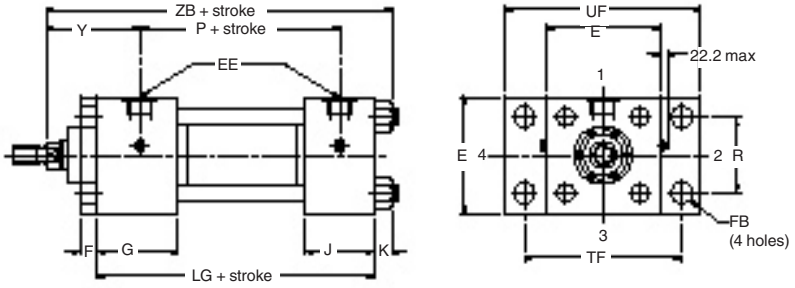
Bore Ø	Rod No.	UM	UT	UW [3]	XG	Min. [2] XI	Y	Style DD min stroke	+ Stroke			
									LB	P	XJ	ZB max
38.1 (1½")	1	127.0	114.3	–	47.6	85.7	49	0.0	127.0	75	123.8	152.4
	2				57.2	95.3	59				133.4	161.9
50.8 (2")	1	158.8	146.1	–	57.2	98.4	59	3.2	133.4	75	133.4	163.5
	2				63.5	104.8	65				139.7	169.9
63.5 (2½")	1	171.5	158.8	–	57.2	98.4	59	0.0	136.5	78	136.5	166.7
	2				69.9	111.1	71				149.2	179.4
	3				63.5	104.8	65				142.9	173.3
82.6 (3¼")	1	215.9	203.2	171.5	66.7	117.5	68	6.4	158.8	90	158.8	195.3
	2				76.2	127.0	79				168.3	204.8
	3				73.0	123.8	76				165.1	201.6
101.6 (4")	1	228.6	215.9	184.2	73.0	123.8	76	0.0	168.3	97	171.5	208.0
	2				82.6	133.4	86				181.0	217.5
	3				76.2	127.0	79				174.6	211.1
127.0 (5")	1	266.7	254.0	228.6	76.2	127.0	79	0.0	181.0	110	187.3	230.2
	2				82.6	133.4	86				193.7	236.5
	3				82.6	133.4	86				193.7	236.5
	4				82.6	133.4	86				193.7	236.5
152.4 (6")	1	317.5	292.1	260.4	85.7	152.4	86	3.2	212.7	130	212.7	266.7
	2											
	3											
	4											
177.8 (7")	1	374.7	342.9	292.1	92.1	165.1	92	0.0	241.3	146	238.1	298.5
	2											
	3											
	4											
203.2 (8")	1	431.8	393.7	323.9	95.3	177.8	94	0.0	266.7	168	260.4	325.4
	2											
	3											
	5											

All dimensions are in millimetres unless otherwise stated.

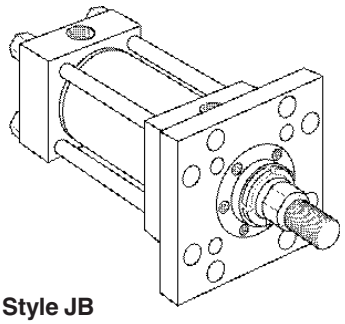
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Cylinder Division
Watford, Herts.



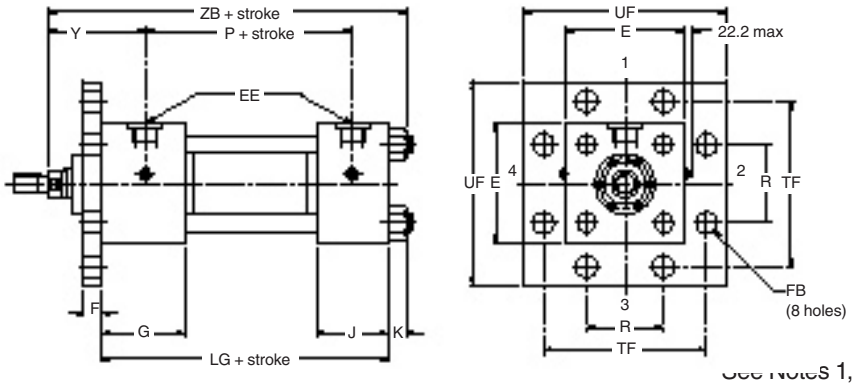
Style J
Head Rectangular Flange
(NFPA Style MF1)



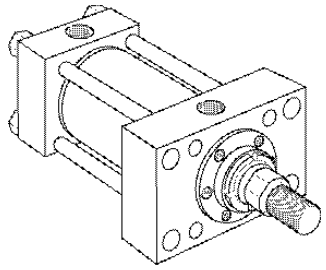
See Notes 1, 2, 3, 4



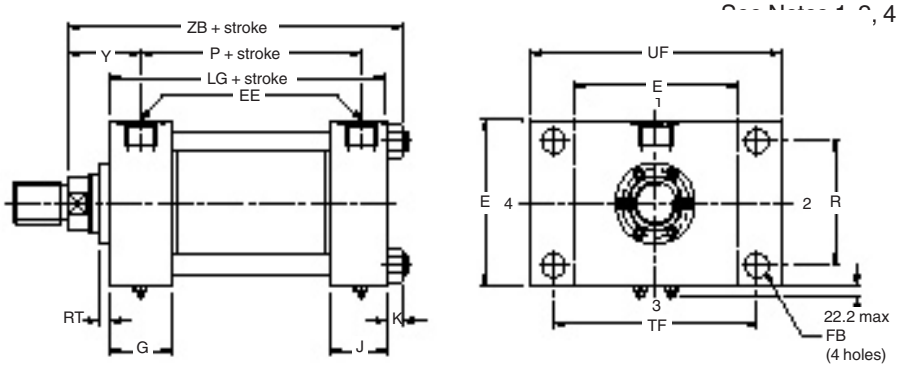
Style JB
Head Square Flange
(NFPA Style MF5)



See Notes 1, 2, 4



Style JJ
Rectangular Head
(NFPA Style ME5)



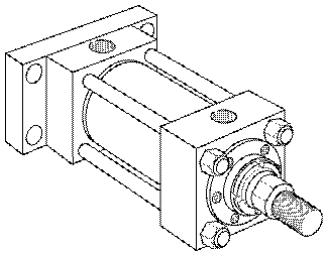
Dimensions J, JB & JJ See also Dimensions, page 42 & Mounting Information, page 30

Bore Ø	Rod No.	E	EE [4] (BSPP)	F	FB	G	J	K	R	RT	TF	UF	Y	+ Stroke		
														LG	P	ZB max
254.0 (10")	1	320.7	G2	42.9	46.0	93.7	93.7	39	244.3	25.4	403.2	482.6	120.7	308.0	215.9	422.3
	2									28.6			127.0			428.6
304.8 (12")	1	377.8	G2½	49.2	52.4	112.7	112.7	See note 2	290.8	33.3	469.9	558.8	136.5	368.3	257.2	449.3
	2									28.6			142.9			455.6

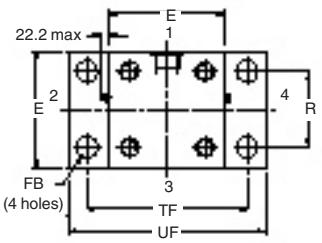
Notes
1 The dimensional drawings show 254mm (10") bore models fitted with four tie rods, but can also be used to determine dimensions for 304.8mm (12") bore models fitted with 16 tie rods – see page 7
2 Tie rod nuts are flush with cap on 304.8mm (12") cylinders
3 For maximum pressure ratings, see page 36
4 Flange ports to ISO 6162 are also available – see page 37

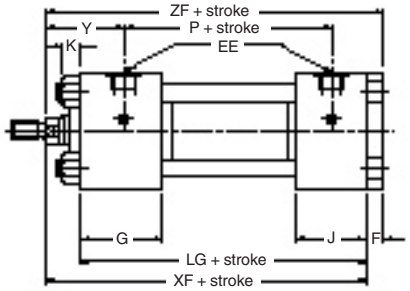
All dimensions are in millimetres unless otherwise stated.

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Watford, Herts.

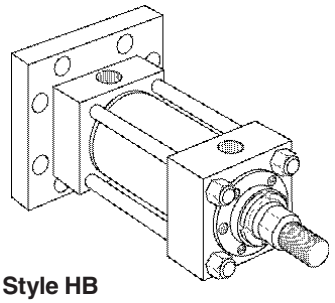


Style H
Cap Rectangular Flange
(NFPA Style MF2)

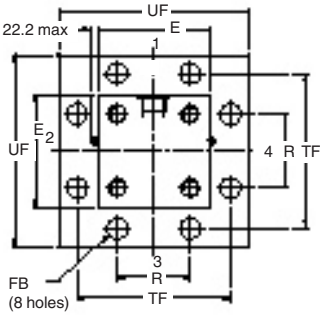


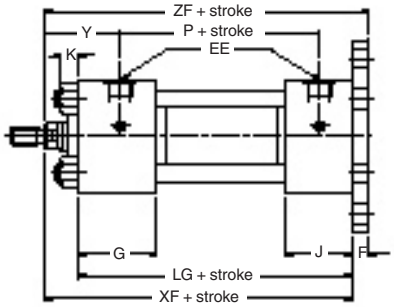


See Notes 1, 2, 3, 4

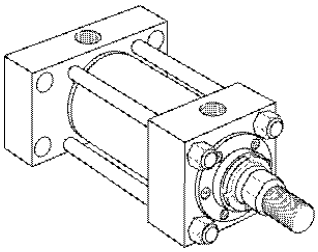


Style HB
Cap Square Flange
(NFPA Style MF6)

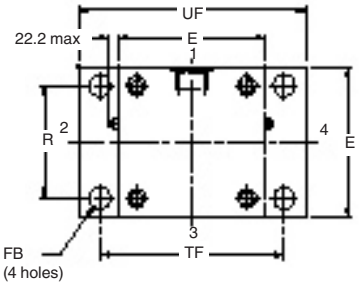


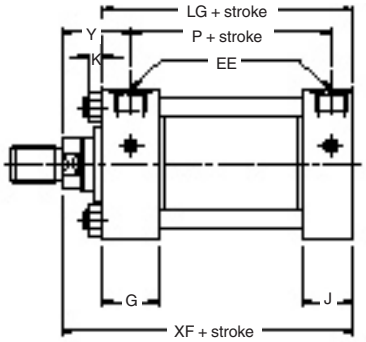


See Notes 1, 2, 4



Style HH
Rectangular Cap
(NFPA Style ME6)





See Notes 1, 2, 4

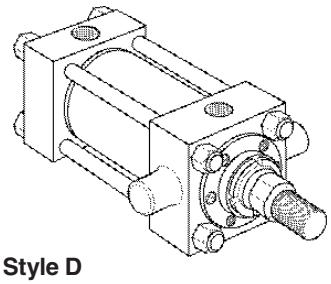
Dimensions H, HB & HH See also Dimensions, page 42 & Mounting Information, page 30

Bore Ø	Rod No.	E	EE [4] (BSPP)	F	FB	G	J	K	R	TF	UF	Y	+ Stroke			
													LG	P	XF	ZF
254.0 (10")	1	320.7	G2	42.9	46.0	93.7	93.7	39	244.3	403.2	482.6	120.7	308.0	215.9	382.6	425.5
	2											127.0			388.9	431.8
304.8 (12")	1	377.8	G2½	49.2	52.4	112.7	112.7	See note 2	290.8	469.9	558.8	136.5	368.3	257.2	449.3	498.5
	2											142.9			455.6	504.8

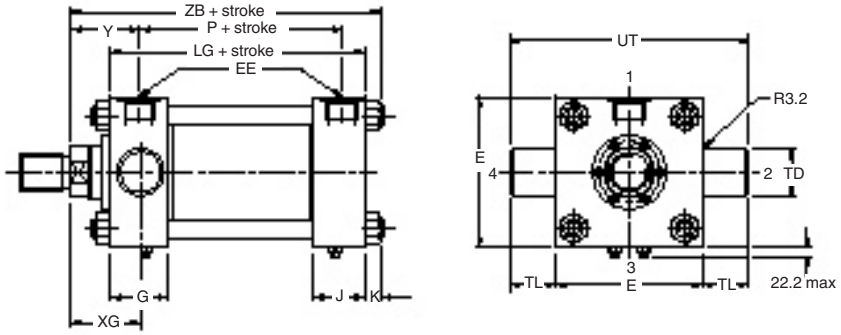
Notes
1 The dimensional drawings show 254mm (10") bore models fitted with four tie rods, but can also be used to determine dimensions for 304.8mm (12") bore models fitted with 16 tie rods – see page 7
2 Tie rod nuts are flush with head on 304.8mm (12") cylinders
3 For maximum pressure ratings, see page 36
4 Flange ports to ISO 6162 are also available – see page 37

All dimensions are in millimetres unless otherwise stated.

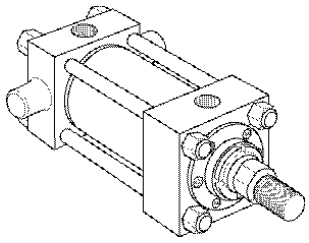
Parker Hannifin plc
Cylinder Division
Watford, Herts.



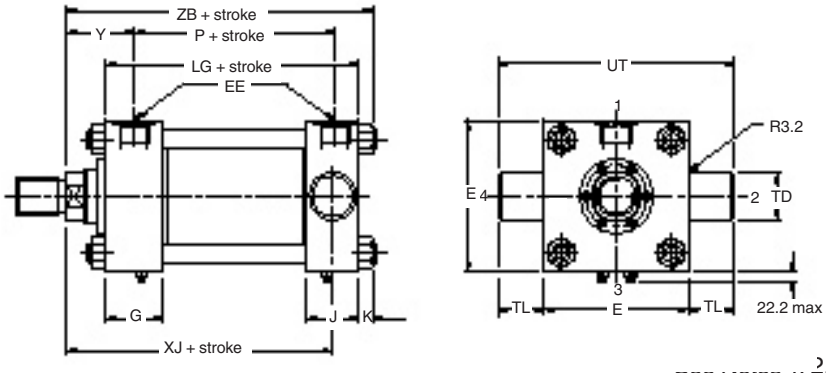
Style D
Head Trunnion
(NFPA Style MT1)



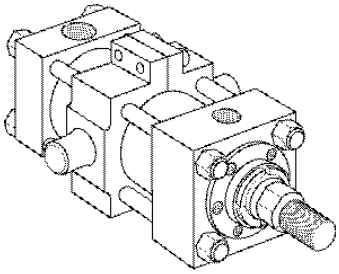
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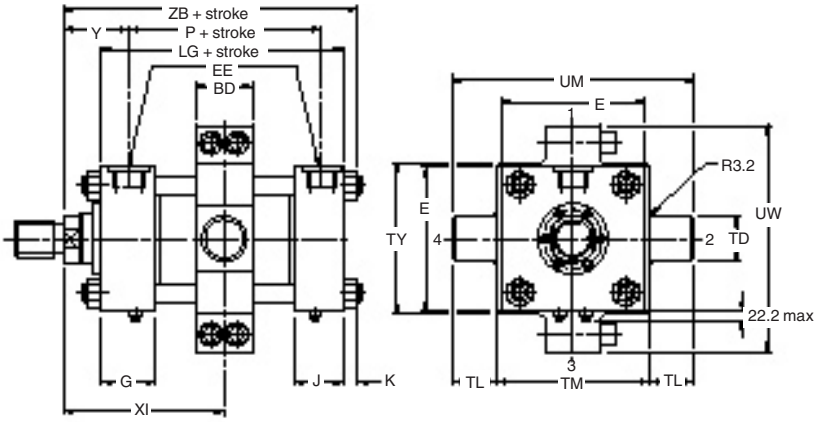
Style DB
Cap Trunnion
(NFPA Style MT2)



1, 2, 4



Style DD
Intermediate Fixed Trunnion
(NFPA Style MT4)



1

Dimensions D, DB, & DD See also Dimensions, page 42 & Mounting Information, page 30

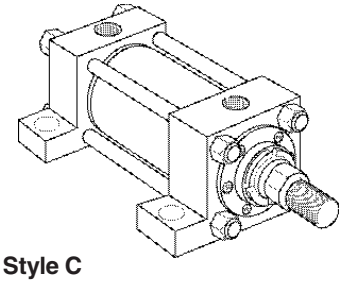
Bore Ø	Rod No.
254.0 (10")	1
	2
304.8 (12")	1
	2

BD	E	EE [4] (BSPP)	G & J	K	TD +0.000 -0.025	TL	TM	TY	UM	UT	UW	Min. [3] XI	XG & Y	+ Stroke			
														LG	P	XJ	ZB max
114.3	320.7	G2	93.7	39	88.9	88.9	355.6	330.2	533.4	498.5	444.5	225.4 231.8	120.7 127.0	308.0	215.9	336.6 342.9	421.6 427.9
139.7	377.8	G2 1/2	112.7	See note 2	101.6	101.6	419.1	393.7	622.3	581.0	527.1	263.5 269.9	136.5 142.9	368.3	257.2	393.7 400.0	449.3 455.6

Notes
1 The dimensional drawings show 254mm (10") bore models fitted with four tie rods, but can also be used to determine dimensions for 304.8mm (12") bore models fitted with 16 tie rods – see page 7
2 Tie rod nuts are flush with head and cap on 304.8mm (12") cylinders
3 Dimension XI to be specified by customer
4 Flange ports to ISO 6162 are also available – see page 37

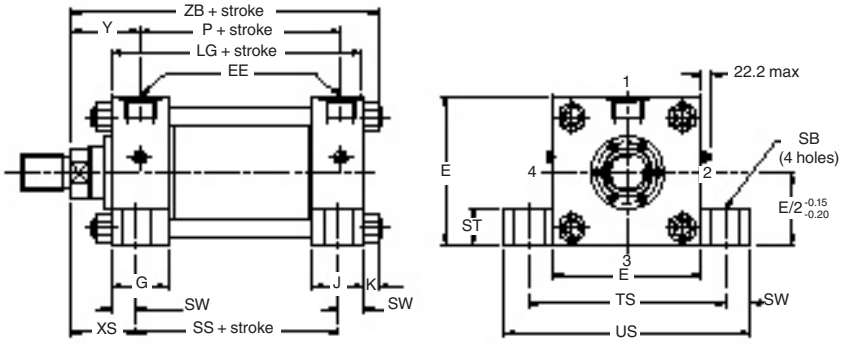
All dimensions are in millimetres unless otherwise stated.

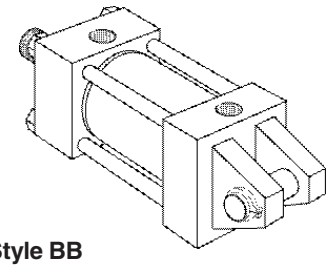
Parker Hannifin plc
Cylinder Division
Watford, Herts.



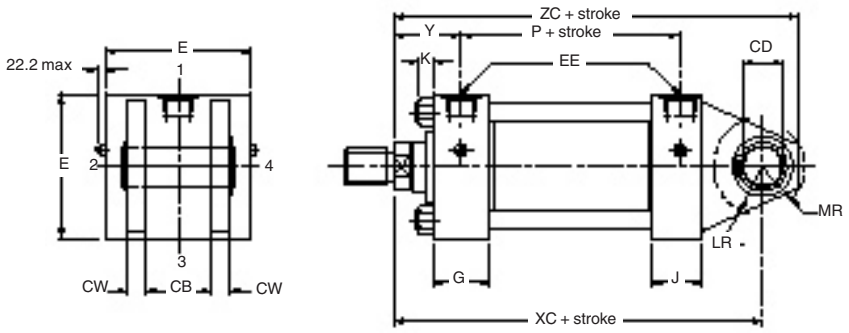
Style C
Side Lug
(NFPA Style MS2)

See Notes 1, 2, 3, 4





Style BB
Cap Fixed Clevis
(NFPA Style MP1)



See Notes 1, 2, 4, 5

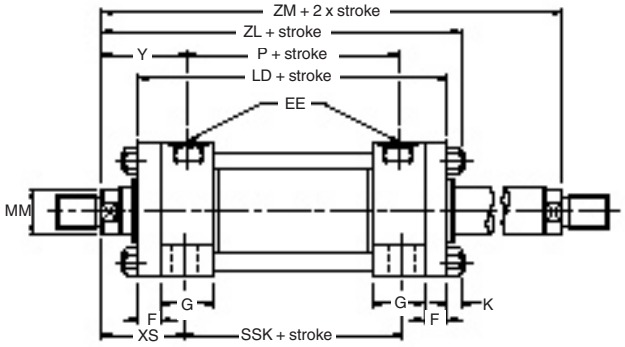
Dimensions C & BB See also Dimensions, page 42 & Mounting Information, page 30

Bore Ø	Rod No.	CB	CD +0.00 -0.08	CW	E	EE [4] (BSPP)	G & J	K	LR	MR	SB	ST	SW	TS	US	XS	Y	+ Stroke					
																		LG	P	SS	XC	ZB max	ZC
254.0 (10")	1	101.6	88.93	50.8	320.7	G2	93.7	39	98.4	90.0	39	57.2	41.3	403.2	485.8	115.9	120.7	308.0	215.9	225.4	483.4	421.6	573.1
	2															122.2	127.0				490.5	427.9	579.4
304.8 (12")	1	114.3	101.63	57.2	377.8	G2 1/2	112.7	See note 2	111.1	111.1	39	76.2	50.8	479.4	581.0	131.8	136.5	368.3	257.2	266.7	563.6	449.3	665.2
	2															138.1	142.9				569.9	455.6	671.5

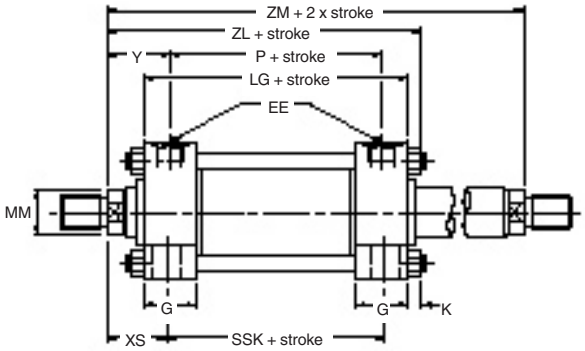
Notes
1 The dimensional drawings show 254mm (10") bore models fitted with four tie rods, but can also be used to determine dimensions for 304.8mm (12") bore models fitted with 16 tie rods – see page 7
2 Tie rod nuts are flush with head and cap on 304.8mm (12") cylinders
3 Style C cylinders can be supplied with the cylinder ports arranged for mounting and sealing to a manifold surface – see page 31
4 Flange ports to ISO 6162 are also available – see page 37
5 Supplied complete with pivot pin

All dimensions are in millimetres unless otherwise stated.

Parker Hannifin plc
Cylinder Division
Watford, Herts.



Double Rod Cylinder 38.1 to 203.2mm Bores Available with Styles TB, TD, J, JB, JJ, C, F, D, DD, and G



Double Rod Cylinders 254 and 304.8mm Bores Available with Styles J, JB, JJ, C, D, and DD

Mounting Styles and Codes
Double rod cylinders are denoted by a 'K' in the model code, shown on page 43.

Dimensions
To obtain dimensional information for double rod cylinders, first select the desired mounting style by referring to the corresponding single rod models shown on the preceding pages. Dimensions for the appropriate single rod model should be supplemented by those from the table opposite to provide a full set of dimensions.

Rod Strength
Double rod cylinders employ two separate piston rods, with one screwed into the end of the other within the piston rod assembly. As a result, one piston rod is stronger than the other. The stronger rod is identified by the letter 'K' stamped on its end, and its pressure limitations with a 4:1 design factor are identical to those shown in the table on page 36 for the equivalent single rod assembly. The weaker rod should always be used for the lighter duty. Pressure limitations for the weaker rod in pull applications at a 4:1 design factor are also identical to those on page 36, except for the bore sizes shown in the table below.

Bore Ø	Rod Diameter	4 : 1 Design Factor (bar)
63.5 (2½")	25.4 (1")	95
82.6 (3¼")	34.9 (1⅜")	115

Combination Rods
Double rod cylinders with stronger and weaker rods of differing rod sizes are also available. Please contact the factory for details.

Cushioning
Double rod cylinders can be supplied with cushions at either or both ends. Cushioning requirements should be specified by inserting a 'C' in the ordering code – see page 43. Double rod cylinders that require cushioning are supplied with floating cushion sleeves as standard.

Bore Ø	Rod No.	MM Rod Diameter
38.1 (1½")	1 2	15.9 (⅝") 25.4 (1")
50.8 (2")	1 2	25.4 (1") 34.9 (1⅜")
63.5 (2½")	1 2 3	25.4 (1") 44.5 (1¾") 34.9 (1⅜")
82.6 (3¼")	1 2 3	34.9 (1⅜") 50.8 (2") 44.5 (1¾")
101.6 (4")	1 2 3	44.5 (1¾") 63.5 (2½") 50.8 (2")
127.0 (5")	1 2 3 4	50.8 (2") 88.9 (3½") 63.5 (2½") 76.2 (3")
152.4 (6")	All	All
177.8 (7")	All	All
203.2 (8")	All	All
254.0 (10")	1	127.0 (5")
304.8 (12")	1	139.7 (5½")

+ Stroke					+ 2x Stroke
LD [1] LG [2]	ZL	SEK [3]	SNK [4]	SSK [5]	ZM
142.9	168.3 177.8	187.3	73.0	104.8	174.6 193.7
155.6	185.7 192.1	203.3	73.0	98.4	193.7 206.4
158.8	188.9 201.6 195.2	206.4	76.2	92.1	196.9 222.3 209.6
184.2	220.7 230.2 227.0	241.4	88.9	111.1	228.6 247.7 241.3
196.9	236.5 246.1 239.7	254.0	95.3	108.0	247.7 266.7 254.0
209.6	258.8 265.1 265.1 265.1	285.7	108.0	120.7	266.7 279.4 279.4 279.4
238.1	292.1	323.9	123.8	130.2	301.6
266.7	323.9	358.7	136.5	146.1	330.2
292.1	350.8	393.7	156.6	171.5	355.6
308.0	422.3	–	–	225.4	457.2
368.3	449.3	–	–	266.7	532.3

[1] Use LD dimensions for 38.1mm to 203.2mm (1½" to 8") bore sizes
[2] Use LG dimensions for 254.0mm & 304.8mm (10" & 12") bore sizes
[3] SEK dimensions apply to mounting style KG only
[4] SNK dimensions apply to mounting style KF only
[5] SSK dimensions apply to mounting style KC only

Style 9 Rod Ends
If a stroke of less than 25mm on bore sizes up to 82.6mm (3¼"), or a stroke of less than 100mm on bore sizes of 101.6mm (4") and over, is required, where Style 9 rod ends are required at both ends, please consult the factory.

All dimensions are in millimetres unless otherwise stated.

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Accessory Selection

Accessories for the rod end of a cylinder are selected by reference to the rod end thread, shown on pages 3 and 42, while the same accessories, when used at the cap end, are selected by cylinder bore size. See tables of part numbers below and on the following pages.

Pivot Pin Diameters

To obtain the same diameter of pivot pin at the rod end and cap end of a style BB clevis-mounted cylinder fitted with a rod clevis or plain rod eye, a no. 1 rod should be specified.
Pivot pins of the same diameter can be obtained at each end of a style SBa cylinder fitted with a rod end spherical bearing by specifying a style 7 rod end and nos. 2, 3 or 4 rods, as indicated in the table on page 3.

Load Capacity

The various accessories on these pages have been load rated for your convenience. The load capacity in kN is the recommended maximum load for that accessory based on a 4:1 factor of safety in tension. (Pivot pin is rated in shear). Before specifying, compare the actual load or the pull force at maximum operating pressure of the cylinder with the load capacity of the accessory you plan to use. If the load or pull force of the cylinder exceeds the load capacity of the accessory, please consult the factory.

Rod and Cap End Accessories

Accessories for the 2H cylinder comprise:

Rod End – rod clevis, eye bracket and pivot pin
– plain rod eye, clevis bracket and pivot pin
– rod eye with spherical bearing

Cap End – eye bracket for style BB mounting

Rod Clevis, Eye Bracket and Pivot Pin

Thread KK	Rod Clevis	Eye Bracket	Pivot Pin	Nominal Force kN	Mass kg
M10x1.5	50940G	69195	68368	18.3	0.7
M12x1.5	50941G	69195	68368	18.3	0.7
M20x1.5	50942G	96196	68369	46.8	2.3
M22x1.5	50943G	85361 [1]	68370	83.8	5.2
M26x1.5	50944G	85361 [1]	68370	91.0	5.1
M33x2	50945G	69198	68371	94.5	9.9
M39x2	50946G	85362 [1]	68372	203.3	19.5
M45x2	50947G	85363 [1]	68373	312.1	28.6
M48x2	50948G	85363 [1]	68373	312.1	28.5
M58x3	50949G	85364 [1]	68374	420.0	48.4
M64x2	50950G	85365 [1]	68375	420.0	54.9
M68x2	50951G	85365 [1]	68375	543.6	63.1
M76x2	50952G	73538	73545	256.0	104.8
M90x2	50953G	73539	73547	334.4	157.8
M100x2	50954G	73539	73547	334.4	156.6
M110x2	–	–	–	–	–

[1] Cylinder accessory dimensions conform to NFPA recommended standard, NFPA/T3.6.8.R1 - 1984

Rod Eye With Spherical Bearing

Thread KK	Part No.	Torque Load Nm	Mass kg
M16x1.5	145239	13	0.4
M20x1.5	145240	13	0.7
M27x2	145241	32	1.2
M33x2	145242	32	2.1
M42x2	145243	64	4.4
M48x2	145244	80	7.6
M64x2	145245	195	14.5

Plain Rod Eye, Clevis Bracket and Pivot Pin

Thread KK	Plain Rod Eye	Clevis Bracket	Pivot Pin	Nominal Force kN	Mass kg
M10x1.5	69089G	69205	68368	22.3	1.3
M12x1.5	69090G	69205	68368	25.4	1.3
M20x1.5	69091G	69206	68369	54.0	3.2
M22x1.5	69092G	69207	68370	58.0	6.6
M26x1.5	69093G	69207	68370	85.6	6.6
M33x2	69094G	69208	68371	149.4	12.7
M39x2	69095G	69209	68372	151.6	23.4
M45x2	69096G	69210	69215	147.2	41.1
M48x2	69097G	69210	69215	147.2	41.5
M58x3	69098G	69211	68374	155.6	51.2
M64x2	69099G	69212	68375	150.7	65.2
M68x2	69100G	69213	69216	164.6	69.5
M76x2	73536G	73542	73545	372.3	126.7
M90x2	73437G	73542	73545	372.3	124.0
M100x2	73438G	73543	82181	457.5	180.7
M110x2	73439G	73544	73547	483.4	173.5

Cap End Eye Bracket for Style BB Cylinders

Bore Ø	Eye Bracket Part No.	Nominal Force kN	Mass kg
38.1 (1 1/2")	69195	18.3	0.4
50.8 (2")	69196	46.8	1.5
63.5 (2 1/2")	69196	46.8	1.5
82.6 (3 1/4")	85361 [1]	91.0	3.4
101.6 (4")	69198	94.5	5.6
127.0 (5")	85362 [1]	220.6	11.1
152.4 (6")	85363 [1]	312.1	17.0
177.8 (7")	85364 [1]	420.0	27.4
203.2 (8")	85365 [1]	543.6	35.8
254.0 (10")	73538	256.0	55.6
304.8 (12")	73539	334.4	84.3

All dimensions are in millimetres unless otherwise stated.

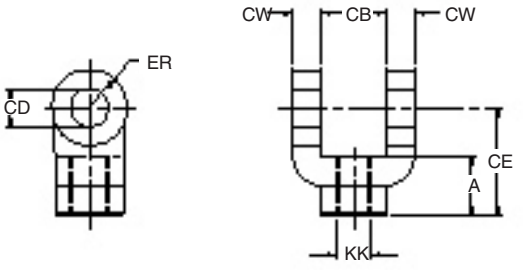
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Rod Clevis, Eye Bracket and Pivot Pin

Rod Clevis Dimensions

Part No.	A	CB	$CD^{+0.10}_{+0.05}$	CE	CW	ER	KK	Nominal Force kN	Mass kg
50940G	19.1	19.8	12.70	38.1	12.7	12.7	M10x1.5	18.9	0.2
50941G	19.1	19.8	12.70	38.1	12.7	12.7	M12x1.5	21.9	0.2
50942G	28.6	32.6	19.05	54.0	15.9	19.1	M20x1.5	49.9	0.6
50943G	41.3	38.9	25.40	74.6	19.1	25.4	M22x1.5	83.8	1.3
50944G	41.3	38.9	25.40	74.6	19.1	25.4	M26x1.5	96.7	1.3
50945G	50.8	51.6	34.93	95.3	25.4	34.9	M33x2	149.4	3.1
50946G	57.2	64.7	44.45	114.3	31.8	44.5	M39x2	203.3	6.0
50947G	76.2	64.7	50.80	139.7	31.8	50.8	M45x2	317.9	8.4
50948G	76.2	64.7	50.80	139.7	31.8	50.8	M48x2	341.6	8.3
50949G	88.9	77.4	63.50	165.1	38.1	63.5	M58x2	480.2	15.1
50950G	88.9	77.4	76.20	171.5	38.1	69.9	M64x2	535.1	19.0
50951G	88.9	77.4	76.20	171.5	38.1	69.9	M68x2	589.9	18.7
50952G	88.9	102.8	88.90	196.9	50.8	88.9	M76x2	1048.8	34.1
50953G	101.6	116.0	101.60	223.8	57.2	101.6	M90x2	1292.2	49.8
50954G	101.6	116.0	101.60	223.8	57.2	101.6	M100x2	1480.0	48.6

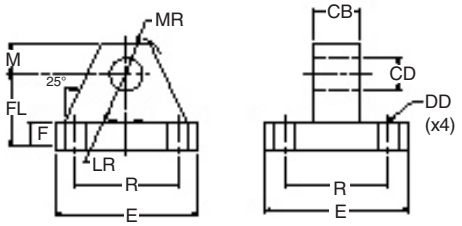
Rod Clevis (Female Clevis)



Eye Bracket Dimensions

Part No.	CB	$CD^{+0.10}_{+0.05}$	DD	E	F	FL	LR	M	MR	R	Nominal Force kN	Mass kg
69195	19.1	12.70	10.3	63.5	9.5	28.6	19.1	12.7	14.3	41.4	18.3	0.4
69196	31.8	19.05	13.5	88.9	15.9	47.6	31.8	19.1	22.2	64.8	46.8	1.5
85361 [1]	38.1	25.40	16.7	114.3	22.2	60.3	38.1	25.4	31.8	82.6	91.0	3.4
69198	50.8	34.93	16.7	127.0	22.2	76.2	54.0	34.9	41.3	97.0	94.5	5.6
85362 [1]	63.5	44.45	23.0	165.1	28.6	85.7	57.2	44.5	54.0	125.7	220.6	11.1
85363 [1]	63.5	50.80	27.0	190.5	38.1	101.6	63.5	50.8	61.9	145.5	312.1	17.0
85364 [1]	76.2	63.50	30.2	215.9	44.5	120.6	76.2	63.5	76.2	167.1	420.0	27.4
85365 [1]	76.2	76.20	33.3	241.3	50.8	133.3	82.6	69.9	82.6	190.5	543.6	35.8
73538	101.6	88.90	46.0	320.7	42.9	114.5	101.6	88.9	95.3	244.3	256.0	55.6
73539	114.3	101.60	52.4	377.8	49.2	163.5	114.3	101.6	108.0	290.8	334.4	84.3

Eye Bracket



[1] Cylinder accessory dimensions conform to NFPA recommended standard, NFPA/T3.6.8.R1 - 1984

Pivot Pin for Clevis Bracket & Eye Bracket

Part No.	$CD^{+0.00}_{-0.05}$	$CL^{+0.0}_{-0.5}$	G	Nominal Force kN	Mass kg
68368	12.73	46.3	56	38.4	0.1
68369	19.08	65.4	75	86.1	0.2
68370	25.43	77.9	88	152.9	0.5
68371	34.95	103.4	115	289.8	1.2
68372	44.48	128.8	143	469.1	2.4
68373	50.83	129.7	145	612.7	3.2
69215	50.83	141.4	158	612.7	3.5
68374	63.53	155.1	171	957.4	5.9
68375	76.23	154.7	173	1378.7	8.6
69216	76.23	167.7	185	1378.7	9.2
73545	88.93	205.7	225	1876.8	15.2
82181	101.63	220.3	254	2522.9	22.4
73547	101.63	231.7	266.7	2522.9	23.5

Pivot Pin for Clevis Bracket & Eye Bracket



All dimensions are in millimetres unless otherwise stated.

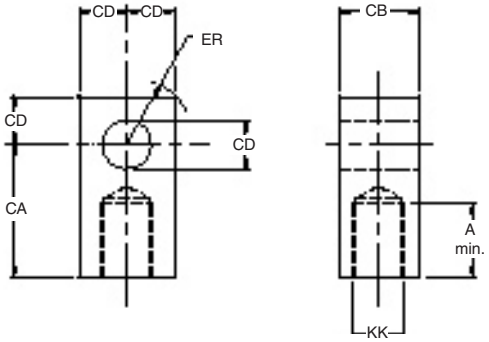
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Plain Rod Eye, Clevis Bracket and Pivot Pin

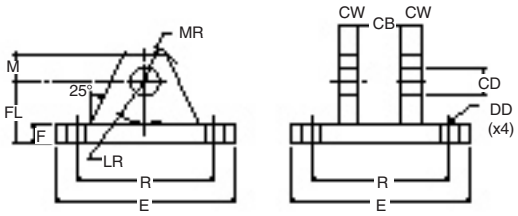
Plain Rod Eye Dimensions

Part No.	A min.	CA	CB	CD	ER	KK	Nominal Force kN	Mass kg
69089G	19.1	38.1	19.1	12.70	18.3	M10x1.5	22.3	0.2
69090G	19.1	38.1	19.1	12.70	18.3	M12x1.5	25.4	0.2
69091G	28.6	52.4	31.8	19.05	27.0	M20x1.5	54.0	0.5
69092G	28.6	60.3	38.1	25.40	36.5	M22x1.5	58.0	1.1
69093G	41.3	71.4	38.1	25.40	36.5	M26x1.5	96.8	1.1
69094G	50.8	87.3	50.8	34.93	50.0	M33x2	149.4	2.6
69095G	57.2	101.6	63.5	44.45	63.5	M39x2	200.6	5.1
69096G	57.2	111.1	63.5	50.80	72.2	M45x2	238.6	6.4
69097G	76.2	127.0	63.5	50.80	72.2	M48x2	334.4	6.8
69098G	88.9	147.6	76.2	63.50	90.5	M58x2	440.1	12.1
69099G	88.9	155.6	76.2	76.20	108.0	M64x2	490.5	16.0
69100G	92.1	165.1	88.9	76.20	108.0	M68x2	549.8	19.6
73536G	101.6	193.7	101.6	88.90	126.2	M76x2	719.3	31.1
73437G	127.0	193.7	101.6	88.90	126.2	M90x2	969.0	28.4
73438G	139.7	231.8	114.3	101.60	144.5	M100x2	1220.9	42.5
73439G	139.7	231.8	127.0	101.60	144.5	M110x2	1375.6	48.4

Plain Rod Eye



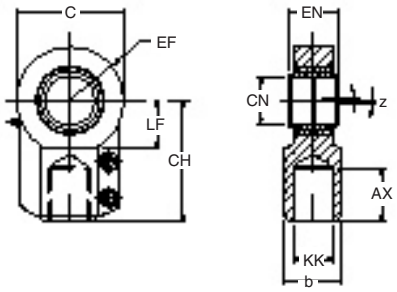
Clevis Bracket



Clevis Bracket Dimensions

Part No.	CB	$CD^{+0.10}_{+0.05}$	CW	DD	E	F	FL	LR	M	MR	R	Nominal Force kN	Mass kg
69205	19.8	12.70	12.7	10.3	88.9	12.7	38.1	19.1	12.7	15.9	64.8	32.6	1.0
69206	32.6	19.05	15.9	13.5	127.0	15.9	47.6	30.2	19.1	23.0	97.0	62.4	2.5
69207	38.9	25.40	19.1	16.7	165.1	19.1	57.2	38.1	25.4	31.8	125.7	85.6	5.0
69208	51.6	34.93	25.4	16.7	190.5	22.2	76.2	50.8	34.9	42.1	145.5	164.6	8.8
69209	64.7	44.45	31.8	23.0	241.3	22.2	92.1	69.9	44.5	56.4	190.5	151.6	15.9
69210	64.7	50.80	38.1	27.0	323.9	25.4	108.0	81.0	57.2	70.6	238.8	147.2	31.2
69211	77.4	63.50	38.1	30.2	323.9	25.4	114.3	88.9	63.5	79.4	238.8	155.6	33.2
69212	77.4	76.20	38.1	33.3	323.9	25.4	152.4	108.0	76.2	91.3	238.8	150.7	40.7
69213	90.1	76.20	38.1	33.3	323.9	25.4	152.4	108.0	76.2	91.3	238.8	164.6	40.7
73542	102.8	88.90	50.8	46.0	393.7	42.9	169.9	127.0	88.9	104.8	304.8	372.3	80.4
73543	116.0	101.60	50.8	52.4	444.5	49.2	195.3	146.1	101.6	123.8	349.3	457.5	115.8
73544	128.2	101.60	50.8	52.4	444.5	49.2	195.3	146.1	101.6	123.8	349.3	483.4	101.6

Rod Eye with Spherical Bearing – ISO 6982



Rod Eye with Spherical Bearing Dimensions - ISO 6982

Part No.	AX min.	b	C max.	CH	CN H7	EF max.	EN h12	KK (Style 7)	LF	Z	Clamp screw torque (Nm)	Mass kg
145239	23	25	50	52	20	25	20	M16x1.5	22		13	0.4
145240	29	30	62	65	25	32	25	M20x1.5	27		13	0.7
145241	37	38	76	80	32	40	32	M27x2	32		32	1.2
145242	46	47	97	97	40	50	40	M33x2	41	4°	32	2.1
145243	57	58	118	120	50	63	50	M42x2	50		64	4.4
145244	64	70	142	140	63	71	63	M48x2	62		80	7.6
145245	86	90	180	180	80	90	80	M64x3	78		195	

All dimensions are in millimetres unless otherwise stated.

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Mounting Styles
General guidance for the selection of mounting styles is given on page 9. The notes which follow provide information for use in specific applications and should be read in conjunction with the information given on page 9.

Extended Tie Rods
The standard tie rod extension for cylinders with mounting styles TB, TC and TD is shown as BB in dimension tables. Longer or shorter extensions can be supplied.

Cylinders with extended tie rod mountings TB and TC are supplied with an additional set of mounting nuts of the appropriate grade for securing the cylinder to the machine member. For style TD, tie rods extended both ends, two additional sets of mounting nuts are supplied.

Cylinders may be ordered with extended tie rods in addition to another mounting style. The extended tie rods may then be used for mounting other systems or machine components.

Flange Mounted Cylinders
The diameter of the rod gland extension (B) at the head end can be used as a pilot to locate the cylinders in relation to the machine. After alignment has been obtained, the flanges may be drilled for pins or dowels to prevent shifting.

Pivot Mountings
Pivot pins are supplied with style BB cap fixed clevis mounted cylinders. Pivot pins are not supplied with the spherical bearing mounting, style SBa, as the pin length will be determined by the customer's equipment.

Spherical Bearing
The life of the spherical bearings is influenced by many factors such as specific load, direction of load, angle of oscillation, and type and frequency of lubrication. The bearings are designed to give an acceptable life under normal operating conditions and, if unusual operating conditions exist, you should consult the factory. The maximum pressure rating for spherical bearing cylinders is 160 bar.

Spherical Bearing Mountings
Where a spherical bearing mounting, style SBa, is specified for the cylinder, a rod eye with spherical bearing should be used at the rod end. A Style 7 rod end should be specified if the same diameter of pivot pin is required at both ends of the cylinder.

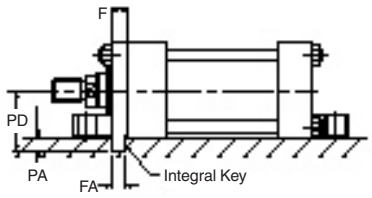
Trunnion Mounted Cylinders
Trunnions require lubricated pillow blocks with minimum bearing clearances. Blocks should be aligned and mounted to eliminate bending moments on the trunnion pins. Self-aligning mounts must not be used to support the trunnions as bending forces can be set up.

An intermediate fixed trunnion mounting can be positioned to balance the weight of the cylinder, or it can be located at any point between the head or cap to suit the application. The position of the trunnion is fixed during manufacture and its location must be specified at the time of order.

Foot Mounted Cylinders
Foot mounted cylinders should not be pinned or keyed at both ends. Changes in temperature and pressure under normal operating conditions cause the cylinder to increase (or decrease) from its installed length and it therefore must be free to expand and contract. It must not be pinned or keyed at both ends as advantages of cylinder elasticity in absorbing high shock loads would be lost.

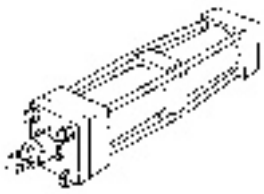
Foot Mountings and Thrust Keys
The turning moment which results from the application of force by a foot mounted cylinder must be resisted by secure mounting and effective guidance of the load. A thrust key modification is recommended to provide positive cylinder location.

Thrust key mountings eliminate the need for fitted bolts or external keys on Styles C, F and G side mounted cylinders. The gland retainer plate is extended below the nominal mounting surface to fit into a keyway milled into the mounting surface of the machine member. See 'Mounting Modifications' in the order code, page 43.



Bore Ø	F Nom.	FA +0.0 -0.075	PA +0.0 -0.2	PD
38.1 (1½")	9.5	8	4.9	36.5
50.8 (2")	15.9	14	8.0	46.0
63.5 (2½")	15.9	14	8.1	52.4
82.6 (3¼")	19.1	18	9.7	66.7
101.6 (4")	22.2	22	11.2	74.6
127.0 (5")	22.2	22	11.2	93.7
152.4 (6")	25.4	25	12.7	108.0
177.8 (7")	25.4	25	12.7	120.7
203.2 (8")	25.4	25	12.7	133.4

Tie Rod Supports
To increase the resistance to buckling of long stroke cylinders, tie rod supports may be fitted. These move the tie rods radially outwards and allow longer than normal strokes to be used without the need for an additional mounting.



Bore Ø	Stroke (metres)												Number of supports req'd.
	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2	
38.1	–	–	1	1	1	2	2	2	3	3	3	4	
50.8	–	–	–	1	1	1	1	2	2	2	2	3	
63.5	–	–	–	–	–	1	1	1	1	1	2	2	
82.6	–	–	–	–	–	–	–	1	1	1	1	1	
101.6	–	–	–	–	–	–	–	–	–	1	1	1	

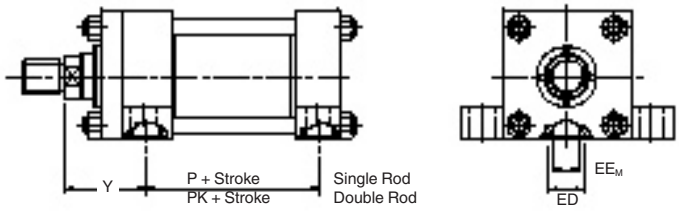
Bore sizes above 101.6mm (4") do not require tie rod supports.

All dimensions are in millimetres unless otherwise stated.

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Manifold Ports

Side mounted cylinders (Style C) can be supplied with the cylinder ports arranged for mounting and sealing to a manifold surface. The ports are drilled and counterbored for O-ring seals which are provided. With these specifications, the mounting is designated Style CM. Please consult the factory.



Bore Ø	Rod No.	Y ±0.8	P ±0.8	PK ±0.8	EE$_M$	ED	Parker O-ring No.
38.1 (1½")	1	50.8	73.0	73.0	19.1	28.6	2-212
	2	60.3					
50.8 (2")	1	60.3	73.0	73.0	19.1	28.6	2-212
	2	66.7					
63.5 (2½")	1	60.3	76.2	76.2	19.1	28.6	2-212
	2	73.0					
	3	66.7					
82.6 (3¼")	1	69.9	88.9	88.9	25.4	34.9	2-216
	2	79.4					
	3	76.2					
101.6 (4")	1	72.2	101.6	103.2	25.4	34.9	2-216
	2	81.8					
	3	75.4					
127.0 (5")	1	79.4	108.0	108.0	25.4	34.9	2-216
	2	85.7					
	3	85.7					
	4	85.7					
152.4 (6")	All	88.9	130.2	123.8	31.8	41.3	2-220
177.8 (7")	All	96.8	149.2	136.5	38.1	47.6	2-223
203.2 (8")	All	100.0	168.3	155.6	38.1	47.6	2-223
254.0 (10")	1	120.7	215.9	215.9	50.8	60.3	010404-0224
	2	127.0					
304.8 (12")	1	136.5	257.2	257.2	63.5	73.0	010404-0256
	2	142.9					

Stroke Tolerances

Stroke length tolerances are required due to the build-up of tolerances of piston, head, cap and cylinder body. Standard production stroke tolerances are -0.4 to +0.8mm on all bore sizes and stroke lengths. For closer tolerances, please specify the required tolerance plus the operating temperature and pressure. Stroke tolerances of less than 0.4mm are generally impracticable due to the elasticity of cylinders and, in these cases, the use of a stroke limiter should be considered – see page 39.

Mounting Bolts

Parker recommends that mounting bolts with a minimum strength of ISO 898/1 grade 10.9 should be used for fixing cylinders to the machine or base. This recommendation is of particular importance where bolts are placed in tension or subjected to shear forces. Mounting bolts should be torque loaded to their manufacturer's recommended figures.

Tie Rod Nuts

Tie rod mounting nuts, with lubricated threads, should be to a minimum strength of ISO 898/2 grade 10, torque loaded to the figures shown.

Bore Ø	Tie Rod Nut Torque Nm min-max
38.1 (1½")	25-27
50.8 (2")	60-65
63.5 (2½")	
82.6 (3¼")	160-165
101.6 (4")	175-180
127.0 (5")	420-425
152.4 (6")	715-735
177.8 (7")	1080-1100
203.2 (8")	1560-1580
254.0 (10")	3390-3410
304.8 (12")	715-735

All dimensions are in millimetres unless otherwise stated.

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Calculation of Cylinder Diameter

Given that the force and operating pressure of the system are known, and that a piston rod size has been estimated taking account of whether the rod is in tension (pull) or compression (push), then the cylinder bore can be selected.

If the piston rod is in compression, use the 'Push Force' table below, as follows:

1. Identify the operating pressure closest to that required.
2. In the same column, identify the force required to move the load (always rounding up).
3. In the same row, look along to the cylinder bore required.

If the cylinder envelope dimensions are too large for the application, increase the operating pressure, if possible, and repeat the exercise.

If the piston rod is in tension, use the 'Deduction for Pull Force' table. The procedure is the same but, due to the reduced area caused by the piston rod, the force available on the 'pull' stroke will be smaller. To determine the pull force:

1. Follow the procedure for 'push' applications as described above.
2. Using the 'pull' table, identify the force indicated according to the rod and pressure selected.
3. Deduct this from the original 'push' force. The resultant is the net force available to move the load.

If this force is not large enough, go through the process again but increase the system operating pressure or cylinder diameter if possible. If in doubt, our design engineers will be pleased to assist.

Push Force

Bore Ø	Piston Area mm²	Cylinder Push Force in kN						Displacement per 10mm stroke Litres
		5 bar	10 bar	25 bar	70 bar	100 bar	210 bar	
38.1 (1½")	1140	0.6	1.1	2.9	8.0	11.4	24.0	0.0114
50.8 (2")	2020	1.0	2.0	5.0	14.1	20.2	42.5	0.0202
63.5 (2½")	3170	1.6	3.2	7.9	22.2	31.7	66.6	0.0317
82.6 (3¼")	5360	2.7	5.4	13.4	37.5	53.5	113	0.0535
101.6 (4")	8110	4.0	8.1	20.3	56.8	81.1	170	0.0811
127.0 (5")	12670	6.4	12.7	31.6	88.5	126	266	0.1267
152.4 (6")	18240	9.1	18.3	45.5	127	182	383	0.1827
177.8 (7")	24830	12.4	24.9	62.2	174	248	523	0.2486
203.2 (8")	32430	16.2	32.5	81.1	227	324	682	0.3246
254.0 (10")	50670	25.4	50.6	127	354	506	1065	0.5073
304.8 (12")	72970	36.5	73.0	182	510	730	1532	0.7294

Deduction for Pull Force

Piston Rod Ø	Piston Rod Area mm²	Piston Rod Force in kN						Displacement per 10mm stroke Litres
		5 bar	10 bar	25 bar	70 bar	100 bar	210 bar	
15.9 (⅝")	200	0.1	0.2	0.5	1.4	2.0	4.2	0.0020
25.4 (1")	500	0.3	0.5	1.3	3.5	5.0	10.5	0.0050
34.9 (1⅜")	960	0.5	1.0	2.4	6.8	9.6	20.2	0.0097
44.5 (1¾")	1560	0.8	1.6	3.9	10.9	15.6	32.8	0.0156
50.8 (2")	2020	1.0	2.0	5.0	14.1	20.2	42.5	0.0202
63.5 (2½")	3170	1.6	3.2	7.9	22.2	31.7	66.6	0.0317
76.2 (3")	4560	2.3	4.6	11.4	32.0	45.6	95.8	0.0456
88.9 (3½")	6210	3.1	6.2	15.5	43.4	62.0	130	0.0621
101.6 (4")	8110	4.0	8.1	20.3	56.8	81.1	171	0.0811
127.0 (5")	12670	6.4	12.7	31.6	88.7	127	266	0.1267
139.7 (5½")	15330	7.7	15.3	38.4	107	153	322	0.1523
177.8 (7")	24830	12.4	24.9	62.2	174	249	523	0.2486
215.8 (8½")	36610	18.3	36.6	91.5	257	366	769	0.3663

All dimensions are in millimetres unless otherwise stated.

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Piston Rod Size Selection

The selection of a piston rod for thrust (push) conditions requires the following steps to be carried out:

1. Determine the type of cylinder mounting style and rod end connection to be used. Consult the Stroke Factor table on page 34 and determine which factor corresponds to the application.

2. Using the appropriate stroke factor from page 34, determine the 'basic length' from the equation:

   Basic Length = Net Stroke x Stroke Factor

   (The graph is prepared for standard rod extensions beyond the face of the gland retainers. For rod extensions greater than standard, add the increases to the net stroke to arrive at the 'basic length'.)

3. Calculate the load imposed for the thrust application by multiplying the full bore area of the cylinder by the system pressure, or by referring to the Push and Pull Force charts on page 32.

4. Using the graph below, look along the values of 'basic length' and 'thrust' as found in 2 and 3 above, and note the point of intersection.

Note: When considering the use of long stroke cylinders, the piston rod should be of sufficient diameter to provide the necessary column strength.

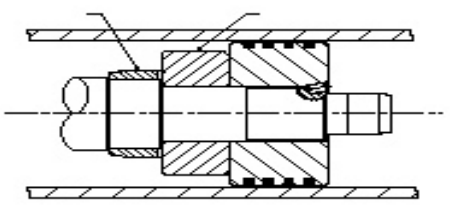
The correct piston rod size is read from the diagonally curved line labelled 'Rod Diameter' above the point of intersection.

Stop Tubes

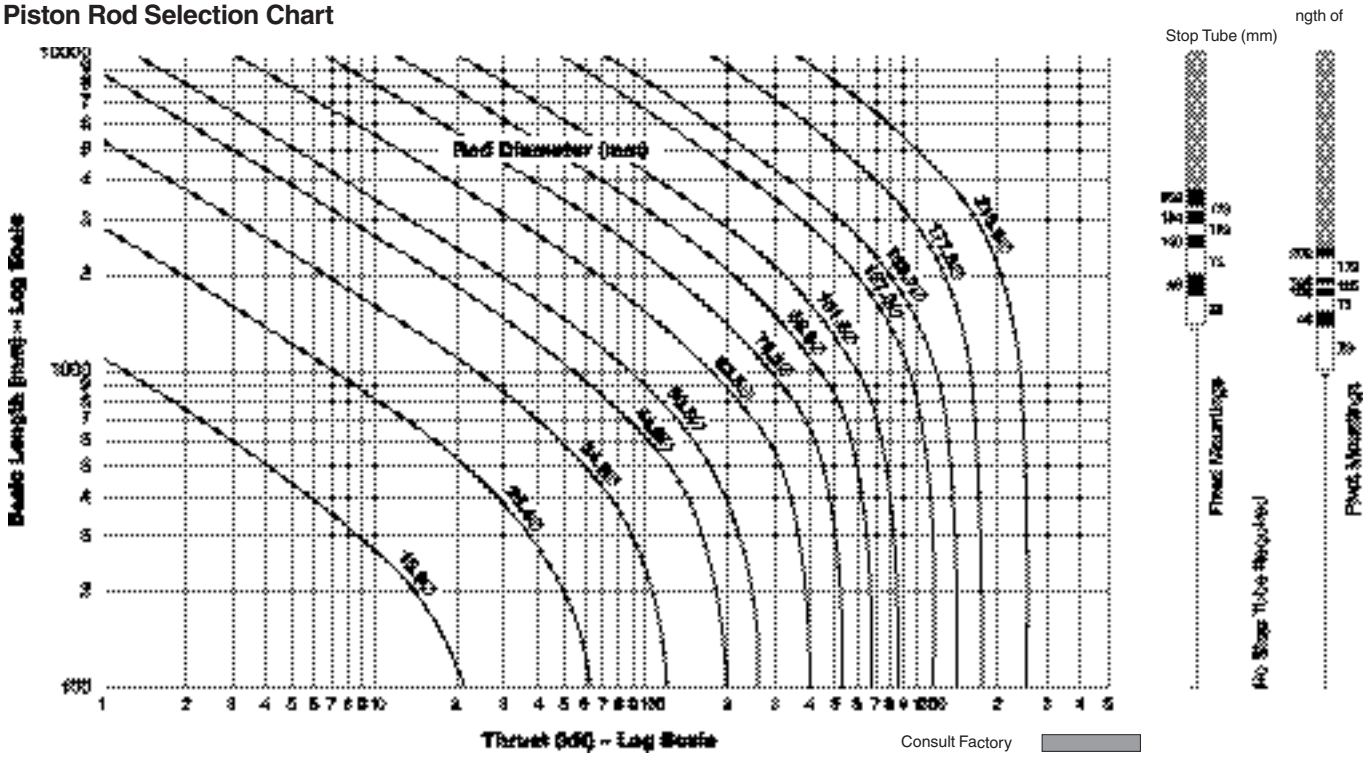
Stop tubes prevent the cylinder from completing its full stroke, to provide a spread between the piston and the rod bearing at full extension. Note that stop tube requirements differ for fixed and pivot mounted cylinders. The required length of stop tube, where necessary, is read from the vertical columns on the right of the graph by following the horizontal band within which the point of intersection lies. If the required length of stop tube is in the region labelled 'consult factory', please supply the following:

1. Cylinder mounting style.
2. Rod end connection and method of guiding load.
3. Bore required, stroke, length of rod extension (dimension W or WF - dimension V – see pages 3 and 42) if greater than standard.
4. Mounting position of cylinder. (Note if at an angle or vertical, and specify the direction of the piston rod.)
5. Operating pressure of cylinder, if limited to less than the standard pressure for the cylinder selected.

For accurate sizing, please refer to the European cylinder inPHorm selection program (1260/1-Eur). When specifying a cylinder with a stop tube, please insert an S (Special) and the net stroke of the cylinder in the order code and state the length of the stop tube. Note that net stroke is equal to the gross stroke of the cylinder less the length of the stop tube. The gross stroke determines the envelope dimensions of the cylinder.



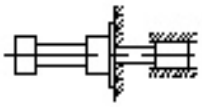
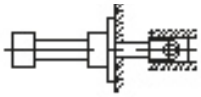
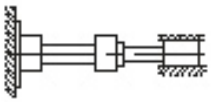
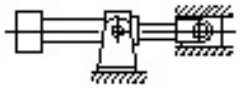
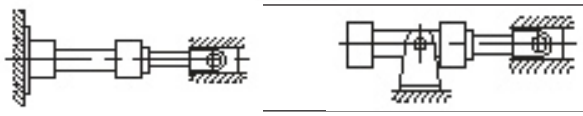
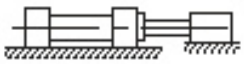
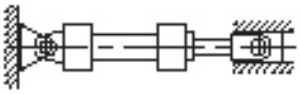
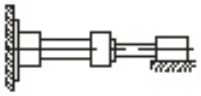
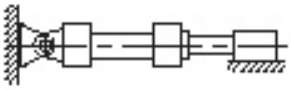
Piston Rod Selection Chart



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Stroke Factors

The stroke factors which follow are used in the calculation of cylinder 'basic length' – see Piston Rod Size Selection, page 33.

Rod End Connection	Mounting Style	Type of mounting	Stroke Factor
Fixed and rigidly Guided	TB, TD, J, JB JJ, C, F, G		0.5
Pivotedand rigidly Guided	TB, TD, J, JB JJ, C, F, G		0.7
Fixed and rigidly Guided	TC, H, HB, HH		1.0
Pivotedand rigidly Guided	D		1.0
Pivotedand rigidly Guided	TC, H, HB, HH, DD		1.5
Supported but not Rigidly Guided	TB, TD, J, JB, JJ, C, F, G		2.0
Pivotedand rigidly Guided	BB, DB, SB		2.0
Supported but not Rigidly Guided	TC, H, HB, HH		4.0
Supported but not Rigidly Guided	BB, DB, SB		4.0

Long Stroke Cylinders

When considering the use of long stroke cylinders, the piston rod should be of sufficient diameter to provide the necessary column strength.

For tensile (pull) loads, rod strength is unaffected by stroke length.

For long stroke cylinders, the use of stop tubes should be considered, to reduce bearing stress. The Piston Rod Selection Chart on page 33 provides guidance where unusually long strokes are required.

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An Introduction to Cushioning

Cushioning is recommended as a means of controlling the deceleration of masses, or for applications where piston speeds are in excess of 0.1m/s and the piston will make a full stroke. Cushioning extends cylinder life and reduces undesirable noise and hydraulic shock.

Deceleration devices or built-in 'cushions' are optional and can be supplied at the head end, cap end, or at both ends of the cylinder without affecting its envelope or mounting dimensions.

Standard Cushioning

Ideal cushion performance shows an almost uniform absorption of energy along the cushioning length, as shown. Many forms of cushioning exist, and each has its own specific merits and advantages. In order to cover the majority of applications, 2H cylinders are supplied with stepped cushioning as standard. Final speed may be adjusted using the cushion screws.



Note that cushion performance will be affected by the use of water or high water based fluids. Please consult the factory for details.

Alternative Forms of Cushioning

To complement the standard offering of stepped cushioning, special cushions can be designed to suit applications where the energy to be absorbed exceeds the standard cushion performance. Please consult the factory for further details.

Cushion Calculations

Modelling the cushion performance on uniform deceleration, the formulae below can be used to determine the approximate force developed in the cushion chamber when decelerating a load.

Formulae

$F = ma + A_d P/10 + mg\sin\alpha - f$
(for inclined or vertically downward direction of mass)

$F = ma + A_d P/10 - mg\sin\alpha - f$
(for inclined or vertically upward direction of mass)

Where:

F = total force acting on the cushion chamber in Newtons
m = mass of load in kilogrammes (including piston, rod, and rod end accessories, see table and pages 27 to 29)
a = deceleration in m/s2, derived from the formula

$$a = \frac{v^2}{2s \times 10^{-3}}$$

where: v = piston velocity in m/s
s = cushion length in mm

A_d = area acted on by pump pressure in mm^2 (see page 32)
P = pump pressure in bar
g = acceleration due to gravity = $9.81 m/s^2$
α = angle to the horizontal in degrees
f = friction forces in Newtons = mg x 0.15

Example

The following example shows how to calculate horizontal deceleration (α=0).

Selected bore/rod 127/50.8mm (No. 1 rod)
Pressure = 35 bar
Mass = 2268kg
Velocity = 0.6m/s
Cushion length = 27mm
Friction coefficient = 0.15 or 3337N.

$$F = ma + A_d P/10$$

where $a = \frac{0.6^2}{2 \times 27 \times 10^{-3}} = 6.66 m/s^2$

and $F = 2268 \times 6.66 + 12670 \times 35/10 - 3337 = 56128N$

The total deceleration force is developed by the fluid compressed in the cushion chamber.
This pressure is approximately equal to the force divided by the annular area (cylinder bore area - rod area):

$$\frac{56128N}{12670mm^2 - 2020mm^2} = 5.3N/mm^2 \text{ or } 53 \text{ bar.}$$

This induced pressure should not exceed 320 bar.

Cushion Length & Piston and Rod Mass

Where specified, 2H cylinders incorporate the longest cushion sleeve and spear that can be accommodated within the standard envelope without reducing the rod bearing and piston bearing lengths (see table of cushion lengths below). Cushions are adjustable via recessed needle valves.

Bore Ø	Rod No.	MM Rod Diameter	Cushion Length Head	Cushion Length Cap	Piston & Rod at Zero stroke kg	Rod only per 10mm Stroke kg
38.1 (1½")	1	15.9 (⅝")	28.6	30.2	0.45	0.02
	2	25.4 (1")			0.73	0.04
50.8 (2")	1	25.4 (1")	28.6	28.6	0.97	0.04
	2	34.9 (1⅜")			1.49	0.07
63.5 (2½")	1	25.4 (1")	28.6	28.6	1.36	0.04
	2	44.5 (1¾")			2.66	0.12
	3	34.9 (1⅜")			1.87	0.07
82.6 (3¼")	1	34.9 (1⅜")	34.9	33.3	2.83	0.07
	2	50.8 (2")	27.0		4.34	0.16
	3	44.5 (1¾")	34.9		3.64	0.12
101.6 (4")	1	44.5 (1¾")	34.9	31.8	4.99	0.12
	2	63.5 (2½")	27.0		7.71	0.25
	3	50.8 (2")	27.0		5.68	0.16
127.0 (5")	1	50.8 (2")	27.0	28.6	8.73	0.16
	2	88.9 (3½")			15.70	0.48
	3	63.5 (2½")			10.75	0.25
	4	76.2 (3")			13.19	0.35
152.4 (6")	1	63.5 (2½")	33.3	38.1	14.98	0.25
	2	101.6 (4")			23.88	0.63
	3	76.2 (3")			17.49	0.35
	4	88.9 (3½")			20.09	0.48
177.8 (7")	1	76.2 (3")	46.0	49.2	22.28	0.35
	2	127.0 (5")	42.9		39.59	0.98
	3	88.9 (3½")	46.0		25.03	0.48
	4	101.6 (4")	33.3		29.01	0.63
203.2 (8")	1	88.9 (3½")	52.4	50.8	33.04	0.48
	2	139.7 (5½")	49.2		54.78	1.19
	3	101.6 (4")	33.3		37.11	0.63
	5	127.0 (5")	42.9		47.91	0.98
254.0 (10")	1	127.0 (5")	54.0	50.8	76.38	0.98
	2	177.8 (7")			105.39	1.92
304.8 (12")	1	139.7 (5½")	54.0	50.8	120.47	1.19
	2	215.9 (8½")			177.25	2.84

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Pressure Limitations – Introduction

The pressure limitations of a hydraulic cylinder must be reviewed when considering its application. To assist the designer in obtaining the optimum performance from a cylinder, the following guidelines are provided. If in doubt, please consult the factory.

Low Pressure Operation

At low operating pressures, a wide range of application factors begin to affect cylinder performance. As a result, consideration should be given to factors such as seal friction and mounting alignment when selecting a cylinder for low pressure use. Low Friction seals are available to special order, to optimise performance at low pressures. For further information, please consult the factory.

Maximum Pressure

Series 2H cylinders are recommended for pressures up to 210 bar for heavy-duty service with hydraulic oil. The 4:1 design factor rating shown is conservative for continuous severe applications. Safety factors at other pressures can be calculated from this rating. In addition, mounting styles, stroke, etc., should be considered because of the limiting effect they may have on these ratings.

The designer must, however, take account of fatigue stress which may restrict the cylinder to a lower pressure. Three main areas of cylinder design may be affected: the cylinder body (pressure envelope), the cylinder mountings, and the piston rod.

The maximum pressures indicated in the tables opposite are based on pure tensile and compressive loadings, without the presence of any bending stresses. Where it is impractical to avoid side loadings, eg: by the use of pivot mountings, please consult the factory giving full details of the application.

Cylinder Body (Pressure Envelope)

In many applications, the pressure developed within a cylinder may be greater than the working pressure, due to pressure intensification across the piston and cushioning, e.g. meter-out circuits. In most cases, this intensification does not affect the cylinder mountings or piston rod threads in the form of increased loading. This induced pressure should not exceed 320 bar. If in doubt, please consult the factory.

For more comprehensive information about pressure limitations for individual cylinders, please refer to the European cylinder InPHorm selection program.

Maximum Pressure Ratings

Bore Ø (with rod no. 1)	4 : 1 Design Factor (yield)		Heavy-duty Service	
	(bar)	(psi)	(bar)	(psi)
38.1 (1½")	145	2040	210	3000
50.8 (2")	165	2340	210	3000
63.5 (2½")	135	1920	210	3000
82.6 (3¼")	150	2100	210	3000
101.6 (4")	145	1970	210	3000
127.0 (5")	135	1900	210	3000
152.4 (6")	150	2100	210	3000
177.8 (7")	130	1840	210	3000
203.2 (8")	145	1980	210	3000
254.0 (10")	155	2200	210	3000
304.8 (12")	170	2380	210	3000

Maximum Pressure for H and J Mountings

Bore Ø	Style H Mounting [1] Pull applications (bar)					Style J Mounting [2] Push applications (bar)				
	Rod Numbers					Rod Numbers				
	1	2	3	4	5	1	2	3	4	5
38.1 (1½")	210	210	–	–	–	180	110	–	–	–
50.8 (2")	210	210	–	–	–	180	110	–	–	–
63.5 (2½")	210	210	210	–	–	180	110	130	–	–
82.6 (3¼")	210	210	210	–	–	180	110	145	–	–
101.6 (4")	210	210	210	–	–	180	110	125	–	–
127.0 (5")	150	210	180	195	–	160	60	115	85	–
152.4 (6")	150	210	180	195	–	130	60	100	75	–
177.8 (7")	110	150	120	125	–	110	40	90	70	–
203.2 (8")	110	150	120	–	130	70	40	55	–	45
254.0 (10")	180	210	–	–	–	72	46	–	–	–
304.8 (12")	135	210	–	–	–	Not recommended			–	–

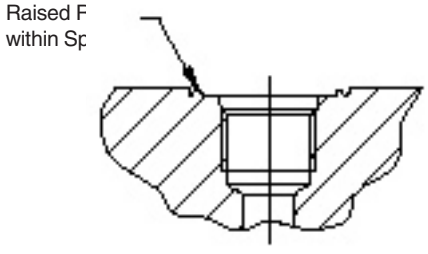
[1] For pressures exceeding those shown use mounting HB or HH
[2] For pressures exceeding those shown use mounting JB or JJ

Ports – Standard Ports

Series 2H cylinders are supplied as standard with BSPP ports to ISO 228/1, spot faced for sealing washers. Metric threaded ports to DIN 3852 Pt.1 and ISO 6149, or NPTF ports in sizes as shown for BSPP ports, can be supplied if specified. The ISO 6149 port incorporates a raised ring in the spot face for identification.

Where required, oversize or additional ports can be supplied on the sides of heads and caps that are not occupied by cushion valves. Refer to the tables of port sizes opposite.

ISO 6149 Port Identification



All dimensions are in millimetres unless otherwise stated.

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Oversize Ports

For higher speed applications, oversize ports can be supplied in all bore sizes, but are not available on Style JJ mounting (please consult the factory). Ports one size larger than standard are the maximum that can be accommodated in most heads or caps within the standard envelope dimensions. All oversize metric, BSPT or NPTF ports require welded port bosses. The bosses protrude from the side of the cylinder. Port sizes are shown in the tables opposite.

Note that Y and P dimensions may vary slightly to accommodate oversize ports – please contact the factory where these dimensions are critical.

Port Size and Piston Speed

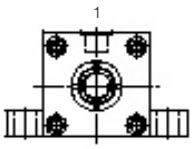
The tables opposite show piston speeds for standard and oversize ports and connecting lines where the velocity of the fluid is 5m/s. Due to piston rod displacement, the flow at the cap end port will be greater than that at the head end, at the same piston speed. If the desired piston speed results in a fluid flow in excess of 5m/s, larger lines with two ports per cap should be considered. Parker recommends that a flow rate of 12m/s in connecting lines should not be exceeded.

Speed Limitations

Where large masses are involved, or piston speeds exceed 0.1m/s and the piston will make a full stroke, cushions are recommended – see page 35. For cylinders with oversize ports and with a fluid velocity exceeding 8m/s into the cap end, please consult the factory with details of the application.

Ports, Air Bleeds and Cushion Adjustment Location

The table below shows standard positions for ports, and cushion adjusting screws where fitted. However, by specifying the position numbers for the desired locations for head and cap ports, many mounting styles can be assembled with ports located at 90° or 180° from standard. In these cases, cushion needle and check valves are also repositioned, where fitted, since their relation with the port position does not change. Air bleeds, see pages 7 and 39, may be fitted in unoccupied faces of the head or cap, depending on mounting.



Bore Ø	Standard Ports				
	Port Size BSPP	Port size Metric	Tube Bore mm	l/min. flow at 5m/sec [1]	Piston Speed in m/sec
38.1 (1 1/2")	G 1/2	M22x1.5	13	40	0.58
50.8 (2")	G 1/2	M22x1.5	13	40	0.33
63.5 (2 1/2")	G 1/2	M22x1.5	13	40	0.21
82.6 (3 1/4")	G 3/4	M27x2	15	53	0.17
101.6 (4")					0.11
127.0 (5")					0.07
152.4 (6")	G1	M33x2	19	85	0.08
177.8 (7")	G1 1/4	M42x2	24	136	0.09
203.2 (8")	G1 1/2	M48x2	30	212	0.11
254.0 (10")	G2	M60x2	38	340	0.11
304.8 (12")	G2 1/2	–	50	589	0.14

Bore Ø	Rod No	Oversize Ports				
		Port Size BSPP	Port size Metric	Tube Bore mm	l/min. flow at 5m/sec [1]	Piston Speed in m/sec
38.1 (1 1/2")	1	G 3/4 [3]	M27x2 [2]	15	53	0.78
	2	G 3/4 [2]				
50.8 (2")	1	G 3/4 [3]	M27x2 [2]	15	53	0.44
	2	G 3/4 [2]				
63.5 (2 1/2")	1	G 3/4	M27x2	15	53	0.28
82.6 (3 1/4")	2	G1	M33x2	19	85	0.27
101.6 (4")	All					0.18
127.0 (5")	All					0.11
152.4 (6")	All	G1 1/4	M42x2	24	136	0.12
177.8 (7")	All	G1 1/2	M48x2	30	212	0.14
203.2 (8")	All	G2	–	38	340	0.18
254.0 (10")	All	–	–	–	–	–
304.8 (12")	All	–	–	–	–	–

[1] This refers to fluid velocity in connecting lines, not piston velocity
[2] Supplied with welded port bosses at both head and cap
[3] Supplied with welded port bosses at cap only

Manifold Ports

Manifold ports are available on all mounting styles to special order. Side mounted cylinders (Style C) can be supplied with the cylinder ports arranged for mounting and sealing to a manifold surface – see page 31.

Flange Ports

Flange ports are available on most large bore 2H series cylinders. Please consult the factory for details.

Positions of Ports and Cushion Screws in Head and Cap		Mounting Styles																											
		TB, TC, TD, J, JB, H, HB, BB & SBa				JJ				HH				C	D			DB				DD				G & F			
Head	Port	1	2	3	4	1	2	3	4	1	2	3	4	1	1		3	1	2	3	4	1	2	3	4	1	2	4	
	Cushion	2	3	4	1	3	3	1	1	3	3	1	1	2	3		1	3	4	1	2	3	4	1	2	2	4	1	
Cap	Port	1	2	3	4	1	2	3	4	1	2	3	4	1	1	2	3	4	1		3	1	2	3	4	1	2	4	
	Cushion	2	3	4	1	3	4	1	2	3	3	1	1	2	3	4	1	2	3		1	3	4	1	2	2	4	1	

All dimensions are in millimetres unless otherwise stated.

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Fluid Group	Seal Materials – a combination of:	Fluid Medium to ISO 6743/4-1982	Temperature Range
1	Nitrile (NBR), PTFE, enhanced polyurethane (AU)	Mineral Oil HH, HL, HLP, HLP-D, HM, MIL-H-5606 oil, air, nitrogen	-20°C to +80°C
2	Nitrile (NBR), PTFE	Water glycol (HFC)	-20°C to +60°C
5	Fluorocarbon elastomer (FPM), PTFE	Fire resistant fluids based on phosphate esters (HFD-R) Also suitable for hydraulic oil at high temperatures or in hot environments. **Not suitable for use with Skydrol.** See fluid manufacturer's recommendations.	-15°C to +150°C
6	Various compounds including nitrile, polyamide, enhanced polyurethane, fluorocarbon elastomers and PTFE	Water Oil in water emulsion 95/5 (HFA)	+5°C to +50°C
7		Water in oil emulsion 60/40 (HFB)	+5°C to +50°C

Operating Medium
Sealing materials used in standard cylinders are suitable for use with most petroleum-based hydraulic fluids.
Special seals are available for use with water-glycol or water-in-oil emulsions, and with fluids such as fire-resistant synthetic phosphate ester and phosphate ester-based fluids.

The table above is a guide to the sealing compounds and operating parameters of the materials used for rod gland, piston and body seals. If there is any doubt regarding seal compatibility with the operating medium, please consult the factory.

Notes
Group 1 Seals are manufactured from an enhanced polyurethane and do not require a gland seal back-up washer. They should not be used if the working fluid is water glycol.
Group 6 Seals – System pressure should not exceed 70 bar when using HFA fluids.

Green Fluids
Special seals for use with specific 'green fluids' are available to special order. Please consult the factory for details.

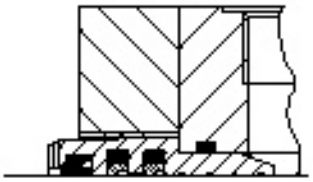
External Fluids
The environment in which a cylinder is used may cause fluids such as cutting fluids, coolants, and wash down fluids, to come into contact with the external surfaces of the cylinder. These fluids may attack the cylinder O-ring seals, the piston rod wiper and/or the rod seal, and must be taken into account when selecting and specifying seal compounds.

Temperature
Group 1 seals can be operated at temperatures between -20°C and +80°C. Where operating conditions result in temperatures outside these limits, special seal compounds may be required to ensure satisfactory service life – please consult the factory.

For seal groups 2, 5, 6 and 7, where operating conditions fall outside of those specified in the table, please contact the factory.

Special Seal Designs and Materials
Group 1 seals are fitted as standard to 2H cylinders. For other duties, the optional seal groups 2, 5, 6 and 7 are available – please quote in the cylinder order code, shown on page 43. (Please note that system pressure for Group 6 seals for use with HFA fluids should not exceed 70 bar). Special seals can also be supplied – please consult the factory with details of the application. Please insert an S (Special) in the order code and specify fluid medium when ordering.

Low Friction Seals
For applications where very low friction and an absence of stick-slip are important, the option of low friction seals is available. In low pressure applications, their use should also be considered. If in doubt, please consult the factory. The gland seals comprise two low friction PTFE stepped seals and a conventional double lip wiper.



Water Service
Special modifications to cylinders are available for high water content fluids. Modifications include a stainless steel piston rod with lipseal piston, and plating of internal surfaces. When ordering, please specify the maximum operating pressure or load/speed conditions, as the stainless steel rod is of lower tensile strength than the standard material.

Pure Water
Parker Hannifin can also supply cylinders for use with pure water as the fluid medium. Please consult the factory.

Warranty Parker Hannifin warrants cylinders modified for water or high water content fluid service to be free of defects in materials or workmanship, but cannot accept responsibility for premature failure caused by excessive wear resulting from lack of lubricity, or where failure is caused by corrosion, electrolysis or mineral deposits within the cylinder.

Filtration
For maximum component life, the system should be protected from contamination by effective filtration. Fluid cleanliness should be in accordance with ISO 4406. The quality of filtration should be in accordance with the appropriate ISO standards.

The rating of the filter medium depends on the system components and the application. The minimum required for hydraulic systems should be class 19/15 to ISO 4406, which equates to 24µ(β10≥75) to ISO 4572.

All dimensions are in millimetres unless otherwise stated.

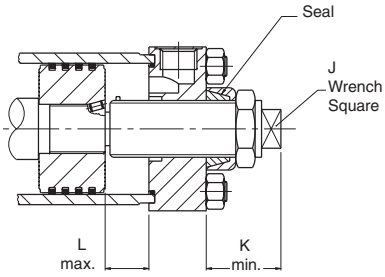
Air Bleeds
The option of bleed screws, illustrated on page 7, is available at either or both ends of the cylinder, at any position except in the port face – see page 37. The selected positions should be shown in the order code – see page 43. Cylinders with bore sizes of 38.1mm (1 1/2") are fitted with M5 bleed screws; for bore sizes of 50.8mm (2") and above, M8 bleed screws are fitted.

Gland Drains
The tendency of hydraulic fluid to adhere to the piston rod can result in an accumulation of fluid in the cavity behind the gland wiperseal under certain operating conditions (see page 7). This may occur with long stroke cylinders where there is a constant back pressure as in differential circuitry, or where the ratio of the extend speed to the retract speed is greater than 2 :1.

A 1/8" NPTF gland drain port can be provided in the retainer on all cylinders up to and including 203.2mm (8") bore sizes, except 38.1mm (1 1/2") with no. 1 rod. For 38.1mm (1 1/2") bore cylinders with no.2 rod, the retainer thickness is increased to 15.9mm (5/8"). For 38.1mm (1 1/2") bore cylinders with no.1 rod, the drain port is located in the head end adjacent to the port.

Gland drains should be piped back to the fluid reservoir, which should be located below the level of the cylinder.

Stroke Limiters
Where absolute precision in stroke length is required, a screwed adjustable stop can be supplied at the cap end. Several types are available – the illustration shows a design suitable for infrequent adjustment of an uncushioned cylinder. Please contact the factory, specifying details of the application and the adjustment required.



Bore Ø	J	K min.	L max.
38.1 (1 1/2")	11	55	127.0
50.8 (2")	17	75	203.2
63.5 (2 1/2")	17	75	228.6
82.6 (3 1/4")	22	85	228.6
101.6 (4")	24	70	457.2
127.0 (5")	32	70	508.0
152.4 (6")	41	75	508.0
177.8 (7")	50	75	508.0
203.2 (8")	60	80	508.0

Rod Locking Devices
These units provide positive locking of the piston rod. They require hydraulic pressure to release, while loss of pressure causes the clamp to operate, allowing them to be used as a fail-safe device. Please consult the factory for further information.

Single-Acting Cylinders
Standard 2H series cylinders are of the double-acting type. They are also suitable for use as single-acting cylinders, where the load or other external force is used to return the piston after the pressure stroke. Cast iron piston rings should not be used with single-acting cylinders.

Spring-Returned, Single-Acting Cylinders
Series 2H single-acting cylinders can also be supplied with an internal spring to return the piston after the pressure stroke. Please supply details of load conditions and friction factors, and advise whether the spring is required to advance or return the piston rod.

On spring-returned cylinders, it is recommended that tie rod extensions be specified on the cylinder end in which the spring is located to allow the spring to be 'backed off' until compression is relieved. Tie rod nuts should be welded to the tie rods at the opposite end of the cylinder, to further assure safe disassembly. Please consult the factory when ordering spring-returned cylinders.

Multiple Stroke Positioning
To obtain linear force in one plane with controlled stopping at intermediate points, several designs are available. For three stopped positions, it is common practice to mount two standard single rod Style H cylinders back-to-back, or to use through-tie rods. By extending or retracting the stroke of each cylinder independently, it is possible to achieve three positions at the piston ends. An alternative technique is to use a tandem cylinder with an independent piston rod in the cap section. Please consult the factory for further details.

Rod End Bellows
Unprotected piston rod surfaces which are exposed to contaminants with air hardening properties should be protected by rod end bellows. Longer rod extensions are required to accommodate the collapsed length of the bellows. Please consult the factory for further information.

Metallic Rod Wipers
Metallic rod wipers replace the standard wiper seal, and are recommended where dust, ice or splashings might damage the wiper seal material. Metallic rod wipers do not affect cylinder dimensions.

DC Proximity Sensors
These can be fitted to give reliable end of stroke signals. See catalogue 0810 for details.

Position Feedback
Linear position transducers of various types are available for 2H series cylinders. See catalogue 1175 for details.

All dimensions are in millimetres unless otherwise stated.

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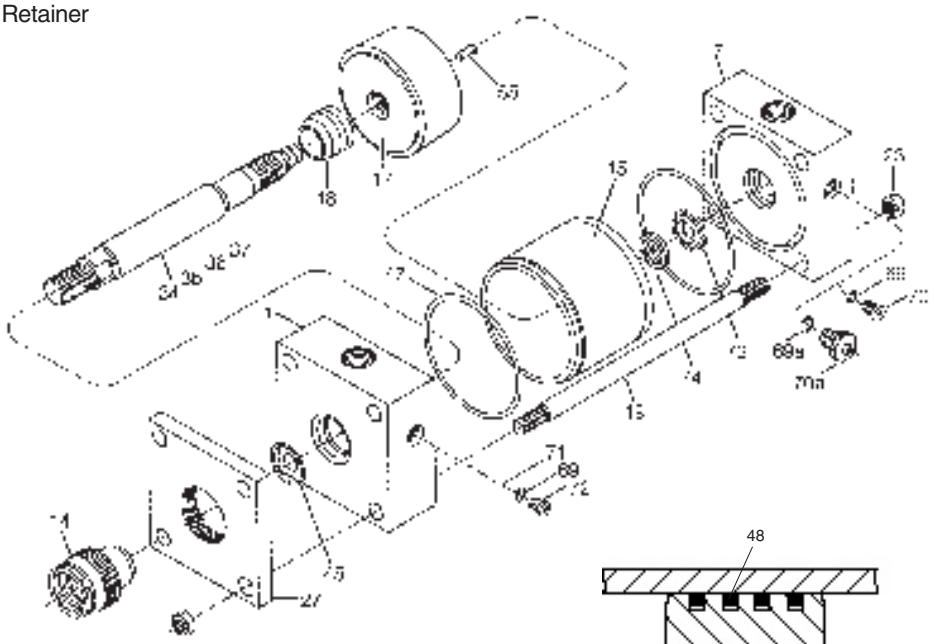
Service Assemblies and Seal Kits

Service Assembly Kits and Seal Kits for 2H cylinders simplify the ordering and maintenance processes. They contain sub-assemblies which are ready for installation, and are supplied with full instructions. When ordering Service Assemblies and Seal Kits, please refer to the identification plate on the cylinder body, and supply the following information:

Serial Number - Bore - Stroke - Model Number - Fluid Type

Key to Part Numbers

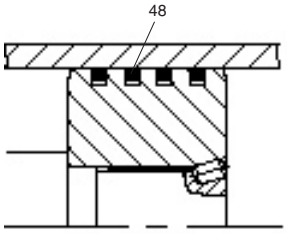
1 Head
7 Cap
14 Gland/bearing cartridge
15 Cylinder body
17 Piston
18 Cushion sleeve
19 Tie rod
23 Tie rod nut
26 Back-up washer – only on 203.2mm to 304.8mm (8" to 12") bore cylinders
27 Retainer



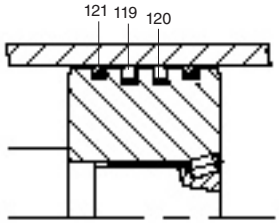
34 Piston rod – single rod, no cushion
35 Piston rod – single rod, cushion at head end
36 Piston rod – single rod, cushion at cap end
37 Piston rod – single rod, cushion at both ends
40 Wiperseal – for gland
41 Lipseal – for gland
42 Lipseal – for Lipseal piston
43 Back-up washer – for gland lipseal 41 (Groups 2, 5, 6 & 7 seals)
44 Back-up washer – for Lipseal piston
45 O-ring – gland/head
47 O-ring – cylinder body
48 Cast iron piston ring
55 Locking pin – piston/rod
57[1] Piston rod – double (stronger[2]) rod, no cushion
58[1] Piston rod – double (stronger[2]) rod, cushion one end
60[1] Piston rod – double (weaker[2]) rod, no cushion
61[1] Piston rod – double (weaker[2]) rod, cushion one end
69 O-ring – needle valve and check valve screws
69a O-ring – cartridge-type needle valve
70 Needle valve, cushion adjustment – bore sizes above 63.5mm (2½")
70a Needle valve assembly, cartridge type – bore sizes up to 63.5mm (2½")
71 Ball – cushion check valve – bore sizes above 101.6mm (4")
72 Cushion check valve screw – bore sizes above 101.6mm (4")
73 Floating cushion bush
74 Retaining ring for cushion bush
119 PTFE rings (Hi-Load piston)
120 Rubber pre-load rings (Hi-Load piston)
121 Wear rings (Hi-Load piston)

[1] Not illustrated
[2] See page 26 – double rod strength

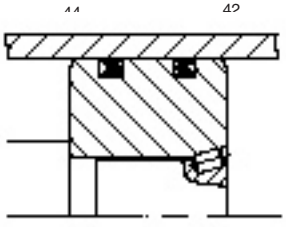
Piston Rod Ø	Gland Cartridge Wrench	Spanner Wrench
15.9	69590	11676
25.4	69591	11676
34.9	69592	11703
44.5	69593	11677
50.8	69594	11677
63.5	69595	11677
76.2	69596	11677
88.9	69597	11677
101.6	69598	11677
127.0	69599	11678
139.7	69600	11678
177.8	–	–
215.9	–	–



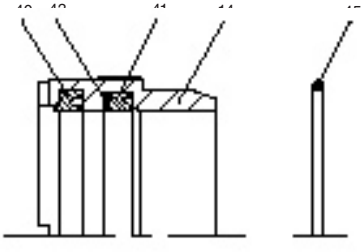
Cast Iron Piston



Hi-Load Piston



Lipseal Piston



Gland Cartridge and Seals

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Piston and Gland Service Kits
(see key to part numbers opposite)

Gland Service Cartridge Kit Contain items 14, 40, 41, 43, 45. Where the original gland incorporates a gland drain, please consult the factory.

Gland Service Kit Contain items 40, 41, 43, 45.

Piston Rod Ø	Gland Service Cartridge Kit * Standard Seals	Gland Service Kit * Standard Seals
15.9 (5/8")	RG2HLTS061	RK2HLTS061
25.4 (1")	RG2HLTS101	RK2HLTS101
34.9 (1 3/8")	RG2HLTS131	RK2HLTS131
44.5 (1 3/4")	RG2HLTS171	RK2HLTS171
50.8 (2")	RG2HLTS201	RK2HLTS201
63.5 (2 1/2")	RG2HLTS251	RK2HLTS251
76.2 (3")	RG2HLTS301	RK2HLTS301
88.9 (3 1/2")	RG2HLTS351	RK2HLTS351
101.6 (4")	RG2HLTS401	RK2HLTS401
127.0 (5")	RG2HLTS501	RK2HLTS501
139.7 (5 1/2")	RG2HLTS551	RK2HLTS551
127.0 (5") [1]	RG902HTS501	RK902HTS501
139.7 (5 1/2") [2]	RG922HTS551	RK922HTS551
177.8 (7") [1]	RG902HLF701	RK902HLF701
215.8 (8 1/2") [2]	RG922HLF851	RK922HLF851

[1] 254.0mm (10") bore size only [2] 304.8 mm (12") bore size only

Piston Service Kit, Cast Iron Rings Contains two of item 47 plus four of item 48.

Piston Service Kit, Lipseal Piston Contains two each of items 42, 47 and 44.

Piston Service Kit, Hi-Load Piston Contains two each of items 47, 119, 120 and 121.

Bore Ø	Piston Service Kit Cast Iron Rings	Piston Service Kit * Lipseal Piston	Piston Service Kit * Hi-Load Piston
38.1 (1 1/2")	PR152H001	PK152HLL01	PK152HK001
50.8 (2")	PR202H001	PK202HLL01	PK202HK001
63.5 (2 1/2")	PR252H001	PK252HLL01	PK252HK001
82.6 (3 1/4")	PR322H001	PK322HLL01	PK322HK001
101.6 (4")	PR402H001	PK402HLL01	PK402HK001
127.0 (5")	PR502H001	PK502HLL01	PK502HK001
152.4 (6")	PR602H001	PK602HLL01	PK602HK001
177.8 (7")	PR702H001	PK702HLL01	PK702HK001
203.2 (8")	PR802H001	PK802HLL01	PK802HK001
254.0 (10")	PR902H001	PK902HLL01	PK902HK001
304.8 (12")	PR922H001	PK922HLL01	PK922HK001

* Seal Groups – Ordering
The part numbers shown in the tables above are for Group 1 seals. For Group 2, 5, 6 or 7 gland seals, substitute 'AHL' for 'HLTS' where used, and replace the '1' at the end of the number sequence with '2', '5', '6' or '7'. For example, a Group 5 RG Gland Cartridge Kit for a 50.8mm rod will be RG2AHL205. For Group 2, 5, 6 or 7 piston seals, substitute a '2', '5', '6' or '7' for the '1' at the end of the number sequence.

Contents of Service Assembly Kits
(see key to part numbers opposite)

Head Assembly
Non-cushioned: 1, 26, 47
Cushioned: 1, 26, 47, 69, (69a), 70, (70a)

Cap Assembly
Non-cushioned: 7, 26, 47
Cushioned: 7, 26, 47, 69, (69a), 70, (70a), 73, 74

Cylinder Body
All types: 15

Cushion Screw/Cartridge Assembly
Screw type: 69, 70
Cartridge type: 69a, 70a

Check Valve Screw Assembly
Screw type: 69, 71, 72 (bore sizes above 101.6mm)

Piston Rod Assemblies
These kits contain a fully assembled piston and rod assembly which is ready to install. They comprise a piston plus a rod from the types listed below.

Piston Types
Cast Iron Ring: 17, 48
Lipseal: 17, 42, 44
Hi-Load: 17, 119, 120, 121

Rod Types
Single rod, non-cushioned: 34
Single rod, cushioned head: 35, 18
Single rod, cushioned cap: 36
Single rod, cushioned both ends: 37, 18

Double rod, non-cushioned: 57, 60,
Double rod, cushioned stronger end: 58, 60, 18
Double rod, cushioned weaker end: 58, 61, 18
Double rod, cushioned both ends: 58, 61, 18 x 2

Tie Rod Torques
Please refer to the table on page 31.

Repairs
Although 2H cylinders are designed to make on-site maintenance or repairs as easy as possible, some operations can only be carried out in our factory. It is standard policy to fit a cylinder returned to the factory for repair with those replacement parts which are necessary to return it to 'as good as new' condition. Should the condition of the returned cylinder be such that repair would be uneconomical, you will be notified.

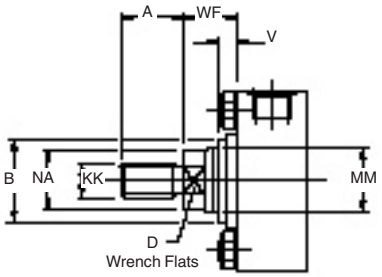
All dimensions are in millimetres unless otherwise stated.

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Watford, Herts.

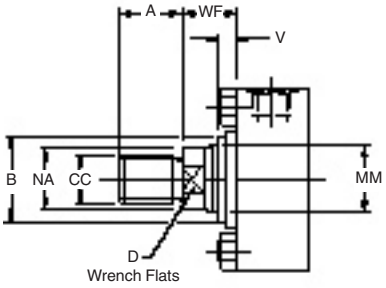
254.0mm & 304.8mm (10" & 12") Bores Only

Rod End Details – All Except J, JB and JJ Mountings

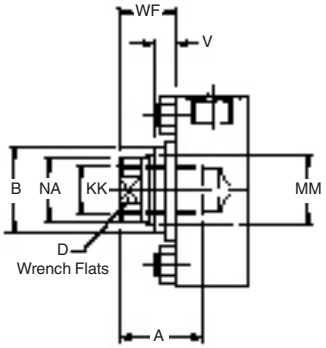
Rod End Style 4



Rod End Style 8

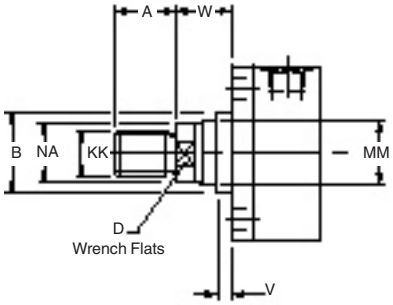


Rod End Style 9

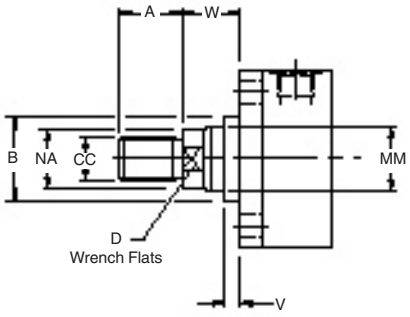


Rod End Details – J and JB Mountings

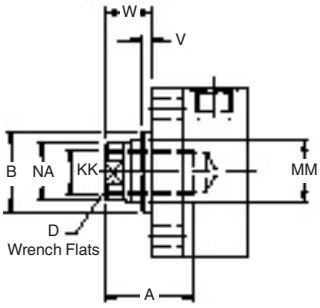
Rod End Style 4



Rod End Style 8

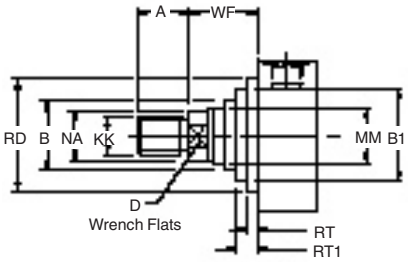


Rod End Style 9



Rod End Details – JJ Mounting

Rod End Style 4



Rod End Styles 4 & 8

Style 4 rod ends are recommended for all applications in which the work piece is secured against the rod shoulder. Where the work piece is not shouldered, Style 8 rod ends are recommended. If rod end style is not specified, Style 4 will be supplied.

Rod End Style 9

For applications where a female thread is required.

Rod End Style 3

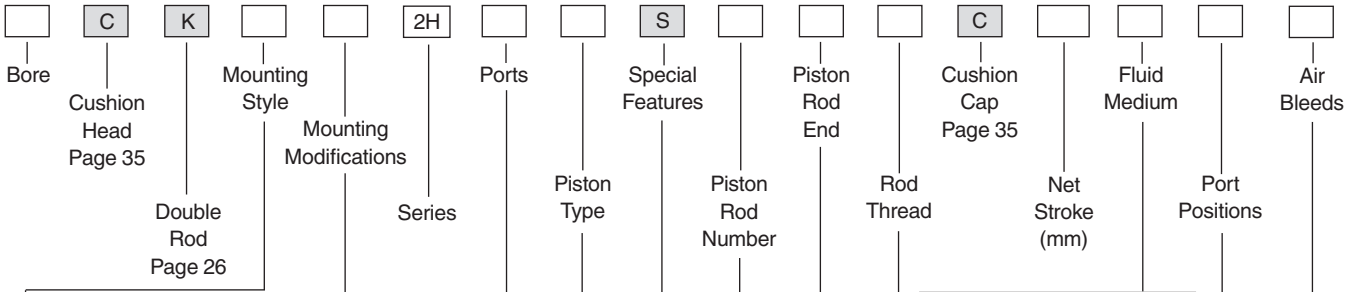
Non-standard piston rod ends are designated 'Style 3'.
A dimensional sketch or description should accompany the order. Please specify dimensions KK or CC, and A.

Rod End Dimensions – 254.0mm & 304.2mm (10" & 12") Bore Sizes Only

Bore Ø	Rod No.	MM Rod Diameter	Style 4 & 9 KK Metric	Style 4 & 9 KK UNF	Style 8 CC Metric	Style 8 CC UNF	A	B +0.00 -0.13	D	NA	V	W	WF	JJ Mount Only B1	JJ Mount Only RD max.	JJ Mount Only RT	JJ Mount Only RT1
254.0 (10")	1	127.0 (5")	M90x2	3½ - 12	M110x2	4¾ - 12	127	146.0	110	123.8	7	32	74.9	–	241.3	25.4	–
	2	177.8 (7")	M100x2	4 - 12	M130x2	4¾ - 12	127	196.3	150	174.6	13	38	81.0	214.3	273.1	28.6	41.7
304.8 (12")	1	139.7 (5½")	M100x2	4 - 12	M130x2	5¼ - 12	140	158.7	120	136.5	7	32	82.0	–	206.4	33.3	–
	2	215.9 (8½")	M115x2	4½ - 12	M130x2	5¼ - 12	140	234.9	180	212.7	13	38	87.2	260.3	336.6	28.6	46.1

All dimensions are in millimetres unless otherwise stated.

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Watford, Herts.



Code	Special Features	Page
S	Flange Ports	37
S	Oversize Ports	24
S	Special Seals	38
S	Stop Tube	19
S	Stroke Limiter	6
S	Rod End Bellows	6
S	Gland Drain Port	25
S	Tie Rod Supports	16
S	Water Service Modifications – or to customer specification	25

Code	Fluid Medium	Page
M	Group 1	38
C	Group 2	38
D	Group 5	38
A1	Group 6	38
B	Group 7	38

Code	Port Position	Page
eg: 1	Head position 1-4	37
1	Cap position 1-4	37

Code	Air Bleed Position	Page
eg: 4	Head position 1-4	37, 39
4	Cap position 1-4	37, 39
00	No air bleeds	37, 39

Code	Piston	Page
C	Cast iron rings (standard)	7
K	Hi-Load	7
L	Lipseal	7

Code	Thread	Page
M	Metric (standard)	3, 42
A	UNF	

Code	Port Style	Page
R	BSPP (ISO 228) – standard	36
G	Metric (ISO 3852 Pt.1)	36
U	NPTF (dry seal pipe thread	36
Y	Metric (ISO 6149)	36

Code	Rod End Style	Page
4	Style 4	28
7	Style 7	28
8	Style 8	28
9	Style 9	28
3	Style 3 (Special) – please supply description or drawing	28

Code	Modification	Page
P	Thrust Key (Styles C, F, G only)	30
M	Manifold Port O-ring (Style C only)	31

Code	Mounting Style	Page
TB, TC, TD	Extended Tie Rods	10, 11
J, JJ, JB	Head Flanges	12, 13, 22
H, HH, HB	Cap Flanges	14, 15, 23
C	Side Lugs	16, 25
F	Side Tapped Holes	16
G	Side End Lugs	17
BB	Cap Fixed Clevis	18, 25
SBa	Cap Fixed Eye with Spherical Bearing	18
D, DB, DD	Fixed Trunnions	20, 21, 24

Code	Rod Number	Page
1	Rod No. 1	3, 42
2	Rod No. 2	3, 42
3	Rod No. 3	3, 42
4	Rod No. 4	3, 42
5	Rod No. 5	3, 42

Accessories

Please state on order whether accessories are to be fitted to the cylinder or supplied separately.

Key

Required for basic cylinder

Indicate optional features or leave blank

Double Rod Cylinders – Example

100	K	JJ	2H	R	K	1	4	M	1	4	M	125	D	11	44

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Cylinder Division
Watford, Herts.

Hydraulics Group Sales Offices

Europe

Austria
Wiener Neustadt
Tel: +43 (0)2622 23501
Fax: +43 (0)2622 66212

Austria
Wiener Neustadt
(Resp. for East Europe)
Tel: +43 (0)2622 23501-970
Fax: +43 (0)2622 23501-977

Belgium
Nivelles
Tel: +32 (0)67 280 900
Fax: +32 (0)67 280 999

Czech Republic
Klecany
Tel: +420 284 083 111
Fax: +420 284 083 112

Denmark
Ballerup
Tel: +45 4356 0400
Fax: +45 4373 3107

Finland
Vantaa
Tel: +358 20 753 2500
Fax: +358 20 753 2200

France
Contamine-sur-Arve
Tel: +33 (0)450 25 80 25
Fax: +33 (0)450 25 24 25

Germany
Kaarst
Tel: +49 (0)2131 4016 0
Fax: +49 (0)2131 4016 9199

Ireland
Dublin
Tel: +353 (0)1 293 9999
Fax: +353 (0)1 293 9900

Italy
Corsico (MI)
Tel: +39 02 45 19 21
Fax: +39 02 4 47 93 40

The Netherlands
Oldenzaal
Tel: +31 (0)541 585000
Fax: +31 (0)541 585459

Norway
Ski
Tel: +47 64 91 10 00
Fax: +47 64 91 10 90

Poland
Warsaw
Tel: +48 (0)22 573 24 00
Fax: +48 (0)22 573 24 03

Portugal
Leca da Palmeira
Tel: +351 22 9997 360
Fax: +351 22 9961 527

Slovakia
Ref. Czech Republic

Spain
Madrid
Tel: +34 91 675 73 00
Fax: +34 91 675 77 11

Sweden
Spånga
Tel: +46 (0)8 597 950 00
Fax: +46 (0)8 597 951 10

United Kingdom
Warwick
Tel: +44 (0)1926 317 878
Fax: +44 (0)1926 317 855

International

Australia
Castle Hill
Tel: +61 (0)2-9634 7777
Fax: +61 (0)2-9842 5111

Canada
Milton, Ontario
Tel: +1 905-693-3000
Fax: +1 905-876-0788

China
Shanghai
Tel: +86 21 5031 2525
Fax: +86 21 5834 3714

Asia Pacific Group
Hong Kong
Tel: +852 2428 8008
Fax: +852 2425 6896

India
Mumbai
Tel: +91 22 5613 7081/82-85
Fax: +91 22 2768 6841/6618

Japan
Tokyo
Tel: +(81) 3 6408 3900
Fax: +(81) 3 5449 7201

Latin America Group
Brazil
Tel: +55 51 3470 9144
Fax: +55 51 3470 9281

South Africa
Kempton Park
Tel: +27 (0)11-961 0700
Fax: +27 (0)11-392 7213

USA
Cleveland (industrial)
Tel: +1 216-896-3000
Fax: +1 216-896-4031
Lincolnshire (mobile)
Tel: +1 847-821-1500
Fax: +1 847-821-7600

Parker Hannifin is the world's premier supplier of motion and control systems and solutions, with sales and manufacturing facilities throughout the world. For product information and details of your nearest Parker sales office, visit us at www.parker.com or call free on 00800 2727 5374.

Catalogue HY07-1110/UK
06/06 PC

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Low Pressure Flat Glass Gages

FM APPROVED

for less demanding process conditions...

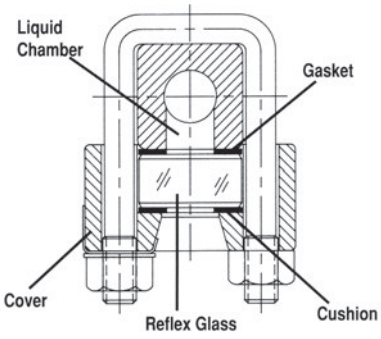
Penberthy's low pressure gages are designed to maximize the mechanical and economical advantages of ductile iron covers.

All materials in low pressure gages conform to ASTM specifications. RL gages can achieve pressures to 2400 psig [16550 kPa] @ 100ºF [38ºC] and TL gages can achieve pressures to 2000 psig [13790 kPa] @ 100ºF [38ºC] when manufactured with size 1 glass – see ratings table below.

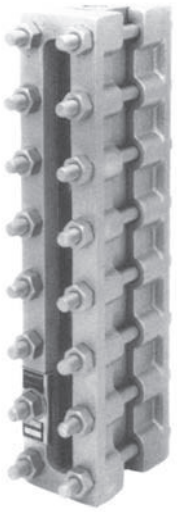
Penberthy does not recommend low pressure gages for steam/water applications.

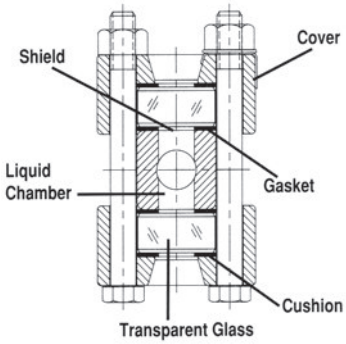
Model RL – Reflex Low Pressure



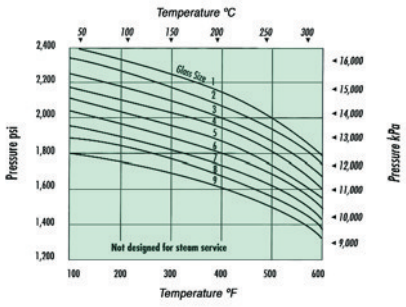


Model TL – Transparent Low Pressure

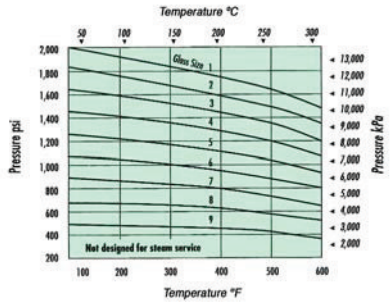




Model RL Pressure/Temperature



Model TL Pressure/Temperature



Standard/Optional Features

CONNECTION TYPE	STANDARD	OPTIONAL
End Connections		
Threaded		
1/2" NPTF	X	
3/4" NPTF		X
Socketweld		
1/2" female		X
3/4" female		X
Flanged		X
Side or Back (typically reflex only) **Connections**		
Threaded		
1/2" NPTF		X
3/4" NPTF		X
Socketweld		
1/2" female		X
3/4" female		X
Flanged		X

NOTE: Pressure/Temperature ratings shown for standard gasket, otherwise see chart on page 13.

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Medium Pressure Flat Glass Gages

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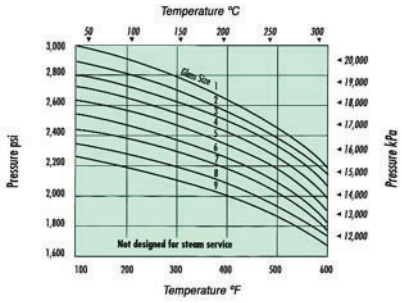
for most common process conditions...

Strength and versatility make Penberthy's medium pressure gages ideal for most common process conditions. Offshore specification 2600.1 is preferred with medium pressure gages in offshore and other corrosive environments.

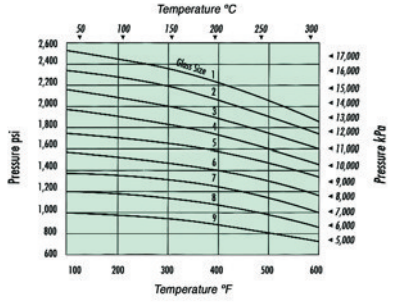
All materials in medium pressure gages conform to ASTM specifications. RM gages can achieve pressures to 3000 psig [20680 kPa] @ 100˚F [38˚C] and TM gages can achieve pressures to 2500 psig [17240 kPa] @ 100˚F [38˚C] when manufactured with size 1 glass – see ratings table below.

Although not designed for thermal cycling, Penberthy allows use of medium pressure gages for steam/ water applications due to historical precendence - see Application Report 2781 in Penberthy Catalog.

Model RM Pressure/Temperature



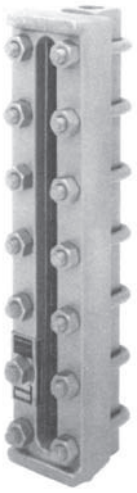
Model TM Pressure/Temperature

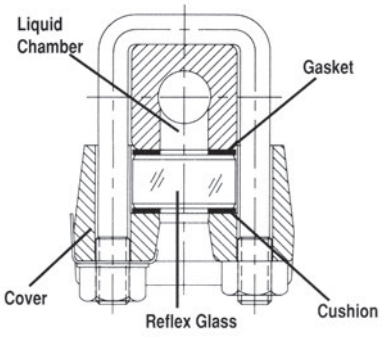


NOTE: Pressure/Temperature ratings shown for standard gasket, otherwise see chart on page 13.

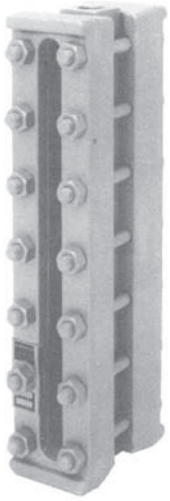
For environmental Nace MR0175 &/or MR0103 gages, pressure de-rating is required

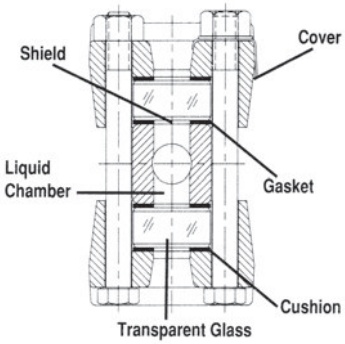
Model RM – Relfex Medium Pressure





Model TM – Transparent Medium Pressure





Standard/Optional Features

CONNECTION TYPE	STANDARD	OPTIONAL
End Connections		
Threaded		
1/2" NPTF	X	
3/4" NPTF		X
Socketweld		
1/2" female		X
3/4" female		X
Flanged		X
Side or Back (typically reflex only) **Connections**		
Threaded		
1/2" NPTF		X
3/4" NPTF		X
Socketweld		
1/2" female		X
3/4" female		X
Flanged		X
Chambers		
Recessed Gasket		X

**Gages with recessed gaskets are designed with the letter R at the end of the Model Number (i.e. RMR)*

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Extract from the online catalog

FBST 500-PLC GY

Order No.: 2966838



http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=2966838

Continuous plug-in bridge, Length: 500 mm, Color: gray

Commercial data	
EAN	4017918130657
Pack	20 pcs.
Customs tariff	85389099
Weight/Piece	0.041035 KG
Catalog page information	Page 111 (TT-2009)

Product notes

WEEE/RoHS-compliant since: 04/27/2006

http://www.download.phoenixcontact.com
Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation. The General Terms and Conditions of Use apply to Internet downloads.

Technical data

General

Length	500 mm
Color	gray

Certificates / Approvals

Certification	GL

Address

PHOENIX CONTACT Deutschland GmbH
Flachsmarktstr. 8
32825 Blomberg,Germany
Phone +49 5235 3 12000
Fax +49 5235 3 41200
http://www.phoenixcontact.de

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Quick Start Guide
00825-0100-4107, Rev CC
July 2016

Rosemount™ 2051 Pressure Transmitter and Rosemount 2051CF Series Flowmeter

with 4–20 mA HART® and 1–5Vdc Low Power HART Protocol (Revision 5 and 7)



HART COMMUNICATION PROTOCOL

EMERSON™
Process Management

NOTICE

This guide provides basic guidelines for Rosemount 2051 Pressure Transmitters. It does not provide instructions for configuration, diagnostics, maintenance, service, troubleshooting, Explosion-proof, Flameproof, or intrinsically safe (I.S.) installations. Refer to the Rosemount 2051 Reference Manual for more instruction. This manual is also available electronically on EmersonProcess.com/Rosemount.

⚠WARNING

Explosions could result in death or serious injury.

Installation of this transmitter in an explosive environment must be in accordance with the appropriate local, national, and international standards, codes, and practices. Review the approvals section of the Rosemount 2051 Reference Manual for any restrictions associated with a safe installation.

- Before connecting a HART-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- In an Explosion-proof/Flameproof installation, do not remove the transmitter covers when power is applied to the unit.

Process leaks may cause harm or result in death.

- To avoid process leaks, only use the O-ring designed to seal with the corresponding flange adapter.

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and the terminals. High voltage that may be present on leads can cause electrical shock.

Conduit/cable entries

- Unless marked, the conduit/cable entries in the transmitter housing use a $^1/_2$–14 NPT thread form.
- Entries marked “M20” are M20 ×1.5 thread form. On devices with multiple conduit entries, all entries will have the same thread form.
- Only use plugs, adapters, glands or conduit with a compatible thread form when closing these entries.

Contents

System readiness 3
Mount the transmitter 4
Consider housing rotation 8
Set the switches 9
Connect the wiring and power up 10
Verify transmitter configuration 12
Trim the transmitter 15
Safety instrumented systems 16
Product Certifications 17

1.0 System readiness

1.1 Confirm HART Revision capability

- If using HART-based control or asset management systems, confirm the HART capability of those systems prior to transmitter installation. Not all systems are capable of communicating with HART Revision 7 Protocol. This transmitter can be configured for either HART Revision 5 or 7.
- For instructions on how to change the HART revision of your transmitter, see page 14.

1.2 Confirm correct device driver

- Verify the latest device driver (DD/DTM™) is loaded on your systems to ensure proper communications.
- Download the latest Device Driver files at EmersonProcess.com or HARTComm.org.

1.3 Rosemount 2051 device revisions and drivers

Verify the latest device driver (DD/DTM) is loaded on your systems to ensure proper communications.

1. Download the latest DD at EmersonProcess.com or HARTComm.org.
2. In the *Browse by Member* dropdown menu, select **Rosemount business unit of Emerson Process Management**.
3. Select desired product. Within Table 1, use the HART Universal Revision and device revision numbers to find the correct device driver.

Table 1. Rosemount 2051 Device Revisions and Files

	Identify device		Find device driver files		Review instructions	Review functionality
Software release date	**NAMUR software revision(1)**	**HART software revision(2)**	**HART universal revision**	**Device revision(2)**	**Manual document number**	**Changes to software(3)**
April 2012	1.0.0	01	7	10	AA	See Footnote 3 for list of changes.
			5	9		
January 1998	N/A	178	5	3		N/A

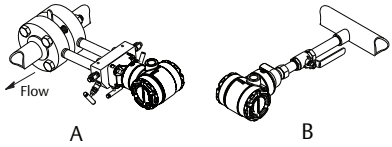
1. NAMUR software revision is located on the hardware tag of the device. HART software revision can be read using a HART capable configuration tool.
2. Device driver file names as device and DD revision, e.g. 10_01. HART Protocol is designed to enable legacy device driver revisions to continue to communicate with new HART devices. To access new functionality, the new device driver must be downloaded. It is recommended to download new device driver files to ensure full functionality.
3. HART Revision 5 and 7 Selectable, Safety Certified. Local Operator Interface, Process Alerts, Scaled Variable, Configurable Alarms, Expanded Engineering Units.

2.0 Mount the transmitter

2.1 Liquid applications

1. Place taps to the side of the line.
2. Mount beside or below the taps.
3. Mount the transmitter so that the drain/vent valves are oriented upward.

Figure 1. Liquid Applications

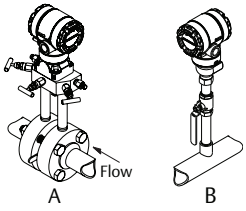


A. Coplanar
B. In-line

2.2 Gas applications

1. Place taps in the top or side of the line.
2. Mount beside or above the taps.

Figure 2. Gas Applications

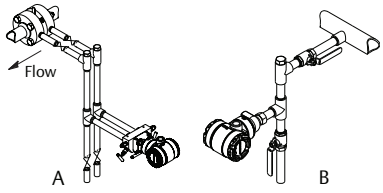


A. Coplanar
B. Inline

2.3 Steam applications

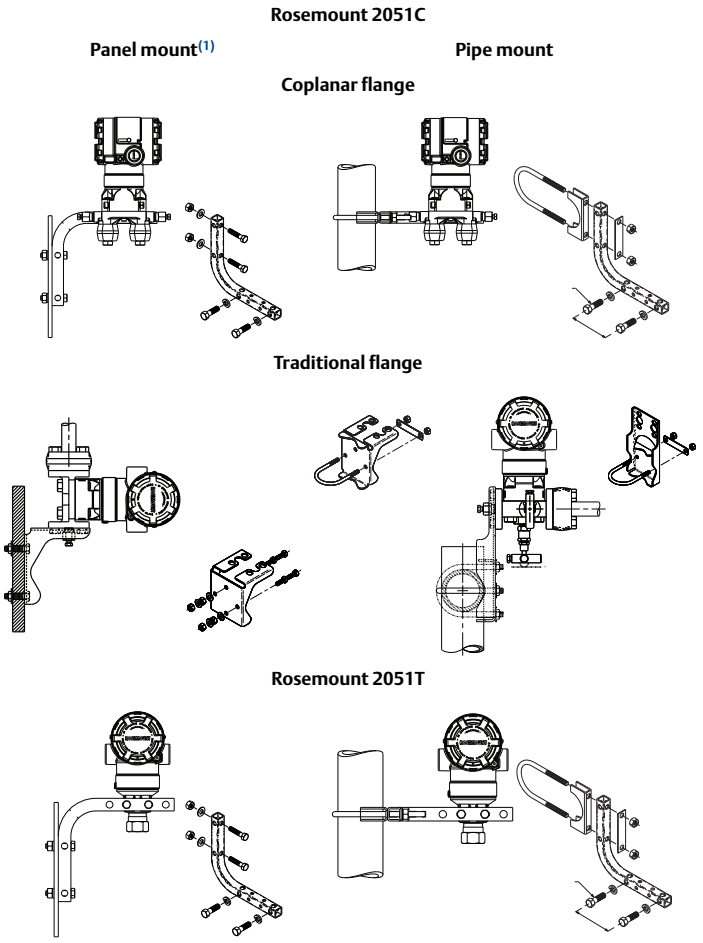
1. Place taps to the side of the line.
2. Mount beside or below the taps.
3. Fill impulse lines with water.

Figure 3. Steam Applications



A. Coplanar
B. Inline

Figure 4. Pipe and Panel Mounting

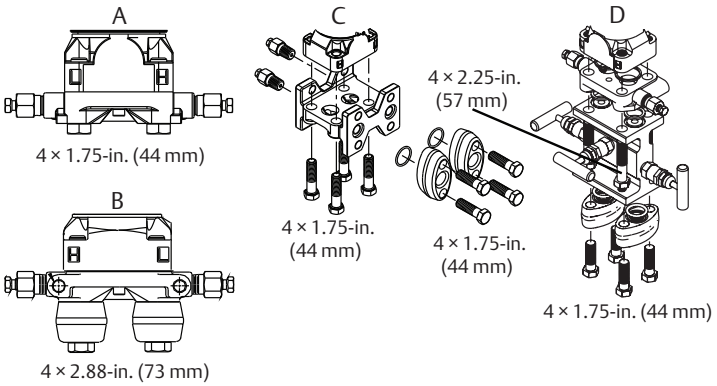


1. Panel bolts are customer supplied.

2.4 Bolting considerations

If the transmitter installation requires assembly of the process flanges, manifolds, or flange adapters, follow these assembly guidelines to ensure a tight seal for optimal performance characteristics of the transmitters. Use only bolts supplied with the transmitter or sold by Emerson™ Process Management as spare parts. Figure 5 illustrates common transmitter assemblies with the bolt length required for proper transmitter assembly.

Figure 5. Common Transmitter Assemblies



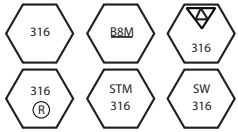
A. Transmitter with coplanar flange
B. Transmitter with coplanar flange and optional flange adapters
C. Transmitter with traditional flange and optional flange adapters
D. Transmitter with coplanar flange and optional manifold and flange adapters

Bolts are typically carbon steel or stainless steel. Confirm the material by viewing the markings on the head of the bolt and referencing Table 2. If bolt material is not shown in Table 2, contact the local Emerson Process Management representative for more information.

Use the following bolt installation procedure:

1. Carbon steel bolts do not require lubrication and the stainless steel bolts are coated with a lubricant to ease installation. However, no additional lubricant should be applied when installing either type of bolt.
2. Finger-tighten the bolts.
3. Torque the bolts to the initial torque value using a crossing pattern. See Table 2 for initial torque value.
4. Torque the bolts to the final torque value using the same crossing pattern. See Table 2 for final torque value.
5. Verify the flange bolts are protruding through the isolator plate before applying pressure.

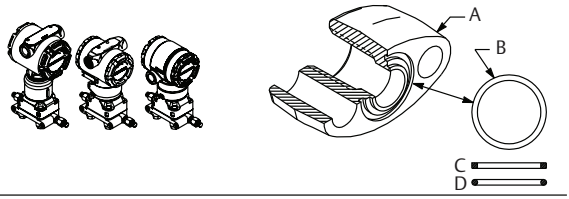
Table 2. Torque Values for the Flange and Flange Adapter Bolts

Bolt material	Head markings	Initial torque	Final torque
Carbon Steel (CS)		300 in-lb	650 in-lb
Stainless Steel (SST)		150 in-lb	300 in-lb

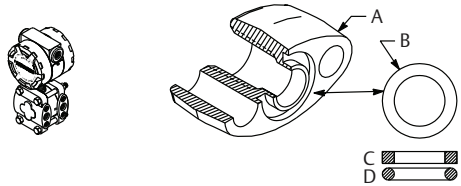
⚠ WARNING

Failure to install proper flange adapter O-rings may cause process leaks, which can result in death or serious injury. The two flange adapters are distinguished by unique O-ring grooves. Only use the O-ring that is designed for its specific flange adapter, as shown below:

Rosemount 3051S/3051/2051/3095



Rosemount 1151



A. Flange adapter
B. O-ring
C. PTFE based (profile is square)
D. Elastomer (profile is round)

2.5 Environmental seal for housing

Thread sealing (PTFE) tape or paste on male threads of conduit is required to provide a water/dust tight conduit seal and meets requirements of NEMA® Type 4X, IP66, and IP68. Consult factory if other Ingress Protection ratings are required.

For M20 threads, install conduit plugs to full thread engagement or until mechanical resistance is met.

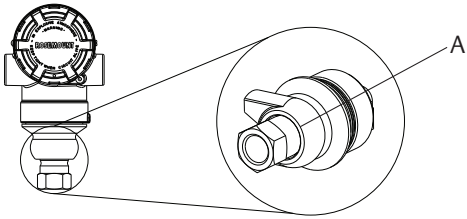
2.6 In-line gage transmitter orientation

The low side pressure port (atmospheric reference) on the in-line gage transmitter is located in the neck of the transmitter, behind the housing. The vent path is 360° around the transmitter between the housing and sensor. (See Figure 6.)

⚠ CAUTION

Keep the vent path free of any obstruction, including but not limited to paint, dust, and lubrication by mounting the transmitter so that the contaminants can drain away.

Figure 6. In-line Gage Low Side Pressure Port



A. Low side pressure port (atmospheric reference)

3.0 Consider housing rotation

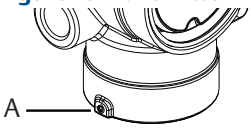
To improve field access to wiring or to better view the optional LCD display:

1. Loosen the housing rotation set screw using a 5/64-in. hex wrench.
2. Turn the housing left or right maximum up to 180° from its original position.(1)

Note
Over rotating can damage the transmitter.

3. Re-tighten the housing rotation set screw to no more than 7 in-lb when desired location is reached.

Figure 7. Transmitter Housing Set Screw



A. Housing rotation set screw (5/64-in.)

1. *Rosemount 3051C original position aligns with "H" side; Rosemount 3051T original position is the opposite side of bracket holes.*

4.0 Set the switches

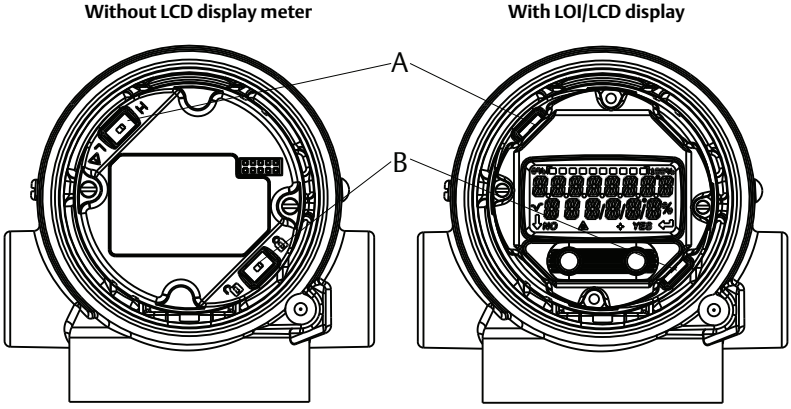
Set alarm and security switch configuration before installation as shown in Figure 8.

- The alarm switch sets the analog output alarm to high or low.
  - Default alarm is high.
- The security switch allows ( ) or prevents ( ) any configuration of the transmitter.
  - Default security is off ( ).

Use the following procedure to change the switch configuration:

1. If the transmitter is installed, secure the loop, and remove power.
2. Remove the housing cover opposite the field terminal side. Do not remove the instrument cover in explosive atmospheres when the circuit is live.
3. Slide the security and alarm switches into the preferred position using a small screwdriver.
4. Reattach the transmitter cover. The cover must be fully engaged to comply with explosion-proof requirements.

Figure 8. Transmitter Electronics Board

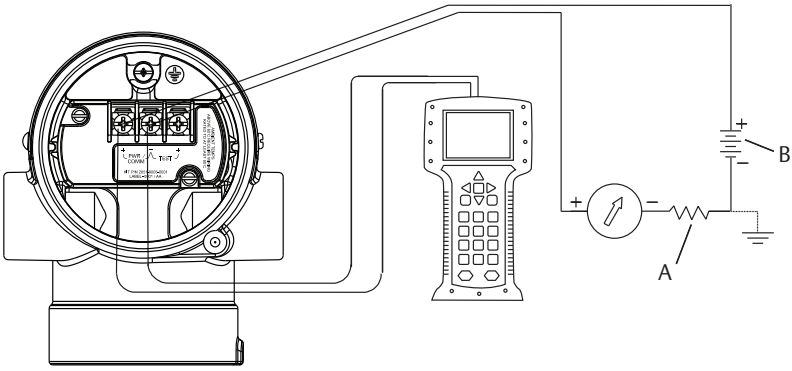


A. Alarm
B. Security

5.0 Connect the wiring and power up

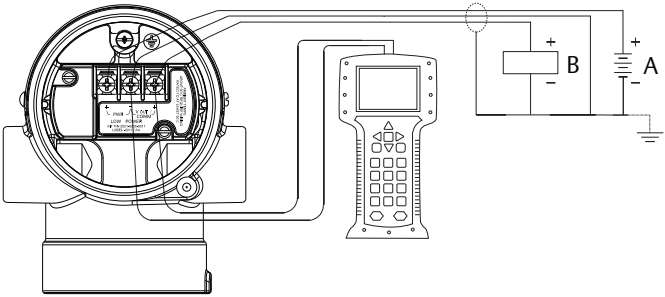
Shielded twisted pair cable should be used for best results. Use 24 AWG or larger wire that does not exceed 5,000 feet (1500 meters) in length. If applicable, install wiring with a drip loop. Arrange the drip loop so the bottom is lower than the conduit connections and the transmitter housing.

Figure 9. Wiring the Transmitter (4–20 mA HART)



A. Vdc supply
B. $R_L \geq 250$ (necessary for HART communication only)

Figure 10. Wiring the Transmitter (1–5 Vdc Low Power)



A. Power supply
B. Voltmeter

⚠ CAUTION

- Installation of the transient protection terminal block does not provide transient protection unless the Rosemount 2051 case is properly grounded.
- Do not run signal wiring in conduit or open trays with power wiring, or near heavy electrical equipment.
- Do not connect the powered signal wiring to the test terminals. Power could damage the test diode in the terminal block.

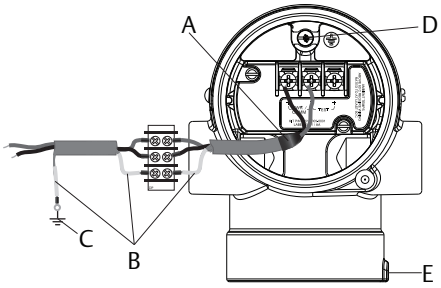
Use the following steps to wire the transmitter:

1. Remove the housing cover on the field terminals side.
2. Connect the leads as shown in Figure 9 or Figure 10.
3. Tighten the terminal screws to ensure full contact with the terminal block screw and washer. When using a direct wiring method, wrap wire clockwise to ensure it is in place when tightening the terminal block screw.

Note
The use of a pin or ferrule wire terminal is not recommended as the connection may be more susceptible to loosening over time or under vibration.

4. Ground housing to fulfill local grounding regulations.
5. Ensure proper grounding. It is important that the instrument cable shield:
   a. Be trimmed close and insulated from touching the transmitter housing.
   b. Be connected to the next shield if cable is routed through a junction box.
   c. Be connected to a good earth ground at the power supply end.
6. If transient protection is needed, refer to section "Grounding for transient terminal block" on page 11 for grounding instructions.
7. Plug and seal unused conduit connections.
8. Replace the housing cover.

Figure 11. Grounding



A. Trim shield and insulate
B. Insulate shield
C. Terminate cable shield drain wire to earth ground
D. Internal ground location
E. External ground location

5.1 Grounding for transient terminal block

Ground termination is provided on the outside of the electronics housing and inside the terminal compartment. These grounds are used when the transient protection terminal blocks are installed. It is recommended that 18 AWG or larger wire is used to connect housing ground to earth ground (internal or external).

If the transmitter is currently not wired for power up and communication, follow Step 1 through 8 of "Connect the wiring and power up" on page 10. When the transmitter is properly wired, refer to Figure 11 for internal and external transient grounding locations.

6.0 Verify transmitter configuration

Verify the configuration using any HART capable configuration tool or local operator interface (LOI) - option code M4. Configuration instructions for a Field Communicator and LOI are included in this step. See the Rosemount 2051 Reference Manual for configuration instructions using AMS™ Device Manager.

6.1 Verifying configuration with a Field Communicator

A Rosemount 2051 DD must be installed on the Field Communicator to verify configuration. Fast Key sequences for the latest DD are shown in Table 3 on page 12. For Fast Key sequences using legacy DD's, contact your local Emerson Process Management representative.

Note
Emerson recommends installing the latest DD to access the complete functionality. Visit EmersonProcess.com or HARTComm.org.

1. Verify device configuration using the fast key sequences in Table 3.
   a. A check (✓) indicates the basic configuration parameters. At minimum, these parameters should be verified as part of configuration and startup.
   b. A (7) indicates availability only in HART Revision 7 mode.

Table 3. Device Revision 9 and 10 (HART7), DD Revision 1 Fast Key Sequence

	Function	Fast Key sequence	
		HART 7	HART 5
✓	Alarm and Saturation Levels	2, 2, 2, 5, 7	2, 2, 2, 5, 7
✓	Damping	2, 2, 1, 1, 5	2, 2, 1, 1, 5
✓	Range Values	2, 2, 2,	2, 2, 2
✓	Tag	2, 2, 7, 1, 1	2, 2, 7, 1, 1
✓	Transfer Function	2, 2, 1, 1, 6	2, 2, 1, 1, 6
✓	Units	2, 2, 1, 1, 4	2, 2, 1, 1, 4
	Burst Mode	2, 2, 5, 3	2, 2, 5, 3
	Custom Display Configuration	2, 2, 4	2, 2, 4
	Date	2, 2, 7, 1, 4	2, 2, 7, 1, 3
	Descriptor	2, 2, 7, 1, 5	2, 2, 7, 1, 4
	Digital to Analog Trim (4–20 mA Output)	3, 4, 2	3, 4, 2
	Disable Configuration Buttons	2, 2, 6, 3	2, 2, 6, 3
	Rerange with Keypad	2, 2, 2, 1	2, 2, 2, 1
	Loop Test	3, 5, 1	3, 5, 1
	Lower Sensor Trim	3, 4, 1, 2	3, 4, 1, 2
	Message	2, 2, 7, 1, 6	2, 2, 7, 1, 5
	Scaled D/A Trim (4–20 mA Output)	3, 4, 2	3, 4, 2
	Sensor Temperature/Trend	3, 3, 3	3, 3, 3

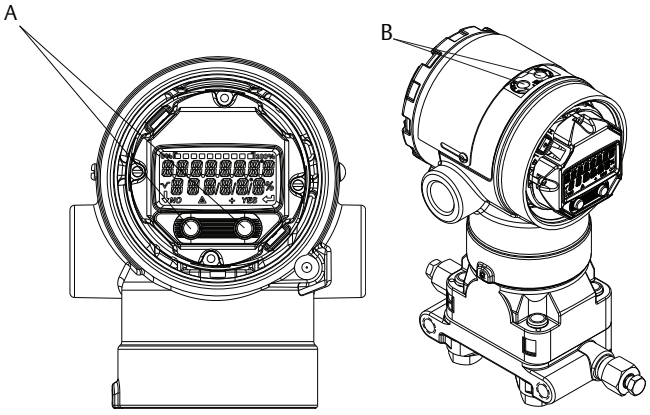
Table 3. Device Revision 9 and 10 (HART7), DD Revision 1 Fast Key Sequence

	Function	Fast Key sequence	
		HART 7	HART 5
	Upper Sensor Trim	3, 4, 1, 1	3, 4, 1, 1
	Digital Zero Trim	3, 4, 1, 3	3, 4, 1, 3
	Password	2, 2, 6, 5	2, 2, 6, 4
	Scaled Variable	3, 2, 2	3, 2, 2
	HART Revision 5 to HART Revision 7 switch	2, 2, 5, 2, 3	2, 2, 5, 2, 3
7	Long Tag	2, 2, 7, 1, 2	N/A
7	Find Device	3, 4, 5	N/A
7	Simulate Digital Signal	3, 4, 5	N/A

6.2 Verifying configuration with LOI

The optional LOI can be used for commissioning the device. The LOI is a two button design with internal and external buttons. The internal buttons are located on the display of the transmitter, while the external buttons are located underneath the top metal tag. To activate the LOI push any button. LOI button functionality is shown on the bottom corners of the display. See Table 4 and Figure 13 for button operation and menu information.

Figure 12. Internal and External LOI Buttons



A. Internal buttons
B. External buttons

Note
See Figure 14 on page 16 to confirm external button functionality.

Table 4. LOI Button Operation

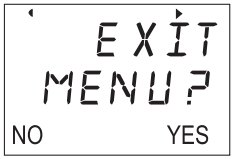
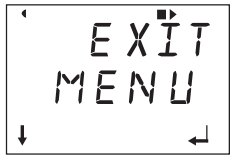
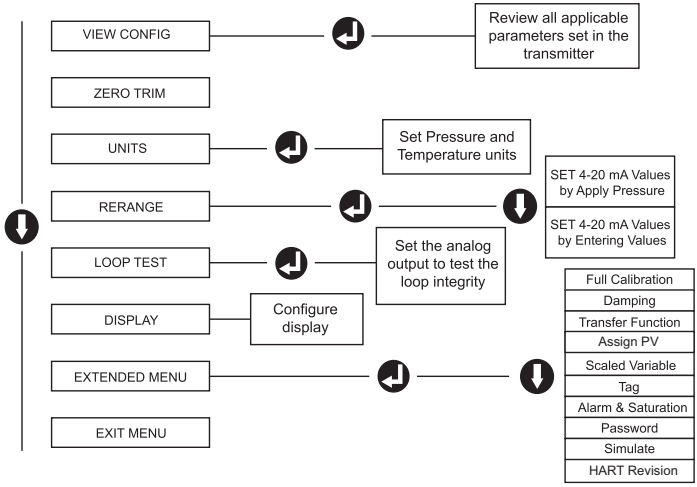
Button		
Left	No	SCROLL
Right	Yes	ENTER

Figure 13. LOI Menu



6.3 Switch HART revision mode

If the HART configuration tool is not capable of communicating with HART Revision 7, the Rosemount 2051 will load a generic menu with limited capability. The following procedures will switch the HART revision mode from the generic menu:

1. *Manual Setup > Device Information > Identification > Message*
   a. To change to HART Revision 5, Enter: “HART5” in the Message field
   b. To change to HART Revision 7, Enter: “HART7” in the Message field

7.0 Trim the transmitter

Devices are calibrated by the factory. Once installed, it is recommended to perform a zero trim on gage and differential pressure transmitters to eliminate error due to mounting position or static pressure effects. A zero trim can be performed using either a Field Communicator or configuration buttons.

For instructions using AMS Device Manager, see the Rosemount 2051 Reference Manual.

Note
When performing a zero trim, ensure the equalization valve is open and all wet legs are filled to the correct level.

⚠ CAUTION

It is not recommended to zero an absolute transmitter, Rosemount 2051TA model.

1. Choose your trim procedure
   a. Analog zero trim – Sets the analog output to 4 mA.
      - Also referred to as a "rerange," it sets the lower range value (LRV) equal to the measured pressure.
      - The display and digital HART output remains unchanged.
   b. Digital zero trim – Recalibrates the sensor zero.
      - The LRV is unaffected. The pressure value will be zero (on display and HART output). 4 mA point may not be at zero.
      - This requires that the factory calibrated zero pressure is within a range of 3% of the URL (0 ± 3% × URL).

Example

URV = 250 inH_2O

Applied zero pressure = +0.03 × 250 inH_2O = +7.5 inH_2O (compared to factory settings) values outside this range will be rejected by the transmitter

7.1 Trimming with a Field Communicator

1. Connect the Field Communicator, see "Connect the wiring and power up" on page 10 for instructions.
2. Follow the HART menu to perform the desired zero trim.

Table 5. Zero Trim Fast Keys

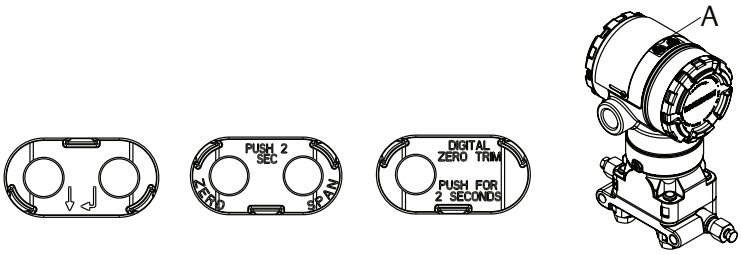
	Analog zero (set 4 mA)	Digital zero
Fast Key sequence	3, 4, 2	3, 4, 1, 3

7.2 Trimming with configuration buttons

A zero trim is to be performed using one of the three possible sets of external configuration buttons located under the top tag.

To access the configuration buttons, loosen the screw and slide the tag on the top of the transmitter. Confirm the functionality using Figure 12.

Figure 14. External Configuration Buttons



A. Configuration buttons

Use the following procedures to perform a zero trim:

Perform trim with LOI (option M4)

1. Set the transmitter pressure.
2. See Figure 13 on page 14 for the operating menu.
   a. Perform an analog zero trim by selecting **Rerange**.
   b. Perform a digital zero trim by selecting **Zero Trim**.

Perform trim with analog zero and span (option D4)

1. Set the transmitter pressure.
2. Press and hold the **Zero** button for two seconds to perform an analog zero trim.

Perform trim with digital zero (option DZ)

1. Set the transmitter pressure.
2. Press and hold the **Zero** button for two seconds to perform a digital zero trim.

8.0 Safety instrumented systems

For safety certified installations, refer to the Rosemount 2051 Reference Manual for installation procedure and system requirements.

9.0 Product Certifications

Rev1.3

9.1 European Directive Information

A copy of the EC Declaration of Conformity can be found at the end of the Quick Start Guide. The most recent revision of the EC Declaration of Conformity can be found at EmersonProcess.com/Rosemount.

9.2 Ordinary Location Certification

As standard, the transmitter has been examined and tested to determine that the design meets the basic electrical, mechanical, and fire protection requirements by a nationally recognized test laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

9.3 North America

E5 USA Explosionproof (XP) and Dust-Ignitionproof (DIP)
Certificate: 3032938
Standards: FM Class 3600 – 2011, FM Class 3615 – 2006, FM Class 3616 – 2011, FM Class 3810 – 2005, ANSI/NEMA 250 -– 2008, ANSI/IEC 60529 2004
Markings: XP CL I, DIV 1, GP B, C, D; DIP CL II, DIV 1, GP E, F, G; CL III; T5(–50 °C ≤ T_a ≤ +85 °C); Factory Sealed; Type 4X

I5 USA Intrinsic Safety (IS) and Nonincendive (NI)
Certificate: 3033457
Standards: FM Class 3600 – 2011, FM Class 3610 – 2010, FM Class 3611 – 2004, FM Class 3810 – 2005, ANSI/NEMA 250 – 2008
Markings: IS CL I, DIV 1, GP A, B, C, D; CL II, DIV 1, GP E, F, G; Class III; DIV 1 when connected per Rosemount drawing 02051-1009; Class I, Zone 0; AEx ia IIC T4; NI CL 1, DIV 2, GP A, B, C, D; T4(–50 °C ≤ T_a ≤ +70 °C); Type 4x

IE USA FISCO
Certificate: 3033457
Standards: FM Class 3600 – 2011, FM Class 3610 – 2010, FM Class 3611 – 2004, FM Class 3810 – 2005
Markings: IS CL I, DIV 1, GP A, B, C, D when connected per Rosemount drawing 02051-1009 (–50 °C ≤ T_a ≤ +60 °C); Type 4x

E6 Canada Explosion-Proof, Dust Ignition Proof
Certificate: 2041384
Standards: CAN/CSA C22.2 No. 0-10, CSA Std C22.2 No. 25-1966, CSA Std C22.2 No. 30-M1986, CAN/CSA-C22.2 No. 94-M91, CSA Std C22.2 No.142-M1987, CAN/CSA-C22.2 No.157-92, CSA Std C22.2 No. 213-M1987, CAN/CSA-E60079-0:07, CAN/CSA-E60079-1:07, CAN/CSA-E60079-11-02, CAN/CSA-C22.2 No. 60529:05, ANSI/ISA-12.27.01–2003
Markings: Explosion-Proof for Class I, Divisions 1, Groups B, C, and D. Dust-Ignition Proof for Class II and Class III, Division 1, Groups E, F, and G. Suitable for Class I, Division 2; Groups A, B, C, and D for indoor and outdoor hazardous locations. Class I Zone 1 Ex d IIC T5. Enclosure type 4X, factory sealed. Single Seal

I6 Canada Intrinsic Safety
Certificate: 2041384
Standards: CSA Std. C22.2 No. 142 - M1987, CSA Std. C22.2 No. 213 - M1987, CSA Std. C22.2 No. 157 - 92, CSA Std. C22.2 No. 213 - M1987, ANSI/ISA 12.27.01 – 2003, CAN/CSA-E60079-0:07, CAN/CSA-E60079-11:02
Markings: Intrinsically safe for Class I, Division 1, Groups A, B, C, and D when connected in accordance with Rosemount drawing 02051-1008. Ex ia IIC T3C. Single Seal. Enclosure Type 4X

9.4 Europe

E1 ATEX Flameproof
Certificate: KEMA 08ATEX0090X
Standards: EN60079-0:2006, EN60079-1:2007, EN60079-26:2007
Markings: Ex II 1/2 G Ex d IIC T6 IP66 ($-50\ °C \le T_a \le 65\ °C$);
Ex II 1/2 G Ex d IIC T5 IP66 ($-50\ °C \le T_a \le 80\ °C$)

Special Conditions for Safe Use (X):

1. The Ex d blanking elements, cable glands and wiring needs to be suitable for a temperature of 90 °C.
2. This device contains a thin wall diaphragm. Installation, maintenance and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for maintenance shall be followed in detail to assure safety during its expected lifetime.
3. In case of repair, contact the manufacturer for information on the dimensions of the flameproof joints.

I1 ATEX Intrinsic Safety
Certificate: Baseefa08ATEX0129X
Standards: EN60079-0:2012, EN60079-11:2012
Markings: Ex II 1 G Ex ia IIC T4 Ga ($-60\ °C \le T_a \le +70\ °C$)

Table 6. Input Parameters

Parameter	HART	Fieldbus/PROFIBUS®
Voltage U_i	30 V	30 V
Current I_i	200 mA	300 mA
Power P_i	1 W	1.3 W
Capacitance C_i	0.012 µF	0 µF
Inductance L_i	0 mH	0 mH

Special Conditions for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V isolation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in Zone 0.

IA ATEX FISCO
Certificate: Baseefa08ATEX0129X
Standards: EN60079-0:2012, EN60079-11:2012
Markings: Ⓔx II 1 G Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +60 °C)

Table 7. Input Parameters

Parameter	FISCO
Voltage U_i	17.5 V
Current I_i	380 mA
Power P_i	5.32 W
Capacitance C_i	0 µF
Inductance L_i	0 mH

Special Conditions for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V isolation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in Zone 0.

N1 ATEX Type n
Certificate: Baseefa08ATEX0130X
Standards: EN60079-0:2012, EN60079-15:2010
Markings: Ⓔx II 3G Ex nA IIC T4 Gc (–40 °C ≤ T_a ≤ +70 °C)

Special Condition for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V electrical strength test as defined in clause 6.5.1 of by EN 60079-15:2010. This must be taken into account during installation.

ND ATEX Dust
Certificate: Baseefa08ATEX0182X
Standards: EN60079-0:2012, EN60079-31:2009
Markings: Ⓔx II 1 D Ex ta IIIC T95 °C T_{500} 105 °C Da (–20 °C ≤ T_a ≤ +85 °C)

Special Condition for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V isolation from earth test and this must be taken into account during installation.

9.5 International

E7 IECEx Flameproof
Certificate: IECExKEM08.0024X
Standards: IEC60079-0:2004, IEC60079-1:2007-04, IEC60079-26:2006
Markings: Ex d IIC T6/T5 IP66, T6(–50 °C ≤ T_a ≤ +65 °C), T5(–50 °C ≤ T_a ≤ +80 °C)

Table 8. Process Temperature

Temperature class	Process temperature
T6	–50°C to +65 °C
T5	–50 °C to +80 °C

Special Conditions for Safe Use (X):

1. The device contains a thin wall diaphragm. Installation, maintenance and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for maintenance shall be followed in detail to assure safety during its expected lifetime.
2. The Ex d blanking elements, cable glands, and wiring shall be suitable for a temperature of 90 °C.
3. In case of repair, contact the manufacturer for information on the dimensions of the flameproof joints.

I7 IECEx Intrinsic Safety
Certificate: IECExBAS08.0045X
Standards: IEC60079-0:2011, IEC60079-11:2011
Markings: Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +70 °C)

Table 9. Input Parameters

Parameter	HART	Fieldbus/PROFIBUS
Voltage U_i	30 V	30 V
Current I_i	200 mA	300 mA
Power P_i	1 W	1.3 W
Capacitance C_i	0.012 µF	0 µF
Inductance L_i	0 mH	0 mH

Special Conditions for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V isolation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in Zone 0.

IG IECEx FISCO
Certificate: IECExBAS08.0045X
Standards: IEC60079-0:2011, IEC60079-11:2011
Markings: Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +60 °C)

Table 10. Input Parameters

Parameter	FISCO
Voltage U_i	17.5 V
Current I_i	380 mA
Power P_i	5.32 W
Capacitance C_i	0 µF
Inductance L_i	0 mH

Special Conditions for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V isolation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in Zone 0.

N7 IECEx Type n
Certificate: IECExBAS08.0046X
Standards: IEC60079-0:2011, IEC60079-15:2010
Markings: Ex nA IIC T4 Gc (–40 °C ≤ T_a ≤ +70 °C)

Special Condition for Safe Use (X):

1. If fitted with a 90 V transient suppressor, the equipment is not capable of withstanding the 500 V electrical strength test as defined in clause 6.5.1 of IEC60079-15:2010. This must be taken into account during installation.

9.6 Brazil

E2 INMETRO Flameproof
Certificate: UL-BR 14.0375X
Standards: ABNT NBR IEC60079-0:2008 + Errata 1:2011, ABNT NBR IEC 60079-1:2009 + Errata 1:2011, ABNT NBR IEC 60079-26:2008 + Errata 1:2009
Markings: Ex d IIC T6/T5 Gb IP66, T6(–50 °C ≤ T_a ≤ +65 °C), T5(–50 °C ≤ T_a ≤ +80 °C)

Special Conditions for Safe Use (X):

1. The device contains a thin wall diaphragm. Installation, maintenance and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.
2. The Ex d blanking elements, cable glands, and wiring shall be suitable for a temperature of 90 °C.
3. In case of repair, contact the manufacturer for information on the dimensions of the flameproof joints.

I2 INMETRO Intrinsic Safety
Certificate: UL-BR 14.0759X
Standards: ABNT NBR IEC 60079-0:2008 + Errata 1:2011; ABNT NBR IEC 60079-11:2009
Markings: Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +70 °C)

Table 11. Input Parameters

Parameter	HART	Fieldbus/PROFIBUS
Voltage U_i	30 V	30 V
Current I_i	200 mA	300 mA
Power P_i	1 W	1.3 W
Capacitance C_i	12 nF	0
Inductance L_i	0	0

Special Conditions for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V insulation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminium alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in atmospheres that require ELP Ga.

IB INMETRO FISCO
Certificate: UL-BR 14.0759X
Standards: ABNT NBR IEC 60079-0:2008 + Errata 1:2011; ABNT NBR IEC 60079-11:2009
Markings: Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +60 °C)

Table 12. Input Parameters

Parameter	FISCO
Voltage U_i	17.5 V
Current I_i	380 mA
Power P_i	5.32 W
Capacitance C_i	0 nF
Inductance L_i	0 µH

Special Conditions for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V insulation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminium alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in atmospheres that require ELP Ga.

9.7 China

E3 China Flameproof
Certificate: GYJ13.1386X; GYJ15.1366X [Flowmeters]
Standards: GB3836.1-2010, GB3836.2-2010, GB3836.20-2010-2010
Markings:
Pressure Transmitter: Ex d IIC Gb, T6(–50 °C ≤ T_a ≤ +65 °C), T5(–50 °C ≤ T_a ≤ +80 °C)
Flowmeter: Ex d IIC Ga/Gb, T6(–50 °C ≤ T_a ≤ +65 °C), T5(–50 °C ≤ T_a ≤ +80 °C)

Special Conditions of Use (X):

1. Symbol “X” is used to denote specific conditions of use:
   - The Ex d blanking elements, cable glands, and wiring shall be suitable for a temperature of 90 °C.
   - This device contains a thin wall diaphragm. Installation, maintenance and use shall take into account the environment conditions to which the diaphragm will be subjected.
2. The relation between T code and ambient temperature range is:

T_a	Temperature class
–50 °C ≤ T_a ≤ +80 °C	T5
–50 °C ≤ T_a ≤ +65 °C	T6

3. The earth connection facility in the enclosure should be connected reliably.
4. During installation, use and maintenance of the product, observe the warning “Don’t open the cover when the circuit is alive.”
5. During installation, there should be no mixture harmful to flameproof housing
6. Cable entry and conduit, certified by NEPSI with type of protection Ex d IIC Gb and appropriate thread form, should be applied when installed in a hazardous location. Blanking elements should be used on the redundant cable entries.
7. End users are not permitted to change any internal components, but to settle the problem in conjunction with the manufacturer to avoid damage to the product.

8. Maintenance should be done in a non-hazardous location.
9. During installation, use and maintenance of this product, observe the following standards: GB3836.13-2013, GB3836.15-2000, GB3836.16-2006, GB50257-2014

I3 China Intrinsic Safety
Certificate: GYJ12.1295X; GYJ15.1365X [Flowmeters]
Standards: GB3836.1-2010, GB3836.4-2010, GB3836.20-2010
Markings: Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +70 °C)

Special Conditions for Safe Use (X):

1. Symbol "X" is used to denote specific conditions of use:
   a. If the apparatus is fitted with an optional 90 V transient suppressor, it is not capable of withstanding the 500 V insulation test for 1 minute. This must be taken into account when installing the apparatus.
   b. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care should be taken to protect it from impact or abrasion if located in Zone 0.
2. The relation between T code and ambient temperature range is:

Model	T code	Temperature range
HART, Fieldbus, PROFIBUS, and Low Power	T4	–60 °C ≤ T_a ≤ +70 °C

3. Intrinsically Safe parameters:

Parameter	HART	Fieldbus/PROFIBUS
Voltage U_i	30 V	30 V
Current I_i	200 mA	300 mA
Power P_i	1 W	1.3 W
Capacitance C_i	0.012 µF	0 µF
Inductance L_i	0 mH	0 mH

Note 1
FISCO parameters comply with the requirements for FISCO field devices in GB3836.19-2010

[For Flowmeters] When Rosemount 644 Temperature Transmitter is used, the transmitter should be used with Ex-certified associated apparatus to establish explosion protection system that can be used in explosive gas atmospheres. Wiring and terminals should comply with the instruction manual of both Rosemount 644 and associated apparatus. The cables between Rosemount 644 and associated apparatus should be shielded cables (the cables must have insulated shield). The shielded cable has to be grounded reliably in a non-hazardous area.

4. The product should be used with Ex-certified associated apparatus to establish explosion protection system that can be used in explosive gas atmospheres. Wiring and terminals should comply with the instruction manual of the product and associated apparatus.
5. The cables between this product and associated apparatus should be shielded cables (the cables must have insulated shield). The shielded cable has to be grounded reliably in a non-hazardous area.
6. End users are not permitted to change any internal components, and needs to settle the problem in conjunction with the manufacturer to avoid damage to the product.
7. During installation, use and maintenance of this product, observe the following standards: GB3836.13-2013, GB3836.15-2000, GB3836.16-2006, GB3836.18-2010, GB50257-2014.

9.8 Japan

E4 Japan Flameproof
Certificate: TC20598, TC20599, TC20602, TC20603 [HART]; TC20600, TC20601, TC20604, TC20605 [Fieldbus]
Markings: Ex d IIC T5

9.9 Technical Regulations Customs Union (EAC)

EM EAC Flameproof
Certificate: RU C-US.GB05.B.01199
Markings: Ga/Gb Ex d IIC X, T5(−50 °C ≤ T_a ≤ +80 °C), T6(−50 °C ≤ T_a ≤ +65 °C)

Special Condition for Safe Use (X):

1. See certificate for special conditions.

IM EAC Intrinsically Safe
Certificate: RU C-US.GB05.B.01199
Markings: 0Ex ia IIC T4 Ga X (−60 °C ≤ T_a ≤ +70 °C)

Special Condition for Safe Use (X):

1. See certificate for special conditions.

9.10 Combinations

K1 Combination of E1, I1, N1, and ND

K2 Combination of E2 and I2

K5 Combination of E5 and I5

K6 Combination of E6 and I6

K7 Combination of E7, I7, N7, and IECEx Dust

IECEx Dust
Certificate: IECEx BAS 08.0058X
Standards: IEC60079-0:2011, IEC60079-31:2008
Markings: Ex ta IIIC T95 °C T_{500} 105 °C Da (−20 °C ≤ T_a ≤ +85 °C)

Special Condition for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding a 500 V isolation from earth test and this must be taken into account during installation.

KA Combination of E1, I1, and K6

KB Combination of K5 and K6

KC Combination of E1, I1, and K5

KD Combination of K1, K5, and K6

KM Combination of EM and IM

9.11 Additional Certifications

SBS American Bureau of Shipping (ABS) Type Approval
Certificate: 09-HS446883B-3-PDA
Intended Use: Marine and Offshore Applications – Measurement of either Gauge or Absolute Pressure for Liquid, Gas, and Vapor.
ABS Rules: 2013 Steel Vessels Rules 1-1-4/7.7, 1-1-Appendix 3, 4-8-3/1.7, 4-8-3/13.1

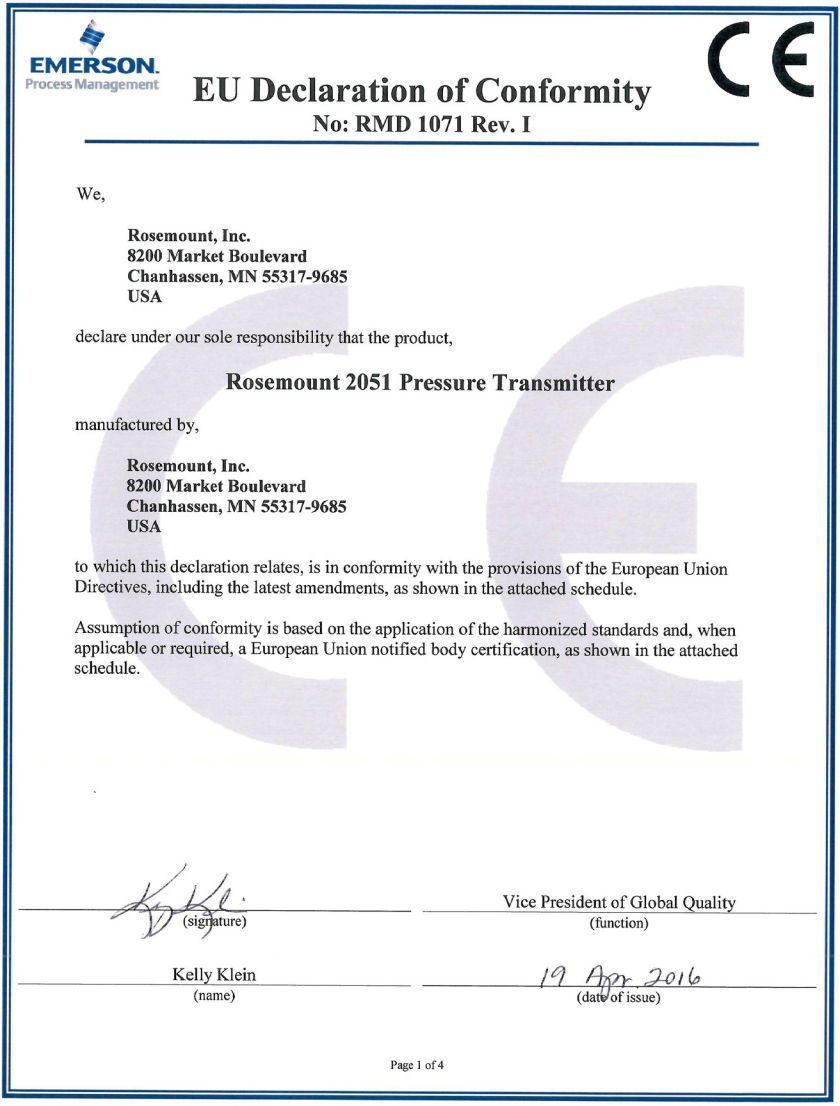
SBV Bureau Veritas (BV) Type Approval
Certificate: 23157/B0 BV
BV Rules: Bureau Veritas Rules for the Classification of Steel Ships
Application: Class notations: AUT-UMS, AUT-CCS, AUT-PORT and AUT-IMS; Pressure transmitter type 2051 cannot be installed on diesel engines

SDN Det Norske Veritas (DNV) Type Approval
Certificate: TAA000004F
Intended Use: DNV GL Rules for Classification - Ships and offshore units
Application:

Location classes	
Type	2051
Temperature	D
Humidity	B
Vibration	A
EMC	B
Enclosure	D

SLL Lloyds Register (LR) Type Approval
Certificate: 11/60002
Application: Environmental categories ENV1, ENV2, ENV3 and ENV5

Figure 15. Rosemount 2051 Declaration of Conformity



EMERSON.
Process Management

EU Declaration of Conformity

No: RMD 1071 Rev. I

We,

Rosemount, Inc.
8200 Market Boulevard
Chanhassen, MN 55317-9685
USA

declare under our sole responsibility that the product,

Rosemount 2051 Pressure Transmitter

manufactured by,

Rosemount, Inc.
8200 Market Boulevard
Chanhassen, MN 55317-9685
USA

to which this declaration relates, is in conformity with the provisions of the European Union Directives, including the latest amendments, as shown in the attached schedule.

Assumption of conformity is based on the application of the harmonized standards and, when applicable or required, a European Union notified body certification, as shown in the attached schedule.

(signature)

Vice President of Global Quality
(function)

Kelly Klein
(name)

19 Apr 2016
(date of issue)

Page 1 of 4

EMERSON.
Process Management

EU Declaration of Conformity

No: RMD 1071 Rev. I

EMC Directive (2004/108/EC) ***This directive is valid until 19 April 2016***
EMC Directive (2014/30/EU) ***This directive is valid from 20 April 2016***

Harmonized Standards:
EN 61326-1:2013, EN 61326-2-3:2013

PED Directive (97/23/EC) ***This directive is valid until 18 July 2016***
PED Directive (2014/68/EU) ***This directive is valid from 19 July 2016***

Rosemount 2051CD2, 3, 4, 5 (also with P9 option)
QS Certificate of Assessment - EC Certificate No. 59552-2009-CE-HOU-DNV
Module H Conformity Assessment
Evaluation Standards:
ANSI / ISA 61010-1:2004

All other Rosemount 2051 Pressure Transmitters
Sound Engineering Practice

Transmitter Attachments: Diaphragm Seal, Process Flange, or Manifold
Sound Engineering Practice

Rosemount 2051CFx DP Flowmeter
See DSI 1000 Declaration of Conformity

ATEX Directive (94/9/EC) ***This directive is valid until 19 April 2016***
ATEX Directive (2014/34/EU) ***This directive is valid from 20 April 2016***

Baseefa08ATEX0129X - Intrinsic Safety Certificate
Equipment Group II Category 1 G
Ex ia IIC T4 Ga
Harmonized Standards Used:
EN60079-0:2012, EN60079-11:2012

EMERSON.
Process Management

EU Declaration of Conformity

No: RMD 1071 Rev. I

Baseefa08ATEX0130X - Type n Certificate
Equipment Group II Category 3 G
Ex nA IIC T4 Gc
Harmonized Standards Used:
EN60079-0:2012, EN60079-15:2010

KEMA08ATEX0090X - Flameproof Certificate
Equipment Group II Category 1/2 G
Ex d IIC T6/T5
Harmonized Standards Used:
EN60079-1:2007; EN60079-26:2007
Other Standards Used:
EN60079-0:2006
(A review against EN60079-0:2012 which is harmonized, shows no significant changes relevant to this equipment so EN60079-0:2006 continues to represent "State of the Art".)

Baseefa08ATEX0182X - Dust Certificate
Equipment Group II Category 1 D
Ex ta IIIC T95°C T_{500}105°C Da
Harmonized Standards Used:
EN60079-0:2012, EN60079-31:2009

EMERSON.
Process Management

EU Declaration of Conformity

No: RMD 1071 Rev. I

PED Notified Body

Det Norske Veritas (DNV) [Notified Body Number: 0575]
Veritasveien 1, N-1322
Hovik, Norway

ATEX Notified Bodies

DEKRA (KEMA) [Notified Body Number: 0344]
Meander 1051
6825 MJ Arnhem
The Netherlands

SGS Baseefa Limited [Notified Body Number: 1180]
Rockhead Business Park
Staden Lane
Buxton, Derbyshire
SK17 9RZ United Kingdom

ATEX Notified Body for Quality Assurance

SGS Baseefa Limited [Notified Body Number: 1180]
Rockhead Business Park
Staden Lane
Buxton, Derbyshire
SK17 9RZ United Kingdom

含有China RoHS管控物质超过最大浓度限值的部件型号列表 Rosemount 2051
List of Rosemount 2051 Parts with China RoHS Concentration above MCVs

部件名称 Part Name	有害物质 / Hazardous Substances					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴联苯醚 Polybrominated diphenyl ethers (PBDE)
电子组件 Electronics Assembly	X	O	O	O	O	O
壳体组件 Housing Assembly	X	O	O	X	O	O
传感器组件 Sensor Assembly	X	O	O	X	O	O

本表格系依据SJ/T11364的规定而制作.
This table is proposed in accordance with the provision of SJ/T11364.

O: 意为该部件的所有均质材料中该有害物质的含量均低于GB/T 26572所规定的限量要求.
O: Indicate that said hazardous substance in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.

X: 意为在该部件所使用的所有均质材料里，至少有一类均质材料中该有害物质的含量高于GB/T 26572所规定的限量要求.
X: Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T 26572.

00825-0100-4107

Quick Start Guide
00825-0100-4107, Rev CC
July 2016

Global Headquarters
Emerson Process Management
6021 Innovation Blvd.
Shakopee, MN 55379, USA
+1 800 999 9307 or +1 952 906 8888
+1 952 949 7001
RFQ.RMD-RCC@EmersonProcess.com

North America Regional Office
Emerson Process Management
8200 Market Blvd.
Chanhassen, MN 55317, USA
+1 800 999 9307 or +1 952 906 8888
+1 952 949 7001
RMT-NA.RCCRFQ@Emerson.com

Latin America Regional Office
Emerson Process Management
1300 Concord Terrace, Suite 400
Sunrise, FL 33323, USA
+1 954 846 5030
+1 954 846 5121
RFQ.RMD-RCC@EmersonProcess.com

Europe Regional Office
Emerson Process Management Europe GmbH
Neuhofstrasse 19a P.O. Box 1046
CH 6340 Baar
Switzerland
+41 (0) 41 768 6111
+41 (0) 41 768 6300
RFQ.RMD-RCC@EmersonProcess.com

Asia Pacific Regional Office
Emerson Process Management Asia Pacific Pte Ltd
1 Pandan Crescent
Singapore 128461
+65 6777 8211
+65 6777 0947
Enquiries@AP.EmersonProcess.com

Middle East and Africa Regional Office
Emerson Process Management
Emerson FZE P.O. Box 17033,
Jebel Ali Free Zone - South 2
Dubai, United Arab Emirates
+971 4 8118100
+971 4 8865465
RFQ.RMTMEA@Emerson.com

Linkedin.com/company/Emerson-Process-Management

Twitter.com/Rosemount_News

Facebook.com/Rosemount

Youtube.com/user/RosemountMeasurement

Google.com/+RosemountMeasurement

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ROSEMOUNT™

EMERSON™
Process Management

Product Data Sheet
February 2017
00813-0100-4101, Rev MA

Rosemount™ 2051 Pressure Transmitter



- Rosemount Coplanar™ platform enables integration of primary elements, manifolds, and remote seal solutions
- Best in Class performance with up to 0.05% high accuracy option
- IEC 62591 (*Wireless*HART®) Protocol enables cost effective installations
- Local Operator Interface (LOI) offers easy to use configuration capabilities at the transmitter
- Protocols available include HART® 4–20 mA, FOUNDATION™ Fieldbus, PROFIBUS® PA, HART 1–5 Vdc Low Power
- Selectable HART Revision prepares your plant for the latest HART capabilities while ensuring seamless integration with today's systems
- SIL2/3 safety certification to IEC 61508 is available with the full 4–20 mA HART offering to simplify compliance

Rosemount 2051 Pressure Transmitter product offering



Foundation of reliable measurement

- Differential, gage, and absolute pressure measurement
- Select from an extensive offering of DP Flowmeters, liquid level, manifolds and flanges
- Available with variety of protocols and materials

Best-in-class capabilities extended to IEC 62591 (*Wireless*HART)

- Cost effectively implement wireless on the industry's most proven platform
- Optimize safety with the industry's only intrinsically safe power module
- Eliminate wiring design and construction complexities to lower costs by 40–60 percent
- Quickly deploy new pressure, level, and flow measurements in 70 percent less time

Innovative, integrated DP Flowmeters

- Fully assembled and leak tested for out-of-the-box installation
- Reduce straight pipe requirements, lower permanent pressure loss, and achieve accurate measurement in small line sizes
- Up to two percent volumetric flow accuracy at 5:1 turndown

Proven, reliable, and innovative DP Level technologies

- Connect to virtually any process with a comprehensive offering of process connections, fill fluids, direct mount or capillary connections and materials.
- Quantify and optimize total system performance with QZ option.
- Optimize level measurement with cost efficient Tuned-System™ Assemblies

Instrument manifolds — quality, convenient, and easy

- Designed and engineered for optimal performance with Rosemount transmitters
- Save installation time and money with factory assembly
- Offers a variety of styles, materials, and configurations

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Rosemount 2051C Coplanar Pressure Transmitter



Rosemount 2051C Coplanar Pressure Transmitter

Configuration	Transmitter output code
4–20 mA HART Rosemount 2051 Rosemount 2051 with Selectable HART(1)	A
Lower Power Rosemount 2051 Rosemount 2051 with Selectable HART(1)	M
FOUNDATION Fieldbus	F
PROFIBUS	W
Wireless	X

1. The 4-20 mA with Selectable HART device can be ordered with transmitter output option code A plus any of the following options codes: M4, QT, DZ, CR, CS, CT, HR5, HR7.

Additional information

Specifications: page 47
Certifications: page 59
Dimensional Drawings: page 69

Specification and selection of product materials, options, or components must be made by the purchaser of the equipment. See page 56 for more information on material selection.

Table 1. Rosemount 2051C Coplanar Pressure Transmitters Ordering Information

The starred offerings (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

Model	Transmitter type		
2051C	Coplanar Pressure Transmitter		
Measurement type			
D	Differential		★
G	Gage		★
Pressure range			
	Rosemount 2051CD	**Rosemount 2051CG**	
1	–25 to 25 inH_2O (–62,2 to 62,2 mbar)	–25 to 25 inH_2O (–62,2 to 62,2 mbar)	★
2	–250 to 250 inH_2O (–623 to 623 mbar)	–250 to 250 inH_2O (–623 to 623 mbar)	★
3	–1000 to 1000 inH_2O (–2,5 to 2,5 bar)	–393 to 1000 inH_2O (–0,98 to 2,5 bar)	★
4	–300 to 300 psi (–20,7 to 20,7 bar)	–14.2 to 300 psi (–0,98 to 20,7 bar)	★
5	–2000 to 2000 psi (–137,9 to 137,9 bar)	–14.2 to 2000 psi (–0,98 to 137,9 bar)	★

Table 1. Rosemount 2051C Coplanar Pressure Transmitters Ordering Information

The starred offerings (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

Transmitter output				
A[1]	4–20 mA with digital signal based on HART Protocol			★
F	FOUNDATION Fieldbus Protocol			★
W	PROFIBUS PA Protocol			★
X	Wireless			★
M	Low Power, 1–5 Vdc with digital signal based on HART Protocol			
Materials of construction				
	Process flange type	**Flange material**	**Drain/vent**	
2	Coplanar	SST	SST	★
3[2]	Coplanar	Cast C-276	Alloy C-276	★
5	Coplanar	Plated CS	SST	★
7[2]	Coplanar	SST	Alloy C-276	★
8[2]	Coplanar	Plated CS	Alloy C-276	★
0	Alternate process connection			★
Isolating diaphragm				
2[2]	316L SST			★
3[2]	Alloy C-276			★
5[3][4]	Tantalum			
O-ring				
A	Glass-filled PTFE			★
B	Graphite-filled PTFE			★
Sensor fill fluid				
1	Silicone			★
2[4]	Inert			★
Housing material			**Conduit entry size**	
A	Aluminum		1/2–14 NPT	★
B	Aluminum		M20 × 1.5	★
J	SST		1/2–14 NPT	★
K[5]	SST		M20 × 1.5	★
P[6]	Engineered polymer		No conduit entries	★
D	Aluminum		G1/2	
M[5]	SST		G1/2	

Table 1. Rosemount 2051C Coplanar Pressure Transmitters Ordering Information

The starred offerings (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

Wireless options (requires wireless output code X and engineered polymer housing code P)

Wireless transmit rate, operating frequency and protocol		
WA3	User configurable transmit rate, 2.4 GHz *Wireless*HART	★
Antenna and SmartPower™		
WP5	Internal antenna, compatible with green power module (I.S. power module sold separately)	★

Options (include with selected model number)

Extended product warranty		
WR3	3-year limited warranty	★
WR5	5-year limited warranty	★
HART revision configuration[18]		
HR5[7]	Configured for HART Revision 5	★
HR7[8]	Configured for HART Revision 7	★
PlantWeb control functionality		
A01	FOUNDATION Fieldbus advanced control function block suite	★
Alternate flange[9]		
H2	Traditional flange, 316 SST, SST drain/vent	★
H3[2]	Traditional flange, Cast C-276, Alloy C-276 drain/vent	★
H7[2]	Traditional flange, 316 SST, Alloy C-276 drain/vent	★
HJ	DIN compliant traditional flange, SST, 7/16-in. adapter/manifold bolting	★
FA	Level flange, SST, 2-in., ANSI Class 150, vertical mount	★
FB	Level flange, SST, 2-in., ANSI Class 300, vertical mount	★
FC	Level flange, SST, 3-in., ANSI Class 150, vertical mount	★
FD	Level flange, SST, 3-in., ANSI Class 300, vertical mount	★
FP	DIN level flange, SST, DN 50, PN 40, vertical mount	★
FQ	DIN level flange, SST, DN 80, PN 40, vertical mount	★
Alternate flange[9]		
HK[10]	DIN compliant traditional flange, SST, 10 mm adapter/manifold bolting	
HL	DIN compliant traditional flange, SST, 12 mm adapter/manifold bolting	
Manifold assembly[10][11]		
S5	Assemble to Rosemount 305 Integral Manifold	★
S6	Assemble to Rosemount 304 Manifold or connection system	★
Integral mount primary element[10][11]		
S4[12]	Assemble to Rosemount 405A, 485, or 585 Annubar™ Primary Element or 1195 Integral Orifice Primary Element	★
S3	Assemble to Rosemount 405C or 405P Compact Orifice Plate	★

Table 1. Rosemount 2051C Coplanar Pressure Transmitters Ordering Information

The starred offerings (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

Seal assemblies[11]		
S1[13]	Assemble to one Rosemount 1199 Diaphragm Seal	★
S2[14]	Assemble to two Rosemount 1199 Diaphragm Seals	★
Mounting brackets		
B1	Traditional flange bracket for 2-in. pipe mounting, CS bolts	★
B2	Traditional flange bracket for panel mounting, CS bolts	★
B3	Traditional flange flat bracket for 2-in. pipe mounting, CS bolts	★
B4	Coplanar flange bracket for 2-in. pipe or panel mounting, all SST	★
B7	B1 bracket with Series 300 SST bolts	★
B8	B2 bracket with Series 300 SST bolts	★
B9	B3 bracket with Series 300 SST bolts	★
BA	SST B1 bracket with Series 300 SST bolts	★
BC	SST B3 bracket with Series 300 SST bolts	★
Product certifications		
E1[5]	ATEX Flameproof	★
E2[5]	INMETRO Flameproof	★
E3[5]	China Flameproof	★
E4[5]	TIIS Flameproof	★
E5	USA Explosion-proof, Dust Ignition-proof	★
E6	Canada Explosion-proof, Dust Ignition-proof, Division 2	★
E7[5]	IECEx Flameproof	★
EW	India (CCOE) Flameproof Approval	★
I1[5]	ATEX Intrinsic Safety	★
I2[5]	INMETRO Intrinsically Safe	★
I3[5]	China Intrinsic Safety	★
I4[5][6]	TIIS Intrinsic Safety	★
I5	USA Intrinsically Safe, Division 2	★
I6	Canada intrinsically Safe	★
I7[5]	IECEx Intrinsic Safety	★
IA[15]	ATEX FISCO Intrinsic Safety	★
IE[15]	USA FISCO Intrinsically Safe	★
IF[15]	Canada FISCO Intrinsically Safe	★
IG[15]	IECEx FISCO Intrinsically Safe	★
IW[5]	India (CCOE) Intrinsically Safe	★
K1[5]	ATEX Flameproof, Intrinsic Safety, Type n, Dust	★
K2	INMETRO Flameproof and Intrinsic Safety	★

Table 1. Rosemount 2051C Coplanar Pressure Transmitters Ordering Information

The starred offerings (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

K5	USA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★
K6	Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★
K7[5]	IECEx Flameproof, Intrinsic Safety, Type n and Dust	★
KA[5]	ATEX and Canada Flameproof, Intrinsically Safe, Division 2	★
KB	USA and Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★
KC[5]	USA and ATEX Explosion-proof, Intrinsically Safe, Division 2	★
KD[5]	USA, Canada, and ATEX Explosion-proof, Intrinsically Safe	★
N1[5]	ATEX Type n	★
N7[5]	IECEx Type n	★
ND[5]	ATEX Dust	★
EM	Technical Regulations Customs Union (EAC) Flameproof	★
IM	Technical Regulations Customs Union (EAC) Intrinsic Safety	★
KM	Technical Regulations Customs Union (EAC) Flameproof and Intrinsic Safety	★
Drinking water approval		
DW[16]	NSF drinking water approval	★
Shipboard approvals[4]		
SBS	American Bureau of Shipping (ABS) type approval	★
SBV	Bureau Veritas (BV) type approval	★
SDN	Det Norske Veritas (DNV) type approval	★
SLL	Lloyds Register (LR) type approval	★
Bolting materials		
L4	Austenitic 316 SST bolts	★
L5	ASTM A 193, Grade B7M bolts	★
L6	Alloy K-500 bolts	★
L8	ASTM A 193 Class 2, Grade B8M bolts	★
Display and interface options		
M4[17]	LCD display with local operator interface	★
M5	LCD display	★
Hardware adjustments		
D4[18]	Zero and span configuration buttons	★
DZ[19]	Digital zero trim	★
Flange adapters[20]		
DF	1/2–14 NPT flange adapters	★
Conduit plug[4][21]		
DO	316 SST conduit plug	★

Table 1. Rosemount 2051C Coplanar Pressure Transmitters Ordering Information

The starred offerings (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

RC 1/4 RC 1/2 process connection[22]		
D9	RC 1/4 flange with RC 1/2 flange adapter - SST	
Ground screw[4][23]		
V5	External ground screw assembly	★
Performance[24]		
P8	High performance option	★
Transient protection[4][25]		
T1	Transient protection terminal block	★
Software configuration[19]		
C1	Custom Software Configuration (Completed Rosemount 2051 Configuration Data Sheet or Rosemount 3051 Configuration Data Sheet for Wireless required with order)	★
Alarm limit[18]		
C4[26]	NAMUR alarm and saturation levels, high alarm	★
CN[26]	NAMUR alarm and saturation levels, low alarm	★
CR	Custom Alarm and saturation signal levels, high alarm (requires C1 and Configuration Data Sheet)	★
CS	Custom Alarm and saturation signal levels, low alarm (requires C1 and Configuration Data Sheet)	★
CT	Low Alarm (standard Rosemount alarm and saturation levels)	★
Pressure testing		
P1	Hydrostatic testing with certificate	
Cleaning process area		
P2	Cleaning for special service	
P3	Cleaning for < 1 PPM Chlorine/Flourine	
Maximum static line pressure		
P9	4500 psig (310 bar) static pressure limit (2051CD Ranges 2–5 only)	★
Calibration certification		
Q4	Calibration certificate	★
QG	Calibration certificate and GOST verification certificate	★
QP	Calibration certification and tamper evident seal	★
Material traceability certification		
Q8	Material traceability certification per EN 10204 3.1	★
Quality certification for safety[27]		
QS	Prior-use certificate of FMEDA data	★

Table 1. Rosemount 2051C Coplanar Pressure Transmitters Ordering Information

The starred offerings (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

QT	Safety certified to IEC 61508 with certificate of FMEDA	★
Surface finish		
Q16	Surface finish certification for sanitary remote seals	★
Toolkit total system performance reports		
QZ	Remote seal system performance calculation report	★
Conduit electrical connection(4)		
GE	M12, 4-pin, male connector (eurofast®)	★
GM	A size mini, 4-pin, male connector (minifast®)	★
NACE certificate(28)		
Q15	Certificate of compliance to NACE® MR0175/ISO 15156 for wetted materials	★
Q25	Certificate of compliance to NACE MR0103 for wetted materials	★
Typical model number: 2051C D 2 A 2 2 A 1 A B4 M5		

1. HART Revision 5 is the default HART output. The Rosemount 2051 with Selectable HART can be factory or field configured to HART Revision 7. To order HART Revision 7 factory configured, add option code HR7.
2. Materials of Construction comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments. Order with Q15 or Q25 to receive a NACE certificate.
3. Available in Ranges 2–5 only.
4. Not available with output code X.
5. Not available with low power output code M.
6. Only available with output code X.
7. Configures the HART output to HART Revision 5. The device can be field configured to HART Revision 7 if needed.
8. Configures the HART output to HART Revision 7. The device can be field configured to HART Revision 5 if needed.
9. Requires 0 code in Materials of Construction for alternate process connection.
10. Not valid with optional code P9 for 4500 psi static pressure.
11. "Assemble-to" items are specified separately and require a completed model number.
12. Process flange limited to coplanar (codes 2, 3, 5, 7, 8) or traditional (H2, H3, H7).
13. Not valid with optional code D9 for RC1/2 adapters.
14. Not valid with optional codes DF or D9 for adapters.
15. Only valid with FOUNDATION Fieldbus output code F.
16. Not available with Alloy C-276 isolator (3 code), tantalum isolator (5 code), all cast C-276 flanges, all plated CS flanges, all DIN flanges, all Level flanges, assemble-to manifolds (S5 and S6 codes), assemble-to seals (S1 and S2 codes), assemble-to primary elements (S3 and S4 codes), surface finish certification (Q16 code), and remote seal system report (QZ code).
17. Not available with FOUNDATION Fieldbus output code F or wireless output code X.
18. Only Available with HART 4–20 mA (output codes A and M).
19. Only available with HART 4–20 mA output(output codes A) and wireless output (code X).
20. Not valid with alternate process connection options S3, S4, S5, S6.
21. Transmitter is shipped with 316 SST conduit plug (uninstalled) in place of standard carbon steel conduit plug.
22. Not available with alternate process connection: DIN flanges and Level flanges.
23. The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.
24. Available with 4–20 mA HART output code A, wireless output code X, FOUNDATION Fieldbus output code F, Rosemount 2051C Ranges 2–5 or Rosemount 2051T Ranges 1–4, SST and Alloy C 276 diaphragms and silicone fill fluid. High performance option includes 0.05% reference accuracy, and five year stability. See Performance specifications for details.
25. The T1 option is not needed with FISCO Product Certifications; transient protection is included in the FISCO product certification codes IA and IE.
26. NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.
27. Only available with HART 4–20 mA output (code A).
28. NACE-Compliant wetted materials are identified by Footnote 2.

Rosemount 2051T In-line Pressure Transmitter



Rosemount 2051T In-line
Wireless Pressure Transmitter

Configuration	Transmitter output code
4–20 mA HART Rosemount 2051 Rosemount 2051 with Selectable HART(1)	A
Lower Power Rosemount 2051 Rosemount 2051 with Selectable HART(1)	M
FOUNDATION Fieldbus	F
PROFIBUS	W
Wireless	X

1. The 4–20mA with Selectable HART device can be ordered with transmitter output option code A plus any of the following options codes: M4, QT, DZ, CR, CS, CT, HR5, HR7.

Additional information

Specifications: page 47
Certifications: page 59
Dimensional Drawings: page 69

Specification and selection of product materials, options, or components must be made by the purchaser of the equipment. See page 56 for more information on material selection.

Table 2. Rosemount 2051T In-line Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Model	Transmitter type		
2051T	In-line Pressure Transmitter		★
Pressure type			
G	Gage		★
A(1)	Absolute		★
Pressure range			
	Rosemount 2051TG	**Rosemount 2051TA**	★
1	-14.7 to 30 psi (–1,0 to 2,1 bar)	0 to 30 psi (0 to 2,1 bar)	★
2	–14.7 to 150 psi (–1,0 to 10,3 bar)	0 to 150 psi (0 to 10,3 bar)	★
3	–14.7 to 800 psi (–1,0 to 55 bar)	0 to 800 psi (0 to 55 bar)	★
4	–14.7 to 4000 psi (–1,0 to 276 bar)	0 to 4000 psi (0 to 276 bar)	★
5	–14.7 to 10000 psi (–1,0 to 689 bar)	0 to 10000 psi (0 to 689 bar)	★

Table 2. Rosemount 2051T In-line Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Transmitter output			
A[2]	4–20 mA with Digital Signal Based on HART Protocol		★
F	FOUNDATION Fieldbus Protocol		★
W	PROFIBUS PA Protocol		★
X	Wireless		★
M	Low-Power, 1–5 Vdc with Digital Signal Based on HART Protocol		
Process connection style			
2B	1/2–14 NPT female		★
2C[3]	G1/2 A DIN 16288 male		★
2F[4]	Coned and threaded, compatible with autoclave type F-250-C (Range 5 only)		
Isolating diaphragm		**Process connection wetted parts material**	
2[5]	316L SST	316L SST	★
3[5]	Alloy C-276	Alloy C-276	★
Sensor fill fluid			
1	Silicone		★
2[4]	Inert		★
Housing material		**Conduit entry size**	
A	Aluminum	1/2–14 NPT	★
B	Aluminum	M20 x 1.5	★
J	SST	1/2–14 NPT	★
K[6]	SST	M20 x 1.5	★
P[7]	Engineered polymer	No conduit entries	★
D	Aluminum	G1/2	
M[6]	SST	G1/2	

Wireless options (requires wireless output code X and engineered polymer housing code P)

Wireless transmit rate, operating frequency and protocol		
WA3	User configurable transmit rate, 2.4 GHz *Wireless*HART	★
Antenna and SmartPower		
WP5	Internal antenna, compatible with green power module (I.S. power module sold separately)	★

Options (include with selected model number)

Extended product warranty		
WR3	3-year limited warranty	★

Table 2. Rosemount 2051T In-line Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

WR5	5-year limited warranty	★
HART revision configuration[18]		
HR5[8]	Configured for HART Revision 5	★
HR7[9]	Configured for HART Revision 7	★
PlantWeb control functionality		
A01	FOUNDATION Fieldbus advanced control function block suite	★
Manifold assemblies[10]		
S5	Assemble to Rosemount 306 Integral Manifold	★
Seal assemblies[10]		
S1[10]	Assemble to one Rosemount 1199 Diaphragm Seal	★
Mounting bracket		
B4	Bracket for 2-in. pipe or panel mounting, All SST	★
Product certifications		
E1[6]	ATEX Flameproof	★
E2[6]	INMETRO Flameproof	★
E3[6]	China Flameproof	★
E4[6]	TIIS Flameproof	★
E5	USA Explosion-proof, Dust Ignition-proof	★
E6	Canada Explosion-proof, Dust Ignition-proof, Division 2	★
E7[6]	IECEx Flameproof	★
EW[6]	India (CCOE) Flameproof Approval	★
I1[6]	ATEX Intrinsic Safety	★
I2[6]	INMETRO Intrinsically Safe	★
I3[6]	China Intrinsic Safety	★
I4[6][7]	TIIS Intrinsic Safety	★
I5	USA Intrinsically Safe, Division 2	★
I6	Canada Intrinsically Safe	★
I7[6]	IECEx Intrinsic Safety	★
IA[13]	ATEX FISCO Intrinsic Safety	★
IE[11]	USA FISCO Intrinsically Safe	★
IF[11]	Canada FISCO Intrinsically Safe	★
IG[11]	IECEx FISCO Intrinsically Safe	★
IW[6]	India (CCOE) Intrinsic Safety Approval	★
K1[6]	ATEX Flameproof, Intrinsic Safety, Type n, Dust	★

Table 2. Rosemount 2051T In-line Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

K5	USA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★
K6	Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★
K7[6]	IECEx Flameproof, Intrinsic Safety, Type n, Dust	★
KA[6]	ATEX and Canada Flameproof, Intrinsically Safe, Division 2	★
KB	USA and Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★
KC[6]	USA and ATEX Explosion-proof, Intrinsically Safe, Division 2	★
KD[6]	USA, Canada, and ATEX Explosion-proof, Intrinsically Safe	★
N1[6]	ATEX Type n	★
N7[6]	IECEx Type n	★
ND[6]	ATEX Dust	★
EM	Technical Regulations Customs Union (EAC) Flameproof	★
IM	Technical Regulations Customs Union (EAC) Intrinsic Safety	★
KM	Technical Regulations Customs Union (EAC) Flameproof and Intrinsic Safety	★
Drinking water approval[12]		
DW	NSF drinking water approval	★
Shipboard approvals[4]		
SBS	American Bureau of Shipping (ABS) type approval	★
SBV	Bureau Veritas (BV) type approval	★
SDN	Det Norske Veritas (DNV) type approval	★
SLL	Lloyds Register (LR) type approval	★
Display and interface options		
M4[13]	LCD display with local operator interface	★
M5	LCD display	★
Hardware adjustments		
D4[14]	Zero and span configuration buttons	★
DZ[15]	Digital zero trim	★
Wireless SST sensor module[7]		
WSM	Wireless SST sensor module	★
Conduit plug[4][16]		
DO	316 SST conduit plug	★
Ground screw[4][17]		
V5	External ground screw assembly	★
Performance[18]		
P8	High performance option	★

Table 2. Rosemount 2051T In-line Pressure Transmitter Ordering Information

★ **The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.**

Terminal blocks[4][19]		
T1	Transient protection terminal block	★
Software configuration[15]		
C1	Custom Software Configuration (Completed Rosemount 2051 Configuration Data Sheet or Rosemount 3051 Configuration Data Sheet for Wireless required with order)	★
Alarm limits[14]		
C4[20]	Analog output levels compliant with NAMUR recommendation NE 43, alarm high	★
CN[21]	Analog output levels compliant with NAMUR recommendation NE 43, alarm low	★
CR	Custom alarm and saturation signal levels, high alarm (requires C1 and Configuration Data Sheet)	★
CS	Custom alarm and saturation signal levels, low alarm (requires C1 and Configuration Data Sheet)	★
CT	Low alarm (standard Rosemount alarm and saturation levels)	★
Pressure testing		
P1	Hydrostatic testing with certificate	
Cleaning process area[22]		
P2	Cleaning for special service	
P3	Cleaning for <1 PPM Chlorine/Fluorine	
Calibration certification		
Q4	Calibration certificate	★
QG	Calibration certificate and GOST verification certificate	★
QP	Calibration certificate and tamper evident seal	★
Material traceability certification		
Q8	Material traceability certification per EN 10204 3.1	★
Quality certification for safety[21]		
QS	Prior-use certificate of FMEDA data	★
QT	Safety certified to IEC 61508 with certificate of FMEDA	★
Surface finish		
Q16	Surface finish certification for sanitary remote seals	★
Toolkit total system performance reports		
QZ	Remote seal system performance calculation report	★
Conduit electrical connector[4]		
GE	M12, 4-pin, male connector (eurofast)	★
GM	A size mini, 4-pin, male connector (minifast)	★

Table 2. Rosemount 2051T In-line Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

NACE certificate[23]		
Q15	Certificate of compliance to NACE MR0175/ISO 15156 for wetted materials	★
Q25	Certificate of compliance to NACE MR0103 for wetted materials	★
Typical model number:	**2051T G 3 A 2B 2 1 A B4 M5**	

1. Wireless output (code X) only available in absolute measurement type (code A) in range 1–5 with 1/2–14 NPT process connection (code 2B), and housing (code P).
2. HART Revision 5 is the default HART output. The Rosemount 2051 with Selectable HART can be factory or field configured to HART Revision 7. To order HART Revision 7 factory configured, add option code HR7.
3. Wireless output (code X) only available in G1/2 A DIN 16288 Male process connection (code 2C) with range 1–4, 316 SST isolating diaphragm (code 2), silicone fill fluid (code 1), and housing (code P).
4. Not available with output code X.
5. Materials of Construction comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments. Order with Q15 or Q25 to receive a NACE certificate.
6. Not available with low power output code M.
7. Only available with output code X.
8. Configures the HART output to HART Revision 5. The device can be field configured to HART Revision 7 if needed.
9. Configures the HART output to HART Revision 7. The device can be field configured to HART Revision 5 if needed.
10. “Assemble-to” items are specified separately and require a completed model number.
11. Only valid with FOUNDATION Fieldbus output code F.
12. Not available with coned and threaded connection (2F code), assemble-to manifold (S5 code), assemble-to seal (S1 code), surface finish certification (Q16 code), remote seal system report (QZ code).
13. Not available with FOUNDATION Fieldbus output code F or wireless output code X.
14. Only Available with HART (output codes A and M).
15. Only available with HART 4–20 mA output (code A) and wireless output (code X).
16. Transmitter is shipped with 316 SST conduit plug (uninstalled) in place of standard carbon steel conduit plug.
17. The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.
18. Available with 4–20 mA HART output code A, wireless output code X, FOUNDATION Fieldbus output code F, Rosemount 2051C Ranges 2–5 or Rosemount 2051T Ranges 1–4, SST and Alloy C 276 diaphragms and silicone fill fluid. High performance option includes 0.05% reference accuracy, and five year stability. See Performance specifications for details.
19. The T1 option is not needed with FISCO Product Certifications; transient protection is included in the FISCO product certification codes IA and IE.
20. NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.
21. Only available with HART 4–20 mA output (code A).
22. Not valid with alternate process connection S5.
23. NACE Compliant wetted materials are identified by Footnote 5.

Rosemount 2051G In-Line Pressure Transmitter



Rosemount 2051G In-Line Pressure Transmitter

Configuration	Transmitter output code
4–20 mA HART	A

Additional Information

Specifications: page 47
Certifications: page 59
Dimensional Drawings: page 69

Table 3. Rosemount 2051G In-Line Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Model	Transmitter type		
2051G	In-line pressure transmitter		
Pressure type			
P	Gage		★
A	Absolute		★
Pressure range			
	Rosemount 2051GP	**Rosemount 2051GA**	★
1	-14.7 to 30 psi (-1.0 to 2.1 bar)	0 to 30 psi (0 to 2.1 bar)	★
2	-14.7 to 150 psi (-1.0 to 10.3 bar)	0 to 150 psi (0 to 10.3 bar)	★
3	-14.7 to 800 psi (-1.0 to 55 bar)	0 to 800 psi (0 to 55 bar)	★
4	-14.7 to 4000 psi (-1.0 to 276 bar)	0 to 4000 psi (0 to 276 bar)	★
Transmitter output			
A	4–20 mA with Digital Signal Based on HART Protocol		★
Process connection style			
2B	1/2–14 NPT female		★
2C	G1/2 DIN 16288 male		★
Isolating diaphragm(1)		**Process connection wetted parts material**	
2	316L SST	316L SST	★
3	Alloy C-276	Alloy C-276	★
Sensor fill fluid			
1	Silicone		★
2	Inert		★

Table 3. Rosemount 2051G In-Line Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Housing material		Conduit entry size	
A	Aluminum	½–14 NPT	★
B	Aluminum	M20 × 1.5	★
D	Aluminum	G 1/2	★

Options (Include with selected model number)

Integral manifold assembly[2]		
S5	Assemble to Rosemount 306 Integral Manifold	★
Seal assemblies[2]		
S1	Assemble to one Rosemount 1199 Diaphragm Seal	★
Mounting bracket[3]		
B4	Bracket for 2-in. pipe or panel mounting, All SST	★
BE	316 SST B4 Bracket with 316 SST Bolts	★
Product certifications[4]		
E1	ATEX Flameproof	
E2	INMETRO Flameproof	
E3	China Flameproof	
E5	USA Explosion-proof, Dust Ignition-proof	
E6	Canada Explosion-proof, Dust Ignition-proof, Division 2	
E7	IECEx Flameproof	
EM	Technical Regulations Customs Union (EAC) Flameproof	
EP	Republic of Korea Flameproof	
EW	India (CCOE) Flameproof	
I1	ATEX Intrinsic Safety	
I2	INMETRO Intrinsic Safety	
I3	China Intrinsic Safety	
I5	USA Intrinsic Safety, Nonincendive	
I6	Canada Intrinsic Safety	
I7	IECEx Intrinsic Safety	
IM	Technical Regulations Customs Union (EAC) Intrinsic Safety	
IP	Republic of Korea Intrinsic Safety	
IW	India (CCOE) Intrinsic Safety	
K1	ATEX Flame-proof, Intrinsic Safety, Type n, Dust (combination of E1, I1 and N1)	
K2	INMETRO Flameproof, Intrinsic Safety	
K3	China Flameproof, Intrinsic Safety	

Table 3. Rosemount 2051G In-Line Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

K5	USA Explosion-proof, Dust Ignition-proof, Intrinsic Safety, and Nonincendive	
K6	Canada Explosion-proof, Dust Ignition-proof, Intrinsic Safety, and Division 2	
K7	IECEx Flameproof, Dust Ignition-proof, Intrinsic Safety, and Type n (combo of I7, E7, N7 and NK)	
KA	Canada and ATEX Explosion proof, Dust Ignition-proof, Intrinsically Safety, division	
KB	USA and Canada Explosion-proof, Dust Ignition-proof, Intrinsic Safety, and Division 2 (combo of K5 and K6)	
KD	USA, Canada and ATEX Explosion proof, Intrinsically Safety (combination of K5, K6 I1 and E1)	
KM	Technical Regulations Customs Union (EAC) Flame-proof, Intrinsic Safety	
KP	Republic of Korea Flame-proof, Intrinsic Safety	
N1	ATEX Type n	
N3	China Type n	
N7	IECEx Type n	
ND	ATEX Dust	
NK	IECEx Dust	
Drinking water approval[5]		
DW	NSF drinking water approval	★
Pressure testing		
P1	Hydrostatic testing with certificate	★
Cleaning process area[6]		
P2	Cleaning for special service	★
P3	Cleaning for <1PPM Chlorine/Flourine	★
Calibration certification		
Q4	Calibration certificate	★
QG	Calibration certificate and GOST verification certificate	★
QP	Calibration certificate and tamper evident seal	★
Material traceability certification		
Q8	Material traceability certification per EN 10204 3.1	★
Quality certification for safety		
QT	Safety certified to IEC 61508 with certificate of FMEDA	★
QS	Prior-use certificate of FMEDA data	★
Configuration buttons		
D4	Analog zero and span	★
DZ	Digital zero trim	★

Table 3. Rosemount 2051G In-Line Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Conduit plug[7]		
DO	316 SST conduit plug	★
Ground screw[8]		
V5	External ground screw assembly	★
Performance[9]		
P8	High performance option	★
Display and interface options[10]		
M4	LCD display and Local Operator Interface	★
M5	LCD display	★
Transient terminal block		
T1	Transient protection terminal block	★
Software configuration		
C1	Custom Software Configuration (requires Configuration Data Sheet)	★
Alarm levels		
C4	Analog output levels compliant with NAMUR recommendation NE 43, high alarm	★
CN	Analog output levels compliant with NAMUR recommendation NE 43, low alarm	★
CR	Custom alarm and saturation signal levels, high alarm (requires C1 and Configuration Data Sheet)	★
CS	Custom alarm and saturation signal levels, low alarm (requires C1 and Configuration Data Sheet)	★
CT	Low alarm (standard Rosemount alarm and saturation levels)	★
Extended product warranty		
WR3	3-year warranty	
WR5	5-year warranty	
HART revision configuration		
HR5[11]	Configured for HART Revision 5	★
HR7[12]	Configured for HART Revision 7	★
Surface finish		
Q16	Surface finish certification for sanitary remote seals	★
Toolkit total system performance reports		
QZ	Remote seals system performance calculation report	★

Table 3. Rosemount 2051G In-Line Pressure Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Conduit electrical connection		
GE	M12, 4-pin, male connector (eurofast(R))	★
GM	A size mini, 4-pin, male connector (minifast(R))	★
NACE certificate(13)		
Q15	Certificate of compliance to NACE(R) MR0175/ISO 15156 for wetted materials	★
Q25	Certificate of compliance to NACE MR0103 for wetted materials	★
Stainless steel tagging		
Y2	316SST Nameplates, Labels, Tags, and Fasteners	
Typical model number:	**2051G P 5 F 2A 2 1 A HR5 B4**	

1. Materials of Construction comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.
2. "Assemble-to" items are specified separately and require a completed model number.
3. Panel mounting bolts are not supplied.
4. Consult an Emerson Representative for availability of Product Certifications.
5. Not available with coned and threaded connection (2F code), assemble-to manifold (S5 code), assemble-to seal (S1 code), surface finish certification (Q16 code), remote seal system report (QZ code).
6. Not valid with alternate process connection S5.
7. Transmitter is shipped with 316 SST conduit plug (uninstalled) in place of standard carbon steel conduit plug.
8. The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.
9. High performance option includes 0.15% reference accuracy, and seven years stability. See Performance specifications for details.
10. Select Configuration Buttons (option code D4 or DZ) if local configuration buttons are required.
11. Configures the HART output to HART Revision 5. The device can be field configured to HART Revision 7 if needed.
12. Configures the HART output to HART Revision 7. The device can be field configured to HART Revision 5 if needed.
13. NACE Compliant wetted materials are identified by Footnote 1.

Rosemount 2051CF Flowmeters



Configuration	Transmitter output code
4–20 mA HART Rosemount 2051 Rosemount 2051 with Selectable HART(1)	A
Lower Power Rosemount 2051 Rosemount 2051 with Selectable HART(1)	M
FOUNDATION Fieldbus	F
PROFIBUS	W
Wireless	X

1. The 4–20 mA with Selectable HART device can be ordered with transmitter output option code A plus any of the following options codes: M4, QT, DZ, CR, CS, CT, HR5, HR7.

Rosemount 2051CFA Annubar Flowmeter



Additional information
Specifications: page 47
Certifications: page 59
Dimensional Drawings: page 69

Specification and selection of product materials, options, or components must be made by the purchaser of the equipment. See page 56 for more information on material selection.

Table 4. Rosemount 2051CFA Annubar Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Model	Product description	
2051CFA	Annubar Flowmeter	
Measurement type		
D	Differential pressure	★
Fluid type		
L	Liquid	★
G	Gas	★
S	Steam	★
Line size		
020	2-in. (50 mm)	★
025	2 1/2-in. (63,5 mm)	★
030	3-in. (80 mm)	★
035	3 1/2-in. (89 mm)	★
040	4-in. (100 mm)	★

Table 4. Rosemount 2051CFA Annubar Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

050	5-in. (125 mm)	★
060	6-in. (150 mm)	★
070	7-in. (175 mm)	★
080	8-in. (200 mm)	★
100	10-in. (250 mm)	★
120	12-in. (300 mm)	★
Pipe I.D. range[1]		
C	Range C from the pipe I.D. table	★
D	Range D from the pipe I.D. table	★
A	Range A from the pipe I.D. table	
B	Range B from the pipe I.D. table	
E	Range E from the pipe I.D. table	
Z	Non-standard pipe I.D. range or line sizes greater than 12-in.	
Pipe material/mounting assembly material		
C	Carbon steel (A105)	★
S	316 stainless steel	★
0[2]	No mounting (customer supplied)	
G	Chrome-Moly Grade F-11	
N	Chrome-Moly Grade F-22	
J	Chrome-Moly Grade F-91	
Piping orientation		
H	Horizontal piping	★
D	Vertical piping with downwards flow	★
U	Vertical piping with upwards flow	★
Annubar type		
P	Pak-Lok	★
F	Flanged with opposite side support	★
Sensor material		
S	316 stainless steel	★
Sensor size		
1	Sensor size 1 — line sizes 2-in. (50 mm) to 8-in. (200 mm)	★
2	Sensor size 2 — line sizes 6-in. (150 mm) to 96-in. (2400 mm)	★
3	Sensor size 3 — line sizes greater than 12-in. (300 mm)	★
Mounting type		
T1	Compression or threaded connection	★

Table 4. Rosemount 2051CFA Annubar Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

A1	Class 150 RF ANSI	★
A3	Class 300 RF ANSI	★
A6	Class 600 RF ANSI	★
D1	DN PN16 flange	★
D3	DN PN40 flange	★
D6	DN PN100 flange	★
R1	Class 150 RTJ flange	
R3	Class 300 RTJ flange	
R6	Class 600 RTJ flange	
Opposite side support or packing gland		
0	No opposite side support or packing gland (required for Pak-Lok and Flange-Lok models)	★
Opposite side support (required for flanged models)		
C	NPT threaded opposite support assembly — extended tip	★
D	Welded opposite support assembly — extended tip	★
Isolation valve for Flo-Tap models		
0[(2)]	Not applicable or customer supplied	★
Temperature measurement		
T	Integral RTD – not available with flanged model greater than Class 600	★
0	No temperature sensor	★
R	Remote thermowell and RTD	
Transmitter connection platform		
3	Direct mount, Integral 3-valve manifold — not available with flanged model greater than Class 600	★
5	Direct mount, 5-valve manifold — not available with flanged model greater than Class 600	★
7	Remote mount NPT connections (1/2-in. FNPT)	★
8	Remote mount SW connections (1/2-in.)	
Differential pressure range		
1	0 to 25 in H_2O (0 to 62,3 mbar)	★
2	0 to 250 in H_2O (0 to 623 mbar)	★
3	0 to 1000 in H_2O (0 to 2,5 bar)	★
Transmitter output		
A[(3)]	4–20 mA with digital signal based on HART Protocol	★
F	FOUNDATION Fieldbus Protocol	★
W	PROFIBUS PA Protocol	★
X	Wireless	★

Table 4. Rosemount 2051CFA Annubar Flowmeter Ordering Information

★ **The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.**

M	Low-Power, 1–5 Vdc with digital signal based on HART Protocol		
Transmitter housing material		**Conduit entry size**	
A	Aluminum	1/2–14 NPT	★
B	Aluminum	M20 x 1.5	★
J	SST	1/2–14 NPT	★
K[4]	SST	M20 x 1.5	★
P[5]	Engineered polymer	No conduit entries	★
D	Aluminum	G1/2	
M[4]	SST	G1/2	
Transmitter performance class			
1	2.0% flow rate accuracy, 5:1 flow turndown, 2-year stability		★

Wireless options (requires wireless output code X and engineered polymer housing code P)

Wireless transmit rate, operating frequency and protocol		
WA3	User configurable transmit rate, 2.4 GHz *Wireless*HART	★
Antenna and SmartPower		
WP5	Internal antenna, compatible with green power module (I.S. power module sold separately)	★

Options (include with selected model number)

Extended product warranty		
WR3	3-year limited warranty	★
WR5	5-year limited warranty	★
Special cleaning[4]		
P2	Cleaning for special services	
PA	Cleaning per ASTM G93 Level D (Section 11.4)	
Material testing[4]		
V1	Dye penetrant exam	
Material examination[4]		
V2	Radiographic examination	
Special inspection[4]		
QC1	Visual and dimensional inspection with certificate	★
QC7	Inspection and performance certificate	★
Surface finish[4]		
RL	Surface finish for low pipe Reynolds number in gas and steam	★

Table 4. Rosemount 2051CFA Annubar Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

RH	Surface finish for high pipe Reynolds number in liquid	★
Material traceability certification[4][6]		
Q8	Material traceability certification per EN 10474:2004 3.1	★
Code conformance[4]		
J2	ANSI/ASME B31.1	
J3	ANSI/ASME B31.3	
Materials conformance[4][6]		
J5	NACE MR-0175/ISO 15156	
Country certification[4]		
J6	European Pressure Directive (PED)	★
J1	Canadian registration	
Instrument connections for remote mount options[4]		
G2	Needle valves, stainless steel	★
G6	OS&Y gate valve, stainless steel	★
G1	Needle valves, carbon steel	
G3	Needle valves, Alloy C-276	
G5	OS&Y gate valve, carbon steel	
G7	OS&Y gate valve, Alloy C-276	
Special shipment[4]		
Y1	Mounting hardware shipped separately	★
Product certifications		
E1[4]	ATEX Flameproof	★
E2[4]	INMETRO Flameproof	★
E3[4]	China Flameproof	★
E5	USA Explosion-proof, Dust Ignition-proof	★
E6	Canada Explosion-proof, Dust Ignition-proof, Division 2	★
E7[4]	IECEx Flameproof	★
I1[4]	ATEX Intrinsic Safety	★
I2[4]	INMETRO Intrinsically Safe	★
I3[4]	China Intrinsic Safety	★
I5	USA Intrinsically Safe, Division 2	★
I6	Canada Intrinsically Safe	★
I7[4]	IECEx Intrinsic Safety	★
IA[4][6]	ATEX FISCO Intrinsic Safety; for FOUNDATION Fieldbus protocol only	★

Table 4. Rosemount 2051CFA Annubar Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

IE[4][6]	USA FISCO Intrinsically Safe	★
IF[4][6]	Canada FISCO Intrinsically Safe	★
IG[4][6]	IECEx FISCO Intrinsically Safe	★
K1[4]	ATEX Flameproof, Intrinsic Safety, Type n, Dust	★
K5	USA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2 (combination of E5 and I5)	★
K6	Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2 (combination of E6 and I6)	★
K7[4]	IECEx Flameproof, Dust Ignition-proof, Intrinsic Safety, Type n (combination of E7, I7, and N7)	★
KA[4]	ATEX and Canada Flameproof, Intrinsically Safe, Division 2	★
KB	USA and Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2 (combination of E5, E6, I5, and I6)	★
KC[4]	USA and ATEX Explosion-proof, Intrinsically Safe, Division 2	★
KD[4]	USA, Canada, and ATEX Explosion-proof, Intrinsically Safe (combination of E5, I5, E6, I6, E1, and I1)	★
N1[4]	ATEX Type n	★
N7[4]	IECEx Type n	★
ND[4]	ATEX Dust	★
Sensor fill fluid and O-ring options[4]		
L1[7]	Inert sensor fill fluid	★
L2	Graphite-filled (PTFE) O-ring	★
LA[7]	Inert sensor fill fluid and graphite-filled (PTFE) O-ring	★
Display and interface options[4]		
M4[8]	LCD display with local operator interface	★
M5	LCD display	★
Transmitter calibration certification[4]		
Q4	Calibration certificate for transmitter	★
Quality certification for safety[9]		
QS	Prior-use certificate of FMEDA data	★
QT	Safety certified to IEC 61508 with certificate of FMEDA	★
Transient protection[4][7][10]		
T1	Transient terminal block	★
Manifold for remote mount option[4]		
F2	3-valve manifold, stainless steel	★
F6	5-valve manifold, stainless steel	★
F1	3-valve manifold, carbon steel	
F5	5-valve manifold, carbon steel	

Table 4. Rosemount 2051CFA Annubar Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

PlantWeb control functionality[4][6]		
A01	FOUNDATION Fieldbus advanced control function block suite	★
Hardware adjustments[4]		
D4[11]	Zero and span hardware adjustments	★
DZ[12]	Digital zero trim	★
Alarm limit[4][11]		
C4[13]	NAMUR alarm and saturation levels, high alarm	★
CN[13]	NAMUR alarm and saturation levels, low alarm	★
CR	Custom alarm and saturation signal levels, high alarm (requires C1 and Configuration Data Sheet)	★
CS	Custom alarm and saturation signal levels, low alarm (requires C1 and Configuration Data Sheet)	★
CT	Low alarm (standard Rosemount alarm and saturation levels)	★
Ground screw[4][7][14]		
V5	External ground screw assembly	★
HART revision configuration[4][11]		
HR5[15]	Configured for HART Revision 5	★
HR7[16]	Configured for HART Revision 7	★
Typical model number: 2051CFA D L 060 D C H P S 2 T1 0 0 0 3 2A A 1A 3		

1. See the Rosemount DP Flowmeters and Primary Elements Product Data Sheet for Pipe I.D. table.
2. Provide the "A" dimension for flanged (page 79) and Pak-Lok (page 79).
3. HART Revision 5 is the default HART output. The Rosemount 2051 with Selectable HART can be factory or field configured to HART Revision 7. To order HART Revision 7 factory configured, add option code HR7.
4. Not available with low power output code M.
5. Only available with output code X.
6. Only valid with FOUNDATION Fieldbus output code F.
7. Not available with output code X.
8. Not available with FOUNDATION Fieldbus (output code F) or wireless (output code X).
9. Only available with 4–20 mA HART (output code A).
10. Not available with housing code 00, 5A or 7J. The T1 option is not needed with FISCO Product Certifications, transient protection is included with the FISCO Product Certification code IA.
11. Only available with 4–20 mA HART (output codes A and M).
12. Only available with HART 4–20 mA output (codes A and M) and wireless output (code X).
13. NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.
14. The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.
15. Configures the HART output to HART Revision 5. The device can be field configured to HART Revision 7 if needed.
16. Configures the HART output to HART Revision 7. The device can be field configured to HART Revision 5 if needed.

Rosemount 2051CFC Compact Flowmeter



Additional information
Specifications: page 47
Certifications: page 59
Dimensional Drawings: page 69

Specification and selection of product materials, options, or components must be made by the purchaser of the equipment. See page 56 for more information on material selection.

Table 5. Rosemount 2051CFC Compact Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Model	Product description	
2051CFC	Compact Flowmeter	
Measurement type		
D	Differential pressure	★
Primary element technology		
A	Annubar averaging pitot tube	
C	Conditioning orifice plate	★
P	Orifice plate	★
Material type		
S	316 SST	★
Line size		
005(1)	1/2-in. (15 mm)	★
010(1)	1-in. (25 mm)	★
015(1)	1 1/2-in. (40 mm)	★
020	2-in. (50 mm)	★
030	3-in. (80 mm)	★
040	4-in. (100 mm)	★
060	6-in. (150 mm)	★
080	8-in. (200 mm)	★
100(2)(3)	10-in. (250 mm)	★
120 (2)(3)	12-in. (300 mm)	★
Primary element type		
N000	Annubar sensor size 1	★
N040	0.40 Beta ratio	★
N050	0.50 Beta ratio	★
N065(4)	0.65 Beta ratio	★

Table 5. Rosemount 2051CFC Compact Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Temperature measurement		
0	No temperature sensor	★
T[5]	Integral RTD	
R	Remote thermowell and RTD	
Transmitter connection platform		
3	Direct mount	★
7	Remote mount, NPT connections	★
Differential pressure range		
1	0 to 25 in H_2O (0 to 62,3 mbar)	★
2	0 to 250 in H_2O (0 to 623 mbar)	★
3	0 to 1000 in H_2O (0 to 2,5 bar)	★
Transmitter output		
A[6]	4–20 mA with digital signal based on HART Protocol	★
F	FOUNDATION Fieldbus Protocol	★
W	PROFIBUS PA Protocol	★
X	Wireless	★
M	Low-Power, 1–5 Vdc with Digital Signal Based on HART Protocol	
Transmitter housing material	**Conduit entry size**	
A	Aluminum	1/2–14 NPT ★
B	Aluminum	M20 x 1.5 ★
J	SST	1/2–14 NPT ★
K[7]	SST	M20 x 1.5 ★
P[8]	Engineered polymer	No conduit entries ★
D	Aluminum	G1/2
M[7]	SST	G1/2
Transmitter performance class		
1	up to ±2.25% flow rate accuracy, 5:1 flow turndown, 2-year stability	★

Wireless options (requires wireless output code X and engineered polymer housing code P)

Wireless transmit rate, operating frequency and protocol		
WA3	User configurable transmit rate, 2.4 GHz *Wireless*HART	★
Antenna and SmartPower		
WP5	Internal antenna, compatible with green power module (I.S. power module sold separately)	★

Table 5. Rosemount 2051CFC Compact Flowmeter Ordering Information

★ **The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.**

Options (include with selected model number)

Extended product warranty		
WR3	3-year limited warranty	★
WR5	5-year limited warranty	★
Installation accessories[7]		
AB	ANSI alignment ring (Class 150) [only required for 10-in. (250 mm) and 12-in. (300 mm) line sizes]	★
AC	ANSI alignment ring (Class 300) [only required for 10-in. (250 mm) and 12-in. (300 mm) line sizes]	★
AD	ANSI alignment ring (Class 600) [only required for 10-in. (250 mm) and 12-in. (300 mm) line sizes]	★
DG	DIN alignment ring (PN16)	★
DH	DIN alignment ring (PN40)	★
DJ	DIN alignment ring (PN100)	★
JB	JIS alignment ring (10K)	
JR	JIS alignment ring (20K)	
JS	JIS alignment ring (40K)	
Remote adapters[7]		
FE	Flange adapters 316 SST (1/2-in. NPT)	★
High temperature application[7]		
HT	Graphite valve packing (T_{max} = 850 °F)	
Flow calibration[7][9]		
WC	Flow calibration, 3 Pt, conditioning orifice option C (all pipe schedules)	
WD	Flow calibration, 10 Pt, conditioning option C (all schedules), Annubar option A (Schedule 40)	
Pressure testing[7]		
P1	Hydrostatic Testing with certificate	
Special cleaning[7]		
P2	Cleaning for special services	
PA	Cleaning per ASTM G93 Level D (Section 11.4)	
Special inspection[7]		
QC1	Visual and dimensional inspection with certificate	★
QC7	Inspection and performance certificate	★
Transmitter calibration certification[7]		
Q4	Calibration certificate for Transmitter	★
Quality certification for safety[7][10][13][15]		
QS	Prior-use certificate of FMEDA data	★
QT	Safety certified to IEC 61508 with certificate of FMEDA	★

Table 5. Rosemount 2051CFC Compact Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Material traceability certification[7]		
Q8	Material traceability certification per EN 10204:2004 3.1	★
Code conformance[7]		
J2	ANSI/ASME B31.1	
J3	ANSI/ASME B31.3	
J4	ANSI/ASME B31.8	
Materials conformance[7][11]		
J5	NACE MR-0175/ISO 15156	
Country certification[7]		
J1	Canadian registration	
Product certifications		
E1[7]	ATEX Flameproof	★
E2[7]	INMETRO Flameproof	★
E3[7]	China Flameproof	★
E5	USA Explosion-proof, Dust Ignition-proof	★
E6	Canada Explosion-proof, Dust Ignition-proof, Division 2	★
E7[7]	IECEx Flameproof	★
I1[7]	ATEX Intrinsic Safety	★
I2[7]	INMETRO Intrinsically Safe	★
I3[7]	China Intrinsic Safety	★
I5	USA Intrinsically Safe, Division 2	★
I6	Canada Intrinsically Safe	★
I7[7]	IECEx Intrinsic Safety	★
IA[7][12]	ATEX FISCO Intrinsic Safety; for FOUNDATION Fieldbus Protocol only	★
IE[7][12]	USA FISCO Intrinsically Safe	★
IF[7][12]	Canada FISCO Intrinsically Safe	★
IG[7][12]	IECEx FISCO Intrinsically Safe	★
K1[7]	ATEX Flameproof, Intrinsic Safety, Type n, Dust	★
K5	USA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2 (combination of E5 and I5)	★
K6	Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2 (combination of E6 and I6)	★
K7[7]	IECEx Flameproof, Dust Ignition-proof, Intrinsic Safety, Type n (combination of E7, I7, and N7)	★
KA[7]	ATEX and CSA Flameproof, Intrinsically Safe, Division 2	★
KB	USAM and Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2 (combination of E5, E6, I5, and I6)	★
KC[7]	USA and ATEX Explosion-proof, Intrinsically Safe, Division 2	★
KD[7]	USA, Canada, and ATEX Explosion-proof, Intrinsically Safe (combination of E5, I5, E6, I6, E1, and I1)	★

Table 5. Rosemount 2051CFC Compact Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

N1[7]	ATEX Type n	★
N7[7]	IECEx Type n	★
ND[7]	ATEX Dust	★
Sensor fill fluid and O-ring options[7]		
L1[13]	Inert sensor fill fluid	★
L2	Graphite-filled (PTFE) O-ring	★
LA[13]	Inert sensor fill fluid and graphite-filled (PTFE) O-ring	★
Display and interface options[7]		
M[10]	LCD display with local operator interface	★
M5	LCD display	★
Transient protection[7][13][14]		
T1	Transient terminal block	★
Manifold for remote mount option[7]		
F2	3-valve manifold, stainless steel	★
F6	5-valve manifold, stainless steel	★
Alarm limit[7][15]		
C4[16]	NAMUR alarm and saturation levels, high alarm	★
CN[16]	NAMUR alarm and saturation levels, low alarm	★
CR	Custom alarm and saturation signal levels, high alarm (requires C1 and Configuration Data Sheet)	★
CS	Custom alarm and saturation signal levels, low alarm (requires C1 and Configuration Data Sheet)	★
CT	Low alarm (standard Rosemount alarm and saturation levels)	★
PlantWeb control functionality[7][12]		
A01	FOUNDATION Fieldbus advanced control function block suite	★
Hardware adjustments[7]		
D4[15]	Zero and span hardware adjustments	★
DZ[17]	Digital zero trim	★
Ground screw[7][13][18]		
V5	External ground screw assembly	★
HART revision configuration[7][15]		
HR5[19]	Configured for HART Revision 5	★
HR7[20]	Configured for HART Revision 7	★
Typical model number: 2051CFC D C S 060 N 065 0 3 2 A A 1 WC E5 M5		

1. Not available for Primary Element Technology C.
2. For the 10-in. (250 mm) and 12-in. (300 mm) line size, the alignment ring must be ordered (installation accessories).

3. 10-in. (250 mm) and 12-in. (300 mm) line sizes not available with Primary Element Technology A.
4. For 2-in. (50 mm) line sizes the Primary Element type is 0.6 for Primary Element Technology code C.
5. Available with Primary Element Technology A only.
6. HART Revision 5 is the default HART output. The Rosemount 2051 with Selectable HART can be factory or field configured to HART Revision 7. To order HART Revision 7 factory configured, add option code HR7.
7. Not available with low power output code M.
8. Only available with output code X.
9. Not available with Primary Element Technology P.
10. Not available with FOUNDATION Fieldbus (output code F) or wireless (output code X).
11. Materials of Construction comply with metallurgical requirements within NACE MR0175/ISO for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.
12. Only valid with FOUNDATION Fieldbus output code F.
13. Not available with output code X.
14. Not available with housing code 00, 5A, or 7J. The T1 option is not needed with FISCO Product Certifications, transient protection is included with the FISCO Product Certification code IA.
15. Only available with 4–20 mA HART (output codes A and M).
16. NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.
17. Only available with HART 4–20 mA (output codes A and M) and wireless (output code X).
18. The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.
19. Configures the HART output to HART Revision 5. The device can be field configured to HART Revision 7 if needed.
20. Configures the HART output to HART Revision 7. The device can be field configured to HART Revision 5 if needed.

Rosemount 2051CFP Integral Orifice Flowmeter



Additional information
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Specification and selection of product materials, options, or components must be made by the purchaser of the equipment. See page 56 for more information on material selection.

Table 6. Rosemount 2051CFP Integral Orifice Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Model	Product description	
2051CFP	Integral Orifice Flowmeter	
Measurement type		
D	Differential pressure	★
Material type		
S	316 SST	★
Line size		
005	1/2-in. (15 mm)	★
010	1-in. (25 mm)	★
015	1 1/2-in. (40 mm)	★
Process connection		
T1	NPT female body (not available with thermowell and RTD)	★
S1(1)	Socket weld body (not available with thermowell and RTD)	★
P1	Pipe ends: NPT threaded	★
P2	Pipe ends: beveled	★
D1	Pipe ends: flanged, DIN PN16, slip-on	★
D2	Pipe ends: flanged, DIN PN40, slip-on	★
D3	Pipe ends: flanged, DIN PN100, slip-on	★
W1	Pipe ends: flanged, RF, ANSI Class 150, weld-neck	★
W3	Pipe ends: flanged, RF, ANSI Class 300, weld-neck	★
W6	Pipe ends: flanged, RF, ANSI Class 600, weld-neck	★
A1	Pipe ends: flanged, RF, ANSI Class 150, slip-on	
A3	Pipe ends: flanged, RF, ANSI Class 300, slip-on	
A6	Pipe ends: flanged, RF, ANSI Class 600, slip-on	

Table 6. Rosemount 2051CFP Integral Orifice Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

R1	Pipe ends: flanged, RTJ, ANSI Class 150, slip-on	
R3	Pipe ends: flanged, RTJ, ANSI Class 300, slip-on	
R6	Pipe ends: flanged, RTJ, ANSI Class 600, slip-on	
Orifice plate material		
S	316 SST	★
Bore size option		
0066	0.066-in. (1,68 mm) for 1/2-in. pipe	★
0109	0.109-in. (2,77 mm) for 1/2-in. pipe	★
0160	0.160-in. (4,06 mm) for 1/2-in. pipe	★
0196	0.196-in. (4,98 mm) for 1/2-in. pipe	★
0260	0.260-in. (6,60 mm) for 1/2-in. pipe	★
0340	0.340-in. (8,64 mm) for 1/2-in. pipe	★
0150	0.150-in. (3,81 mm) for 1-in. pipe	★
0250	0.250-in. (6,35 mm) for 1-in. pipe	★
0345	0.345-in. (8,76 mm) for 1-in. pipe	★
0500	0.500-in. (12,70 mm) for 1-in. pipe	★
0630	0.630-in. (16,00 mm) for 1-in. pipe	★
0800	0.800-in. (20,32 mm) for 1-in. pipe	★
0295	0.295-in. (7,49 mm) for 1 1/2-in. pipe	★
0376	0.376-in. (9,55 mm) for 1 1/2-in. pipe	★
0512	0.512-in. (13,00 mm) for 1 1/2-in. pipe	★
0748	0.748-in. (19,00 mm) for 1 1/2-in. pipe	★
1022	1.022-in. (25,96 mm) for 1 1/2-in. pipe	★
1184	1.184-in. (30,07 mm) for 1 1/2-in. pipe	★
0010	0.010-in. (0,25 mm) for 1/2-in. pipe	
0014	0.014-in. (0,36 mm) for 1/2-in. pipe	
0020	0.020-in. (0,51 mm) for 1/2-in. pipe	
0034	0.034-in. (0,86 mm) for 1/2-in. pipe	
Transmitter connection platform		
D3	Direct mount, 3-valve manifold, SST	★
D5	Direct mount, 5-valve manifold, SST	★
R3	Remote mount, 3-valve manifold, SST	★
R5	Remote mount, 5-valve manifold, SST	★
Differential pressure ranges		
1	0 to 25 in H_2O (0 to 62,3 mbar)	★

Table 6. Rosemount 2051CFP Integral Orifice Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

2	0 to 250 in H_2O (0 to 623 mbar)	★
3	0 to 1000 in H_2O (0 to 2,5 bar)	★
Transmitter output		
A[2]	4–20 mA with digital signal based on HART Protocol	★
F	FOUNDATION Fieldbus Protocol	★
W	PROFIBUS PA Protocol	★
X	Wireless	★
M	Low-Power, 1–5 Vdc with digital signal based on HART Protocol	
Transmitter housing material	**Conduit entry size**	
A	Aluminum	1/2–14 NPT ★
B	Aluminum	M20 x 1.5 ★
J	SST	1/2–14 NPT ★
K[3]	SST	M20 x 1.5 ★
P[4]	Engineered polymer	No conduit entries ★
D	Aluminum	G1/2
M[3]	SST	G1/2
Transmitter performance class		
1	up to ±2.25% flow rate accuracy, 5:1 flow turndown, 2-year stability	★

Wireless options (requires wireless output code X and engineered polymer housing code P)

Wireless transmit rate, operating frequency and protocol		
WA3	User configurable transmit rate, 2.4 GHz *Wireless*HART	★
Antenna and SmartPower		
WP5	Internal antenna, compatible with green power module (I.S. power module sold separately)	★

Options (include with selected model number)

Extended product warranty		
WR3	3-year limited warranty	★
WR5	5-year limited warranty	★
Temperature sensor[3][5]		
RT	Thermowell and RTD	
Optional connection[3]		
G1	DIN 19213 transmitter connection	★
Pressure testing[3][6]		
P1	Hydrostatic testing with certificate	

Table 6. Rosemount 2051CFP Integral Orifice Flowmeter Ordering Information

★ **The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.**

Special cleaning[3]		
P2	Cleaning for special services	
PA	Cleaning per ASTM G93 Level D (Section 11.4)	
Material testing[3]		
V1	Dye penetrant exam	
Material examination[3]		
V2	Radiographic examination	
Flow calibration[3][7]		
WD	Discharge coefficient verification	
Special inspection[3]		
QC1	Visual and dimensional inspection with certificate	★
QC7	Inspection and performance certificate	★
Material traceability certification[3]		
Q8	Material traceability certification per EN 10204:2004 3.1	★
Code conformance[3][8]		
J2	ANSI/ASME B31.1	
J3	ANSI/ASME B31.3	
J4	ANSI/ASME B31.8	
Materials conformance[3][9]		
J5	NACE MR-0175/ISO 15156	
Country certification[3]		
J6	European Pressure Directive (PED)	★
J1	Canadian registration	
Transmitter calibration certification[3]		
Q4	Calibration certificate for transmitter	★
Quality certification for safety[3][10][12][13]		
QS	Prior-use certificate of FMEDA data	★
QT	Safety certified to IEC 61508 with certificate of FMEDA	★
Product certifications		
E1[3]	ATEX Flameproof	★
E2[3]	INMETRO Flameproof	★
E3[3]	China Flameproof	★
E5	USA Explosion-proof, Dust Ignition-proof	★

Table 6. Rosemount 2051CFP Integral Orifice Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

E6	Canada Explosion-proof, Dust Ignition-proof, Division 2	★
E7[3]	IECEx Flameproof	★
I1[3]	ATEX Intrinsic Safety	★
I2[3]	INMETRO Intrinsically Safe	★
I3[3]	China Intrinsic Safety	★
I5	USA Intrinsically Safe, Division 2	★
I6	Canada Intrinsically Safe	★
I7[3]	IECEx Intrinsic Safety	★
IA[3][10]	ATEX FISCO Intrinsic Safety; for FOUNDATION Fieldbus Protocol only	★
IE[3][10]	USA FISCO Intrinsically Safe	★
IF[3][10]	Canada FISCO Intrinsically Safe	★
IG[3][10]	IECEx FISCO Intrinsically Safe	★
K1[3][10]	ATEX Flameproof, Intrinsic Safety, Type n, Dust	★
K5	USA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2 (combination of E5 and I5)	★
K6	Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2 (combination of E6 and I6)	★
K7[3]	IECEx Flameproof, Dust Ignition-proof, Intrinsic Safety, Type n (combination of E7, I7, and N7)	★
KA[3]	ATEX and CSA Flameproof, Intrinsically Safe, Division 2	★
KB	USA and Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2 (combination of E5, E6, I5, and I6)	★
KC[3]	USA and ATEX Explosion-proof, Intrinsically Safe, Division 2	★
KD[3]	USA, Canada, and ATEX Explosion-proof, Intrinsically Safe (combination of E5, I5, E6, I6, E1, and I1)	★
N1[3]	ATEX Type n	★
N7[3]	IECEx Type n	★
ND[3]	ATEX Dust	★
Sensor fill fluid and O-ring options[3]		
L1[11]	Inert sensor fill fluid	★
L2	Graphite-filled (PTFE) O-ring	★
LA[11]	Inert sensor fill fluid and graphite-filled (PTFE) O-ring	★
Display and interface options[3]		
M4[12]	LCD display with local operator interface	★
M5	LCD display	★
Transient protection[3][11][12]		
T1	Transient terminal block	★

Table 6. Rosemount 2051CFP Integral Orifice Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Alarm limit[3][13]		
C4[14]	NAMUR alarm and saturation levels, high alarm	★
CN[14]	NAMUR alarm and saturation levels, low alarm	★
CR	Custom alarm and saturation signal levels, high alarm (requires C1 and Configuration Data Sheet)	★
CS	Custom alarm and saturation signal levels, low alarm (requires C1 and Configuration Data Sheet)	★
CT	Low alarm (standard Rosemount alarm and saturation levels)	★
PlantWeb control functionality[3][10]		
A01	FOUNDATION Fieldbus advanced control function block suite	★
Hardware adjustments[3]		
D4[13]	Zero and span hardware adjustments	★
DZ[15]	Digital zero trim	★
Ground screw[3][11][16]		
V5	External ground screw assembly	★
HART revision configuration[3][13]		
HR5[17]	Configured for HART Revision 5	★
HR7[18]	Configured for HART Revision 7	★
Typical model number: 2051CFP D S 010 W1 S 0500 D3 2 A A 1 E5 M5		

1. To improve pipe perpendicularity for gasket sealing, socket diameter is smaller than standard pipe O.D.
2. HART Revision 5 is the default HART output. The Rosemount 2051 with Selectable HART can be factory or field configured to HART Revision 7. To order HART Revision 7 factory configured, add option code HR7.
3. Not available with low power output code M.
4. Only available with output code X.
5. Thermowell Material is the same as the body material.
6. Does not apply to process connection codes T1 and S1.
7. Not available for bore sizes 0010, 0014, 0020, or 0034.
8. Not available with DIN process connection codes D1, D2, or D3.
9. Materials of Construction comply with metallurgical requirements within NACE MR0175/ISO for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.
10. Only valid with FOUNDATION Fieldbus output code F.
11. Not available with output code X.
12. Not available with housing code 00, 5A, or 7J. The T1 option is not needed with FISCO Product Certifications, transient protection is included with the FISCO Product Certification code IA.
13. Only available with 4–20 mA HART (output codes A).
14. NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.
15. Only available with HART 4–20 mA (output codes A and M) and wireless (output code X).
16. The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.
17. Configures the HART output to HART Revision 5. The device can be field configured to HART Revision 7 if needed.
18. Configures the HART output to HART Revision 7. The device can be field configured to HART Revision 5 if needed.

Rosemount 2051L Liquid Level Transmitter



Rosemount 2051L Liquid Level Transmitter

Configuration	Transmitter output code
4–20 mA HART Rosemount 2051 Rosemount 2051 with Selectable HART(1)	A
Lower Power Rosemount 2051 Rosemount 2051 with Selectable HART(1)	M
FOUNDATION Fieldbus	F
PROFIBUS	W
Wireless	X

1. The 4–20mA with Selectable HART device can be ordered with transmitter output option code A plus any of the following options codes: M4, QT, DZ, CR, CS, CT, HR5, HR7.

Additional information

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Table 7. Rosemount 2051L Liquid Level Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Model	Transmitter type		
2051L	Liquid Level Transmitter		★
Pressure range			
2	–250 to 250 inH_2O (–0,6 to 0,6 bar)		★
3	–1000 to 1000 inH_2O (–2,5 to 2,5 bar)		★
4	–300 to 300 psi (–20,7 to 20,7 bar)		★
Transmitter output			
A(1)	4–20 mA with digital signal based on HART Protocol		★
F	FOUNDATION Fieldbus Protocol		★
W	PROFIBUS PA Protocol		★
X	Wireless		★
M	Low-Power, 1–5 V dc with digital signal based on HART Protocol		
Process connection size, diaphragm material (high side)			
	Process connection size	**Diaphragm**	
G(2)	2-in./DN 50	316L SST	★
H(2)	2-in./DN 50	Alloy C-276	★
J	2-in./DN 50	Tantalum	★
A(2)	3-in./DN 80	316L SST	★
B(2)	4-in./DN 100	316L SST	★

Table 7. Rosemount 2051L Liquid Level Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

C[2]	3-in./DN 80	Alloy C-276		★
D[2]	4-in./DN 100	Alloy C-276		★
E	3-in./DN 80	Tantalum		★
F	4-in./DN 100	Tantalum		★
Extension length (high side)				
0	None, flush mount			★
2	2-in./50 mm			★
4	4-in./100 mm			★
6	6-in./150 mm			★
Mounting flange size, rating, material (high side)				
	Size	**Rating**	**Material**	
M	2-in.	ANSI/ASME B16.5 Class 150	CS	★
A	3-in.	ANSI/ASME B16.5 Class 150	CS	★
B	4-in.	ANSI/ASME B16.5 Class 150	CS	★
N	2-in.	ANSI/ASME B16.5 Class 300	CS	★
C	3-in.	ANSI/ASME B16.5 Class 300	CS	★
D	4-in.	ANSI/ASME B16.5 Class 300	CS	★
X[2]	2-in.	ANSI/ASME B16.5 Class 150	SST	★
F[2]	3-in.	ANSI/ASME B16.5 Class 150	SST	★
G[2]	4-in.	ANSI/ASME B16.5 Class 150	SST	★
Y[2]	Displayed	ANSI/ASME B16.5 Class 300	SST	★
H[2]	3-in.	ANSI/ASME B16.5 Class 300	SST	★
J[2]	4-in.	ANSI/ASME B16.5 Class 300	SST	★
Q	DN50	PN 10-40 per EN 1092-1	CS	★
R	DN80	PN 40 per EN 1092-1	CS	★
K[2]	DN50	PN 10-40 per EN 1092-1	SST	★
T[2]	DN80	PN 40 per EN 1092-1	SST	★
Seal fill fluid (high side)		**Specific gravity at 77 °F (25 °C)**	**Temperature limits (ambient temperature of 70 °F [21 °C])**	
A	SYLTHERM™ XLT	0.85	–102 to 293 °F (–75 to 145 °C)	★
C	Silicone 704	1.07	32 to 401 °F (0 to 205 °C)	★
D	Silicone 200	0.93	–49 to 401 °F (–45 to 205 °C)	★
F	Silicone 200 for vacuum applications limits: For use in vacuum applications below 14.7 psia (1 bar-a), refer to vapor pressure curves in Rosemount DP Level Fill Fluid Specification Technical Note.			
H	Inert (halocarbon)	1.85	5 to 401 °F (–15 to 205 °C)	★
G	Glycerin and water	1.13	–49 to 320 °F (–45 to 160 °C)	★

Table 7. Rosemount 2051L Liquid Level Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

L	Silicone 704 for Vacuum Applications Limits: For use in vacuum applications below 14.7 psia (1 bar-a), refer to vapor pressure curves in Rosemount DP Level Fill Fluid Specification Technical Note.			
N	Neobee® M-20	0.92	5 to 401 °F (–15 to 205 °C)	★
P	Propylene glycol and water	1.02	5 to 203 °F (–15 to 95 °C)	★
Sensor module configuration, flange adapter (low side)				
	Configuration	**Flange adapter**		
1	Gage	SST		★
2	Differential	SST		★
3(3)	Tuned-System with remote seal	None		★
Sensor module diaphragm material, sensor fill fluid (low side)				
	Diaphragm material	**Sensor fill fluid**		
1	316L SST	Silicone		★
2	Alloy C-276 (SST valve seat)	Silicone		★
7	Alloy C-276 (Alloy C-276 valve seat)	Silicone		★
A(4)	316L SST	Inert (halocarbon)		★
B(2)(4)	Alloy C-276 (SST valve seat)	Inert (halocarbon)		★
G(4)	Alloy C-276 (Alloy C-276 valve seat)	Inert (halocarbon)		★
O-ring				
A	Glass-filled PTFE			★
Housing material		**Conduit entry size**		
A	Aluminum	1/2–14 NPT		★
B	Aluminum	M20 x 1.5		★
J	SST	1/2–14 NPT		★
K(5)	SST	M20 x 1.5		★
P(6)	Engineered polymer	No conduit entries		★
D	Aluminum	G1/2		
M(5)	SST	G1/2		

Wireless options (requires wireless output code X and engineered polymer housing code P)

Wireless transmit rate, operating frequency and protocol		
WA3	User configurable transmit rate, 2.4 GHz *Wireless*HART	★
Antenna and SmartPower		
WP5	Internal antenna, compatible with green power module (I.S. power module sold separately)	★

Table 7. Rosemount 2051L Liquid Level Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Options (include with selected model number)

Extended product warranty		
WR3	3-year limited warranty	★
WR5	5-year limited warranty	★
PlantWeb control functionality[7]		
A01	FOUNDATION Fieldbus advanced control function block suite	★
Seal assemblies[8]		
S1	Assemble to one Rosemount 1199 Seal (requires 1199M)	★
Product certifications		
E1[5]	ATEX Flameproof	★
E2[5]	INMETRO Flameproof	★
E3[5]	China Flameproof	★
E4	TIIS Flameproof	★
E5	USA Explosion-proof, Dust Ignition-proof	★
E6	Canada Explosion-proof, Dust Ignition-proof, Division 2	★
E7[5]	IECEx Flameproof	★
EW[5]	India (CCOE) Flameproof Approval	★
I1[5]	ATEX Intrinsic Safety	★
I2[5]	INMETRO Intrinsically Safe	★
I3[5]	China Intrinsic Safety	★
I4[5][6]	TIIS Intrinsic Safety	★
I5	USA Intrinsically Safe, Division 2	★
I6	Canada Intrinsically Safe	★
I7[5]	IECEx Intrinsic Safety	★
IA[7]	ATEX FISCO Intrinsic Safety	★
IE[7]	USA FISCO Intrinsically Safe	★
IF[7]	Canada FISCO Intrinsically Safe	★
IG[7]	IECEx FISCO Intrinsically Safe	★
IW[5]	India (CCOE) Intrinsically Safety Approval	★
K1[5]	ATEX Flameproof, Intrinsic Safety, Type n, Dust	★
K2	INMETRO Flameproof and Intrinsic Safety	★
K5	USA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★
K6	Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★
K7[5]	IECEx Flameproof, Intrinsic Safety, Type n and Dust	★
KA[5]	ATEX and Canada Flameproof, Intrinsically Safe, Division 2	★
KB	USA and Canada Explosion-proof, Dust Ignition-proof, Intrinsically Safe, Division 2	★

Table 7. Rosemount 2051L Liquid Level Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

KC[5]	USA and ATEX Explosion-proof, Intrinsically Safe, Division 2	★
KD[5]	USA, Canada, and ATEX Explosion-proof, Intrinsically Safe	★
N1[5]	ATEX Type n	★
N7[5]	IECEx Type n	★
ND[5]	ATEX Dust	★
EM	Technical Regulations Customs Union (EAC) Flameproof	★
IM	Technical Regulations Customs Union (EAC) Intrinsic Safety	★
KM	Technical Regulations Customs Union (EAC) Flameproof and Intrinsic Safety	★
Shipboard approvals[4]		
SBS	American Bureau of Shipping (ABS) type approval	★
SBV	Bureau Veritas (BV) type approval	★
SDN	Det Norske Veritas (DNV) type approval	★
SLL	Lloyds Register (LR) type approval	★
Display and interface options		
M4[9]	LCD display with local operator interface	★
M5	LCD display	★
Hardware adjustments		
D4[10]	Zero and span configuration buttons	★
DZ[11]	Digital zero trim	★
Flange adapters[12]		
DF	1/2–14 NPT flange adapters	★
Conduit plug[4][13]		
DO	316 SST conduit plug	★
Ground screw[4][14]		
V5	External ground screw assembly	★
Transient protection[4][15]		
T1	Transient terminal block	★
Software configuration[11]		
C1	Custom software configuration (requires completed Configuration Data Sheet)	★
Alarm limit[10]		
C4[16]	NAMUR alarm and saturation levels, high alarm	★
CN[16]	NAMUR alarm and saturation levels, low alarm	★
CR	Custom alarm and saturation signal levels, high alarm (requires C1 and Configuration Data Sheet)	★
CS	Custom alarm and saturation signal levels, low alarm (requires C1 and Configuration Data Sheet)	★
CT	Low alarm (standard Rosemount alarm and saturation levels)	★

Table 7. Rosemount 2051L Liquid Level Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery. The Expanded offering is subject to additional delivery lead time.

Calibration certification				
Q4	Calibration certificate			★
QG	Calibration certificate and GOST verification certificate			★
GP	Calibration certificate and tamper evident seal			★
Material traceability certification				
Q8	Material traceability certification per EN 10204 3.1			★
Quality certification for safety(17)				
QS	Prior-use certificate of FMEDA data			★
QT	Safety certified to IEC 61508 with certificate of FMEDA			★
Toolkit total system performance reports				
QZ	Remote seal system performance calculation report			★
Conduit electrical connector(4)				
GE	M12, 4-pin, male connector (eurofast)			★
GM	A size mini, 4-pin, male connector (minifast)			★
NACE certificate(18)				
Q15	Certificate of compliance to NACE MR0175/ISO 15156 for wetted materials			★
Q25	Certificate of compliance to NACE MR0103 for wetted materials			★
Lower housing flushing connection options				
	Ring material	**Number**	**Size (NPT)**	
F1	316 SST	1	1/4–18 NPT	★
F2	316 SST	2	1/4–18 NPT	★
F3(19)	Alloy C-276	1	1/4–18 NPT	★
F4(19)	Alloy C-276	2	1/4–18 NPT	★
F7	316 SST	1	1/2–14 NPT	★
F8	316 SST	2	1/2–14 NPT	★
F9	Alloy C-276	1	1/2–14 NPT	★
F0	Alloy C-276	2	1/2–14 NPT	★
Typical model number:	**2051L 2 A A0 X D 21 A A B4 M5 F1**			

1. HART Revision 5 is the default HART output. The Rosemount 2051 with Selectable HART can be factory or field configured to HART Revision 7. To order HART Revision 7 factory configured, add option code HR7.
2. Materials of Construction comply with metallurgical requirements highlighted within NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments. Order with Q15 or Q25 to receive a NACE certificate.
3. Requires option code S1.
4. Not available with output code X.
5. Not available with low power output code M.
6. Only available with output code X.
7. Only valid with FOUNDATION Fieldbus output code F.

8. “Assemble-to” items are specified separately and require a completed model number.
9. Not valid with FOUNDATION Fieldbus output code F and wireless output code X.
10. Only available with 4–20 mA HART (output codes A and M).
11. Only available with HART 4–20 mA output (codes A) and wireless output (code X).
12. Not available with remote mount seal assembly option S1.
13. Transmitter is shipped with 316 SST conduit plug (uninstalled) in place of standard carbon steel conduit plug.
14. The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.
15. The T1 option is not needed with FISCO Product Certifications; transient protection is included in the FISCO product certification codes IA, IE, IF, and IG.
16. NAMUR-Compliant operation is pre-set at the factory.
17. Only available with HART 4–20 mA output (code A).
18. NACE Compliant wetted materials are identified by Footnote 2.
19. Not available with option codes A0, B0, and G0.

Specifications

Performance specifications

This product data sheet covers HART, Wireless, FOUNDATION Fieldbus, and PROFIBUS PA Protocols unless specified.

Conformance to specification (±3σ [sigma])

Technology leadership, advanced manufacturing techniques, and statistical process control ensure specification conformance to at least ±3σ.

Reference accuracy

Stated reference accuracy equations include terminal based linearity, hysteresis, and repeatability. For Wireless, FOUNDATION Fieldbus, and PROFIBUS PA devices, use calibrated range in place of span.

Models	Standard	High performance option, P8	
Rosemount 2051C			
Range 1	±0.10% of span For spans less than 15:1, accuracy = $\pm\left(0.025 + 0.005\left[\frac{URL}{Span}\right]\right)$ % of span	N/A	N/A
Ranges 2–4	±0.065% of span For spans less than 10:1, accuracy = $\pm\left(0.025 + 0.005\left[\frac{URL}{Span}\right]\right)$ % of span	Ranges 2–4	High accuracy option, P8 ±0.05% of span For spans less than 10:1[1], accuracy = $\pm\left(0.015 + 0.005\left[\frac{URL}{Span}\right]\right)$ % of span
Range 5	±0.075% of span For spans less than 10:1, accuracy= $\pm\left(0.025 + 0.005\left[\frac{URL}{Span}\right]\right)$ % of span	Range 5	High performance option, P8 ±0.065% of span For spans less than 10:1, accuracy= $\pm\left(0.015 + 0.005\left[\frac{URL}{Span}\right]\right)$ % of span
Rosemount 2051T, 2051G			
Ranges 1–4	±0.065% of span For spans less than 10:1, accuracy = $\pm\left(0.0075\left[\frac{URL}{Span}\right]\right)$ % of span	Ranges 1–4	High accuracy option, P8 ±0.05% of span For spans less than 10:1[1], accuracy = $\pm\left(0.0075\left[\frac{URL}{Span}\right]\right)$ % of span
Range 5[2]	±0.075% of span For spans less than 10:1, accuracy = $\pm\left(0.0075\left[\frac{URL}{Span}\right]\right)$ % of span	N/A	N/A
Rosemount 2051L			
Ranges 2–4	±0.075% of span For spans less than 10:1, accuracy = $\pm\left(0.025 + 0.005\left[\frac{URL}{Span}\right]\right)$ % of span	N/A	N/A

1. For protocol code F, accuracy specification is for spans less than 7:1. Not available with output code W.
2. Rosemount 2051G is not available with Range 5.

Flow performance

Flow reference accuracy

Rosemount 2051CFA Annubar Flowmeter		
Ranges 2–3		±2.00% of flow rate at 5:1 flow turndown
Rosemount 2051CFC_A Compact Annubar Flowmeter — Annubar option A		
Ranges 2–3	Standard	±2.60% of flow rate at 5:1 flow turndown
	Calibrated	±2.30% of flow rate at 5:1 flow turndown
Rosemount 2051CFC Compact Orifice Flowmeter — conditioning option C		
Ranges 2–3	β = 0.4	±2.25% of flow rate at 5:1 flow turndown
	β = 0.65	±2.45% of flow rate at 5:1 flow turndown
Rosemount 2051CFC Compact Orifice Flowmeter — orifice type option P[1]		
Ranges 2–3	β =0.4	±2.50% of flow rate at 5:1 flow turndown
	β =0.65	±2.50% of flow rate at 5:1 flow turndown

Rosemount 2051CFP Integral Orifice Flowmeter		
Ranges 2–3	Bore < 0.1	±3.10% of flow rate at 5:1 flow turndown
	0.1 < Bore < 0.2	±2.75% of flow rate at 5:1 flow turndown
	0.2 < Bore < 0.6	±2.25% of flow rate at 5:1 flow turndown
	0.6 < Bore < 0.8	±3.00% of flow rate at 5:1 flow turndown

1. For smaller line sizes, see Rosemount Compact Orifice.

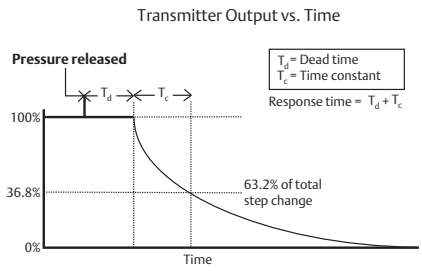
Long-term stability

±50 °F (28 °C) temperature changes and up to 1000 psi (6,9 MPa) line pressure.

Models	Standard	High performance option, P8
Rosemount 2051C		
Range 1 (CD)	±0.2% of URL for 1 year	±0.175% of URL for 7 years
Ranges 2–5	±0.125% of URL for 5 years	
Rosemount 2051T, 2051G		
Ranges 1–5[1]	±0.125% of URL for 5 years	±0.15% of URL for 7 years

1. Rosemount 2051G is not available with range 5.

Dynamic performance

	4–20 mA HART[1] 1–5 Vdc HART Low Power	FOUNDATION Fieldbus and PROFIBUS PA Protocols[2]	Typical HART transmitter response time
Total response time ($T_d + T_c$):			
Rosemount 2051C Range 3–5: Range 1: Range 2: 2051T and 2051G: 2051L:	 115 ms 270 ms 130 ms 100 ms See Instrument Toolkit™	 152 ms 307 ms 152 ms 152 ms See Instrument Toolkit	
Dead time (T_d)	60 ms (nominal[3])	97 ms	
Update rate[4]	22 times per second	22 times per second	

1. Dead time and update rate apply to all models and ranges; analog output only.
2. Transducer block response time, Analog Input block execution time not included.
3. Nominal total response time at 75 °F (24 °C) reference conditions.
4. Does not apply to wireless (output code X). See "Wireless (output code X)" on page 53 for wireless update rate.

Line pressure effect per 1000 psi (6,9 MPa)

For line pressures above 2000 psi (13,7 MPa) and Ranges 4–5, see Rosemount 2051 Reference Manual for HART, Rosemount 2051 Reference Manual for *Wireless*HART, Rosemount 2051 Reference Manual for FOUNDATION Fieldbus, and Rosemount 2051 Reference Manual PROFIBUS PA.

Models	Line pressure effect	
Rosemount 2051CD, 2051CF	**Zero Error**[1]	**Span Error**
Range 1	±0.25% of URL/ 1000 psi (68,9 bar)	±0.4% of reading/ 1,000 psi (68,9 bar)
Ranges 2–3	±0.05% of URL/ 1000 psi (68,9 bar) for line pressures from 0 to 2000 psi (0 to 13,7 MPa)	±0.1% of reading/ 1,000 psi (68,9 bar)

1. Can be calibrated out at line pressure.

Ambient temperature effect per 50 °F (28 °C)

Models	Ambient temperature effect
Rosemount 2051C, 2051CF	
Ranges 2–5	±(0.025% URL + 0.125% span) from 1:1 to 5:1 ±(0.05% URL + 0.25% span) from 5:1 to 100:1
Range 1	±(0.1% URL + 0.25% span) from 1:1 to 30:1
Rosemount 2051T, 2051G	
Range 2–4	±(0.05% URL + 0.25% span) from 1:1 to 10:1 ±(0.07% URL + 0.125% span) from 10:1 to 100:1
Range 1	±(0.05% URL + 0.25% span) from 1:1 to 5:1 ±(0.10% URL + 0.125% span) from 5:1 to 100:1
Range 5[1]	±(0.1% URL + 0.15% span)
Rosemount 2051L	See Instrument Toolkit (TM)

1. Rosemount 2051G is not available with range 5.

Mounting position effects

Models	Mounting position effects
Rosemount 2051C	Zero shifts up to ±1.25 inH_2O (3,1 mbar), which can be calibrated out. No span effect.
Rosemount 2051T and 2051G	Zero shifts up to ±2.5 inH_2O (6,2 mbar), which can be calibrated out. No span effect.
Rosemount 2051L	With liquid level diaphragm in vertical plane, zero shift of up to 1 inH_2O (2,49 mbar). With diaphragm in horizontal plane, zero shift of up to 5 inH_2O (12,43 mbar) plus extension length on extended units. Zero shifts can be calibrated out. No span effect.

Vibration effect

Less than ±0.1% of URL when tested per the requirements of IEC60770-1 field or pipeline with high vibration level (10–60 Hz 0.21mm displacement peak amplitude/60–2000 Hz 3g).

Power supply effect

Less than ±0.005% of calibrated span per volt.

Electromagnetic compatibility (EMC)

Meets all industrial environment requirements of EN61326 and NAMUR NE-21[(1)]. Maximum deviation < 1% span during EMC disturbance[(2)].

1. NAMUR NE-21 does not apply to Low-Power (Transmitter output option code M) and Wireless (Transmitter output code X).
2. During surge event device may exceed maximum EMC deviation limit or reset; however, device will self-recover and return to normal operation within specified start-up time.

Transient protection (option code T1)

Meets IEEE C62.41, category location B

- 6 kV crest (0.5 µs–100 kHz)
- 3 kA crest (8 × 20 microseconds)
- 6 kV crest (1.2 × 50 microseconds)

Functional specifications

Range and sensor limits

Table 8. Range and Sensor Limits for Rosemount 2051CD, 2051CF, 2051CG, 2051L models

Range	Minimum span	Upper (URL)	Lower (LRL)			
			Rosemount 2051C Differential, 2051CF flowmeters	Rosemount 2051C Gage[1]	Rosemount 2051L Differential	Rosemount 2051L Gage[1]
1	0.5 inH_2O (1,2 mbar)	25 inH_2O (62,3 mbar)	–25 inH_2O (–62,1 mbar)	–25 inH_2O (–62,1 mbar)	N/A	N/A
2	2.5 inH_2O (6,2 mbar)	250 inH_2O (0,62 bar)	–250 inH_2O (–0,62 bar)	–250 inH_2O (–0,62 bar)	–250 inH_2O (–0,62 bar)	–250 inH_2O (–0,62 bar)
3	10 inH_2O (24,9 mbar)	1000 inH_2O (2,49 bar)	–1000 inH_2O (–2,49 bar)	–393 inH_2O (–979 mbar)	–1000 inH_2O (–2,49 bar)	–393 inH_2O (–979 mbar)
4	3 psi (0,207 bar)	300 psi (20,7 bar)	–300 psi (–20,7 bar)	–14.2 psig (–979 mbar)	–300 psi (–20,7 bar)	–14.2 psig (–979 mbar)
5	20 psi (1,38 bar)	2000 psi (137,9 bar)	–2000 psi (–137,9 bar)	–14.2 psig (–979 mbar)	N/A	N/A

1. Assumes atmospheric pressure of 14.7 psig.

Table 9. Range and Sensor Limits for Rosemount 2051T and 2051G model

Range	Minimum span	Upper (URL)	Lower (LRL)(Abs)	Lower[1] (LRL)(Gage)
1	0.3 psi (20,7 mbar)	30 psi (2,07 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
2	1.5 psi (0,103 bar)	150 psi (10,3 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
3	8 psi (0,55 bar)	800 psi (55,2 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
4	40 psi (2,76 bar)	4000 psi (275,8 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
5[2]	2,000 psi (137,9 bar)	10,000 psi (689,5 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)

1. Assumes atmospheric pressure of 14.7 psig.
2. Rosemount 2051G is not available with Range 5.

Service

Liquid, gas, and vapor applications

Protocols

4–20 mA HART (output code A)

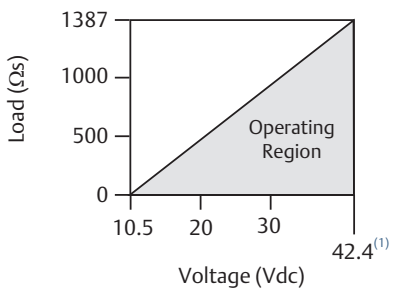
Power supply

External power supply required. Standard transmitter operates on 10.5 to 42.4 Vdc with no load.

Load limitations

Maximum loop resistance is determined by the voltage level of the external power supply, as described by:

Max. Loop Resistance = 43.5 (Power Supply Voltage – 10.5)



Communication requires a minimumloop resistance of 250 ohms.

1. For Canada approval, power supply must not exceed 42.4 V.

Indication

Optional two line LOI/LCD display

Zero and span adjustment requirements

Zero and span values can be set anywhere within the range limits stated in Table 8 and Table 9.

Span must be greater than or equal to the minimum span stated in Table 8 and Table 9.

Output

Two-wire 4–20mA, user selectable for linear or square root output. Digital process variable superimposed on 4–20 mA signal, available to any host that conforms to HART Protocol.

Rosemount 2051

Digital communications based on HART Revision 5 Protocol.

Rosemount 2051 with Selectable HART

The Rosemount 2051 with Selectable HART comes with Selectable HART Revisions. Digital communications based on HART Revision 5 (default) or Revision 7 (option code HR7) Protocol can be selected. The HART revision can be switched in the field using any HART based configuration tool or the optional LOI.

LOI

The LOI utilizes a two-button menu with internal and external configuration buttons. Internal buttons are always configured for LOI. External buttons can be configured for either LOI, (option code M4), analog zero and span (option code D4) or digital zero trim (option code DZ). See Rosemount 2051 with Selectable HART Reference Manual for LOI configuration menu.

FOUNDATION Fieldbus (output code F)

Power supply

External power supply required; transmitters operate on 9.0 to 32.0 Vdc transmitter terminal voltage for non-I.S. applications, 9.0 to 30 Vdc for entity model intrinsically safe applications and 9.0 to 17.5 Vdc for FISCO intrinsically safe applications.

Current draw

17.5 mA for all configurations (including LCD display option)

Indication

Optional two-line LCD display

FOUNDATION Fieldbus function block

Execution times

Block	Execution time
Resource	N/A
Transducer	N/A
LCD display block	N/A
Analog input 1, 2	20 milliseconds
PID	25 milliseconds
Arithmetic	20 milliseconds
Input selection	20 milliseconds
Signal characterizer	20 milliseconds
Integrator	20 milliseconds
Output splitter	20 milliseconds
Control selector	20 milliseconds

FOUNDATION Fieldbus parameters

Schedule entries	7 (max.)
Links	25 (max.)
Virtual communications relationships (VCR)	20 (max.)

Standard function blocks

Resource block

The resource block contains diagnostic, hardware and electronics information. There are no linkable inputs or outputs to the resource block.

Sensor transducer block

The sensor transducer block contains sensor information including the sensor diagnostics and the ability to trim the pressure sensor or recall factory calibration.

LCD display transducer block

The LCD display transducer block is used to configure the LCD display meter.

Analog input block

The Analog input (AI) function block processes the measurements from the sensor and makes them available to other function blocks. The output value from the AI block is in engineering units and contains a status indicating the quality of the measurement. The AI block is widely used for scaling functionality.

Note

The channel, Set XD_Scale, Set L_Type, and sometimes Set Out_Scale are typically configured by instrument personnel. Other AI block parameters, block links, and schedule are typically configured by the control systems configuration engineer.

Input selector block

The input selector (ISEL) function block can be used to select the first good, Hot Backup™, maximum, minimum, or average of as many as eight input values and place it at the output. The block supports signal status propagation.

Integrator block

The integrator (INT) function block integrates one or two variables over time. The block compares the integrated or accumulated value to pre-trip and trip limits and generates discrete output signals when the limits are reached.
The Integrator Block is used as a totalizer. This block will accept up to two inputs, has six options how to totalize the inputs, and two trip outputs.

Arithmetic block

The arithmetic (ARTH) function block provides the ability to configure a range extension function for a primary input. It can also be used to compute nine different arithmetic functions including flow with partial density compensation, electronic remote seals, hydrostatic tank gauging, ratio control and others.

Signal characterizer block

The signal characterizer (SGCR) function block characterizes or approximates any function that defines an input/output relationship. The function is defined by configuring as many as twenty X,Y coordinates. The block interpolates an output value for a given input value using the curve defined by the configured coordinates. Two separate analog input signals can be processed simultaneously to give two corresponding separate output values using the same defined curve.

PID block

The PID function block combines all of the necessary logic to perform proportional/integral/derivative (PID) control. The block supports mode control, signal scaling and limiting, feed forward control, override tracking, alarm limit detection, and signal status propagation.

Control selector block

The control selector function block selects one of two or three inputs to be the output. The inputs are normally connected to the outputs of PID or other function blocks. One of the inputs would be considered Normal and the other two overrides.

Output splitter block

The output splitter function block provides the capability to drive two control outputs from a single input. It takes the output of one PID or other control block to control two valves or other actuators.

Backup link active scheduler (LAS)

The transmitter can function as a LAS if the current link master device fails or is removed from the segment.

PROFIBUS PA (output code W)

Profile version

3.02

Power supply

External power supply required; transmitters operate on 9.0 to 32.0 Vdc transmitter terminal voltage for non-I.S. applications, 9.0 to 30 Vdc for entity model intrinsically safe applications and 9.0 to 17.5 Vdc for FISCO intrinsically safe applications.

Current draw

17.5 mA for all configurations (including LCD display option)

Output update rate

Four times per second

Standard function blocks

Analog Input (AI block)

The AI function block processes the measurements and makes them available to the host device. The output value from the AI block is in engineering units and contains a status indicating the quality of the measurement.

Physical block

The physical block defines the physical resources of the device including type of memory, hardware, electronics, and diagnostic information.

Transducer block

Contains actual sensor measurement data including the sensor diagnostics and the ability to trim the pressure sensor or recall factory defaults.

Indication

Optional two-line LCD display

LOI

Optional external configuration buttons

Wireless (output code X)

Output

IEC 62591 (*Wireless*HART), 2.4 GHz DSSS

Wireless radio (internal antenna, WP5 option)

- Frequency: 2.400–2.485 GHz
- Channels: 15
- Modulation: IEEE 802.15.4 compliant DSSS
- Transmission: maximum of 10 dBm EIRP

Local display

The optional three-line, seven-digit LCD display can display user-selectable information such as primary variable in engineering units, scaled variable, percent of range, sensor module temperature, and electronics temperature. The display updates based on the wireless update rate.

Digital zero trim

Digital zero trim (option DZ) is an offset adjustment to compensate for mounting position effects, up to 5% of URL.

Update rate

User selectable 1 second to 60 minutes

Wireless sensor module for in-line transmitters

The Rosemount 2051 Wireless Transmitter requires the engineered polymer housing to be selected. The standard sensor module will come with aluminum material. If stainless steel is required, the option WSM must be selected.

Power module

Field replaceable, keyed connection eliminates the risk of incorrect installation, Intrinsically Safe Lithium-thionyl chloride Power Module with PBT/PC enclosure. Ten-year life at one minute update rate.(1)

1. Reference conditions are 70 °F (21 °C), and routing data for three additional network devices.

   Note: Continuous exposure to ambient temperature limits of –40 °F to 185 °F (–40 °C to 85 °C) may reduce specified life by less than 20%.

HART 1–5 Vdc Low Power (output code M)

Output

Three-wire 1–5 Vdc output, user-selectable for linear or square root output. Digital process variable superimposed on voltage signal, available to any host conforming to the HART Protocol.

Rosemount 2051

Digital communications based on HART Revision 5 Protocol.

Rosemount 2051 with Selectable HART

The Rosemount 2051 with Selectable HART comes with Selectable HART Revisions. Digital communications based on HART Revision 5 (default) or Revision 7 (option code HR7) Protocol can be selected. The HART revision can be switched in the field using any HART based configuration tool or the optional LOI.

LOI

The LOI utilizes a two-button menu with internal and external configuration buttons. Internal buttons are always configured for LOI. External buttons can be configured for either LOI, (option code M4), analog zero and span (option code D4) or digital zero trim (option code DZ). See Rosemount 2051 with Selectable HART Reference Manual for LOI configuration menu.

Power supply

External power supply required. Standard transmitter operates on 9 to 28 Vdc with no load.

Power consumption

3.0 mA, 27–84 mW

Output load

100 kΩ or greater (meter input impedance)

Turn-on time

Performance within specifications less than two seconds after power is applied to the transmitter.

Overpressure limits

Transmitters withstand the following limits without damage:

Rosemount 2051C, 2051CF

- Ranges 2–5: 3,626 psig (250 bar)
  4,500 psig (310,3 bar) for option code P9
- Range 1: 2,000 psig (137,9 bar)

Rosemount 2051T, 2051G

- Range 1: 750 psi (51,7 bar)
- Range 2: 1,500 psi (103,4 bar)
- Range 3: 1,600 psi (110,3 bar)
- Range 4: 6,000 psi (413,7 bar)
- Range 5: 15,000 psi (1034,2 bar)(1)

1. *The Rosemount 2051G is not available with Range 5.*

Rosemount 2051L

Limit is flange rating or sensor rating, whichever is lower (See Table 10).

Table 10. Rosemount 2051L Flange Rating

Standard	Type	CS rating	SST rating
ANSI/ASME	Class 150	285 psig	275 psig
ANSI/ASME	Class 300	740 psig	720 psig
At 100 °F (38 °C), the rating decreases with increasing temperature, per ANSI/ASME B16.5.			
DIN	PN 10–40	40 bar	40 bar
DIN	PN 10/16	16 bar	16 bar
At 248 °F (120 °C), the rating decreases with increasing temperature, per DIN 2401.			

Static pressure limit

Rosemount 2051CD, 2051CF

- Operates within specifications between static line pressures of –14.2 psig (0,034 bar) and 3626 psig (250 bar)
- For Option Code P9, 4500 psig (310,3 bar)
- Range 1: 0.5 psia to 2000 psig (34 mbar and 137,9 bar)

Burst pressure limits

Rosemount 2051C, 2051CF coplanar or traditional process flange

10,000 psig (689.5 bar)

Rosemount 2051T in-line

- Ranges 1–4: 11000 psi (758,4 bar)
- Range 5: 26000 psi (1792,6 bar)

Temperature limits

Ambient

–40 to 185 °F (–40 to 85 °C)
With LCD display(1)(2): –40 to 175 °F (–40 to 80 °C)

Storage(1)

–50 to 230 °F (–46 to 110 °C)
With LCD display: –40 to 185 °F (–40 to 85 °C)
With Wireless output: –40 °F to 185 °F (–40 °C to 85 °C)

1. Rosemount 2051 LCD display may not be readable and LCD display updates may be slower at temperatures below –22 °F (–30 °C).
2. Wireless LCD display may not be readable and LCD display updates will be slower at temperatures below –4 °F (–20 °C).

Process

At atmospheric pressures and above. See Table 11.

Table 11. Process Temperature Limits

Rosemount 2051C, 2051CF	
Silicone fill sensor(1)	
with coplanar flange	–40 to 250 °F (–40 to 121 °C)(2)
with traditional flange	–40 to 300 °F (–40 to 149 °C)(2)(3)
with level flange	–40 to 300 °F (–40 to 149 °C)(2)
with Rosemount 305 Integral Manifold	–40 to 300 °F (–40 to 149 °C)(2)
Inert fill sensor(1)	–40 to 185 °F (–40 to 85 °C)(3)
Rosemount 2051T (process fill fluid)	
Silicone fill sensor(1)	–40 to 250 °F (–40 to 121 °C)(2)
Inert fill sensor(1)	–22 to 250 °F (–30 to 121 °C)(2)
Rosemount 2051L low side temperature limits	
Silicone fill sensor(1)	–40 to 250 °F (–40 to 121 °C)(2)
Inert fill Sensor(1)	–40 to 185 °F (–40 to 85 °C) (2)
Rosemount 2051L high side temperature limits (process fill fluid)	
SYLTHERM XLT	–102 to 293 °F (–75 to 145°C)
Silicone 704	32 to 401 °F (0 to 205 °C)
Silicone 200	–49 to 401 °F (–45 to 205 °C)
Inert	–49 to 320 °F (–45 to 160 °C)
Glycerin and water	5 to 203 °F (–15 to 95 °C)
Neobee M-20	5 to 401 °F (–15 to 205 °C)
Propylene glycol and water	5 to 203 °F (–15 to 95 °C)

1. Process temperatures above 185 °F (85 °C) require derating the ambient limits by a 1.5:1 ratio.
2. 220 °F (104 °C) limit in vacuum service; 130 °F (54 °C) for pressures below 0.5 psia.
3. 160 °F (71 °C) limit in vacuum service.

Humidity limits

0–100% relative humidity

Volumetric displacement

Less than 0.005 in^3 (0,08 cm^3)

Damping

4–20 mA HART

Rosemount 2051 with selectable HART

Analog output response to a step input change is user-enterable from 0 to 60 seconds for one time constant. This software damping is in addition to sensor module response time.

Rosemount 2051

Analog output response to a step input change is user-selectable from 0.4 to 60 seconds for one time constant. This software damping is in addition to sensor module response time.

FOUNDATION Fieldbus

Transducer block: User configurable
AI block: User configurable

PROFIBUS PA

AI block only: User configurable

Failure mode alarm

HART 4–20 mA (output code A)

If self-diagnostics detect a sensor or microprocessor failure, the analog signal is driven either high or low to alert the user. High or low failure mode is user-selectable with a jumper on the transmitter. The values to which the transmitter drives its output in failure mode depend on whether it is factory-configured to standard or NAMUR-compliant operation. The values for each are as follows:

Table 12. Standard Operation

Output code	Linear output	Fail high	Fail low
A	3.9 ≤ I ≤ 20.8	I ≥ 21.75 mA	I ≤ 3.75 mA
M	0.97 ≤ V ≤ 5.2	V ≥ 5.4 V	V ≤ 0.95 V

Table 13. NAMUR-Compliant Operation

Output code	Linear output	Fail high	Fail low
A	3.8 ≤ I ≤ 20.5	I ≥ 22.5 mA	I ≤ 3.6 mA

Output code F and X

If self-diagnostics detect a gross transmitter failure, that information gets passed as a status along with the process variable.

Physical specifications

Material selection

Emerson provides a variety of Rosemount product with various product options and configurations including materials of construction that can be expected to perform well in a wide range of applications. The Rosemount product information presented is intended as a guide for the purchaser to make an appropriate selection for the application. It is the purchaser's sole responsibility to make a careful analysis of all process parameters (such as all chemical components, temperature, pressure, flow rate, abrasives, contaminants, etc.), when specifying product, materials, options and components for the particular application. Emerson Process Management is not in a position to evaluate or guarantee the compatibility of the process fluid or other process parameters with the product, options, configuration or materials of construction selected.

Electrical connections

1/2–14 NPT, G1/2, and M20 x 1.5 conduit

Process connections

Rosemount 2051C

- 1/4–18 NPT on 2 1/8-in. centers
- 1/2–14 NPT and RC 1/2 on 2-in. (50,8 mm), 2 1/8-in. (54,0 mm), or 2 1/4-in. (57,2 mm) centers (process adapters)

Rosemount 2051T, 2051G

- 1/2–14 NPT female
- G1/2 A DIN 16288 male
  (available in SST for Range 1–4 transmitters only)
- Autoclave type F-250-C (pressure relieved 9/16–18 gland thread; 1/4 O.D. high pressure tube 60° cone; available in SST for Range 5 transmitters only)

Rosemount 2051L

- High pressure side: 2-in.(50,8 mm), 3-in. (72 mm), or 4-in. (102 mm), ASME B 16.5 (ANSI) Class 150 or 300 flange; 50, 80, or 100 mm, DIN 2501 PN 40 or 10/16 flange
- Low pressure side: 1/4–18 NPT on flange, 1/2–14 NPT on process adapter

Rosemount 2051CF

- For Rosemount 2051CFA wetted parts, see Rosemount DP Flowmeters and Primary Elements Product Data Sheet in the 485 section
- For Rosemount 2051CFC wetted parts, see Rosemount DP Flowmeters and Primary Elements Product Data Sheet in the 405 section
- For Rosemount 2051CFP wetted parts, see Rosemount DP Flowmeters and Primary Elements Product Data Sheet in the 1195 section

Rosemount 2051C process wetted parts

Drain/vent valves

316 SST or Alloy C-276

Process flanges and adapters

Plated carbon steel, SST CF-8M (cast version of 316 SST, material per ASTM-A743), or CW2M (cast version of Alloy C)

Wetted O-rings

Glass-filled PTFE or graphite-filled PTFE

Process isolating diaphragms

316L SST, Alloy C-276, or Tantalum

Rosemount 2051T process wetted parts

Process connections

316L SST or Alloy C-276

Process Isolating diaphragms

316L SST or Alloy C-276

Rosemount 2051L Process wetted parts

Flanged process connection (transmitter high side)

Process diaphragms, including process gasket surface

316L SST, Alloy C-276, or Tantalum

Extension

CF-3M (Cast version of 316L SST, material per ASTM-A743), or Cast C-276. Fits schedule 40 and 80 pipe.

Mounting flange

Zinc-cobalt plated CS or SST

Reference process connection (transmitter low side)

Isolating diaphragms

316L SST or Alloy C-276

Reference flange and adapter

CF-8M (cast version of 316 SST, material per ASTM-A743)

Non-wetted parts for Rosemount 2051C, 2051T, 2051L, 2051G

Electronics housing

Low-copper aluminum or CF-8M (cast version of 316 SST)
Enclosures meet NEMA® Type 4X, IP66, and IP68 when properly installed.
Housing material code P: PBT/PC with NEMA 4X and IP66/67/68

Paint for aluminum housing

Polyurethane

Coplanar sensor module housing

CF-3M (cast version of 316L SST)

Bolts

ASTM A449, Type 1 (zinc-cobalt plated carbon steel)
ASTM F593G, Condition CW1 (Austenitic 316 SST)
ASTM A193, Grade B7M (zinc plated alloy steel)
Alloy K-500

Sensor module fill fluid

Silicone or inert halocarbon
In-line series uses Fluorinert® FC-43

Process fill fluid (2051L only)

SYLTHERM XLT, Silicone 704, Silicone 200, inert, glycerin and water, Neobee M-20, or propylene glycol and water

Cover O-rings

Buna-N
Silicone (for wireless option code X)

Power module

Field replaceable, keyed connection eliminates the risk of incorrect installation, Intrinsically Safe Lithium-thionyl chloride power module with PBT enclosure.

Shipping weights

Table 14. Transmitter Weights without Options(1)

Transmitter	Standard lb (kg)	Wireless lb (kg)
Rosemount 2051C	4.9 (2.2)	3.9 (1,8)
Rosemount 2051L	See Table 15	See Table 15
Rosemount 2051T	3.1 (1.4)	1.9 (0,86)
Rosemount 2051G	2.4 (1,1)	N/A

1. Transmitter weights include the sensor module and housing only (aluminum for standard Rosemount 2051 and polymer for wireless).

Table 15. Rosemount 2051L Weights without Options

Flange	Flush lb (kg)	2-in. ext. lb (kg)	4-in. ext. lb (kg)	6-in. ext. lb (kg)
2-in., Class 150	12.5 (5,7)	N/A	N/A	N/A
3-in., Class 150	17.5 (7,9)	19.5 (8,8)	20.5 (9,3)	21.5 (9,7)
4-in., Class 150	23.5 (10,7)	26.5 (12,0)	28.5 (12,9)	30.5 (13,8)
2-in., Class 300	17.5 (7,9)	N/A	N/A	N/A
3-in., Class 300	22.5 (10,2)	24.5 (11,1)	25.5 (11,6)	26.5 (12,0)
4-in., Class 300	32.5 (14,7)	35.5 (16,1)	37.5 (17,0)	39.5 (17,9)
DN 50/PN 40	13.8 (6,2)	N/A	N/A	N/A
DN 80/PN 40	19.5 (8,8)	21.5 (9,7)	22.5 (10,2)	23.5 (10,6)
DN 100/PN 10/16	17.8 (8,1)	19.8 (9,0)	20.8 (9,5)	21.8 (9,9)
DN 100/PN 40	23.2 (10,5)	25.2 (11,5)	26.2 (11,9)	27.2 (12,3)

Table 16. Transmitter Options Weights

Code	Option	Add lb (kg)
J, K, L, M	Stainless steel housing	3.9 (1,8)
M5	LCD display for aluminum housing	0.5 (0,2)
M5	LCD display for wireless output	0.1 (0,04)
B4	SST mounting bracket for coplanar flange	1.0 (0,5)
B1, B2, B3	Mounting bracket for traditional flange	2.3 (1,0)
B7, B8, B9	Mounting bracket for traditional flange	2.3 (1,0)
BA, BC	SST bracket for traditional flange	2.3 (1,0)
H2	Traditional flange	2.6 (1,2)
H3	Traditional flange	3.0 (1,4)
H4	Traditional flange	3.0 (1,4)
H7	Traditional Flange	2.7 (1,2)
FC	Level flange—3-in., Class 150	12.7 (5,8)
FD	Level flange—3-in., Class 300	15.9 (7,2)
FA	Level flange—2-in., Class 150	8.0 (3,6)
FB	Level flange—2-in., Class 300	8.4 (3,3)
FP	DIN Level flange, SST, DN 50, PN 40	7.8 (3,5)
FQ	DIN Level flange, SST, DN 80, PN 40	12.7 (5,8)
WSM	SST sensor module	1.0 (0,45)
	Power module (701PGNKF)	0.4 (0,18)

Product certifications

Rosemount 2051C/T/L

Rev 1.5

European Directive Information

A copy of the EU Declaration of Conformity can be found at the end of the Quick Start Guide. The most recent revision of the EU Declaration of Conformity can be found at Emerson.com/Rosemount.

Ordinary Location Certification

As standard, the transmitter has been examined and tested to determine that the design meets the basic electrical, mechanical, and fire protection requirements by a nationally recognized test laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

North America

E5 USA Explosionproof (XP) and Dust-Ignitionproof (DIP)
Certificate: FM16US0232
Standards: FM Class 3600 – 2011, FM Class 3615 – 2006, FM Class 3616 – 2011, FM Class 3810 – 2005, ANSI/NEMA 250 – 2008. ANSI/IEC 60529 2004
Markings: XP CL I, DIV 1, GP B, C, D; DIP CL II, DIV 1, GP E, F, G; CL III; T5(–50 °C ≤ T_a ≤ +85 °C); Factory Sealed; Type 4X

I5 USA Intrinsic Safety (IS) and Nonincendive (NI)
Certificate: FM16US0231X
Standards: FM Class 3600 – 2011, FM Class 3610 – 2010, FM Class 3611 – 2004, FM Class 3810 – 2005, ANSI/NEMA 250 – 2008
Markings: IS CL I, DIV 1, GP A, B, C, D; CL II, DIV 1, GP E, F, G; Class III; DIV 1 when connected per Rosemount drawing 02051-1009; Class I, Zone 0; AEx ia IIC T4; NI CL 1, DIV 2, GP A, B, C, D; T4(–50 °C ≤ T_a ≤ +70 °C); Type 4X

Special Condition for Safe Use (X):

1. The Model 2051 transmitter housing contains aluminum and is considered a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact and friction.

IE USA FISCO
Certificate: FM16US0231X
Standards: FM Class 3600 – 2011, FM Class 3610 – 2010, FM Class 3611 – 2004, FM Class 3810 – 2005
Markings: IS CL I, DIV 1, GP A, B, C, D when connected per Rosemount drawing 02051-1009 (–50 °C ≤ T_a ≤ +60 °C); Type 4X

E6 Canada Explosion-Proof, Dust Ignition Proof
Certificate: 2041384
Standards: CAN/CSA C22.2 No. 0-10, CSA Std C22.2 No. 25-1966, CSA Std C22.2 No. 30-M1986, CAN/CSA-C22.2 No. 94-M91, CSA Std C22.2 No.142-M1987, CAN/CSA-C22.2 No.157-92, CSA Std C22.2 No. 213-M1987, CAN/CSA-E60079-0:07, CAN/CSA-E60079-1:07, CAN/CSA-E60079-11-02, CAN/CSA-C22.2 No.60529:05, ANSI/ISA-12.27.01–2003
Markings: Explosion-Proof for Class I, Divisions 1, Groups B, C, and D. Dust-Ignition Proof for Class II and Class III, Division 1, Groups E, F, and G. Suitable for Class I, Division 2; Groups A, B, C, and D for indoor and outdoor hazardous locations. Class I Zone 1 Ex d IIC T5. Enclosure type 4X, factory sealed. Single Seal.

I6 Canada Intrinsic Safety
Certificate: 2041384
Standards: CSA Std. C22.2 No. 142 - M1987, CSA Std.C22.2 No. 213 - M1987, CSA Std. C22.2 No.157 - 92, CSA Std. C22.2 No. 213 - M1987, ANSI/ISA 12.27.01 – 2003, CAN/CSA-E60079-0:07, CAN/CSA-E60079-11:02
Markings: Intrinsically safe for Class I, Division 1, Groups A,B, C, and D when connected in accordance with Rosemount drawing 02051-1008. Ex ia IIC T3C. Single Seal. Enclosure Type 4X

Europe

E1 ATEX Flameproof
Certificate: KEMA 08ATEX0090X
Standards: EN 60079-0:2012 + A11:2013, EN 60079-1:2014, EN 60079-26:2015
Markings: Ⓔx II 1/2 G Ex db IIC Ga/Gb T6(–60 °C ≤ T_a ≤ +70 °C), T4/T5 (–60 °C ≤ T_a ≤ +80 °C)

Table 17. Process Connection Temperature

Temperature class	Process temperature	Ambient temperature
T6	–60 °C to +70 °C	–60 °C to +70 °C
T5	–60 °C to +80 °C	–60 °C to +80 °C
T4	–60 °C to +120 °C	–60 °C to +80 °C

Special Conditions for Safe Use (X):

1. Appropriate cable, glands and plugs need to be suitable for a temperature of 5 °C greater than maximum specified temperature for location where installed.
2. Non- standard paint options may cause risk from electrostatic discharge. Avoid installations that could cause electrostatic build-up on painted surfaces, and only clean the painted surfaces with a damp cloth. If paint is ordered through a special option code, contact the manufacturer for more information.
3. The device contains a thin wall diaphragm less than 1 mm thickness that forms a boundary between zone 0 (process connection) and zone 1 (all other parts of the equipment). The model code and data sheet are to be consulted for details of the diaphragm material. Installation, maintenance and use shall take into account the environmental conditions to which the diaphragm shall be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.
4. Flameproof joints are not intended for repair.

I1 ATEX Intrinsic Safety
Certificate: Baseefa08ATEX0129X
Standards: EN60079-0:2012, EN60079-11:2012
Markings: ⟨Ex⟩ II 1 G Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +70 °C)

Table 18. Input Parameters

Parameter	HART	Fieldbus/PROFIBUS
Voltage U_i	30 V	30 V
Current I_i	200 mA	300 mA
Power P_i	1.0 W	1.3 W
Capacitance C_i	0.012 µF	0 µF
Inductance L_i	0 mH	0 mH

Special Condition for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V isolation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in Zone 0.

IA ATEX FISCO
Certificate: Baseefa08ATEX0129X
Standards: EN60079-0:2012, EN60079-11:2012
Markings: ⟨Ex⟩ II 1 G Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +60 °C)

Table 19. Input Parameters

Parameter	FISCO
Voltage U_i	17.5 V
Current I_i	380 mA
Power P_i	5.32 W
Capacitance C_i	0 µF
Inductance L_i	0 mH

Special Conditions for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V isolation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in Zone 0.

N1 ATEX Type n
Certificate: Baseefa08ATEX0130X
Standards: EN60079-0:2012, EN60079-15:2010
Markings: ⟨Ex⟩ II 3G Ex nA IIC T4 Gc (–40 °C ≤ T_a ≤ +70 °C)

Special Condition for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V electrical strength test as defined in clause 6.5.1 of by EN 60079-15:2010. This must be taken into account during installation.

ND ATEX Dust
Certificate: Baseefa08ATEX0182X
Standards: EN60079-0:2012, EN60079-31:2009
Markings: ⟨Ex⟩ II 1 D Ex ta IIIC T95 °C T_{500} 105 °C Da (–20 °C ≤ T_a ≤ +85 °C)

Special Condition for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V isolation from earth test and this must be taken into account during installation.

International

E7 IECEx Flameproof
Certificate: IECExKEM08.0024X
Standards: IEC 60079-0:2011, IEC 60079-1:2014-06, IEC 60079-26:2014-10
Markings: Ex db IIC T6...T4 Ga/Gb; T6(–60 °C ≤ T_a ≤ +70 °C), T4/T5(–60 °C ≤ T_a ≤ +80 °C)

Table 20. Process Connection Temperature

Temperature class	Process temperature	Ambient temperature
T6	–60 °C to +70 °C	–60 °C to +70 °C
T5	–60 °C to +80 °C	–60 °C to +80 °C
T4	–60 °C to +120 °C	–60 °C to +80 °C

Special Conditions for Safe Use (X):

1. The device contains a thin wall diaphragm less than 1 mm thickness that forms a boundary between zone 0 (process connection) and zone 1 (all other parts of the equipment). The model code and data sheet are to be consulted for details of the diaphragm material. Installation, maintenance and use shall take into account the environmental conditions to which the diaphragm shall be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.
2. Appropriate cable, glands and plugs need to be suitable for a temperature of 5 °C greater than maximum specified temperature for location where installed.
3. Flameproof joints are not intended for repair.
4. Non-standard paint options may cause risk from electrostatic discharge. Avoid installations that could cause electrostatic build-up on painted surfaces, and only clean the painted surfaces with a damp cloth. If paint is ordered through a special option code, contact the manufacturer for more information.

I7 IECEx Intrinsic Safety
Certificate: IECExBAS08.0045X
Standards: IEC60079-0:2011, IEC60079-11:2011
Markings: Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +70 °C)

Table 21. Input Parameters

Parameter	HART	Fieldbus/PROFIBUS
Voltage U_i	30 V	30 V
Current I_i	200 mA	300 mA
Power P_i	1.0 W	1.3 W
Capacitance C_i	0.012 µF	0 µF
Inductance L_i	0 mH	0 mH

Special Condition for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V isolation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in Zone 0.

IG IECEx FISCO
Certificate: IECExBAS08.0045X
Standards: IEC60079-0:2011, IEC60079-11:2011
Markings: Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +60 °C)

Table 22. Input Parameters

Parameter	FISCO
Voltage U_i	17.5 V
Current I_i	380 mA
Power P_i	5.32 W
Capacitance C_i	0 µF
Inductance L_i	0 mH

Special Condition for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V isolation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in Zone 0.

N7 IECEx Type n
Certificate: IECExBAS08.0046X
Standards: IEC60079-0:2011, IEC60079-15:2010
Markings: Ex nA IIC T4 Gc (–40 °C ≤ T_a ≤ +70 °C)

Special Condition for Safe Use (X):

1. If fitted with a 90 V transient suppressor, the equipment is not capable of withstanding the 500 V electrical strength test as defined in clause 6.5.1 of IEC60079-15:2010. This must be taken into account during installation.

Brazil

E2 INMETRO Flameproof
Certificate: UL-BR 14.0375X
Standards: ABNT NBR IEC60079-0:2008 + Errata 1:2011, ABNT NBR IEC 60079-1:2009 + Errata 1:2011,ABNT NBR IEC 60079-26:2008 + Errata 1:2009
Markings: Ex d IIC T6/T5 Gb IP66, T6(–50 °C ≤ T_a ≤ +65 °C), T5(–50 °C ≤ T_a ≤ +80 °C)

Special Condition for Safe Use (X):

1. The device contains a thin wall diaphragm. Installation, maintenance and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.
2. The Ex d blanking elements, cable glands, and wiring shall be suitable for a temperature of 90 °C
3. In case of repair, contact the manufacturer for information on the dimensions of the flameproof joints.

I2 INMETRO Intrinsic Safety
Certificate: UL-BR 14.0759X
Standards: ABNT NBR IEC 60079-0:2008 + Errata 1:2011; ABNT NBR IEC 60079-11:2009
Markings: Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +70 °C)

Table 23. Input Parameters

Parameter	HART	Fieldbus/PROFIBUS
Voltage U_i	30 V	30 V
Current I_i	200 mA	300 mA
Power P_i	1 W	1.3 W
Capacitance C_i	0.012 µF	0 µF
Inductance L_i	0 mH	0 mH

Special Conditions for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V insulation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminium alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in atmospheres that require ELP Ga.

IB INMETRO FISCO
Certificate: UL-BR 14.0759X
Standards: ABNT NBR IEC 60079-0:2008 + Errata 1:2011; ABNT NBR IEC 60079-11:2009
Markings: Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +60 °C)

Table 24. Input Parameters

Parameter	FISCO
Voltage U_i	17.5 V
Current I_i	380 mA
Power P_i	5.32 W
Capacitance C_i	0 µF
Inductance L_i	0 mH

Special Condition for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding the 500 V insulation from earth test and this must be taken into account during installation.
2. The enclosure may be made of aluminium alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact and abrasion when located in atmospheres that require ELP Ga.

China

E3 China Flameproof
Certificate: GYJ13.1386X; GYJ5.1366X [Flowmeters]
Standards: GB3836.1-2010, GB3836.2-2010, GB3836.20-2010-2010
Markings:
Pressure Transmitter: Ex d IIC Gb, T6(–50 °C ≤ T_a ≤ +65 °C), T5(–50 °C ≤ T_a ≤ +80 °C)
Flowmeter: Ex d IIC Ga/Gb, T6(–50 °C ≤ T_a ≤ +65 °C), T5(–50 °C ≤ T_a ≤ +80 °C)

Special Conditions for Safe Use (X):

1. Symbol "X" is used to denote specific conditions of use:
   - The Ex d blanking elements, cable glands, and wiring shall be suitable for a temperature of 90 °C.
   - This device contains a thin wall diaphragm. Installation, maintenance and use shall take into account the environment conditions to which the diaphragm will be subjected.
2. The relation between T code and ambient temperature range is:

T_a	Temperature class
–50 °C ≤ T_a ≤ +80 °C	T5
–50 °C ≤ T_a ≤ +65 °C	T6

3. The earth connection facility in the enclosure should be connected reliably.
4. During installation, use and maintenance of the product, observe the warning "Don't open the cover when the circuit is alive."
5. During installation, there should be no mixture harmful to flameproof housing
6. Cable entry and conduit, certified by NEPSI with type of protection Ex d IIC and appropriate thread form, should be applied when installed in a hazardous location. Blanking elements should be used on the redundant cable entries.
7. End users are not permitted to change any internal components, but to settle the problem in conjunction with the manufacturer to avoid damage to the product.
8. Maintenance should be done in a non-hazardous location.
9. During installation, use and maintenance of this product, observe the following standards: GB3836.13-2013, GB3836.15-2000, GB3836.16-2006, GB50257-2014.

I3 China Intrinsic Safety
Certificate: GYJ12.1295X; GYJ15.1365X [Flowmeters]
Standards: GB3836.1-2010, GB3836.4-2010, GB3836.20-2010
Markings: Ex ia IIC T4 Ga (–60 °C ≤ T_a ≤ +70 °C)

Special Conditions for Safe Use (X):

1. Symbol "X" is used to denote specific conditions of use:
   a. If the apparatus is fitted with an optional 90 V transient suppressor, it is not capable of withstanding the 500 V insulation test for 1 minute. This must be taken into account when installing the apparatus.
   b. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care should be taken to protect it from impact or abrasion if located in Zone 0.
2. The relation between T code and ambient temperature range is:

Model	T code	Temperature range
HART, Fieldbus, PROFIBUS, and Low Power	T4	–60 °C ≤ T_a ≤ +70 °C

3. Intrinsically safe parameters:

Parameter	HART	Fieldbus/ PROFIBUS	FISCO
Voltage U_i	30 V	30 V	17.5 V
Current I_i	200 mA	300 mA	380 mA
Power P_i	1 W	1.3 W	5.32 W
Capacitance C_i	0.012 µF	0 µF	0 nF
Inductance L_i	0 mH	0 mH	0 µF

Note 1: FISCO parameters comply with the requirements for FISCO field devices in GB3836.19-2010.
Note 2: [For Flowmeters] When Rosemount 644 Temperature Transmitter is used, the transmitter should be used with Ex-certified associated apparatus to establish explosion protection system that can be used in explosive gas atmospheres. Wiring and terminals should comply with the instruction manual of both Rosemount 644 and associated apparatus. The cables between Rosemount 644 and associated apparatus should be shielded cables (the cables must have insulated shield). The shielded cable has to be grounded reliably in a non-hazardous area.

4. The product should be used with Ex-certified associated apparatus to establish explosion protection system that can be used in explosive gas atmospheres. Wiring and terminals should comply with the instruction manual of the product and associated apparatus.
5. The cables between this product and associated apparatus should be shielded cables (the cables must have insulated shield). The shielded cable has to be grounded reliably in a non-hazardous area.
6. End users are not permitted to change any internal components, and needs to settle the problem in conjunction with the manufacturer to avoid damage to the product.
7. During installation, use and maintenance of this product, observe the following standards: GB3836.13-2013, GB3836.15-2000, GB3836.16-2006, GB3836.18-2010, GB50257-2014.

Japan

E4 Japan Flameproof
Certificate: TC20598, TC20599, TC20602, TC20603 [HART]; TC20600, TC20601, TC20604, TC20605 [Fieldbus]
Markings: Ex d IIC T5

Technical Regulations Customs Union (EAC)

EM EAC Flameproof
Certificate: RU C-US.GB05.B.01199
Markings: Ga/Gb Ex d IIC T5/T6 X, T5(–50 °C ≤ T_a ≤ +80 °C), T6(–50 °C ≤ T_a ≤ +65 °C)

Special Condition for Safe Use (X):

1. See certificate for special conditions.

IM EAC Intrinsically Safe
Certificate: RU C-US.GB05.B.01199
Markings: 0Ex ia IIC T4 Ga X (–60 °C ≤ T_a ≤ +70 °C)

Special Condition for Safe Use (X):

1. See certificate for special conditions.

Combinations

K1 Combination of E1, I1, N1, and ND

K2 Combination of E2 and I2

K5 Combination of E5 and I5

K6 Combination of E6 and I6

K7 Combination of E7, I7, N7 and IECEx Dust

IECEx Dust
Certificate: IECExBAS08.0058X
Standards: IEC60079-0:2011, IEC60079-15:2010
Markings: Ex nA IIIC T95 °C T_{500} 105 °C Da (–20 °C ≤ T_a ≤ +85 °C)

Special Condition for Safe Use (X):

1. If the equipment is fitted with an optional 90 V transient suppressor, it is incapable of withstanding a 500 V isolation from earth test and this must be taken into account during installation.

KA Combination of E1, I1, and K6

KB Combination of K5 and K6

KC Combination of E1, I1, and K5

KD Combination of K1, K5, and K6

KM Combination of EM and IM

Additional Certifications

SBS American Bureau of Shipping (ABS) Type Approval
Certificate: 09-HS446883B-3-PDA
Intended Use: Marine and Offshore Applications
Measurement of either Gauge or Absolute Pressure for Liquid, Gas, and Vapor
ABS Rules: 2013 Steel Vessels Rules 1-1-4/7.7, 1-1-Appendix 3, 4-8-3/1.7, 4-8-3/13.1

SBV Bureau Veritas (BV) Type Approval
Certificate: 23157/B0 BV
BV Rules: Bureau Veritas Rules for the Classification of Steel Ships

Application: Class notations: AUT-UMS, AUT-CCS, AUT-PORT and AUT-IMS; Pressure transmitter type 2051 cannot be installed on diesel engines.

SDN Det Norske Veritas (DNV) Type Approval
Certificate: TAA00004F
Intended Use: DNV GL Rules for Classification — Ships and offshore units
Application:

Locations classes	
Type	2051
Temperature	D
Humidity	B
Vibration	A
EMC	B
Enclosure	D

SLL Lloyds Register (LR) Type Approval
Certificate: 11/60002
Application: Environmental categories ENV1, ENV2, ENV3, and ENV5

Rosemount 2051G

Rev 1.0

European Directive Information

A copy of the EU Declaration of Conformity can be found at the end of the Quick Start Guide. The most recent revision of the EU Declaration of Conformity can be found at Emerson.com/Rosemount.

Europe

E1 ATEX Flameproof
Certificate: KEMA97ATEX2378X
Standards: EN 60079-0:2012 + A11:2013, EN60079-1:2014, EN60079-26:2015
Markings: Ex II 1/2 G Ex db IIC T6.T4 Ga/Gb, T6(–60 °C ≤ T_a ≤ +70°C)), T5/T4 (–60 °C ≤ T_a ≤ +80 °C)

Table 25. Process Connection Temperature

Temperature class	Process connection temperature	Ambient temperature
T6	–60 °C to +70 °C	–60 °C to +70 °C
T5	–60 °C to +80 °C	–60 °C to +80 °C
T4	–60 °C to +120 °C	–60 °C to +80 °C

Special Conditions for Safe Use (X):

1. This device contains a thin wall diaphragm less than 1 mm thickness that forms a boundary between zone 0 (process connection) and zone 1 (all other parts of the equipment). The model code and data sheet are to be consulted for details of the diaphragm material. Installation, maintenance and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.
2. Flameproof joints are not intended for repair.
3. Non-standard paint options may cause risk from electrostatic discharge. Avoid installations that could cause electrostatic build-up on painted surfaces, and only clean the painted surfaces with a damp cloth. If paint is ordered through a special option code, contact the manufacturer for more information.
4. Appropriate cable, glands and plugs need to be suitable for a temperature of 5°C greater than maximum specified temperature for location where installed.

I1 ATEX Flameproof
Certificate: BAS00ATEX1166X
Standards: EN60079-0:2012 + A11:2013, EN60079-11:2012
Markings: Ex II 1 G Ex ia IIC T4 Ga (–55°C ≤ T_a ≤ +70°C)

Table 26. Input Parameters

	HART
Voltage U_i	30 V
Current I_i	200 mA
Power P_i	0.9 W
Capacitance C_i	0.012 µF

Special Conditions for Safe Use (X):

1. The apparatus is not capable of withstanding the 500 V insulation test required by EN60079-11. This must be taken into account when installing the apparatus.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care should be taken to protect it from impact or abrasion if located in a Zone 0 environment.

International

E7 IECEx Flameproof
Certificate: IECEx KEM 06.0021X
Standards: IEC 60079-0:2011, IEC 60079-1:2014, IEC 60079-26:2014
Markings: Ex db IIC T6...T4 Ga/Gb T6(–60 °C ≤ T_a ≤ +70 °C), T5/T4(–60 °C ≤ T_a ≤ +80 °C)

Table 27. Process Connection Temperature

Temperature class	Process connection temperature	Ambient temperature
T6	–60 °C to +70 °C	–60 °C to +70 °C
T5	–60 °C to +80 °C	–60 °C to +80 °C
T4	–60 °C to +120 °C	–60 °C to +80 °C

Special Conditions for Safe Use (X):

1. This device contains a thin wall diaphragm less than 1 mm thickness that forms a boundary between zone 0 (process connection) and zone 1 (all other parts of the equipment). The model code and data sheet are to be consulted for details of the diaphragm material. Installation, maintenance and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.
2. Flameproof joints are not intended for repair.
3. Non-standard paint options may cause risk from electrostatic discharge. Avoid installations that could cause electrostatic build-up on painted surfaces, and only clean the painted surfaces with a damp cloth. If paint is ordered through a special option code, contact the manufacturer for more information.
4. Appropriate cable, glands and plugs need to be suitable for a temperature of 5°C greater than maximum specified temperature for location where installed.

I7 IECEx Intrinsic Safety
Certificate: IECEx BAS 12.0071X
Standards: IEC60079-0:2011, IEC60079-11:2011
Markings: Ex ia IIC T4 Ga (-55°C ≤ T_a ≤+70°C)

Table 28. Input Parameters

Voltage U_i	30 V
Current I_i	200 mA
Power P_i	0.9 W
Capacitance C_i	0.012 µF

Special Conditions for Safe Use (X):

1. When fitted with a transient suppression terminal block, the Model 2088 is incapable of passing the 500V isolation test. This must be taken into account during installation.
2. The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care should be taken to protect it from impact or abrasion if located in a Zone 0 environment.

Conduit Plugs and Adapters

IECEx Flameproof and Increased Safety
Certificate: IECEx FMG 13.0032X
Standards: IEC60079-0:2011, IEC60079-1:2007, IEC60079-7:2006-2007
Markings: Ex d e IIC Gb

ATEX Flameproof and Increased Safety
Certificate: FM13ATEX0076X
Standards: EN60079-0:2012, EN60079-1:2007, IEC60079-7:2007
Markings: II 2 G Ex d e IIC Gb

Table 29. Conduit Plug Thread Sizes

Thread	Identification Mark
M20 x 1.5	M20
1/2 - 14 NPT	1/2 NPT
G 1/2	G 1/2

Table 30. Thread Adapter Thread Sizes

Male Thread	Identification Mark
M20 x 1.5 – 6H	M20
1/2 - 14 NPT	1/2 - 14 NPT
3/4 - 14 NPT	3/4 - 14 NPT
Female Thread	**Identification Mark**
M20 x 1.5 – 6H	M20
1/2 - 14 NPT	1/2 - 14 NPT
G1/2	G1/2

Special Conditions for Safe Use (X):

1. When the thread adapter or blanking plug is used with an enclosure in type of protection increased safety “e” the entry thread shall be suitably sealed in order to maintain the ingress protection rating (IP) of the enclosure.
2. The blanking plug shall not be used with an adapter.
3. Blanking Plug and Threaded Adapter shall be either NPT or Metric thread forms. G1/2 thread forms are only acceptable for existing (legacy) equipment installations.

Rosemount 2051 Wireless

Rev 1.2

European Directive Information

A copy of the EU Declaration of Conformity can be found at the end of the Quick Start Guide. The most recent revision of the EU Declaration of Conformity can be found at Emerson.com/Rosemount.

Telecommunication compliance

All wireless devices require certification to ensure that they adhere to regulations regarding the use of the RF spectrum. Nearly every country requires this type of product certification. Emerson is working with governmental agencies around the world to supply fully compliant products and remove the risk of violating country directives or laws governing wireless device usage.

FCC and IC

This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions: This device may not cause harmful interference. This device must accept any interference received, including interference that may cause undesired operation. This device must be installed to ensure a minimum antenna separation distance of 20 cm from all persons.

Ordinary Location Certification

As standard, the transmitter has been examined and tested to determine that the design meets the basic electrical, mechanical, and fire protection requirements by a nationally recognized test laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

Installing in North America

The US National Electrical Code® (NEC) and the Canadian Electrical Code (CEC) permit the use of Division marked equipment in Zones and Zone marked equipment in Divisions. The markings must be suitable for the area classification, gas, and temperature class. This information is clearly defined in the respective codes.

USA

I5 U.S.A. Intrinsically Safe (IS)
Certificate: FM 3046325
Standards: FM Class 3600 – 2011,
FM Class 3610 – 2010,
FM Class 3810 – 2005,
ANSI/ISA 60079-0 – 2009,
ANSI/ISA 60079-11 – 2009,
NEMA 250 – 2003, ANSI/IEC 60529
Markings: IS CL I, DIV 1, GP A, B, C, D T4;
CL 1, Zone 0 AEx ia IIC T4;
T4(–40 °C ≤ T_a ≤ +70 °C) when installed per Rosemount drawing 03031-1062;
Type 4X/IP66/IP68

Special Conditions for Safe Use (X):

1. The Rosemount 2051 Wireless Pressure Transmitter shall only be used with the 701PGNKF Rosemount SmartPower Battery Pack.
2. The in-line pressure sensor may contain more than 10% aluminum and is considered a potential risk of ignition by impact or friction. Care must be taken into account during installation and used to prevent impact and friction.
3. The surface resistivity of the transmitter housing is greater than one gigaohm. To avoid electrostatic charge build-up, it must not be rubbed or cleaned with solvents or a dry cloth.

Canada

I6 Canada Intrinsically Safe
Certificate: CSA 2526009
Standards: CAN/CSA C22.2 No. 0-M91,
CAN/CSA C22.2 No. 94-M91,
CSA Std C22.2 No. 142-M1987,
CSA Std C22.2 No. 157-92,
CSA Std C22.2 No. 60529:05
Markings: Intrinsically Safe for Class I, Division 1, Groups A, B, C, D, T4 when installed per Rosemount drawing 03031-1063;
Type 4X/IP66/IP68

Europe

I1 ATEX Intrinsic Safety
Certificate: Baseefa12ATEX0228X
Standards: EN 60079-0:2012, EN 60079-11:2012
Markings: ⟨Ex⟩ II 1 G Ex ia IIC T4 Ga,
T4(–40 °C ≤ T_a ≤ +70 °C) IP66/IP68

Special Conditions for Safe Use (X):

1. The plastic enclosure may constitute a potential electrostatic ignition risk and must not be rubbed or cleaned with a dry cloth.
2. The Rosemount 701PGNKF Power Module may be replaced in a hazardous area. The power module has a surface resistivity greater than 1 GΩ and must be properly installed in the wireless device enclosure. Care must be taken during transportation to and from the point of installation to prevent electrostatic charge build-up.

International

I7 IECEx Intrinsic Safety
Certificate: IECEx BAS 12.0124X
Standards: IEC 60079-0:2011, IEC 60079-11:2011
Markings: Ex ia IIC T4 Ga, T4(–40 °C ≤ T_a ≤ +70 °C)
IP66/IP68

Special Conditions for Safe Use (X):

1. The plastic enclosure may constitute a potential electrostatic ignition risk and must not be rubbed or cleaned with a dry cloth.
2. The Rosemount 701PGNKF Power Module may be replaced in a hazardous area. The power module has a surface resistivity greater than 1 GΩ and must be properly installed in the wireless device enclosure. Care must be taken during transportation to and from the point of installation to prevent electrostatic charge build-up.

Brazil

I2 INMETRO Intrinsic Safety
Certificate: UL-BR 13.0534X
Standards: ABNT NBR IEC 60079-0:2008 + Errata 1:2011, ABNT NBR IEC 60079-11:2009
Markings: Ex ia IIC T4 IP66 Ga, T4(–40 °C ≤ T_a ≤ +70 °C)

Special Condition for Safe Use (X):

1. See certificate for special conditions.

China

I3 China Intrinsic Safety
Certificate: GYJ12.1295X
GYJ15.1365X [Flowmeters]
Standards: GB3836.1-2010, GB3836.4-2010, GB3836.20-2010
Markings: Ex ia IIC Ga T4, –40 ~ +70 °C

Special Condition for Safe Use (X):

1. See certificate for special conditions.

Japan

I4 TIIS Intrinsic Safety
Certificate: TC22022X (2051C/L)
TC22023X (2051T)
TC22024X (2051CFx)
Markings: Ex ia IIC T4 Ga, T4(–20 ~ +60 °C)

Special Condition for Safe Use (X):

1. See certificate for special conditions.

EAC - Belarus, Kazakhstan, Russia

IM Technical Regulation Customs Union (EAC) Intrinsic Safety
Certificate: RU C-US.ГБ05.B.00390
Markings: 0Ex ia IIC T4 Ga X;

Special Condition for Safe Use (X):

1. See certificate for special conditions.

Korea

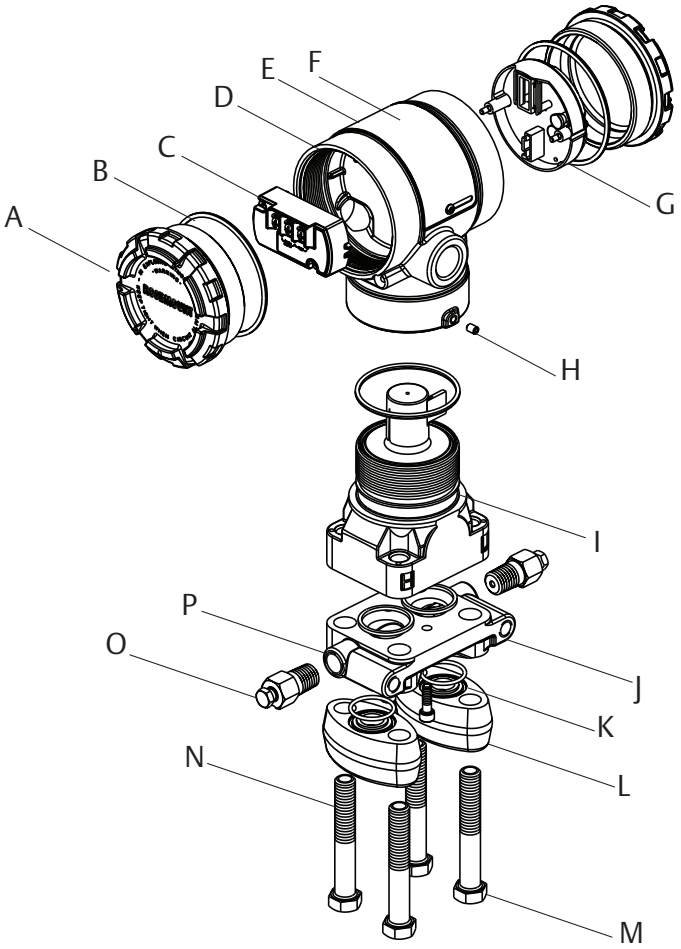
IP Korea Intrinsic Safety
Certificate: 13-KB4BO-0295X
Markings: Ex ia IIC T4 (–40 °C ≤ T_a ≤ +70 °C)

Special Condition for Safe Use (X):

1. See certificate for special conditions.

Dimensional drawings

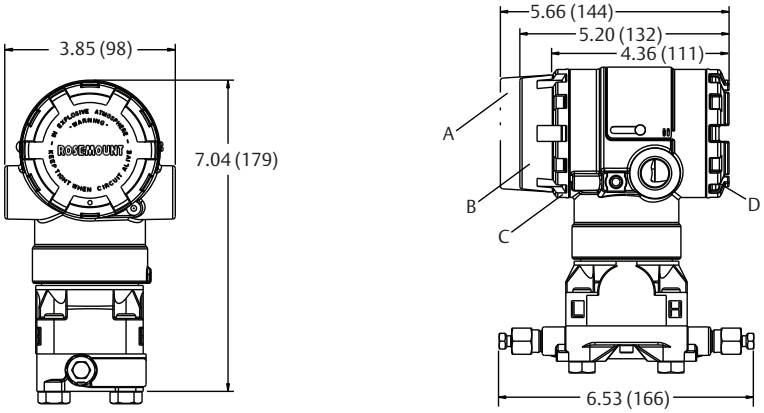
Figure 1. Rosemount 2051C Exploded View



A. Cover
B. Cover O-ring
C. Terminal block
D. Electronics housing
E. Local configuration buttons(1)
F. Nameplate
G. Electronics board
H. Housing rotation set screw
(180° maximum housing rotation without further disassembly)
I. Sensor module
J. Process O-ring
K. Flange adapter O-ring
L. Flange alignment screw (not pressure retaining)
M. Flange bolts
N. Flange adapters
O. Drain/vent valve
P. Coplanar flange

1. Span and zero adjustment buttons are optional with 4–20 mA and 1–5 Vdc HART Protocol. LOI buttons are optional for PROFIBUS PA Protocol. Local configuration buttons are not available with FOUNDATION Fieldbus.

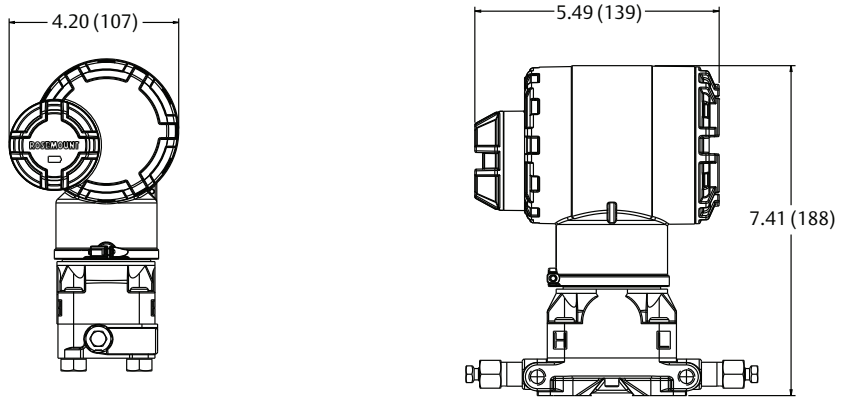
Figure 2. Rosemount 2051C Coplanar Flange



A. Fieldbus display cover
B. HART display cover
C. Transmitter circuitry
D. Terminal connections

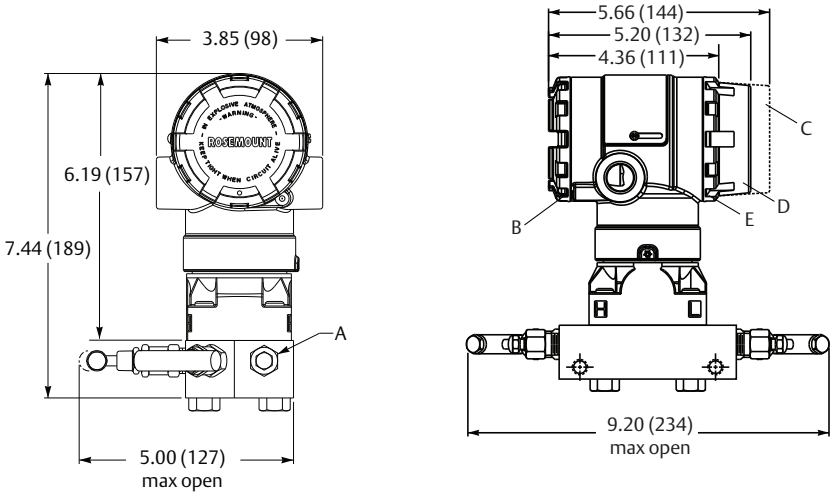
Dimensions are in inches (millimeters).

Figure 3. Rosemount 2051 Wireless Housing with Coplanar Platform



Dimensions are in inches (millimeters).

Figure 4. Rosemount 2051C Coplanar with Rosemount 305 Three-Valve Coplanar Integral Manifold

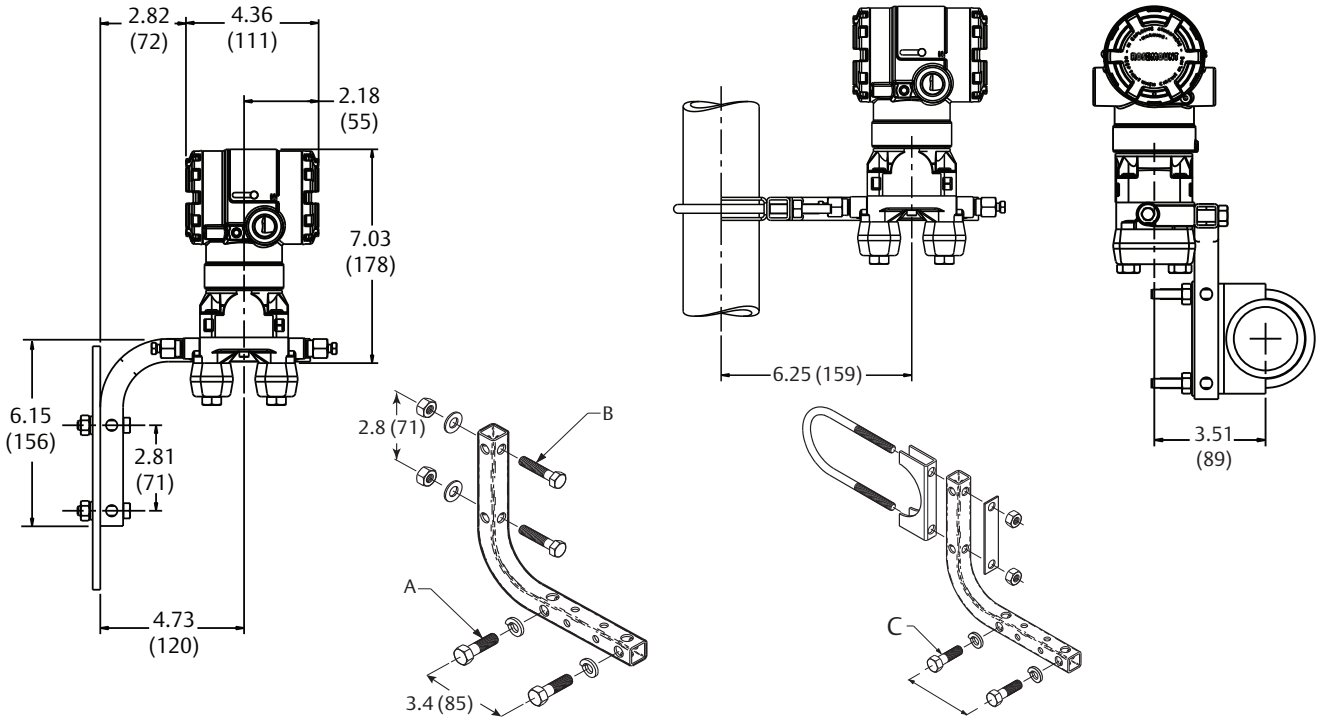


A. Drain/Vent valve
B. Terminal connections
C. Fieldbus display cover
D. HART display cover
E. Transmitter circuitry

Dimensions are in inches (millimeters).

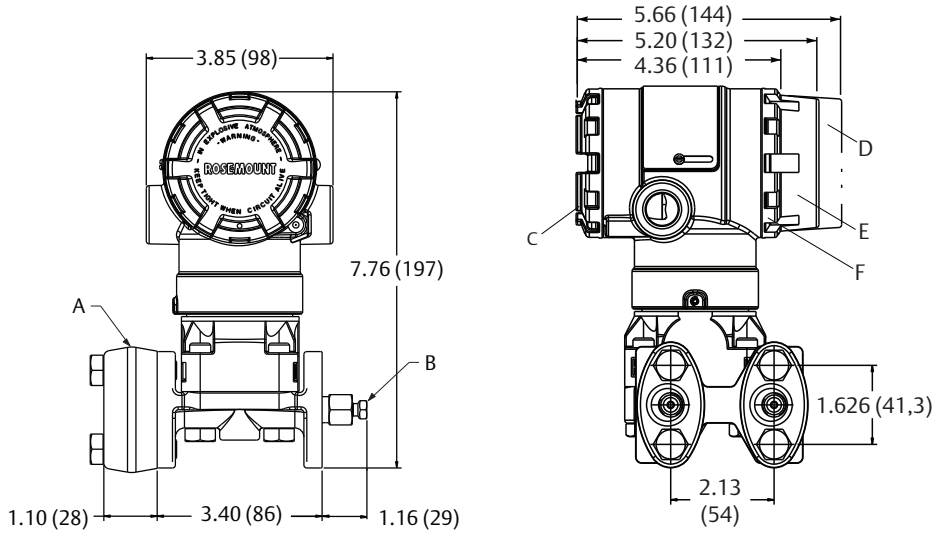
Figure 5. Coplanar Flange Mounting Configurations with Optional Bracket (B4) for 2-in. Pipe or Panel Mounting

Panel mounting **Pipe mounting**



A. $^{3}/_{8}$–16 × $1^{1}/_{4}$ bolts for mounting to transmitter
B. $^{5}/_{16}$ × $1^{1}/_{2}$ bolts for panel mounting (not supplied)
C. 2-in. U-bolt for pipe mounting
Dimensions are in inches (millimeters).

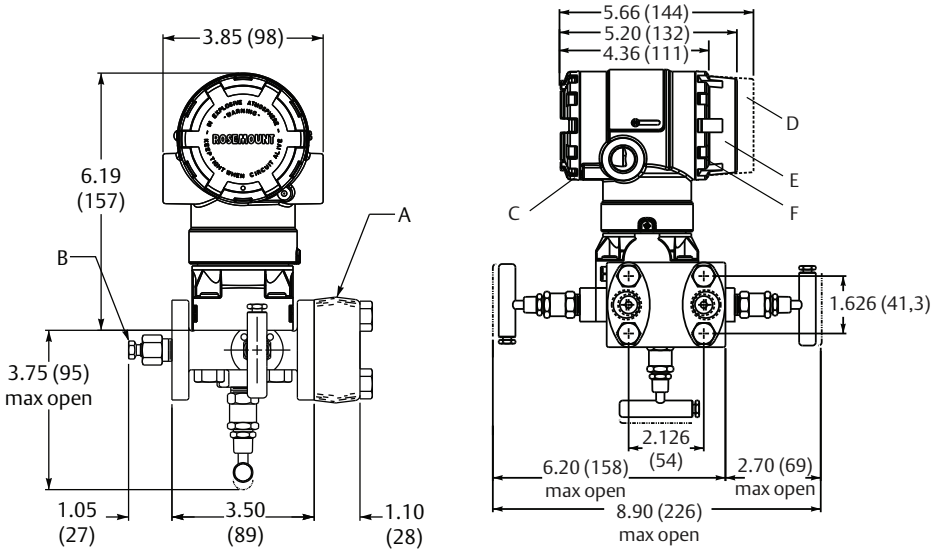
Figure 6. Rosemount 2051C Coplanar with Traditional Flange



A. 1/2–14 NPT flange adapter (optional)
B. Drain/vent valve
C. Terminal connections
D. Fieldbus display cover
E. HART display cover
F. Transmitter circuitry

Dimensions are in inches (millimeters).

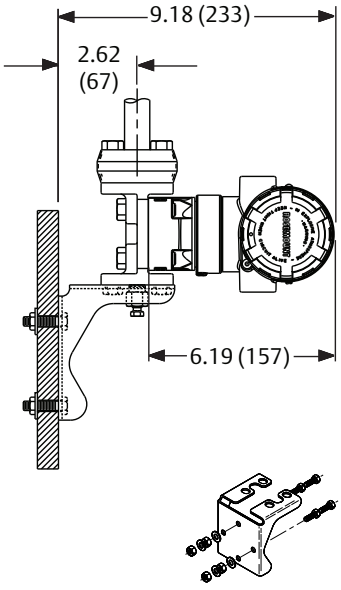
Figure 7. Rosemount 2051C Coplanar with Rosemount 305 Three-Valve Traditional Integral Manifold



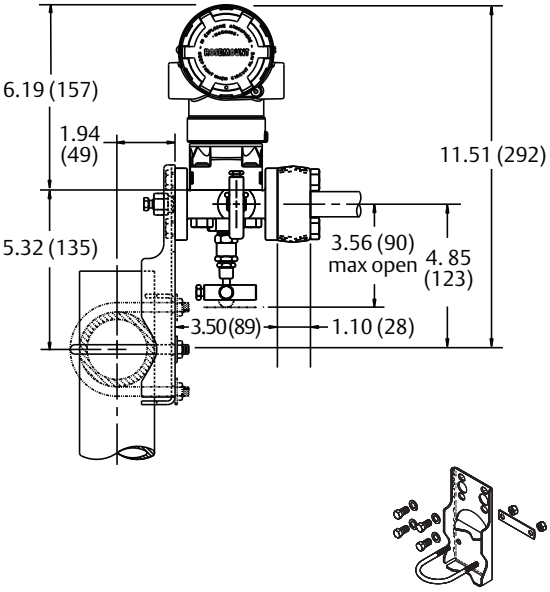
A. 1/2–14 NPT flange adapter (optional)
B. Drain/vent valve
C. Terminal connections
D. Fieldbus display cover
E. HART display cover
F. Transmitter circuitry
Dimensions are in inches (millimeters).

Figure 8. Traditional Flange Mounting Configurations with Optional Brackets for 2-in. Pipe or Panel Mounting

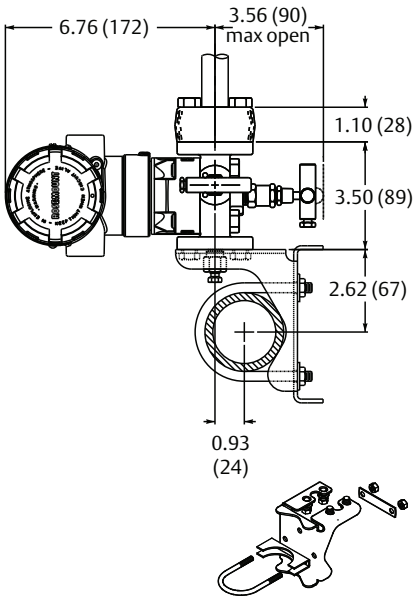
Panel mount (bracket option B2/B8)



Pipe mount (bracket option B3/B9/BC)

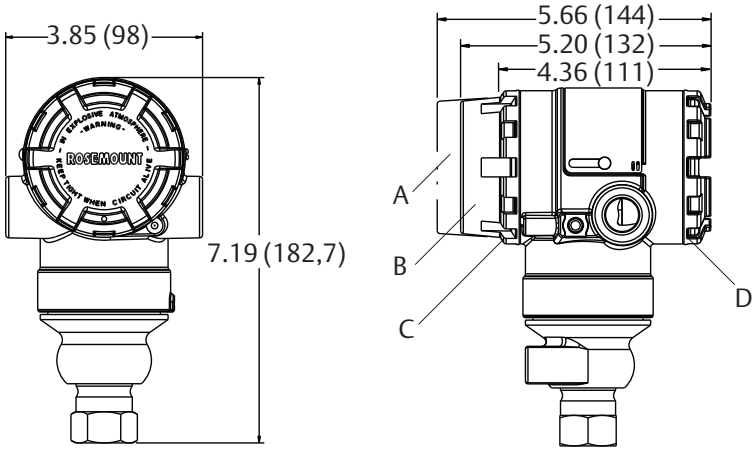


Pipe mount (bracket option B1/B7/BA)



Dimensions are in inches (millimeters).

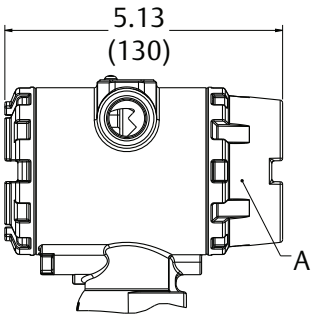
Figure 9. Rosemount 2051T



A. Fieldbus display cover
B. HART display cover
C. Transmitter circuitry
D. Terminal connections

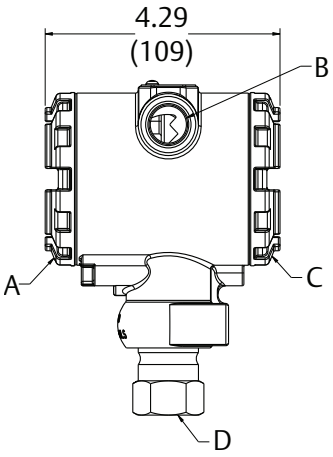
Dimensions are in inches (millimeters).

Figure 10. Rosemount 2051G with Optional Display



A. Digital display cover

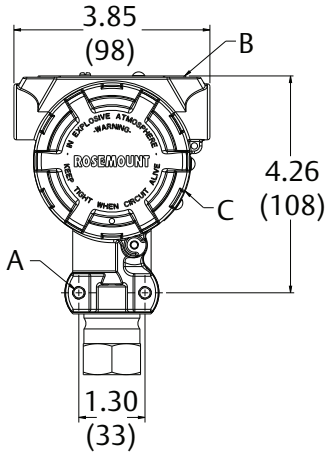
Figure 11. Rosemount 2051G Process Connection



A. Field terminals
B. Conduit connection
C. Transmitter electronics
D. 1/2–14 NPT female connection(1)

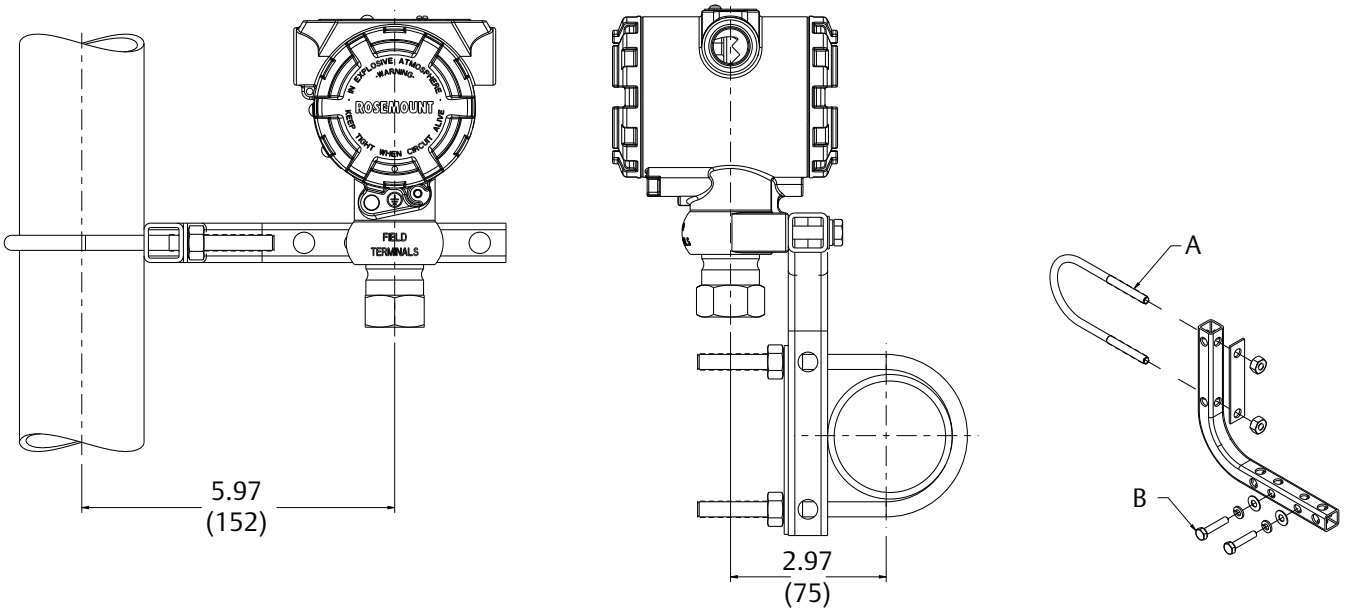
1. RC 1/2 female (PT 1/2 female), and M20 female also available as options.

Figure 12. Rosemount 2051G Nameplate and Labels



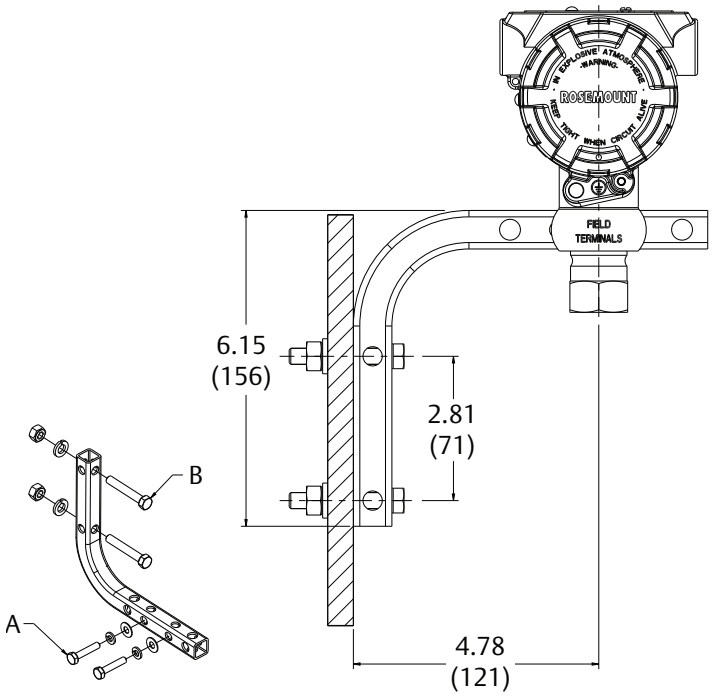
A. Bracket mounting holes (1/4–20 UNC)
B. Nameplate
C. Certification label (located on side)

Figure 13. Rosemount 2051G with Optional Pipe Mounting Bracket



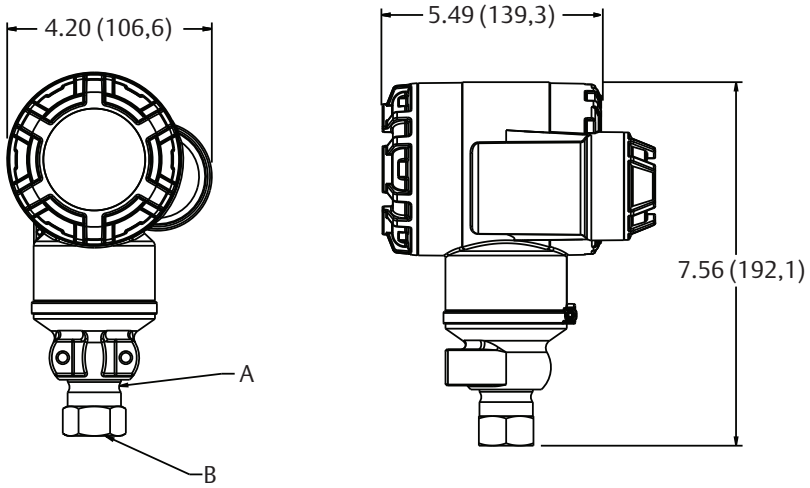
A. 2–in. U-bolt for pipe mounting (clamp shown)
B. 1/4 x 1 1/4 bolts for transmitter mounting
Dimensions are in inches (millimeters).

Figure 14. Rosemount 2051G with Optional Mounting Bracket



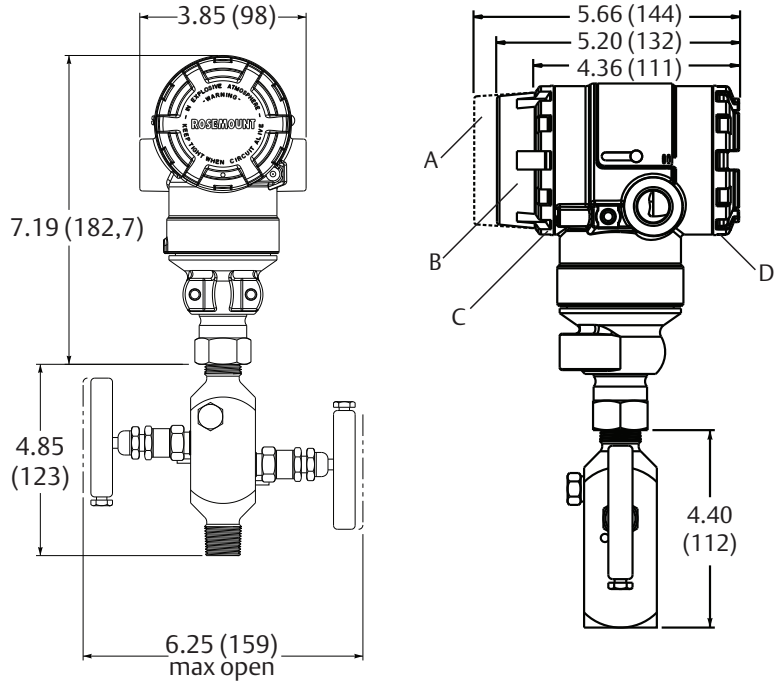
A. 1/4 x 1 1/4 bolts for transmitter mounting
B. 5/16 x 1/2 bolts for panel mounting (not supplied)
Dimensions are in inches (millimeters)

Figure 15. Rosemount 2051 Wireless Housing with In-line Platform



A. U-Bolt bracket
B. 1/2–14 NPT female or G1/2 A DIN 16288 make process connection
Dimensions are in inches (millimeters).

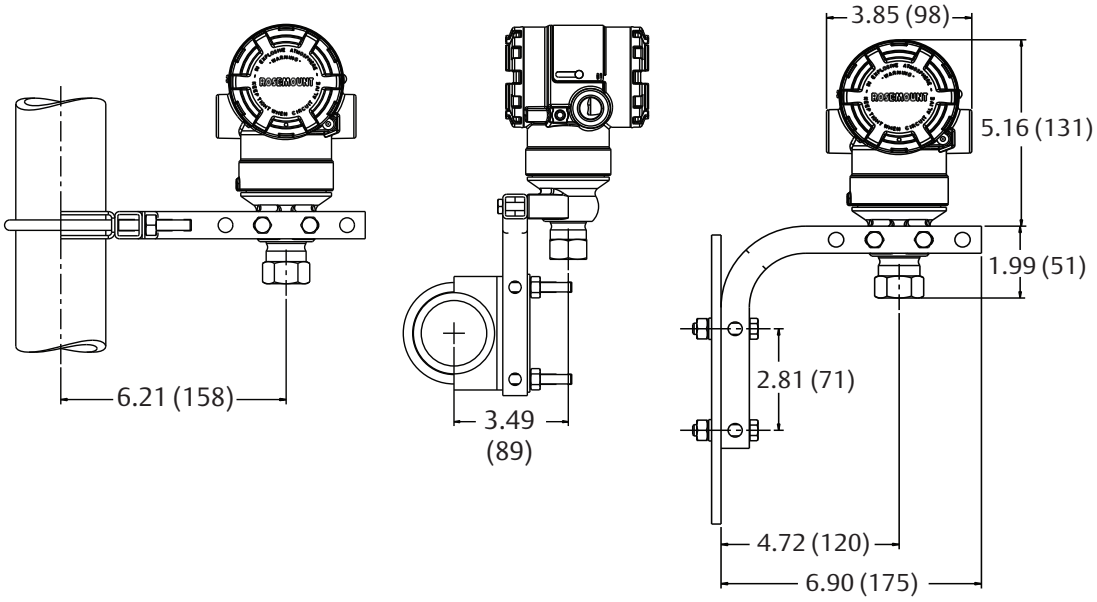
Figure 16. Rosemount 2051T with Rosemount 306 Two-Valve Integral Manifold



A. Fieldbus display cover
B. HART display cover
C. Transmitter circuitry
D. Terminal connections
Dimensions are in inches (millimeters).

Figure 17. Rosemount 2051T Typical Mounting Configurations with Optional Mounting Bracket

Pipe mounting **Panel mounting**



Dimensions are in inches (millimeters).

Figure 18. Rosemount 2051CFA Pak-Lok Annubar Flowmeter[1]

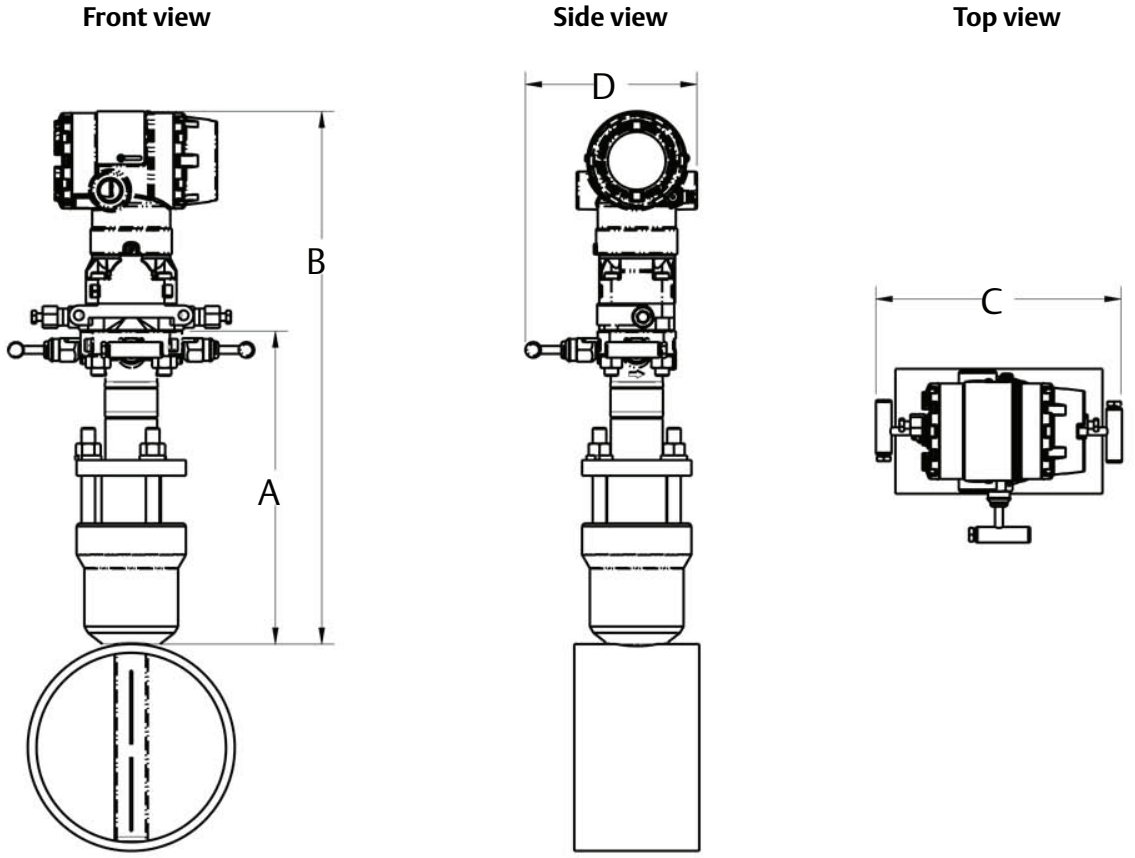


Table 31. Rosemount 2051CFA Pak-Lok Annubar Flowmeter Dimensional Data

Sensor size	A (max)	B (max)	C (max)	D (max)
1	8.50 (215.9)	14.55 (369.6)	9.00 (228.6)	6.00 (152.4)
2	11.00 (279.4)	16.30 (414.0)	9.00 (228.6)	6.00 (152.4)
3	12.00 (304.8)	19.05 (483.9)	9.00 (228.6)	6.00 (152.4)

Dimensions are in inches (millimeters).

1. *The Pak-Lok Annubar model is available up to Class 600 ANSI (1,440 psig at 100 °F [99 bar at 38 °C]).*

Figure 19. Rosemount 2051CFC Compact Orifice Flowmeter

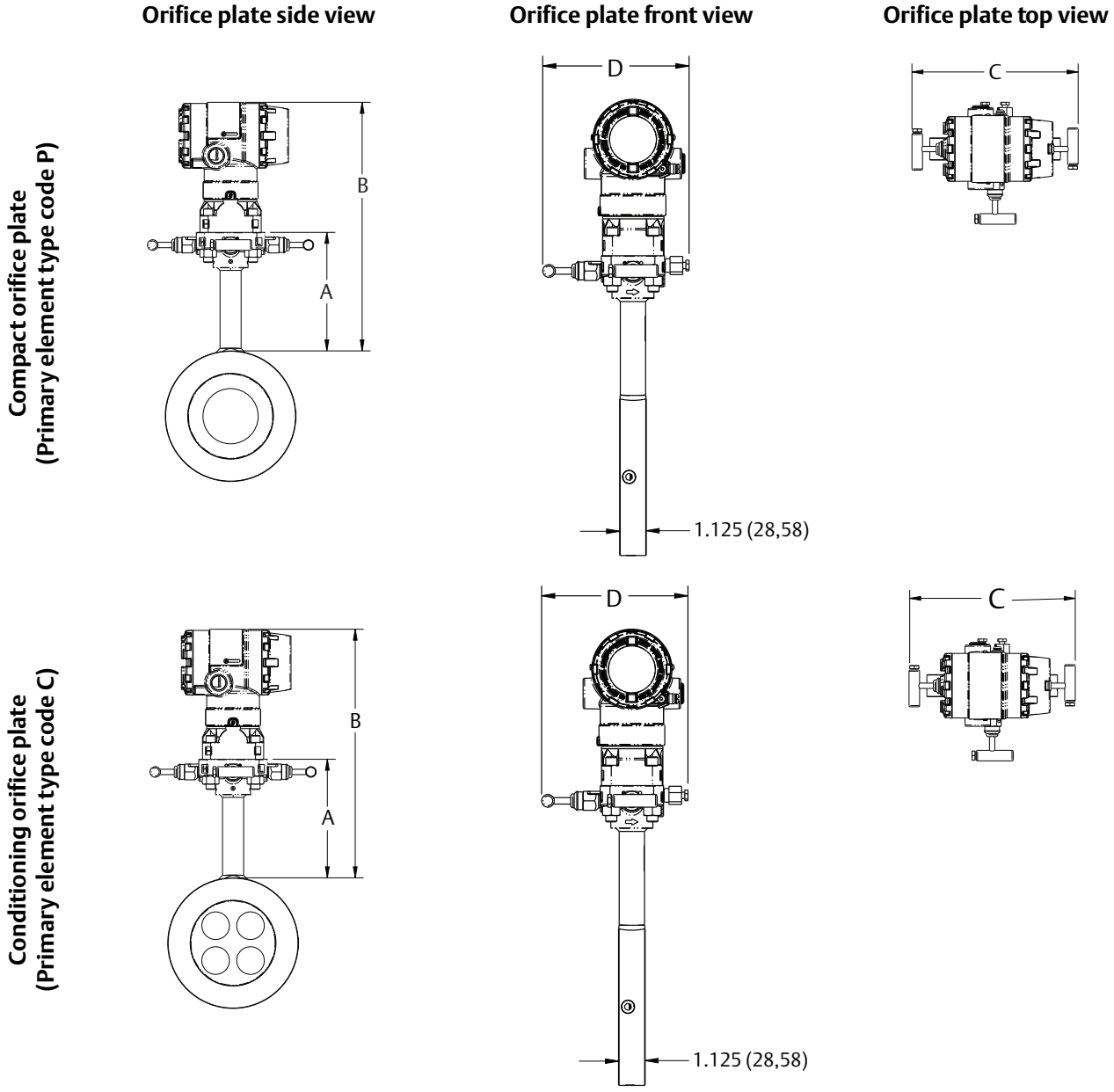
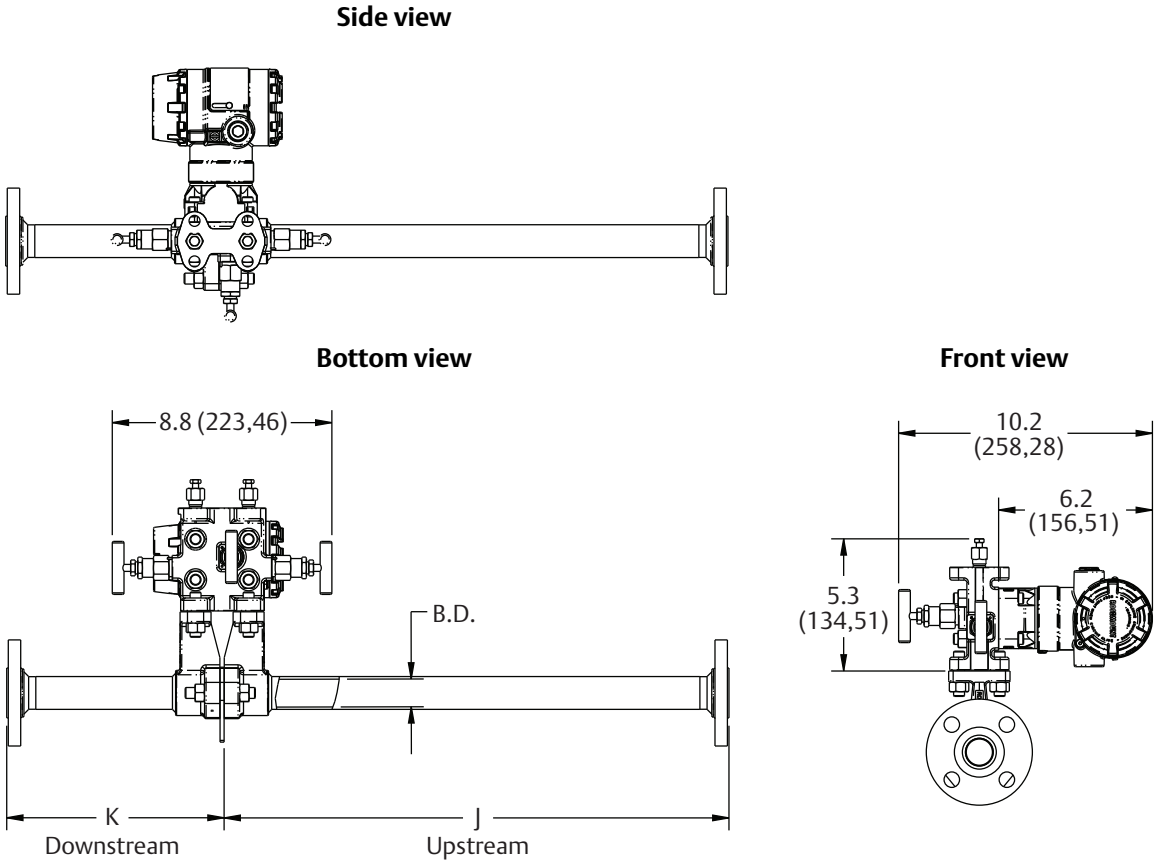


Table 32. Rosemount 2051CFC Dimensional Data

Primary element type	A	B	Transmitter height	C	D
Type P and C	5.62 (143)	Transmitter Height + A	6.27 (159)	7.75 (197) - closed 8.25 (210) - open	6.00 (152) - closed 6.25 (159) - open

Dimensions are in inches (millimeters).

Figure 20. Rosemount 2051CFP Integral Orifice Flowmeter



Dimensions are in inches (millimeters).

Table 33. Rosemount 2051CFP Dimensional Data

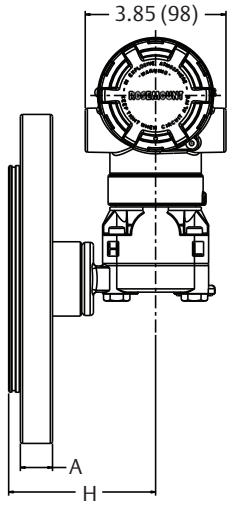
Dimension	Line size		
	1/2-in. (15 mm)	1-in. (25 mm)	1 1/2-in. (40 mm)
J (beveled/threaded pipe ends)	12.54 (318.4)	20.24 (514,0)	28.44 (722,4)
J (RF slip-on, RTJ slip-on, RF-DIN slip on)	12.62 (320,4)	20.32 (516,0)	28.52 (724,4)
J (RF Class 150, weld neck)	14.37 (364,9)	22.37 (568,1)	30.82 (782,9)
J (RF Class 300, weld neck)	14.56 (369,8)	22.63 (574,7)	31.06 (789,0)
J (RF Class 600, weld neck)	14.81 (376,0)	22.88 (581,0)	31.38 (797,1)
K (beveled/threaded pipe ends)	5.74 (145,7)	8.75 (222,2)	11.91 (302,6)
K (RF slip-on, RTJ slip-on, RF-DIN slip on)(1)	5.82 (147,8)	8.83 (224,2)	11.99 (304,6)
K (RF Class 150, weld neck)	7.57 (192,3)	10.88 (276,3)	14.29 (363,1)
K (RF Class 300, weld neck)	7.76 (197,1)	11.14 (282,9)	14.53 (369,2)
K (RF Class 600, weld neck)	8.01 (203,4)	11.39 (289,2)	14.85 (377,2)
B.D. (bore diameter)	0.664 (16,87)	1.097 (27,86)	1.567 (39,80)

Dimensions are in inches (millimeters).

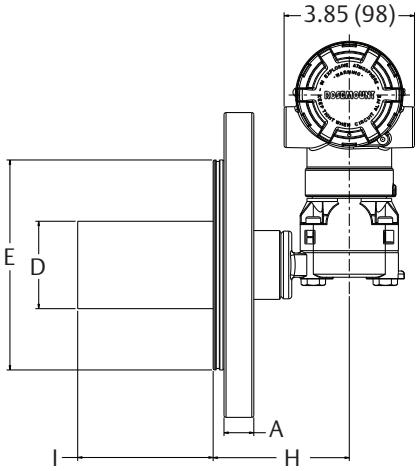
1. Downstream length shown here includes plate thickness of 0.162-in. (4.11 mm).

Figure 21. Rosemount 2051L Liquid Level

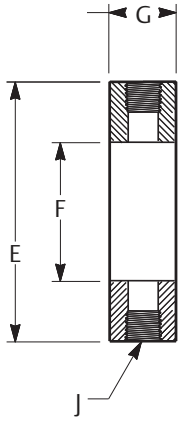
2-in. flange configuration (flush mount only)



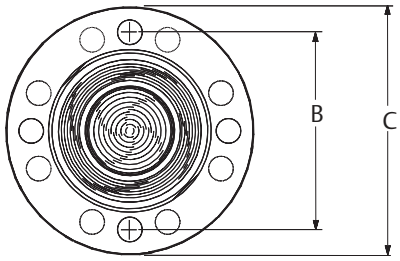
3- and 4-in. flange configuration

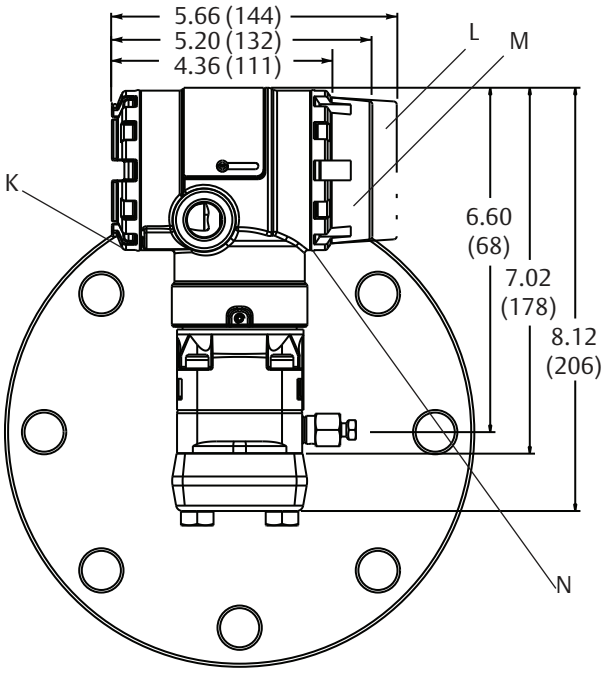


Optional flushing connection ring (lower housing)



Diaphragm assembly and mounting flange





A–H. Refer to Table 34
I. 2-, 4-, or 6-in. extension (50.8, 101.6, 152.4)
J. Flushing connection
Dimensions are in inches (millimeters).

K. Terminal connections
L. Fieldbus display cover
M. HART display cover
N. Transmitter circuitry

Table 34. 2051L Dimensional Specifications

Class[1]	Pipe size	Flange thickness A	Bolt circle diameter B	Outside diameter C	No. of bolts	Bolt hole diameter	Extension diameter[1] D	O.D. gasket surface E
ASME B16.5 (ANSI) 150	2 (51)	0.69 (18)	4.75 (121)	6.0 (152)	4	0.75 (19)	N/A	3.6 (92)
	3 (76)	0.88 (22)	6.0 (152)	7.5 (191)	4	0.75 (19)	2.58 (66)	5.0 (127)
	4 (102)	0.88 (22)	7.5 (191)	9.0 (229)	8	0.75 (19)	3.5 (89)	6.2 (158)
ASME B16.5 (ANSI) 300	2 (51)	0.82 (21)	5.0 (127)	6.5 (165)	8	0.75 (19)	N/A	3.6 (92)
	3 (76)	1.06 (27)	6.62 (168)	8.25 (210)	8	0.88 (22)	2.58 (66)	5.0 (127)
	4 (102)	1.19 (30)	7.88 (200)	10.0 (254)	8	0.88 (22)	3.5 (89)	6.2 (158)
DIN 2501 PN 10–40	DN 50	20 mm	125 mm	165 mm	4	18 mm	N/A	4.0 (102)
DIN 2501 PN 25/40	DN 80	24 mm	160 mm	200 mm	8	18 mm	66 mm	5.4 (138)
	DN 100	24 mm	190 mm	235 mm	8	22 mm	89 mm	6.2 (158)

Dimensions are in inches (millimeters).

Class[1]	Pipe size	Process side F	Lower housing G		H
			1/4 NPT	1/2 NPT	
ASME B16.5 (ANSI) 150	2 (51)	2.12 (54)	0.97 (25)	1.31 (33)	5.65 (143)
	3 (76)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
	4 (102)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
ASME B16.5 (ANSI) 300	2 (51)	2.12 (54)	0.97 (25)	1.31 (33)	5.65 (143)
	3 (76)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
	4 (102)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
DIN 2501 PN 10–40	DN 50	2.4 (61)	0.97 (25)	1.31 (33)	5.65 (143)
DIN 2501 PN 25/40	DN 80	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
	DN 100	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)

Dimensions are in inches (millimeters).

1. Tolerances are –0.020 and +0.040 (–0,51 and +1,02).

Options

Standard configuration

Unless otherwise specified, transmitter is shipped as follows:

Engineering units	inH_2O (Ranges 1, 2, and 3)
Differential/Gage	psi (Ranges 4–5)
2051TA	psi (all ranges)
4 mA (1 Vdc)(1)	0 (engineering units)
20 mA (5 Vdc)(1):	Upper range limit
Output:	Linear
Flange type	Specified model code option
Flange material	Specified model code option
O-ring material	Specified model code option
Drain/vent:	Specified model code option
LCD display	Installed or none
Alarm(1)	High
Software tag	(Blank)

1. Not applicable to FOUNDATION Fieldbus, PROFIBUS PA, or Wireless.

Custom configuration(1)

If option code C1 is ordered, the customer may specify the following data in addition to the standard configuration parameters.

- Output information
- Transmitter information
- LCD display configuration
- Hardware selectable information
- Signal selection
- Wireless information
- Scaled variable
- and more

Refer to the Rosemount 2051 Configuration Data Sheet and the Rosemount 2051 Wireless Configuration Data Sheet.

1. Not applicable to FOUNDATION Fieldbus or PROFIBUS PA Protocols.

Tagging (3 options available)

Standard SST hardware tag is permanently affixed on transmitter. Tag character height is 0.125-in. (3,18 mm), 84 characters maximum.

Tag may be wired to the transmitter nameplate upon request, 85 characters maximum.

Tag may be stored in transmitter memory. Character limit is dependent on Protocol.

- HART Revision 5: 8 characters
- HART Revision 7 and Wireless: 32 characters
- FOUNDATION Fieldbus: 32 characters
- PROFIBUS PA: 32 characters

Commissioning tag(1)

A temporary commissioning tag is attached to all transmitters. The tag indicates the device ID and allows an area for writing the location.

1. Only applicable to FOUNDATION Fieldbus.

Optional Rosemount 304, 305, or 306 Integral manifolds

Factory assembled to Rosemount 2051C, 2051T, and 2051G Transmitters. Refer to the Rosemount Manifolds Product Data Sheet for additional information.

Other seals

Refer to the Rosemount DP Level Transmitters and 1199 Seal Systems Product Data Sheet for additional information.

Output information

Output range points must be the same unit of measure. Available units of measure include:

Pressure		
atm	mmH_2O @ 4 °C[1]	ftH_2O @ 4 °C[1]
mbar	ftH_2O	psi
bar	inH_2O @ 60 °F[1]	torr
inH_2O	Psf[1]	cmH_2O @ 4 °C[1]
inHg	g/cm^2	cmHg @ 0 °C[1]
hPa[1]	kg/cm^2	ftH_2O @ 60 °F[1]
mHg @ 0 °C[1]	Pa	mH_2O @ 4 °C[1]
inH_2O @ 4 °C[1]	kPa	mHg @ 0 °C[1]
mmH_2O	MPa[1][2]	hPa[1]
mmHg	kg/m^2[1]	
Flow[2][3]		
bbl	kg	cm^3
ft^3	lb	m^3
gal	L	ton
Level[3]		
%	ft	cm
in	mm	

1. Available with enhanced 2051 and wireless.
2. Available on PROFIBUS PA.
3. All flow units are available per second, minute, hour or day.

Display and interface options

M4 Digital display with LOI

- Available for 4–20 mA HART, 4–20 mA HART Low Power, and PROFIBUS PA

M5 Digital display

- 2-line, 5-digit LCD display for 4–20 mA HART
- 2-line, 5-digit LCD display for 1–5 Vdc HART Low Power
- 2-line, 8-digit LCD display for FOUNDATION Fieldbus and PROFIBUS PA
- 3-line, 7-digit LCD display for wireless
- Direct reading of digital data for higher accuracy
- Displays user-defined flow, level, volume, or pressure units
- Displays diagnostic messages for local troubleshooting
- 90-degree rotation capability for easy viewing

Configuration buttons[1]

Rosemount 2051 requires option **D4** (analog zero and span), **DZ** (digital trim), **M4** (LOI) for local configuration buttons.

Transient protection

T1 Integral transient protection terminal block
Meets IEEE C62.41, category location B

- 6 kV crest (0.5 µs–100 kHz)
- 3 kA crest (8 × 20 microseconds)
- 6 kV crest (1.2 × 50 microseconds)

Bolts for flanges and adapters

Standard material is plated carbon steel per ASTM A449, type 1

L4 Austenitic 316 stainless steel bolts
L5 ASTM A 193, Grade B7M bolts
L6 Alloy K-500 bolts
L8 ASTM A 193 Class 2, Grade B8M bolts

Conduit plug

DO 316 SST conduit plug
Single 316 SST conduit plug replaces carbon steel plug

Rosemount 2051C coplanar flange and 2051T bracket option

B4 Bracket for 2-in. pipe or panel mounting

- For use with the standard coplanar flange configuration
- Bracket for mounting of transmitter on 2-in. pipe or panel
- Stainless steel construction with stainless steel bolts

Rosemount 2051C traditional flange bracket options

B1 Bracket for 2-in. pipe mounting

- For use with the traditional flange option
- Bracket for mounting on 2-in. pipe
- Carbon steel construction with carbon steel bolts
- Coated with polyurethane paint

B2 Bracket for panel mounting

- For use with the traditional flange option
- Bracket for mounting transmitter on wall or panel
- Carbon steel construction with carbon steel bolts
- Coated with polyurethane paint

B3 Flat bracket for 2-in. pipe mounting

- For use with the traditional flange option
- Bracket for vertical mounting of transmitter on 2-in. pipe
- Carbon steel construction with carbon steel bolts
- Coated with polyurethane paint

B7 B1 bracket with SST bolts

- Same bracket as the B1 option with Series 300 stainless steel bolts

B8 B2 bracket with SST bolts

- Same bracket as the B2 option with Series 300 stainless steel bolts

B9 B3 bracket with SST bolts

- Same bracket as the B3 option with Series 300 stainless steel bolts

BA Stainless steel B1 bracket with SST bolts

- B1 bracket in stainless steel with Series 300 stainless steel bolts

BC Stainless steel B3 bracket with SST bolts

- B3 bracket in stainless steel with Series 300 stainless steel bolts

Global Headquarters
Emerson Automation Solutions
6021 Innovation Blvd.
Shakopee, MN 55379, USA
+1 800 999 9307 or +1 952 906 8888
+1 952 949 7001
RFQ.RMD-RCC@Emerson.com

North America Regional Office
Emerson Automation Solutions
8200 Market Blvd.
Chanhassen, MN 55317, USA
+1 800 999 9307 or +1 952 906 8888
+1 952 949 7001
RMT-NA.RCCRFQ@Emerson.com

Latin America Regional Office
Emerson Automation Solutions
1300 Concord Terrace, Suite 400
Sunrise, FL 33323, USA
+1 954 846 5030
+1 954 846 5121
RFQ.RMD-RCC@Emerson.com

Europe Regional Office
Emerson Automation Solutions Europe GmbH
Neuhofstrasse 19a P.O. Box 1046
CH 6340 Baar
Switzerland
+41 (0) 41 768 6111
+41 (0) 41 768 6300
RFQ.RMD-RCC@Emerson.com

Asia Pacific Regional Office
Emerson Automation Solutions Asia Pacific Pte Ltd
1 Pandan Crescent
Singapore 128461
+65 6777 8211
+65 6777 0947
Enquiries@AP.Emerson.com

Middle East and Africa Regional Office
Emerson Automation Solutions
Emerson FZE P.O. Box 17033,
Jebel Ali Free Zone - South 2
Dubai, United Arab Emirates
+971 4 8118100
+971 4 8865465
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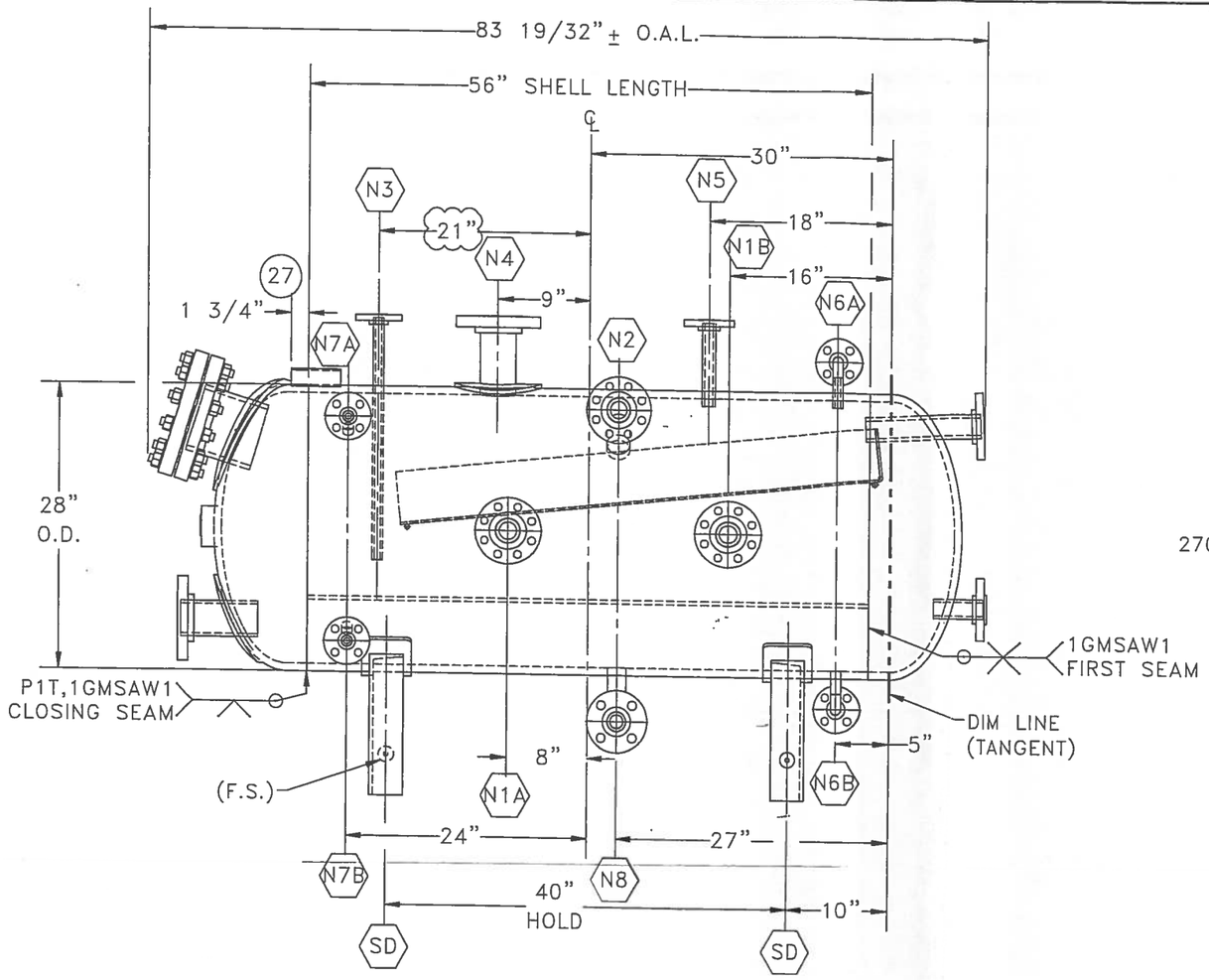
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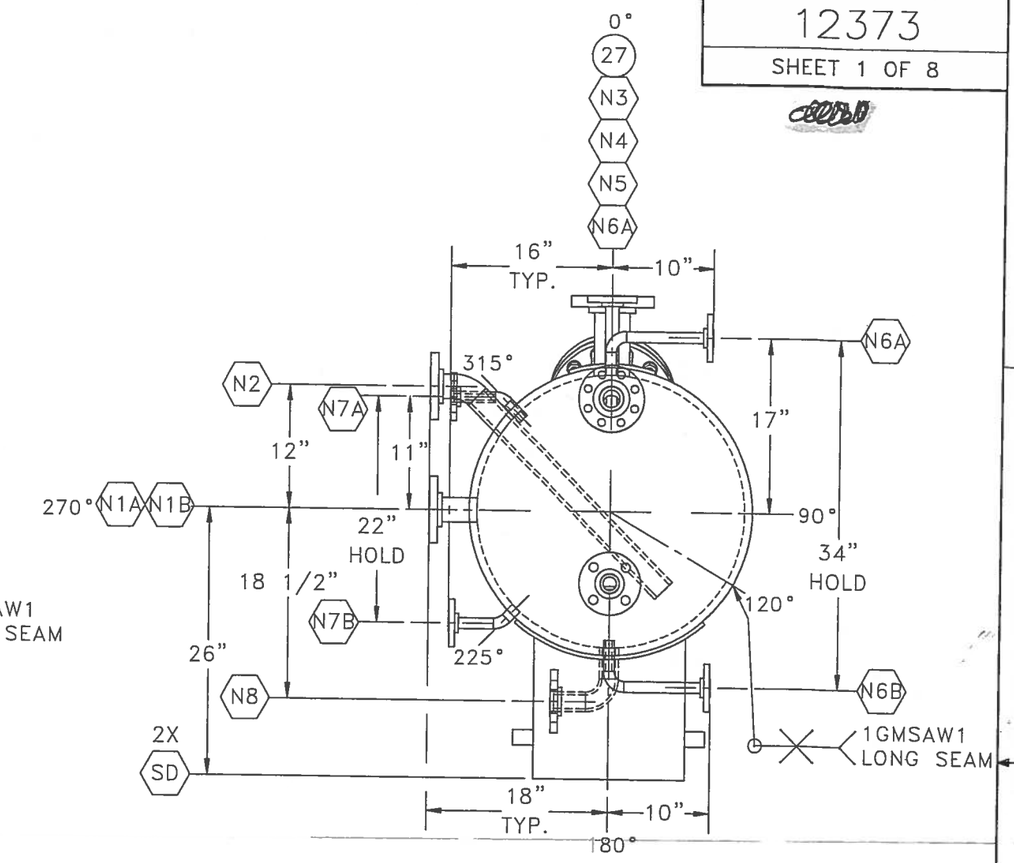
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X1 1 02C

DRAWING NO. 12373

SHEET 1 OF 8





Q.C.No. 1
REL. Date 10/20/2016
REV. No. 1
DWG. No. 1 of 9

NOZZLE SCHEDULE				NOZZLE SCHEDULE			
NOZZLE	SERVICE	SIZE	CLASS	NOZZLE	SERVICE	SIZE	CLASS
N1A/N1B	PUMP SUCTION	2"	300# RFSO	N7A/N7B	LEVEL SWITCH	3/4"	300# RFSO
N2	RETURN LINE	2"	300# RFSO	N8	DRAIN	1 1/2"	300# RFSO
N3	FILL PUMP	3/4"	300# RFSO	N9	INSPECTION	6"	300# RFSO
N4	MIST ELIMINATOR	3"	300# RFSO	N10	HEATER	3"	300# RFSO
N5	SRV	1"	300# RFSO	N11	BEARING DRAIN	2"	300# RFSO
N6A/N6B	LEVEL GAUGE	3/4"	300# RFSO	N12	THERMOWELL	1 1/2"	600# RFSO

3. FLANGE BOLT HOLES TO STRADDLE VESSEL CENTERLINES.
2. REPADS TO HAVE 1/8"–NPT WEEP HOLE. AIR TEST @ 10 PSI MAX.
1. BREAK ALL SHARP EDGES.

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South Gate Engineering
custom - fabricated ASME pressure vessels

SOUTH GATE ENGINEERING, LLC
13477 YORBA AVENUE
CHINO, CALIFORNIA 91710
PH.(909)628–2779
FAX.(909)628–6779

REV	DATE	DESCRIPTION	APP'D
6	--	--	
5	--	--	
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3	--	--	
2	--	--	
1	10/18	2ND SUBMIT	
0	10/14	SUBMITTAL	

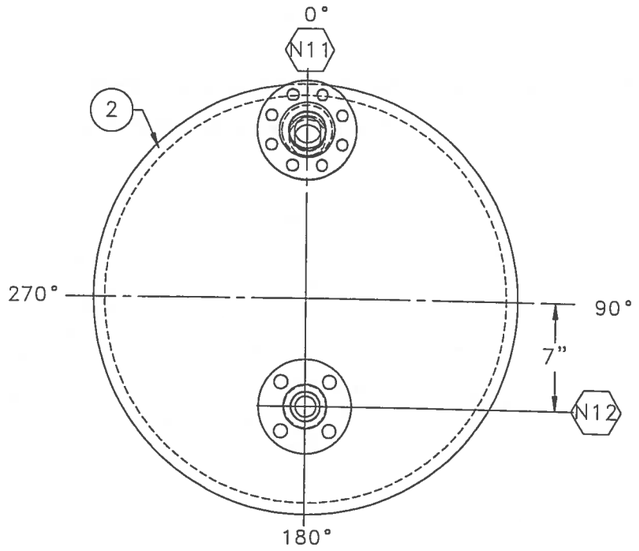
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PROJECT NAME:	P.O.#23599/ HORIZONTAL OIL RESERVOIR		
SERIAL NO.: 25350	MODEL NO.: HOT28–56U	NATL BRD#.: WILL ADVISE	
RELEASE DATE: 10/20	DRAWN BY: JEFF HARPER	APPVD BY:	
MAWP: 650 PSI@ 200 F°	DESIGN: 650 PSI@ 200 F°	PED: N/A	CRN: N/A
MAEWP: 15 PSI@ 200 F°	HYDRO TEST: 975 PSI@ AMB F°	RADIOGRAPHY: RT–1	
MDMT: –20 F°@ 650 PSI	CORROSION ALLOW: 1/16"	PWHT: NONE	
VOLUME: {166} GAL.	EMPTY WEIGHT: 2000 LBS.		

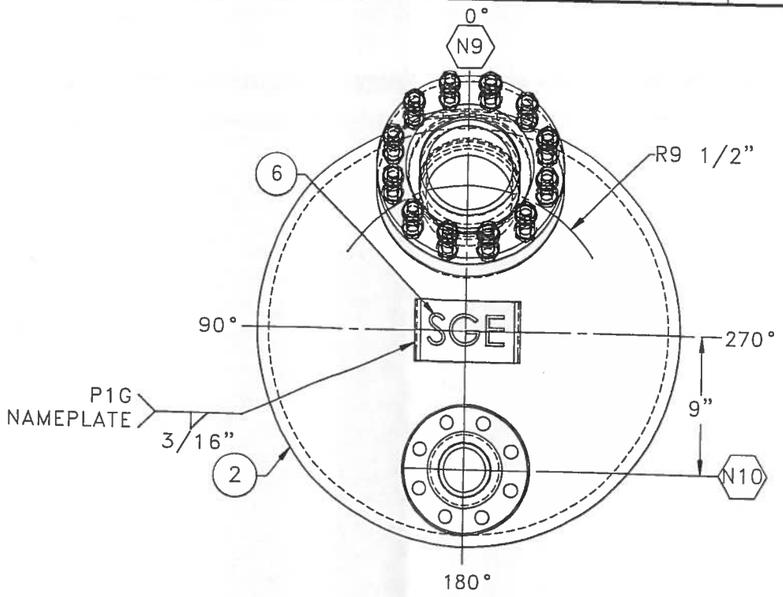
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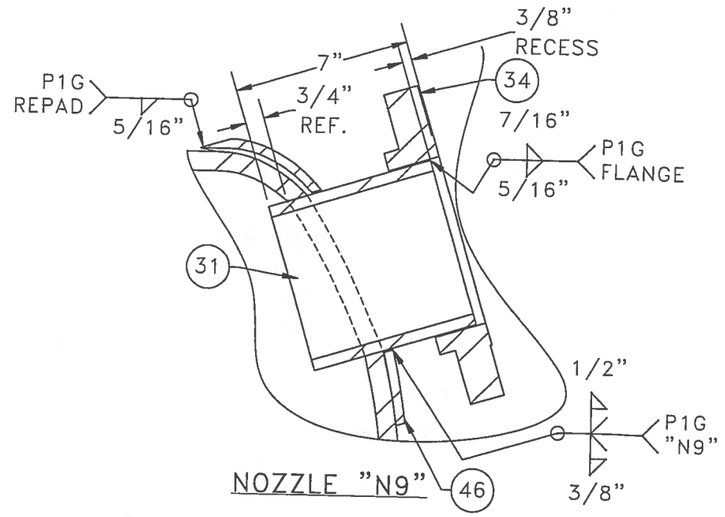
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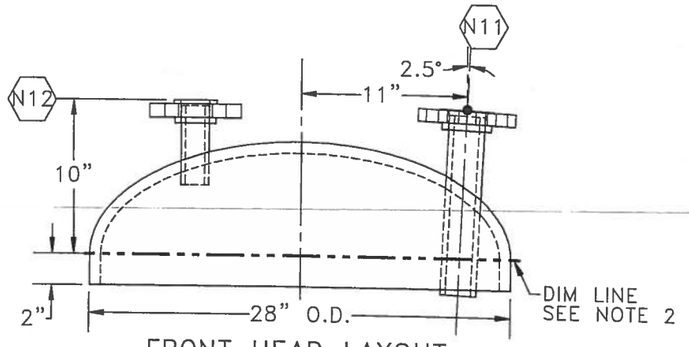
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SHEET 2 OF 8

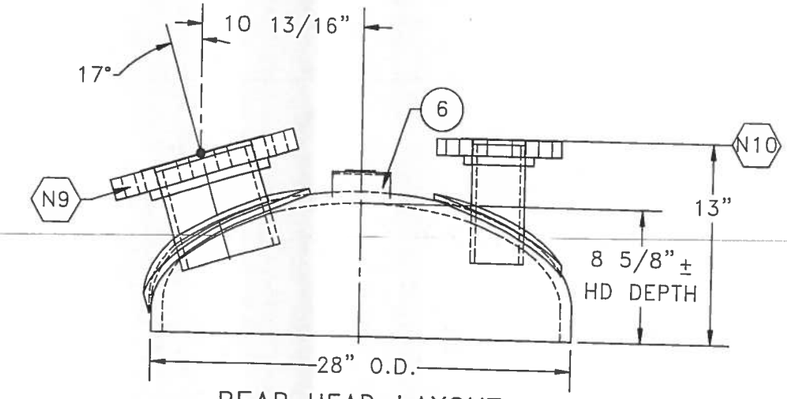




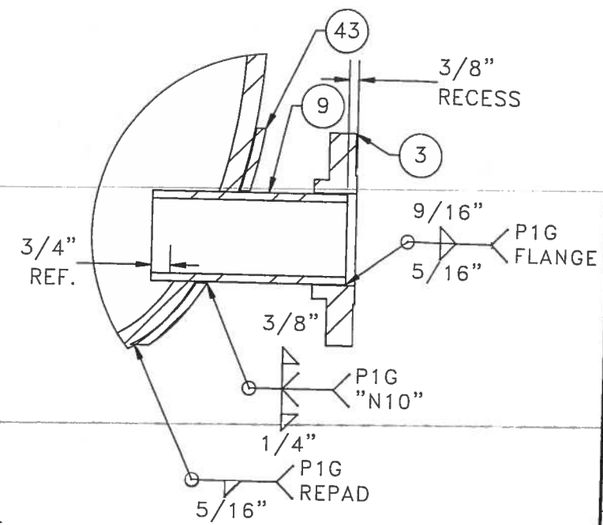




FRONT HEAD LAYOUT
VIEW ROTATED FOR CLARITY



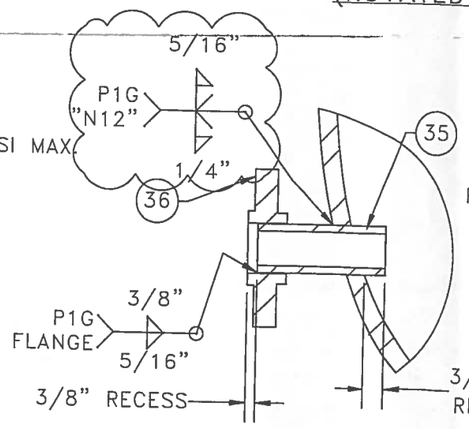
REAR HEAD LAYOUT
(ROTATED FOR CLARITY)



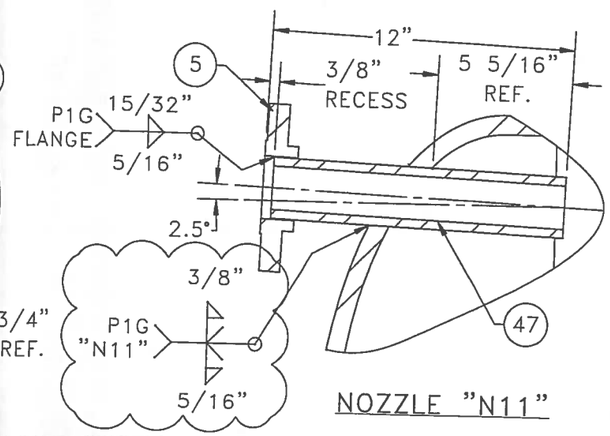
NOZZLE "N10"

4. FLANGE BOLT HOLES TO STRADDLE VESSEL CENTERLINES.
3. REPADS TO HAVE 1/8"–NPT WEEP HOLE. AIR TEST @ 10 PSI MAX.
2. PUNCH MARK @ 0°, 90°, 180°, 270°.
1. BREAK ALL SHARP EDGES.

NOTES:



NOZZLE "N12"



NOZZLE "N11"

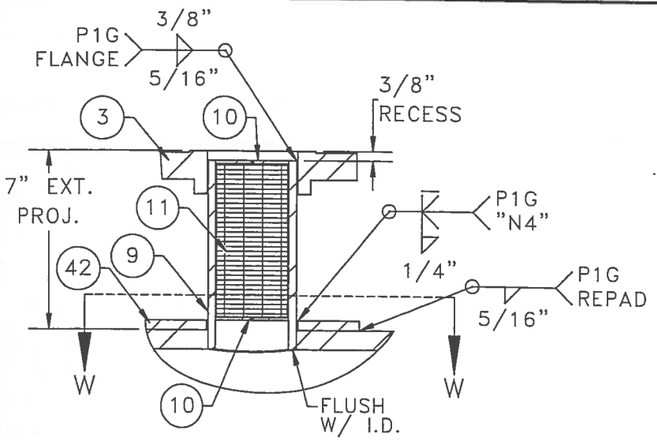
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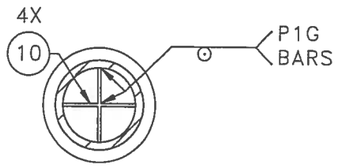
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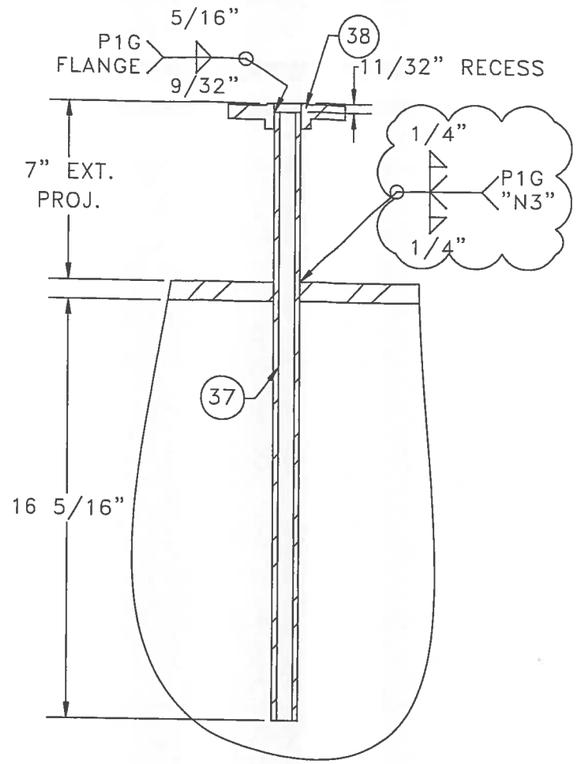
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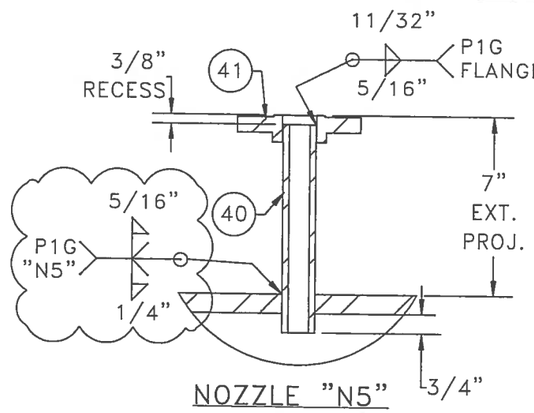
NOZZLE "N4"



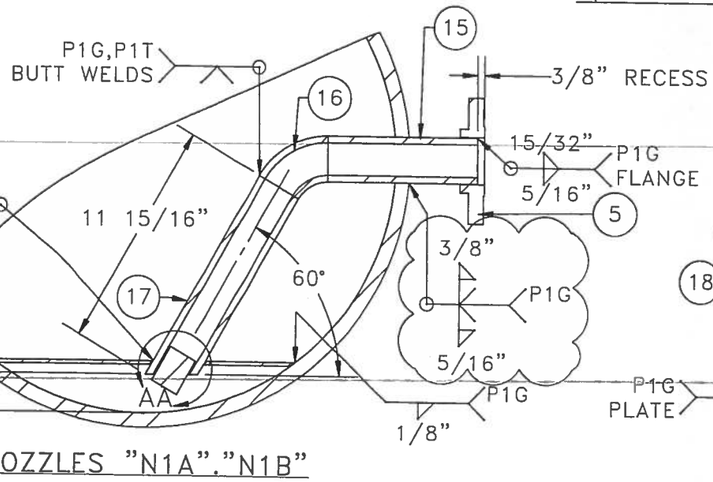
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(2) PLACES



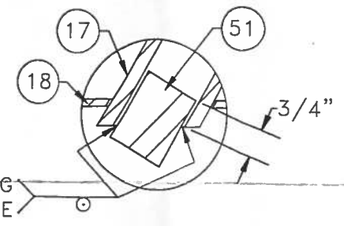
NOZZLE "N3"



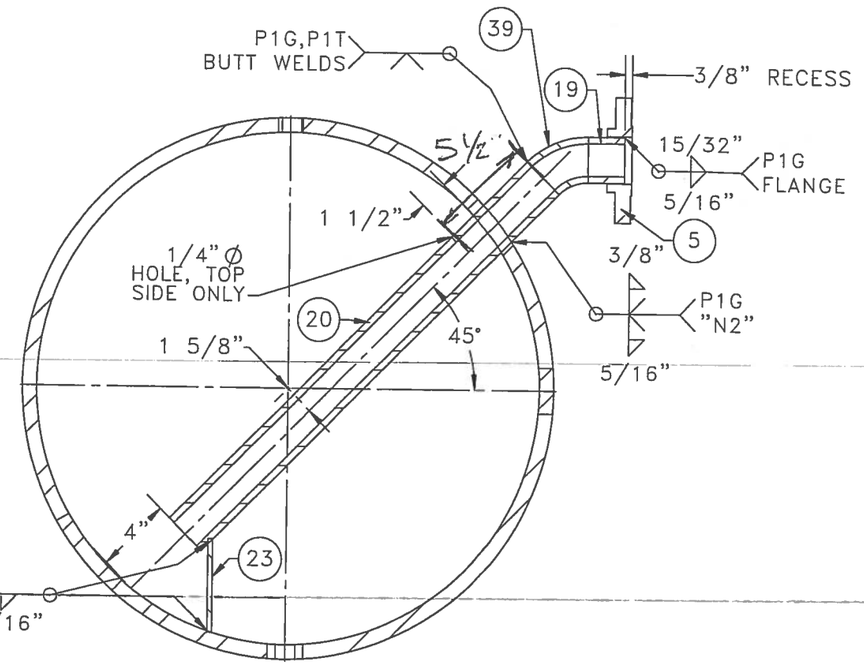
NOZZLE "N5"



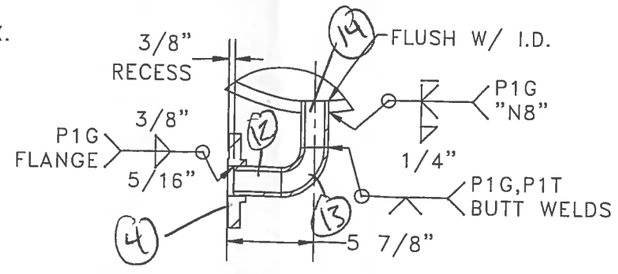
NOZZLES "N1A","N1B"



DETAIL AA



NOZZLE "N2"



NOZZLE "N8"

NOTES:
1. BREAK ALL SHARP EDGES.
2. FLANGE BOLT HOLES TO STRADDLE CENTERLINES.
3. REPADS TO HAVE 1/8"–NPT WEEP HOLE. AIR TEST @ 10 PSI MAX.

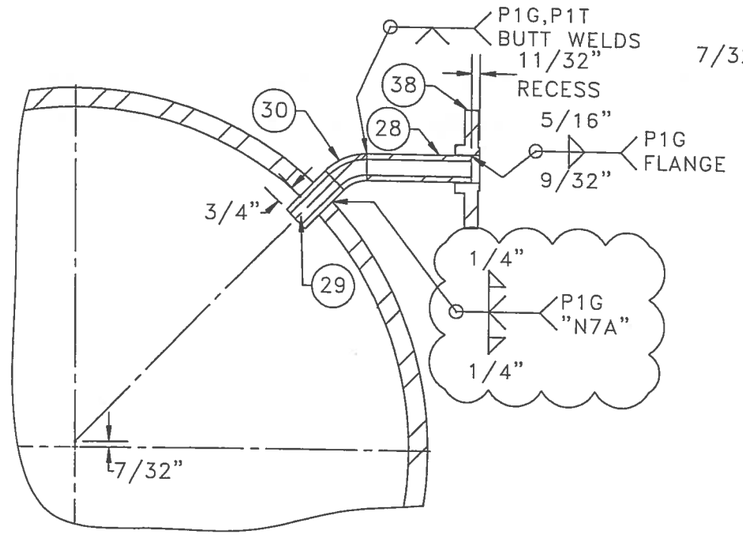
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CHINO, CALIFORNIA
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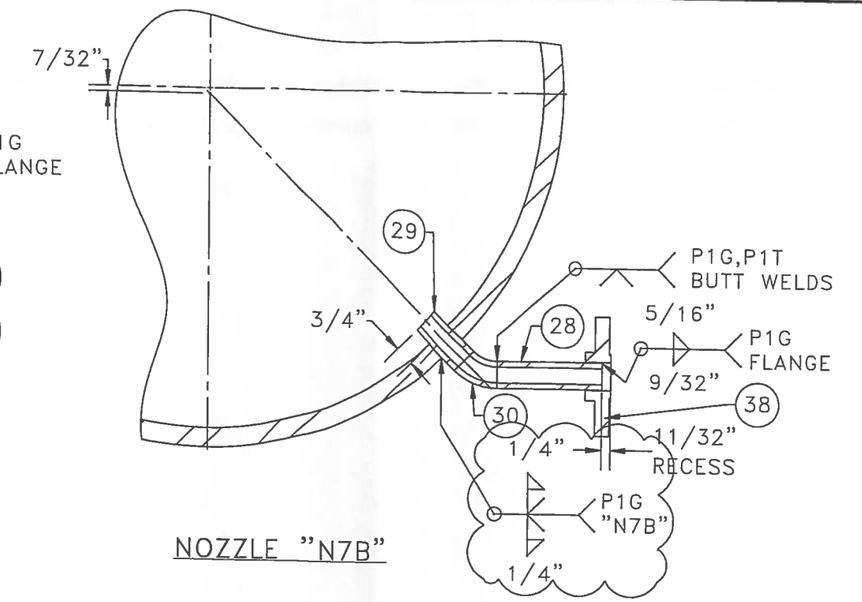
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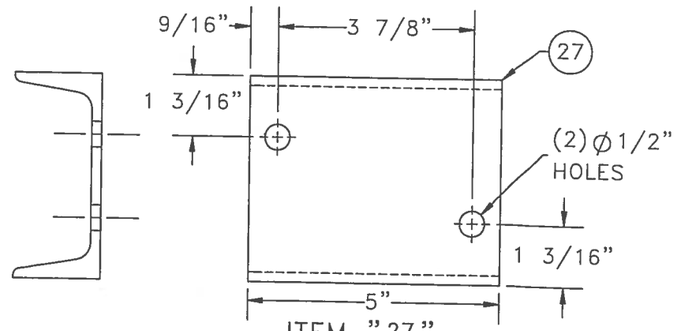
SHEET 4 OF 8



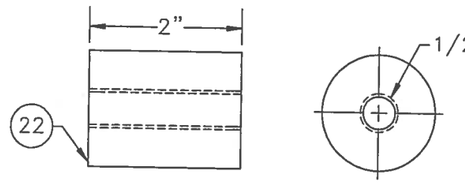
NOZZLE "N7A"



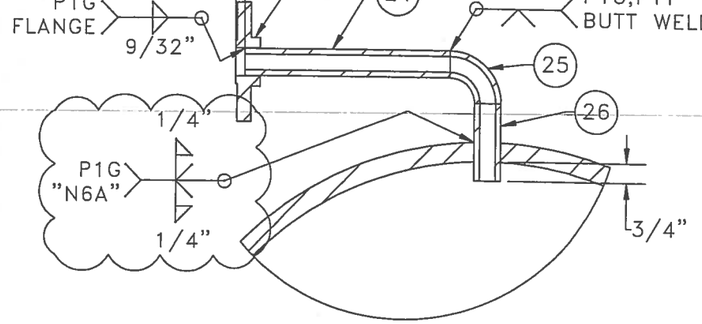
NOZZLE "N7B"



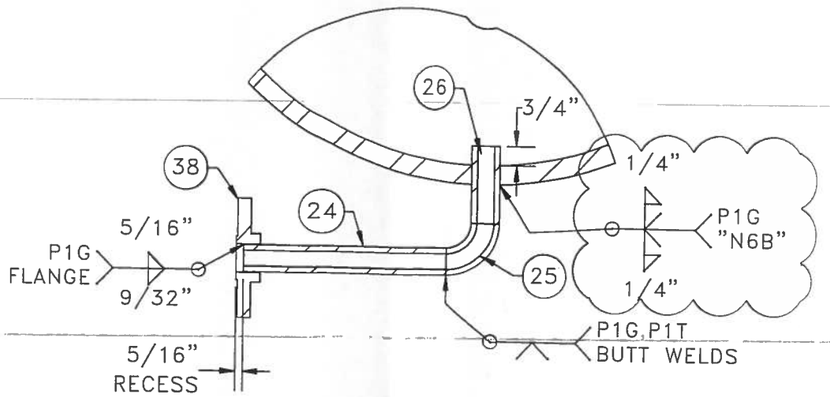
ITEM "27"



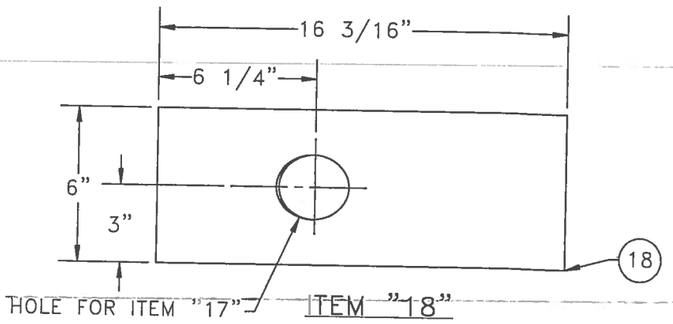
ITEM "22"



NOZZLE "N6A"



NOZZLE "N6B"



ITEM "18"

3. REPADS TO HAVE 1/8"-NPT WEEP HOLE. AIR TEST @ 10 PSI MAX.
2. FLANGE BOLT HOLES TO STRADDLE CENTERLINES.
1. BREAK ALL SHARP EDGES.

NOTES:

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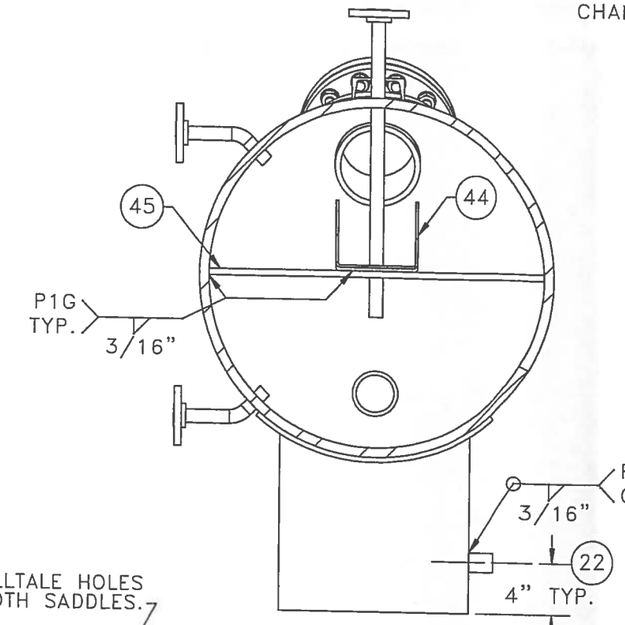
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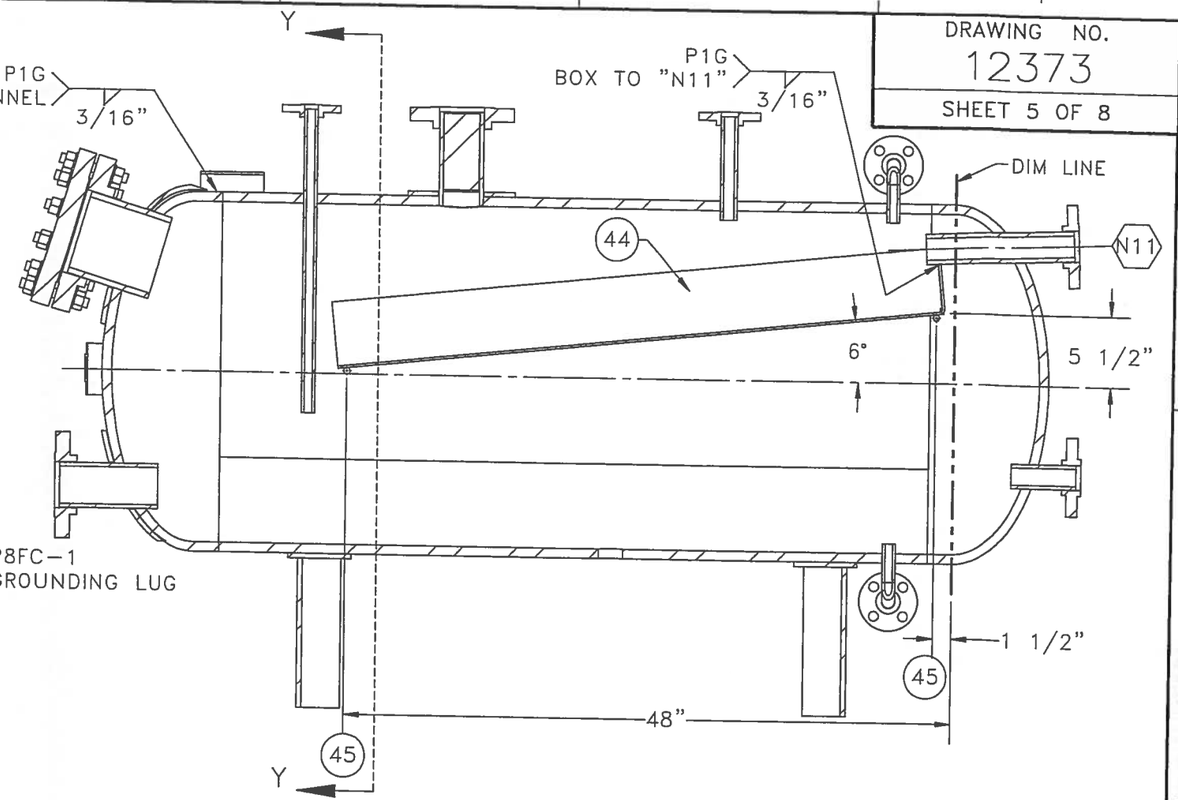
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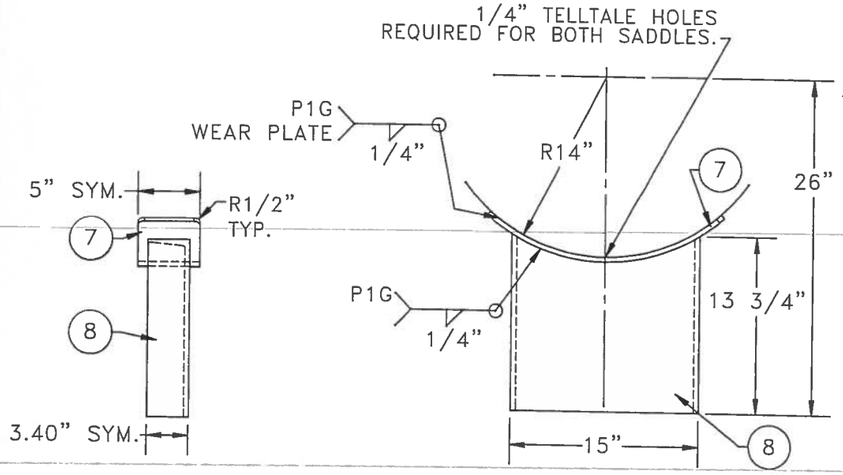
CONSTRUCTION AND STAMPING PER A.S.M.E. SECTION VIII, DIVISION 1

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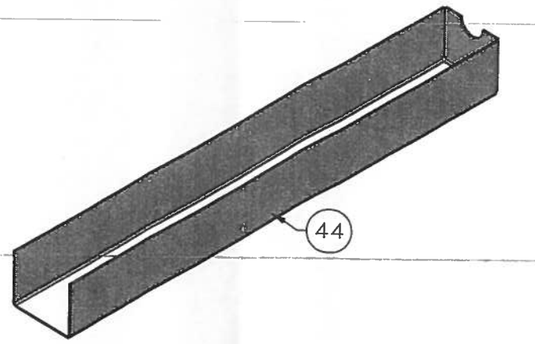
DRAWING NO.
12373
SHEET 5 OF 8

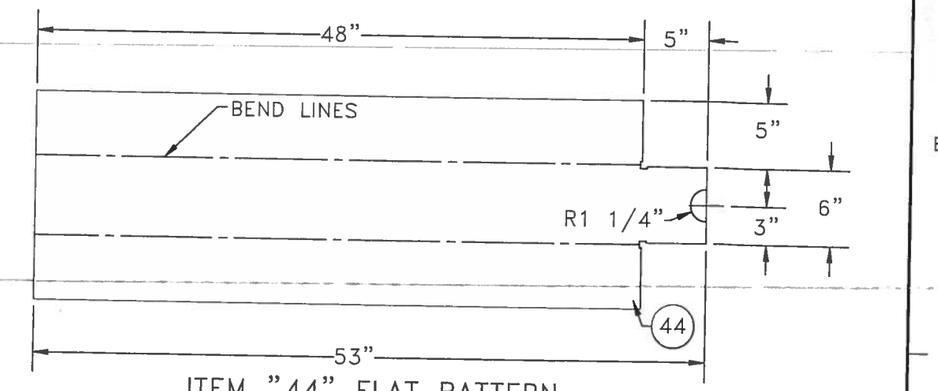




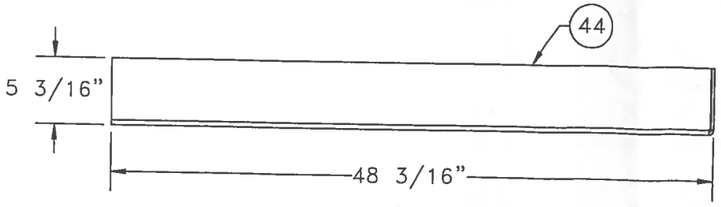


SADDLE DETAIL

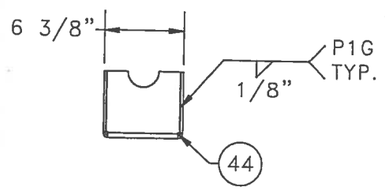




ITEM "44" FLAT PATTERN



TROUGH BOX DETAIL



NOTES:
1. BREAK ALL SHARP EDGES.

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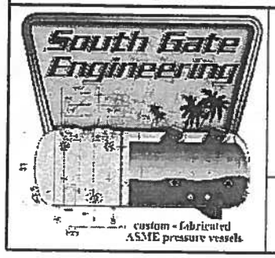
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ITEM NO.	PART NUMBER	DESCRIPTION	PAGE REF.	THICKNESS	WIDTH/I.D.	LENGTH/O.D.	MATERIAL	QTY.	COMMENTS	HEAT NUMBER
1	–	PLATE, 28"OD SHELL		3/4"	56"	85 3/4"	SA-516.70	(1) ✓		W69570-E19 OK
2	3310010280750	HEAD, SEMI-ELIP, 28"OD, 2" S.F.		3/4" NOM.			SA-516.70	(2) ✓	0.6563" MIN AFTER FORMING	OK
3	2413050300300	FLANGE, 3"-300# RFSO					SA-105	2 ✓	NOZZLES N4,N10	
4	2413050150300	FLANGE, 1 1/2"-300# RFSO					SA-105	1 ✓	NOZZLE N8	
5	2413050200300	FLANGE, 2"-300# RFSO					SA-105	4 ✓	NOZZLES N1A,N1B,N2,N11	
6	–	FB , STD NAMEPLATE BKT		1/8"	4"	9"	SA-36	(1) ✓		
7	–	PLATE, WEAR		3/8"	5"	20"	SA516-70	(2) ✓		W6D569-911 OK
8	2012153390	CHANNEL, C15X33.9#				14"	SA-36	(2) ✓		
9	221403000080	PIPE, 3"-SCH.80(XH)				7 11/16"	SA-106, B	(2) ✓	NOZZLES N4,N10	FA1742 OK
10	–	ROUND BAR		Ø1/8"		1 1/2"	SA-36	(8) ✓	NOZZLE N4, MISTER MESH ASSEMBLY	
11	–	MIST ELIMINATOR MESH		3" DIAM.		6"	304 S.S.	1 ✓	MISTER MESH MODEL #3BF	
12	221400150160	PIPE, 1 1/2"-SCH.160				3 1/4"	SA-106, B	(1) ✓	NOZZLE N8	RA0400 OK
13	2623060150160	90 ELBOW, 1 1/2"-SCH.160 LONG RADIUS					SA-234, WPB	1 ✓	NOZZLE N8	
14	221401500160	PIPE, 1 1/2"-SCH.160				3 1/2"	SA-106, B	(1) ✓	NOZZLE N8	RA0400 OK
15	221402000160	PIPE, 2"-SCH.160				7 15/16"	SA-106, B	(2) ✓	NOZZLES N1A,N1B	LA1316 OK
16	2623060200160	90 ELBOW, 2"-SCH.160 LONG RADIUS					SA-234, WPB	2 ✓	NOZZLES N1A,N1B,TRIM TO 60 DEGREES	
17	221402000160	PIPE, 2"-SCH.160				12"	SA-106, B	(2) ✓	NOZZLES N7A,N7B	LA1316 OK
18	–	PLATE, BAFFLE		3/16"	6"	16 3/16"	SA-516.70	(2) ✓	NOZZLES N1A,N1B	B4H811-0625
19	221402000160	PIPE, 2"-SCH.160				1 15/16"	SA-106, B	(1) ✓	NOZZLE N2	LA1316 OK
20	221402000160	PIPE, 2"-SCH.160				26 3/8"	SA-106, B	(1) ✓	NOZZLE N2	LA1316 OK

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SHEET 6 OF 8

NOTES: 1. MTR'S REQUIRED FOR ALL PRESSURE RETAINING MATERIALS.



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ITEM NO.	PART NUMBER	DESCRIPTION	PAGE REF.	THICKNESS	WIDTH/I.D.	LENGTH/O.D.	MATERIAL	QTY.	COMMENTS	HEAT NUMBER
21	2623060200160	45 ELBOW, 2"– SCH.160, LONG RADIUS					SA–234,WPB	1	NOZZLE N2	
22	–	ROUND BAR, GROUNDING LUG		Ø1 1/2"		2"	SA–479–304/304L	2		
23	–	ROUND BAR, BRACE		Ø1/4"		4 13/16"	SA–36	1		
24	221400750160	PIPE, 3/4"–SCH.160				8 3/16"	SA–106, B	2	NOZZLES N6A,N6B	RA0396 OK
25	2623060075160	90 ELBOW, 3/4"–SCH.160 LONG RADIUS					SA–234, WPB	2	NOZZLES N6A,N6B	
26	221400750160	PIPE, 3/4"–SCH.160				3"	SA–106, B	2	NOZZLES N6A,N6B	RA0396 OK
27	2012040725	CHANNEL, C4x7.25#				5"	SA–36	1		
28	221400750160	PIPE, 3/4"–SCH.160				4 1/8"	SA–106, B	2		RA0396 OK
29	221400750160	PIPE, 3/4"–SCH.160				2.18	SA–106, B	2		RA0396 OK
30	262306160075160	45 ELBOW, 3/4"–SCH.160 LONG RADIUS					SA–234, WPB	2	NOZZLE N10	
31	221406000080	PIPE, 6"–SCH.80(XH)				6 5/8"	SA–106, B	1	NOZZLE N9	8835 OK
32	2513050600300	BLIND FLANGE, 6"–300# RF					STEEL	1	NOZZLE N9	
33	–	RING GASKET, 6"–300# FLEXITALLIC CG		1/8"			304 S.S.	1	NOZZLE N9, FLEXIBLE GRAPHITE FILLER	
34	2413050200150	FLANGE, 6"–300# RFSO					SA–105	1	NOZZLE N9	
35	221401500160	PIPE, 1 1/2"–SCH.160				5 1/8"	SA–106, B	1	NOZZLE N12	RA0400 OK
36	2413050150600	FLANGE, 1 1/2"–600# RFSO					SA–105	1	NOZZLE N12	
37	221400750160	PIPE, 3/4"–SCH.160				23 3/4"	SA–106, B	1	NOZZLE N3	RA0396 OK
38	2413050075300	FLANGE, 3/4"–300# RFSO					SA–105	5	NOZZLES N3,N6A,N6B,N7A,N7B	
39	262306160200160	45 ELBOW, 2"–SCH.160 LONG RADIUS					SA–234,WPB	1		
40	221401000160	PIPE, 1"–SCH.160				8 1/8"	SA–106, B	1	NOZZLE N5	RA0311 OK

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SHEET 7 OF 8

NOTES: 1. MTR'S REQUIRED FOR ALL PRESSURE RETAINING MATERIALS.

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SOUTH GATE ENGINEERING, LLC
13477 YORBA AVENUE
CHINO, CALIFORNIA 91710
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ITEM NO.	PART NUMBER	DESCRIPTION	PAGE REF.	THICKNESS	WIDTH/I.D.	LENGTH/O.D.	MATERIAL	QTY.	COMMENTS	HEAT NUMBER
41	2413050100300	FLANGE, 1"–300# RFSO					SA–105	1	NOZZLE N5	
42	–	PLATE, REPAD		3/8"	3 5/8" I.D.	8 1/2" O.D.	SA–516.70	1	NOZZLE N4	W6D569-G11 OK
43	–	PLATE, REPAD		3/8"	3 5/8" I.D.	8 1/2" O.D.	SA–516.70	1	NOZZLE N10	W6D569-G11 OK
44	–	TROUGH BOX		3/16"	16"	53"	SA–516.70	1		B4H811-0625
45	–	ROUND BAR		Ø1/2"		28"	SA–36	2	TROUGH SUPPORT	
46	–	PLATE, REPAD		3/8"	6 3/4" I.D.	12 1/2" O.D.	SA–516.70	1	NOZZLE N9	W6D569-G11 OK
47	221402000160	PIPE, 2"–SCH.160				11 5/8"	SA–106, B	1	NOZZLE N11	LA1316 OK
48	–	STUD, 3/4"–10UNC				5 1/2"	SA–193,B7	12	NOZZLE N9, ZINC PLATED	
49	–	FLAT WASHER, 3/4"					F436	24	NOZZLE N9, ZINC PLATED	
50	–	HEAVY HEX NUT 3/4"–10UNC					SA–194,2H	24	NOZZLE N9, ZINC PLATED	
51	–	SHEET		10GA.	1 1/2"	2"	SA–414,G	2	NOZZLES N1A,N1B	1160912

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SHEET 8 OF 8

NOTES: 1. MTR'S REQUIRED FOR ALL PRESSURE RETAINING MATERIALS.

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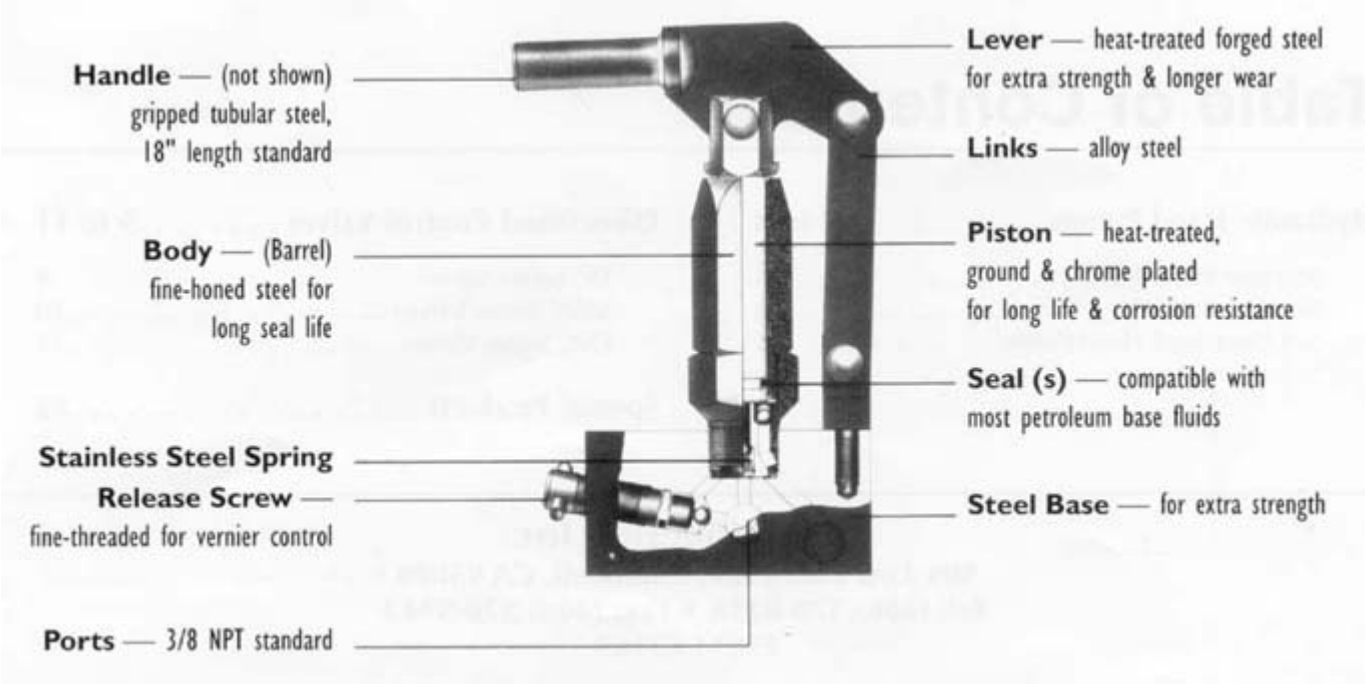
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TR ENGINEERING HAND PUMP

- Standard TR Engineering Hand Pumps do not have a relief valve.
- Standard Hand Pumps handles are removable and not shown in all illustrations.
- A knurled knob release screw option is available on these Hand Pumps.



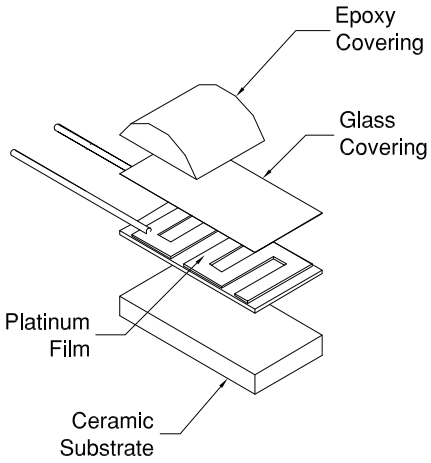
TECHNICAL REFERENCE

Resistance Temperature Detector (RTD) elements are normally constructed of platinum, copper, nickel or nickel/iron. They operate as a positive temperature coefficient device when an excitation voltage is applied to convert changes in temperature to voltage signals by the measurement of resistance. The metals have the properties necessary for use in RTD elements due to their resistance to temperature characteristics that increase in resistance as temperature increases and, conversely, decrease in resistance as temperature decreases. These metals are best suited for RTD applications because of their linear resistance-temperature characteristics, their high coefficient of resistance, and their ability to withstand repeated temperature cycles. The change in electrical resistance to temperature for a material is termed the " temperature coefficient of resistance".

Thermo Electric uses two types of RTD, the wire wound and the thin film.

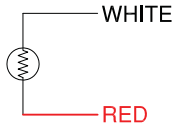


Wire wound design uses helical coil of very small platinum sensing wire of known alpha value. This coil is then slid into a ceramic insulator. Larger extension leads are spot welded to the ends of the platinum wire and cemented in place. Another construction is an outer winding of the platinum around a center mandrel usually made of ceramic. This winding is then coated with glass as a means of securing the windings. Wire wound elements are available in a number of materials and suitable for a wider temperature range.

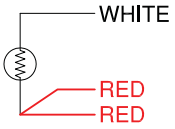


Thin film sensing elements are manufactured with a thin layer of platinum deposited on to a ceramic substrate. The platinum film is laser cut or chemical etched to achieve the desired resistance path. The element is then coated with a thin layer of glass for protection.
Lead wires are welded to the platinum with epoxy applied to hold the lead wires in place. Thin film elements are lower in cost than wire wound and faster in response time.

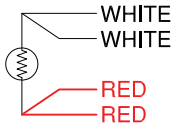
RTD's are available in two, three and four wire configuration. Selection of the lead wire configuration is usually based on the instrumentation, desired accuracy and stability.



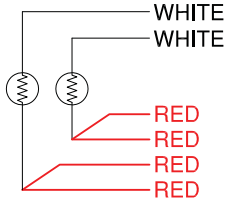
Two wire RTD: One lead wire is attached to each side of the element. This is the least accurate due to the inability to compensate for lead length resistance.



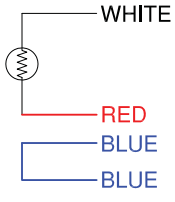
Three wire RTD: This is the most commonly used configuration. By adding a third lead to one end of the sensing element instrumentation can detect and compensate for lead resistance.



Four wire RTD: Four wire provide for the most accurate method of RTD measurement. A constant current is carried through two leads with the remaining two used to measure the voltage drop.



Duplex RTD: RTD's are available in duplex construction in any of the wire configurations. With wire wound bulbs two sets of windings are used. In thin film, two elements are set in place side-by-side. The second element may be used as a spare, testing purposes or connection to a second instrument. In most of Thermo Electric ordering codes a "D" is added to the prefix to denote duplex construction.



Compensating Loop RTD: A compensating loop is an extra pair of lead wires that have the same resistance as the actual lead wires but which are not connected to the RTD element. Its purpose is to correct for lead wire resistance errors when making temperature measurement.

The Information contained hereon shall be considered the sole property of Thermo Electric Company, Inc. The recipient thereof agrees not to disclose or reproduce said information to parties outside the recipients organization without the written permission of Thermo Electric.

Temperature Coefficient and Sensitivity of RTD's

The best RTD for a given application meets the temperature range required and delivers the performance and cost requirements expected. All RTDs are specified by both a base resistance and the Temperature Coefficient of Resistance (TCR) or Alpha, expressed as Ω/Ω/°C. The base resistance is usually the ice point, the most common exception is Copper which is specified as 10 Ω at 25°C. The TCR is the RTD's Resistance change from 0 too 100°C, divided by the resistance at 0°C, divided by 100°C. The following is the formula used to calculate TCR.

$$\text{TCR } (\Omega/\Omega/°C) = \frac{R100°C - R0°C}{R0°C \times R100°C}$$

R = 200 ft. x 0.0103 Ω/ft. = 2.06Ω

Approximate Error

$$E = \frac{2.06\Omega}{0.385\ \Omega/°C} = 5.35°C$$

The most common and important use of TCR is in specifying the curves for Platinum RTDs. It is important that the TCR be matched properly when replacing RTDs or connecting them to instrumentation or erroneous readings will result . The most popular RTD used in most applications is a 100 U+03A9 with a TCR of 0.00385. Sensitivity of an RTD is the value of the TCR multiplied by R0°C and is therefore a function of the base resistance and TCR. Sensitivity is expressed as Ω/°C. Since an RTD is a resistance type sensor any variable that can alter the resistance between the RTD and the control instrument will add to the reading. Therefore, the length of the lead wires can alter the readings. Since, the copper in lead wire changes resistance with changing ambient temperatures, the resistance is not constant. Lead wire error can be calculated by multiplying the total length of the lead wire, in feet, by the resistance value per foot of the wire gauge used at a given temperature. This figure is then divided by the sensitivity value to obtain an error figure. Lead wire errors can be significant when using small gauge wires or elements with low sensitivity. Example: A two wire 100 Ω Platinum RTD has a sensitivity value of 0.385 W°C. Leadwires are 100 feet, 20 gauge copper wire with a resistance value of 0.0103

Available RTD Elements

The most commonly used element material is the standard platinum with a resistance of 100 ohms at 0°C and a temperature coefficient of resistance of 0.00385 ohms/ohms/°C. Other types of RTDs are available from Thermo Electric. Below is a listing for some of the other element types that we supply.

ELEMENT MATERIAL	NOMINAL RESISTANCE	TEMPERATURE COEFFICIENT OHMS/OHM/° C	RELATED STANDARDS
PLATINUM	50 Ohms @ 0° C	0.003916	JIS C1604-1997, US STANDARD*
PLATINUM	98.129 Ohms @ 0° C	0.003923	SAMA RC21-4-1966
PLATINUM	100 Ohms @ 0° C	0.00385	ASTM-1137, IEC-60751, DIN 43760, ITS-90 BS EN 60751:1998(Replaces BS 1904:1984)
PLATINUM	100 Ohms @ 0° C	0.003916	JIS C1604-1997, US STANDARD*
PLATINUM	100 Ohms @ 0° C	0.003902	US STANDARD*
PLATINUM	130 Ohms @ 0° C	0.003900	BS 2G 148 (British Aircraft Industry)
PLATINUM	200 Ohms @ 0° C	0.00385	DIN 43760
PLATINUM	500 Ohms @ 0° C	0.00385	DIN 43760
PLATINUM	1000 Ohms @ 0° C	0.00385	DIN 43760
NICKEL	100 Ohms @ 0° C	0.00617	DIN 43760
NICKEL	120 Ohms @ 0° C	0.00672	Edison No. 7
NICKEL/IRON	604 Ohms @ 0° C	0.00518	N/A
COPPER	10 Ohms @ 25° C	0.00427	Edison No. 15

*No document exists for US Standard.

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TECHNICAL REFERENCE

RTD Stability: Stability is a RTD ability to maintain its specified resistance to temperature characteristic over long periods of time while being operated within its specified temperature limits. Often refered to as long term stability is the ability of the element to maintain its initial accuracy over an extended period of time. Most RTD's are stable to less than 0.05°C per year. However, stability is also affected by the environment, vibration, thermal shock and mechanical abuse it may be subject to.

RTD Interchangeability: Interchangeability is the measure of the variable based on tolerance and temperature coefficient from element to element. RTD's allow for easier interchangeability since their original variation is much lower than that of thermocouples.

Insulation Resistance: RTD's are insulated with MgO or insulated lead wire which is then sealed in a stainless steel tube. To prevent a shunting effect between the sensing element and the tube, care must be taken to assure no contamination or moisture absorption is present to cause any potential problems.

Repeatability: Repeatability of the element is defined as the relationship of the original resistance at 0°C and any different resistance at 0°C after being subjected to the following test. The sensor shall be brought slowly to the upper limits of its temperature range and then exposed to air at room temperature. It shall then be brought slowly to its lower limit, and exposed to air at room temperature. This procedure is repeated ten times. The resistance of 0°C is then measured and the difference from the pretesting resistance at 0°C is noted. For a typical platinum probe, the resistance should not change more than 0.3°C for a 0.12 % sensor or 0.15°C for a 0.06% sensor. The 0.12% and 0.06% are original resistance tolerances at 0°C of the element.

Self Heating: To measure resistance, it is necessary to pass a current through the element. The voltage drop across fine wire of a wire wound or thin coating of a thin film will tend to heat the element, this is known as Joule heating. To prevent this self heating RTD's are specified to have a current applied of 1 mA or less. (Self Heating: 0.01 °C/mW in still liquid)

Vibration: Damage to the weld joints caused by excessive vibration can cause erratic readings or complete failure. All styles of Thermo Electric RTD's were tested and passed in accordance with IEC 60751 over a frequency range of 10 to 500Hz with a forcing acceleration of 20m/s² to 30m/s² peak-to-peak.

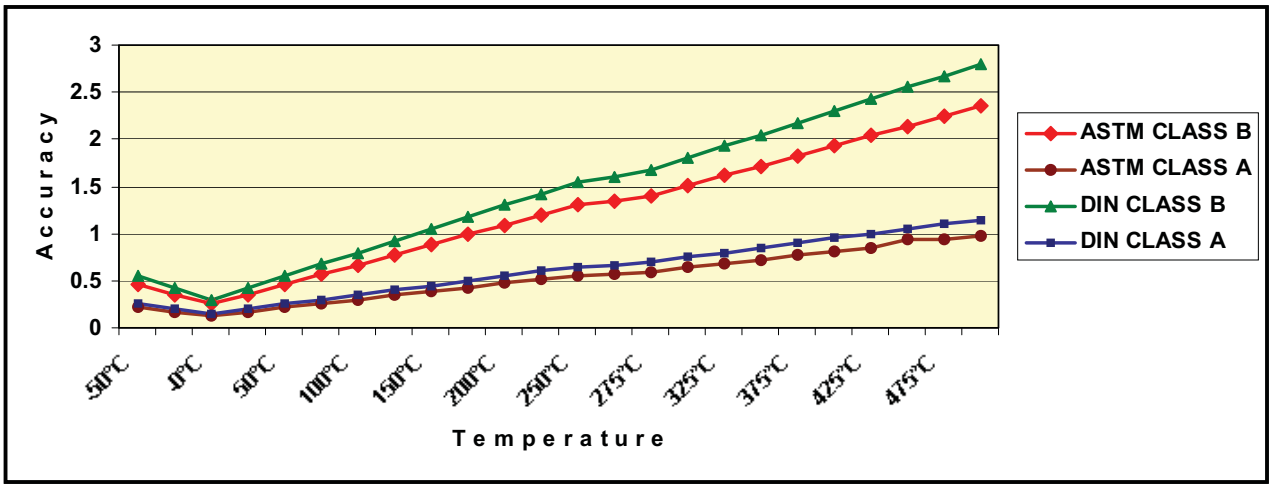
Response Time: Thermal response time is the time necessary for an RTD to reach 63.2 % step change of temperature and reach the resistance corresponding to some specified fraction of the total temperature change. Table to the right shows typical performance of the time constant in moving water at 3FT/sec.

SHEATH DIAMETER	TIME
.125" (3.2mm)	1.5 seconds
.188" (4.8mm)	3.0 seconds
.25" (6.4mm)	3.0 seconds

Callendar Van Dusen: Founded by British physicist Hugh Longbourne Callendar, and refined by M. S. Van Dusen. The Callendar-Van Dusen equation is an equation that describes the relationship between resistance (R) and temperature (t) of platinum. The Callendar Van Dusen equation analytically addresses the tolerance and accuracy of a platinum RTD at any point within its operation temperature range independent of alpha and ice point resistance.

ACCURACY	ASTM E1137	DIN EN 60751
CLASS B	± .10% @ 0°C (32°F)	± .12% @ 0°C (32°F)
CLASS A	± .05% @ 0°C (32°F)	± .06% @ 0°C (32°F)

Accuracy: Platinum RTD's typically are provided in grades (or class) of tolerance. Grade A has an ice point tolerance of ±0.06 % at ice point and grade B ±0.12 % at ice point. The ASTM standard is slightly better than the DIN at ±0.05 % and 0.10%. The accuracy will decrease with temperature. Thermo Electric RTD's conform to standard ASTM grade B accuracy and ASTM grade A accuracy when selected in ordering code.



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L.A. Turbine QC Data Book

Project No.: LAT574EC

CUSTOMER: **UOP RUSSELL, LLC**

PROJECT NAME: 60 MMscfd Cryo Plant
(JOB#: J447XX)

CUSTOMER'S P.O. NO.: 4500743460

EQUIPMENT: ONE, FRAME L2000 EXPANDER COMPRESSOR UNIT

info@laturbine.com
www.laturbine.com

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK FOR LAT574EC
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- INSPECTION CERTIFICATE
- NDE CERTIFICATION
- HYDROSTATIC TEST CERTIFICATE

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- OVERSPEED TEST CERTIFICATE
- DYE PENETRANT TEST CERTIFICATE
- DYNAMIC BALANCING TEST CERTIFICATE

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Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

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- CERTIFICATION OF CONFORMANCE

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- FINAL INSPECTION CERTIFICATE

L.A. Turbine™
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28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 1: EXPANDER CASING

- MATERIAL CERTIFICATION
- INSPECTION CERTIFICATE
- NDE CERTIFICATION
- HYDROSTATIC TEST CERTIFICATE

EXP-1

Eastham Forge, Inc. ISO 9001: 2008 CERTIFIED

EFI MATERIAL CERTIFICATION

A Subsidiary of Eastham Enterprises, Inc.

1050 Neches Street
Beaumont, Texas 77701
409 835-4212

MTR Reference ID: 9705.00

SOLD TO
LA TURBINE CORPORATION
29151 AVENUE PENN
VALENCIA . CA 91355

SHIP TO
LA TURBINE CORPORATION
29151 AVENUE PENN
VALENCIA,CA
91355

Customer Order #	Line Item	Approval Date	Shop Order #	Ship Wgt EA(lbs)	Quantity	Total
23674	1	11/04/2016	9705.00	1139	1	1

Forge to Finish	Part Number	Forge Ratio	Melt Practice
7770006233	7770006233	32.01 : 1	EAF/AOD

Material Grade	Heat Number	Heat Code	Specifications:	ASME SA182-2015 304/304L
304L	001114	9708-PA	ASME SA745-2015 (UT SPEC)	
Serial Number(s)	LAT574			

Producing Mill Name: COGNE SPECIALTY STEEL

Mill Austenitic Grain Size:

Chemistry Ladle Analysis

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	N	Nb
0.028	1.87	0.032	0.0010	0.50	0.39	8.34	18.14	0.28	0.086	0.010
Ti	Co	B								
0.010	0.07	0.0009								

HEAT TREATMENT PERFORMED

Cycle	Temp	Hours	Quenchant (Start-Stop °F)	Method
SOL. ANNEAL	1950 °F	8.00	WATER (69-71°F)	A

Monitor Method Legend: A: [Furnace TC] B: [Contact TC] C: [Heat Sink TC]

Forging Hardness: N/A

Number of Pieces Checked:

QTC DATA & MECHANICAL PROPERTIES

Mechanical Properties: 10.5" H X 10.5" W X 20.0" L

QTC Ref . #: 6819.01

QTC Melt Practice: EAF/AOD

QTC Forge Ratio: 25.33: 1

QTC Heat Treatment

Cycle	Temp F	Hours	Quenchant (Start-Stop °F)	Method
SOLUTION ANNEA	1950 °F	8.00	WATER (68-76)	A

Monitor Method Legend:
A: [Furnace Monitoring] B: [Contact TC] C: [Heat Sink TC]

QTC Properties

0.498 Tensile Bar	Actual	10MM x 10MM	Actual
Tensile Str. (Long.)	83.5 KSI	CVN	
0.2% Offset Yield Str	44.7 KSI	Temp	
% Elong. IN 2"	62.3	Ft. Lbs.	
% Reduction of Area	80.5	Lateral_Exp. (in.	
Surface Hardness **	169-170	% Shear	

** HBW 10/3000

*** Material Test Report Notes ***

DURING PROCESSING AT EASTHAM FORGE. INC., THIS MATERIAL HAS NOT COME INTO CONTACT WITH MERCURY OR ANY RADIOACTIVE CONTAMINATION.

We hereby certify that all test results and process information contained herein are correct and true as contained in the records of the company.

Date : 11/04/2016

By : A Woodard

ALMA WOODARD

Title : DOCUMENTATION SPECIALIST

FORM 405.01 REV C

EFI MATERIAL CERTIFICATION

A Subsidiary of Eastham Enterprises, Inc.
1050 Neches Street
Beaumont, Texas 77701
409 835-4212

MTR Reference ID: 9705.00

SOLD TO
LA TURBINE CORPORATION
29151 AVENUE PENN
VALENCIA , CA 91355

SHIP TO
LA TURBINE CORPORATION
29151 AVENUE PENN
VALENCIA,CA
91355

Customer Order #	Line Item	Approval Date	Shop Order #	Ship Wgt EA(lbs)	Quantity	Total
23674	1	11/04/2016	9705.00	1139	1	1

Forge to Finish	Part Number	Forge Ratio	Melt Practice
7770006233	7770006233	32.01 : 1	EAF/AOD

Material Grade	Heat Number	Heat Code	Specifications:	ASME SA182-2015 304/304L
304L	001114	9708-PA	ASME SA745-2015 (UT SPEC)	
Serial Number(s)	LAT574			

***** Material Test Report Notes (cont) *****

NO WELDING HAS BEEN PERFORMED ON THESE FORGINGS.

HEAT TREATMENT PERFORMED IN FURNACES CALIBRATED AND CERTIFIED TO MEET OR EXCEED THE REQUIREMENTS OF API SPECIFICATION 16A (ISO 13533:2001) 3RD EDITION, DECEMBER, 2004 - ANNEX A AND API 6D 24TH EDITION, APPX. F

MATERIAL, ITEMS OR SERVICES FURNISHED UNDER THIS ORDER HAVE BEEN PRODUCED TO THE SPECIFICATIONS AND REQUIREMENTS STATED ON THIS ORDER AND IN ACCORDANCE WITH THE EASTHAM FORGE, INC. ISO 9001:2008 QUALITY MANAGEMENT SYSTEM; CERTIFICATE OF COMPLIANCE NO: 30087, ORIGINAL CERTIFICATION DATE: 17 JULY 2002 EXPIRATION DATE: 21 FEB 2018

EASTHAM FORGE, INC. IS CERTIFIED TO BE COMPLIANT WITH THE PROVISIONS OF THE PRESSURE EQUIPMENT DIRECTIVE (PED) 97/23/EC 7/2, ANNEX I, PARA 4.3 - CERTIFICATE NO. 41761 - EXPIRATION DATE 1/27/2018

DOCUMENTATION SUPPLIED MEET REQUIREMENTS OF EN 10204:2004, TYPE 3.1

DIMENSIONAL INSPECTION REPORT INCLUDED.

VOLUMETRIC N.D.E. IN ACCORDANCE WITH ASTM ASME SA745 (QL-5 & QL-1).

We hereby certify that all test results and process information contained herein are correct and true as contained in the records of the company.

Date : 11/04/2016
By : A Woodard
ALMA WOODARD
Title : DOCUMENTATION SPECIALIST

FORM 405.01 REV C

EASTHAM FORGE, INC.

MACHINING DIMENSIONAL INSPECTION REPORT

DATE: 11-1-16 QTY: 1 SHOP ORDER: 9705.00

HEAT CODE: 9708-PA HEAT NUMBER: 001114

DWG/DESCRIPTION: 7770006233 PCS ACCEPTED: 1 PCS REJECTED:

INSPECTOR: F REMARKS:

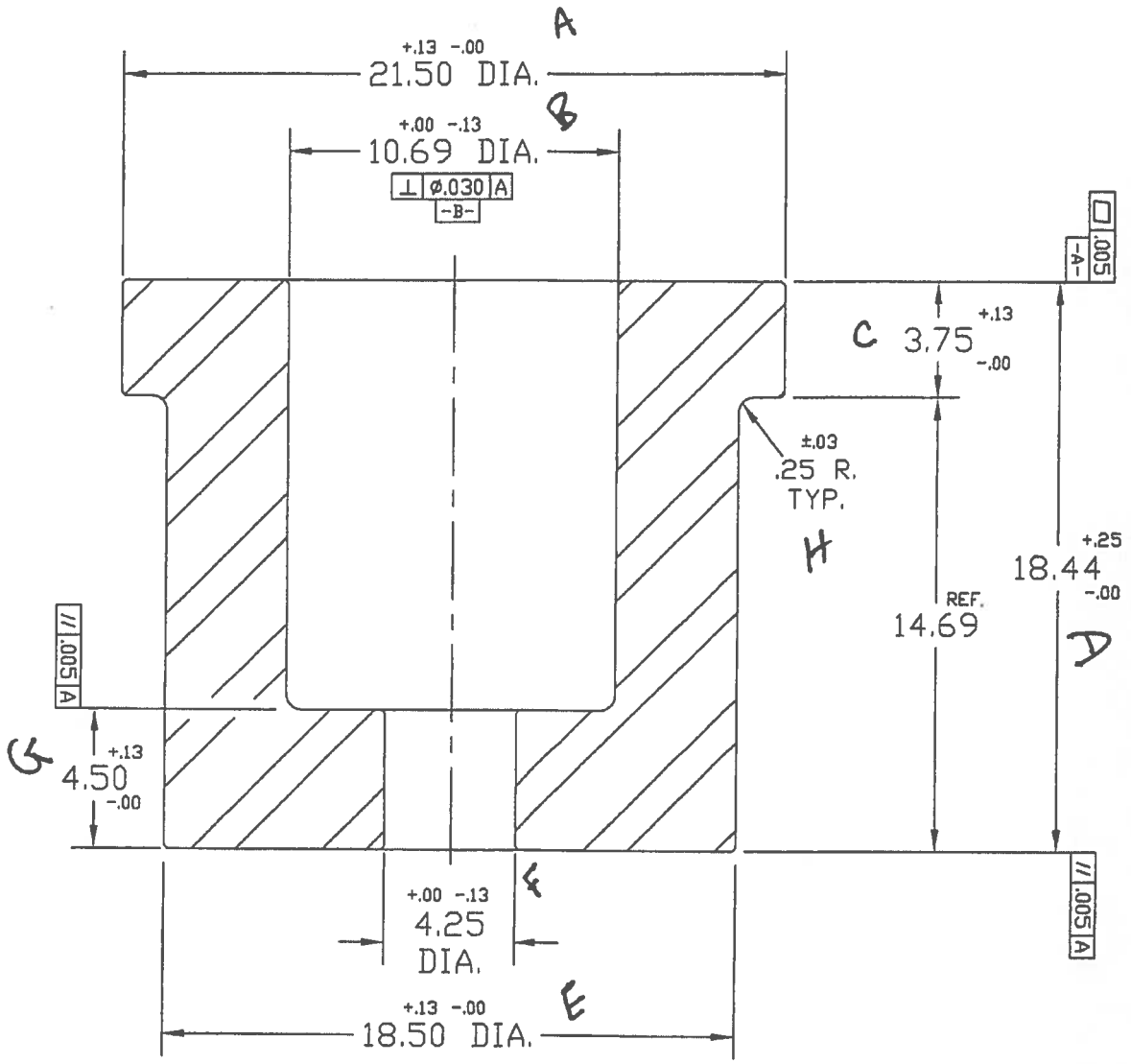
DIM REQ'D	21.5	10.69	3.75	18.44	18.5	4.25	4.5	R.25				
SER #	DIM A	DIM B	DIM C	DIM D	DIM E	DIM F	DIM G	DIM H	DIM I	DIM J	DIM K	DIM L
1	21.600	10.575	3.850	18.520	18.600	4.135	4.58	/				

EASTHAM FORGE, INC
REVIEWED BY Q.A.
DATE 11-3-16
BY
☑ APPROVED ☐ REJECTED

Form 902.04 REV A

S/O 9705.00

HEAT TREAT CROSS SECTION = 4 1/2"		DRAWING SK-12804-RM



250 ✓ FINISH ON ALL SURFACES

BREAK ALL SHARP CORNERS .12 ±.03 X 45°

ALL COAXIAL DIAMETERS RUNOUT TO DATUM A & B RESPECTIVELY WITHIN .010 T.I.R. UNLESS NOTED

EST. R/M WT. = 1140 LBS.

LETTER	REVISIONS	DATE	CHK'D BY
A	INITIAL ISSUE	9/26/16	JWC

MAT'L	STOCK SIZE	CUT WT.	NET WT.
304			

CONFIDENTIAL
THIS IS A PROPRIETARY DESIGN OF EASTHAM FORGE INC., DATA AND INFORMATION RELATING THERETO IS NOT TO BE USED, DISSEMINATED, OR REPRODUCED IN WHOLE OR IN PART WITHOUT WRITTEN CONSENT OF EASTHAM FORGE, INC.

EASTHAM FORGE, INC.
BEAUMONT, TEXAS

R/M DWG. FOR-
EXPANDER CASE

DRAWN BY	JWC	9/26/16	SCALE .1875
CHECKED BY	JS	9.26.16	
FILE RM	DRAWING	SK-12804-RM	REV A

TEAM INDUSTRIAL SERVICES, INC.

Field Ticket No. 75615

3875 W. Cardinal Drive Beaumont, Texas 77705
(409) 840-9955 Fax (409) 842-4190

ULTRASONIC INSPECTION REPORT

Customer	Location	Date	S/O #
Eastham Forge, Inc.	BEAUMONT ,TX	11/04/2016	9705.00

Sold To LA TURBINE CORPORATION

Part Number 7770006233

Customer Order Number 23674

S/N(s) LAT574

Procedure UT.ASTM.1 R6

Description SK-12804-RM

Specification ASME SA745 QL-5 & QL-1

Scope of Examination 100% VOLUMETRIC

Material 304L

Heat Number 001114

Quantity 1

Heat Code 9708-PA

TEST PARAMETERS

Instrument EPOCH-650 Serial No. 150068307 Date of Calibration 08/14/16

Longitudinal Frequency	2.25 MHZ	Size	1"	Type	SINGLE	Serial No.	01XL5M
Longitudinal Frequency	MHZ	Size		Type		Serial No.	
Longitudinal Frequency	MHZ	Size		Type		Serial No.	
Shear Wave Frequency	2.25 MHZ	Size	1/2" X 1"	Type	SINGLE	Serial No.	0111PN

Couplant SONOTECH UT-X

Calibration Standard(s)

Cable Type/Length BCB-74-6

1/8" FBH 1/2"-6" S/N:201-207 1/4" FBH 6"-20" S/N: 101-107

Surface Condition MACHINED

ANGLE BEAM: 4" S/N: EF229

	0°	0°	0°	30°	35°	45°
Calibration Reference Level (dB)	50.5	43.3			53.7	
Transfer Technique (dB)	4.0	4.0			4.0	
Corrected Reference Level (dB)	54.5	47.3			57.7	
Scanning Gain Correction (dB)	6	6			6	

INSPECTION RESULTS

Acceptable 1 Unacceptable 0

Remarks EASTHAM FORGE, INC.
REVIEWED BY Q.A.
DATE 11/04/16
BY Michael Benfield
☒APPROVED ☐REJECTED

RAYMOND STEELEY JR.
TECHNICIAN (PRINT)

Raymond Steeley
TECHNICIAN SIGNATURE

LEVEL ☒ II ☐ III

WITNESS
ASSISTANT

DATE
LEVEL ☐ I ☐ II

THIS REPORT IS EXPRESSLY LIMITED TO TEAM INDUSTRIAL SERVICES INTERPRETATION OF THE RESULTS OBTAINED FROM THE TEST SPECIFIED AND DOES NOT CONSTITUTE A RESPRESENTATION, WARRANTY OR GUARANTY OF THE ACTUAL CONDITION OF THE MATERIALS TESTED. TISI expressly disclaims any responsibility for any loss, cost, damage or expense, including personal injury or death, caused by or attributed to TISI misinterpretation of conditions or the performance of any test.

TEAM® Industrial Services
Personnel Qualification and Certification

Employee Name: Raymond W. Steeley **Employee ID#:** 910106

Vision Acuity Expiration Date: 6/16/2017

METHOD	LEVEL	DATE CERTIFIED	EXPIRATION DATE	GENERAL-I/II METHOD-III SCORE	SPECIFIC SCORE	PRACTICAL SCORE	COMPOSITE SCORE %	EXPERIENCE HOURS	TRAINING HOURS	LIMITED TO	COMMENTS
MT	II-L	7/1/2014	7/1/2017	100	90	96	95	5635	20	Yoke	
PT	II-L	7/1/2014	7/1/2017	85	80	97	87	1995	12	Type II	
UT	II	8/5/2014	8/5/2017	92	80	96	89	17304	80		
VT	II	1/21/2015	1/21/2018	80	825	95	86	2170	24		

The above named individuals qualification history has been reviewed and found to be acceptable IAW TEAM's requirements for certification; 33.G.103-S1, SNT-TC-1A-2011 and earlier editions (1992, 2001 and 2006), as published by the American Society for Nondestructive Testing and/or any additional certification standards listed in the comments section above.

Certifying Authority: **Date:** 6/17/2016

Charles M. Lee
Corporate Level III
ASNT Cert # 58053

EXP-2

TUBACEX

INSPECTION CERTIFICATE EN 10204 3.1

Number: 559880 Page: 1 / 3	Rev: 00
Created on: Date: 10/04/2012	Modified on:

TTI - TUBACEX TUBOS INOXIDABLES
Registro Mercantil de Alava, Tomo 587, Folio 189, Hoja VI 2885 - N.I.F. A-01140227
Tres cruces, 8
01400 Llodio (Alava)
SPAIN
TL: +34 946719300
FAX: +34 946725062
E-MAIL: qualitytti@tubacex.es

103417

CUSTOMER DESCRIPTION

CLIENT SOLD TO	CLIENT SHIP TO
GLOBAL STAINLESS SUPPLY INC 8900 RAILWOOD DR. HOUSTON TX 77078 USA	GLOBAL STAINLESS SUPPLY INC 8900 RAILWOOD DR. HOUSTON TX 77078 USA

CLIENT ORDER: 10449
SALES ORDER: 123326

MATERIAL:SEAML. STAINL. STEEL TUBES/PIPES
HEAT-TREATED, PICKLED, PICKLED-PASSIVATED
GRADE: TP304,TP304L,
STANDARD: ASME SECT.II PART.A SA312/SA312M-2010 ED. 2011 ADD.
ASME SECT.II PART.A SA376/SA376M-2010 ED. 2011 ADD.
ASTM A376/376M-06
ASTM A312/A312M-12
NACE MR0103-2010
CORROSION TESTED ACC. TO MIL-P-24691/3(ASTM A262 PCT.E)
CORROSION TESTED ACC. TO ASTM A262 PRACTICE B
NACE MR0175/ISO 15156-3:2009
TOLERANCES: ASTM A312/A312M-12
ASTM A999/A999M-04A
RANDOM LENGTHS 11' - 16'
PLAIN ENDS,
DIMENSIONS: 8" SCH 80
HOT FINISHED

L.A. TURBINE CO PO#:
23668 JOB LAT574

DESCRIPTION:
8" S80S (.500) SMLS PIPE SA312
T304/304L X 8-3/4" HT# 46226
PN 7770006166-2 EXPANDER CASE

Sales Item	Client Item	Delivery No	Lot No.	Heat No	Pieces	Weight	Tot Lgth	Un Lgth
120		8110020160	200080166	46226	10	3,224 KG	48.01 M	3353-4877 MM
120		8110020161	200079666	45920	1	228 KG	3.39 M	3353-4877 MM
120		8110020161	200080166	46226	4	1,302 KG	19.36 M	3353-4877 MM

RAW MATERIAL

Heat Nr:	Supplier	Method
45920	ACERALAVA (SPAIN)	Electric furnace+AOD
46226	ACERALAVA (SPAIN)	Electric furnace+AOD

CHEMICAL COMPOSITION (%) *L: Ladle C:Products

*	Heat	Seq	C	Mn	Si	P	S	Ni	Cr	Mo	Cu	V
L	45920	1	0.020	1.88	0.270	0.025	0.0010	9.25	18.40	0.50	0.35	0.046
L	46226	1	0.020	1.76	0.270	0.029	0.0010	9.20	18.20	0.35	0.37	0.067

AENOR ER Empresa Registrada
AENOR Gestión Ambiental

TUBACEX TUBOS INOXIDABLES S.A.
INGENIERIA DE CALIDAD

TUBACEX

INSPECTION CERTIFICATE
EN 10204 3.1

Number: 559880 Page: 2 / 3	Rev: 00
Created on: Date: 10/04/2012	Modified on:

*	Heat	Seq	Ti	Nb	W	Co	N
L	45920	1	0.002	0.017	0.010	0.060	0.0805
L	46226	1	0.012	0.013	0.010	0.110	0.0830

HEAT TREATMENT

SOLUT.ANNEALED 1040 °C RAPIDLY COOLED

TENSILE TEST

Lot No.	Sample	T	Rp0.2	Rp1.0	Rm	A2"	A5	Type
		°C	MPa	MPa	MPa	%	%	
200079666	1	20	262	311	590	62	55	L
200080166	1	20	280	325	591	56	54	L

HARDNESS TEST

Lot No.	Sample	HRB1	HRB2
200079666	1	81	82
200080166	1	78	79

METALURGICAL TESTS

INTERGRANULAR CORROSION TEST ACC. TO ASTM A262
PRACT.E/MIL-P-24691-3:SATISFACTORY

NON-DESTRUCTIVE TESTS

100 % HYDROSTATIC PRESSURE TESTED AT 1700 PSI, DURING 5 SEC, GOOD.

POSITIVE MATERIAL IDENTIFICATION TEST ON EACH TUBE/PIPE BY
"X-RAY-FLUORESCENCE-ANALYZER": SATISFACTORY

DIMENSIONAL CHECKING ON EACH TUBE: SATISFACTORY

VISUAL INSPECTION ON EACH TUBE: SATISFACTORY

TECHNOLOGICAL TESTS

FLATTENING TEST: SATISFACTORY

MARKING

TX3 TUBACEX 8" SCH 80 ASME SA312 ASME SA376 ASTM A312 ASTM A376 TP304 TP304L HF SMLS S10 HEAT/ PMI-AV LOT NO/ SPAIN

REMARKS

NO MERCURY, MERCURY COMPOUNDS OR MERCURY BEARING INSTRUMENTS AND/OR EQUIPMENT HAVE BEEN USED ALONG MANUFACTURING AND INSPECTION PROCESS.

NO WELD REPAIR WAS PERFORMED

AENOR ER Empresa Registrada

AENOR Gestión Ambiental

TUBACEX TUBOS INOXIDABLES S.A.
INGENIERÍA DE CALIDAD

TUBACEX

INSPECTION CERTIFICATE
EN 10204 3.1

Number: 559880 Page: 3 / 3	Rev: 00
Created on: Date: 10/04/2012	Modified on:

REMARKS

MATERIAL MANUFACTURER APPROVED BY TÜV SÜD Industrie Service GmbH (NOTIFIED BODY 036)TO ISSUE CERTIFICATES OF SPECIFIC PRODUCT CONTROL IN ACCORDING TO PRESSURE EQUIPMENT DIRECTIVE 97/23/EC ANNEX I POINT 4.3.

MATERIAL CHARACTERISTICS COMPLY WITH POINT 7.5 OF ANNEX I TO PED BY HAVING AN ELONGATION AFTER RUPTURE AT TENSILE TEST NO LESS THAN 14% AND A BENDING RUPTURE ENERGY AT IMPACT TEST NO LESS THAN 27J AT 20ºC.

MATERIAL IS FREE OF RADIATION CONTAMINATION

AENOR ER Empresa Registrada

AENOR Gestión Ambiental

TUBACEX TUBOS INOXIDABLES S.A.
INGENIERIA DE CALIDAD

NAS NORTH AMERICAN STAINLESS

METALLURGICAL TEST REPORT

6870 Highway 42 East
Ghent, KY 41045-9615
(502) 347-6000

Certificate: 129536 02

Customer: 5417 015

Mail To:
TRUE STEEL AND CUTTING, INC.
4320 WESTMINSTER AVE.
SANTA ANA, CA 92703

Ship To:
TRUE STEEL AND CUTTING, INC.
4320 WESTMINSTER AVE.
SANTA ANA, CA 92703

TSCI
016

Date: 1/08/2016 Page: 1

Steel: 304/304L

Finish: HRAP

Your Order: 8910

NAS Order: AN 0688865 11

Corrosion: ASTM A262/14 A 180and-GK

PRODUCT DESCRIPTION:

STAINLESS STEEL PLATE, HRAP; UNS 30400/30403
ASTM A240/15a,A480/14b,A666/15;ASME SA240/13,SA480/13a,SA666/13
CHEM ONLY ON FOLLOWING ASTM: A276/13,A479/13a,A484/13a,A312/13
CHEM ONLY ON FOLLOWING ASME: SA312/13,SA479/13
AMS 5511H/5513J XMEK; MIL-S-5059D AMD3(X CHK NEAS); MIL-S-4043B
NACE MR0175/ISO 15156-3:2009 A, MR0103/07;QQS766D-A X NAS PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED
NAS IS AN APPROVED MANUFACTURER IN ACCORDANCE WITH THE PRESSURE EQUIPMENT DIRECTIVE PED 97/23/EC.

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; RoHS 1 & 2 Compliant
Material is Free of Radioactive Contamination
Steel Making Process: EAF, AOD, & Cont. Casting
Product Mfg.by a Quality Mgt.Sys. in Conf. w/ISO 9001
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

Product ID #	Coil #	Thickness	Width	Weight	--------Length--------	Mark	Pieces
04X4V0 AA	* 04X4V0 AA	1.9999	60.0000	8,450	PLATE 240.00	1	1

Lab Accreditation Bureau, ISO/IEC 17025, Certificate# L2323

CHEMICAL ANALYSIS

CM(Country of Melt) ES(Spain) US(United States) ZA(South Africa) JP(Japan) Chemical analysis per ASTM A751/08

HEAT	CM	C %	CO %	CR %	CU %	MN %	MO %	N %	NI %	P %
X4V0	US	.0209	.1535	18.0590	.4215	1.7975	.3395	.0820	8.0070	.0340

S %	SI %
.0010	.2625

MECHANICAL PROPERTIES

Product ID #	Coil #	Loc	Dir	UTS KSI	20C .2% YS KSI	20C ELONG %-2"	% Hard RB	A 262 Pr A Pr A	A 262 'E' Pr B	R of A %
04X4V0 AA	04X4V0 AA	F	T	83.73	36.35	64.03	80.50	OK	OK	69.45

TSCI
Accepted 016 Rejected ∅

GTM Metals Inc.
Date 10/21/16
GTM Metals SO # 17832
Customer PO # 23679

Qty 2 Date 10-20-16

Additional Comments:

NAS hereby certifies that the analysis on this certification is correct. Based upon the results and the accuracy of the test methods used, the material meets the specifications stated. These results relate only to the items tested and this report cannot be reproduced, except in its entirety, without the written approval of NAS.

Technical Dept. Mgr. KRIS LARK 1/08/2016

EXH-23

EXP-4

ECHJAY FORGINGS PVT. LTD.
PUSHPAMAN FORGINGS DIVISION

Honad Village, Khalapur Taluka, Raigad District, Khopoli, Maharashtra 410203, India.

AD-2000-Merkblatt WO Certificate No. 07 202 1423 WP131209
(PED 97 / 23 / EC Certificate No. 07 202 1423 WZ 1312/09

EN 10204 JAN 2005 - 3.1 — **Abnahmeprufzeugnis / Test Report**

T.C. No. EF2013-EXP-00081-017-038 — T.C. Date 18-Jul-2012
Bestller / Customer: Warren Alloy Valve & Fitting Company, L.P.
Bestller No. / Order No. 112083 — Date 11-Apr-2012
Zeichen des Herstellerwerkes / Manufacturer's Brand

Address 5721 Harvey Wilson DR., Texas., Houston 77020, United States of America

Erz eugnis / Werkstoff Item Description / Material	Article No.	Schmelze Nr./Des Prufloses Heat / Lot No.	Stuckzahl Qty.
ANSI B16.5 SO RF 600 6.00		S-7925	25
ASTM A182 F304/304L		AQ-17	Nos

Anforderungem / Demands	Heat Treatment	Stempel des Abnehmers
ASTM A182 - 2008, ASME SA-182, ANSI B 16.5 - 2003, NACE MR0175, NACE MR0103	Solution Annealed	Stamp of the testing engineer

Exigencias Sinormas / Requirements

	%C	%Mn	%Si	%S	%P	%Ni	%Cr	%Mo	%Cu	%V	%Al	%Ti	%Cb	%N	%Co	%	%	%
Min	-	-	-	-	-	8.0000	18.0000	-	-	-	-	-	-	-	-	-	-	-
Max	0.0300	2.0000	1.0000	0.0300	0.0450	11.0000	20.0000	-	-	-	-	-	-	0.1000	-	-	-	-
Schmelzen Analyse / Heat Analysis																		
	0.0220	1.8400	0.3300	0.0240	0.0430	8.3300	18.2000	-	-	-	-	-	-	0.0863	-	-	-	-

Erschmelzungsart / Melting Process EF/AOD/MEMS.

Probe Sample		Rch / Rp Mpa (N / mm²) / PSI			Rm Mpa	A (%)	A (%)	Z (%)	Hardness
			0.2 %	1.0 %	N / mm² / PSI	Lo = 4D	Lo = 5.65 A		HRC / BHN
Nr No.	Large Orientation	Anforderungem / Demands							
TANG	Min		205/30000		515/75000	30		50	
	Max								22 / 248
		Prufbergebnisse / Test Results							
TANG			324		598	59.37		68.20	146/152 BHN.

Charpy Impact Test

Form / Forms ISO V Av / K (J)	I	II	III	AVG.	TEMP.
Specified					
Observed					

Sonstiges / Other Remarks

PMI Test: 100 % No Objections
Dimension & Visual Check: 100% Satisfactory

Material was Solution Annealed at 1040°C Min. and water Quenched.
IGC - test in accordance with ASTM A262 Pract. E : Satisfactory.
Radioactivity checked - (µR/hr) Radiation level found within limits w.r.t. natural background.
Country of Origin for melt - INDIA
"All material supplied is free of Mercury contamination and no mercury bearing equipment was used during manufacturing".

L.A. TURBINE CO PO#: 23668 JOB LAT574

DESCRIPTION:
6" 600 RF SO FLNG SA182 T304/304L PT# 7760001649-4
EXPANDER CASE HEAT# S-7925

We confirm that the products have been supplied in accordance with the requirements of the order specifications and ordered standards.

MANUFACTURER
Echjay Forgings Pvt. Ltd.
Checked By

S. Y. Naik

Kishore Shringarpure
Vice President (Q.A.)
Works Authorised Inspector

F-LB-14-Rev.-00

RXP-6
-5

PO#: G9233G Pack#:411286 Order#: 1028090 Lot# : KAN.FKP-242 Desc: 6 80S .432W A/SA312 304/L SMLS PIPE SRL CHI

KANGLONG

Zhejiang Kanglong Steel Co.,Ltd

MILL TEST/INSPECTION REPORT 1 to EN 10204.2004/3.1. A

Customer : THE GLOBAL GROUP

PO No. : 202775 Cert No. : ZJKL141123-15

Specification : ASTM A312-13a/ASME SA312 , ASTM A376-13/ASME SA376 ASME B36.19-2004 (2010)

Surface finished : ANNEALED & PICKLED

Steel Grade : TP304/304L Production Tech : Cold Finished

Goods : STAINLESS STEEL SEAMLESS PIPE INV NO.: KLGSS01-2-3

Heat No.	Chemical Composition (%)										
	C	Mn	Si	P	S	Ni	Cr	Mo	Cu		
Spec. min.						8.00	18.00				
Spec. max	0.035	2.00	1.00	0.045	0.030	11.00	20.00				
FKP-242	0.023	1.41	0.25	0.039	0.009	8.13	18.50	/	/		

Size	Quantity						Test No.
1	6" X Sch80S	6	PC	1453	KG	112.795	FT	ZJKL141123-15-1

Test data	Mechanical Properties								Hydrostatic Test
	Yield Strength Mpa	Tensile Strength Mpa	Elongation A(%)	Hardness Test HRB	Flaring Test	Flattening Test	Heat Treatment ℃		Acc to ASTM A450-09
Spec. min.	205	515	35						
Spec. max				90					
6" X Sch80S	260	575	47.5	79	GOOD	GOOD	1042		/
TEST STANDARD	Acc to ASTM A370-11 original gage length:50mm Width: 20mm				Acc to ASTM A999-13/ASME SA999		23 min		

Nondestructive Examination		Inter-granular Corrosion	STATEMENT:
Eddy Current Test	Ultrasonic Test		1) No welded repair performed for pipe. 2) All pipe are radiation free. 3) All pipes do not come in contact with mercury during our manufacturing
Acc to ASTM A426-11a	Acc to ASTM E213-09	Acc to ASTM A262-2013 Practice E	
GOOD E426. Reference Standard: 2.7mm	/	GOOD	

Additional Remarks:

1.Dimension & Surface: OK 2.Country of Origin: China

3.Hardness acc. to NACE MR 01-75-2009 4.100% PMI

We hereby certify that the products were manufactured, sampled, tested, and inspected in accordance with and meets with ASME B36.19,ASME SA312, ASME SA376, ASTM A312, ASTM A376, ASTM A999 and ASTM A1024/A1024M-13a latest revisions. has been found to meet the requirements. The materials meets the requirements of NACE MR0103/2012 AMSSTP-0 and ISO15156-2009.

2014-11-23

Date

Quality Technology Director

L.A. TURBINE CO PO#:
23668 JOB LAT574

DESCRIPTION:
6" S80 (.432) SMLS PIPE SA312
T304/304L X 4" HT# FKP-242
PN 7770006166-6 EXPNDR CASE

EXP -7

From: Valbruna Stainless Inc Date: 5/20/2016 To: GTM METALS INC SO#: A764375 Ln#: 2 PO#: 16897 Part: 304D0.5 Heat#: 267512 Tag: V46972068

Acciaierie Valbruna S.p.A.

ISO 9001 AS 9100 ISO/TS 16949

QUALITY MANAGEMENT SYSTEM CERTIFIED BY LLOYD'S REGISTER

CERTIFICATO DI COLLAUDO
ABNAHMEPRUEFZEUGNIS
INSPECTION CERTIFICATE
CERTIFICAT DE RECEPTION
EN 10204 (2004) , 3.1

36100 VICENZA (Italia) - Viale della scienza, 25 z.i.
Telefono 0444.968211 - Fax 0444.963836
Stab.: 39100 BOLZANO (Italia) - Via A. Volta, 4/37
Telefono 0471.924111 - Fax 0471.924497

Cliente / Besteller/Purchaser/Client
VALBRUNA STAINLESS INC.
2400 TAYLOR STREET WEST
46801 - FORT WAYNE, IN 46801 - US

Produttore : **STABILIMENTO DI BOLZANO**
Hersteller/Item/Usine productrice

Stato di fornitura : Hot rolled - Annealed Cold Drawn
Lieferzustand / Delivery state
Etat de livraison

Avviso di Spedizione: D-BZ15008391
Lieferanzeige/Packing list/B L

Ordine nr: 46972 STOCK CHINO
Bestell
Your order
Commande

Tipo di Elaborazione: E+AOD
Erschmelzungsart/Melting process/Mode d'elaboration

Certificato nr: MEST777188/2015/
Prüfung/Test/Essai

Conferma ordine nr: EI15009884
Werks/Our Order/Ref nr.

Marchio di Fabbrica:
Zeichen des Lieferwerkes
Trade mark
Sigle de l'usine productrice

Punzone del Collaudatore: MR
Stempel des Werksachverständigen
Inspector's stamp/Poinçon de l'assayeur

Specifiche:
Anforderungen / Requirements / Exigences

VSI 0 304/304L A,CF
AMS 5647 J S30403 (1)
ASME SA182 2013 S30400/03 (4)
ASME SA320 2013 B8 (7)
ASTM A193 2014A B8 (A)
ASTM A314 2008 S30400/03
ASTM A473 2001 S30400/03 (C)
QQ-S-763 F 304/304L (D)

AISI 304/304L
AMS-QQ-S-763 C 304 (2)
ASME SA193 2013 B8 (5)
ASME SA479 2013 S30400/03 A (8)
ASTM A262 2013 PRACTICE E
ASTM A320 2011A B8 (B)
ASTM A479 2014 S30400/03 A

AMS 5639 H S30400 (0)
AMS-QQ-S-763 C 304L (3)
ASME SA276 2013 S30400/03 A,CF (6)
ASTM A182 2014A S30400/03 (9)
ASTM A276 2013A S30400/03 A,CF
ASTM A370 2014 .
MIL-S-862 B/1 304/304L

(0)Chemical analysis only.
(2)Chemical analysis only.
(4)SECTION II PT.A 2013 EDITION
(5)SECTION II PT.A 2013 EDITION
(6)SECTION II PT.A 2013 EDITION
(7)Chemical analysis only.
(9)Chemical analysis only.
(B)Chemical analysis only.
(D)Chemical analysis only.

(1)Chemical analysis only.
(3)Chemical analysis only.
(4)Chemical analysis only.
(5)Chemical analysis only.
(7)SECTION II PT.A 2013 EDITION
(8)SECTION II PT.A 2013 EDITION
(A)Chemical analysis only.
(C)Chemical analysis only.

Qualità: 304/304L
Werkstoff/Grade/Nuance

Marca: MVAISL MAXIVAL
Markenbezeichnung/Brand/Nuance

Tolleranze: ASTM A484-15 TABLE 7
Toleranze/Allowance/Tolerance

Punzonatura: 304/304L
Kennzeichnung/Marking/Marquage

Pos. nr.	Oggetto	Dimensioni - in	Lunghezze - in	Colata	Pezzi	Peso - LB	Lotto nr.
		Abmessungen / Dimension / Dimension	Länge / Length / Longueur	Schmelze / Heat / Coulée	Stückzahl / Pieces / Pièces	Gewicht / Weight / Poids	Losnr / Lot nr / Lot nr
0060	Round	0,5000	145/ 145	267512		5.465	508600600

TEST ALLO STATO DI FORNITURA
Test on delivery condition Prüefung auf lieferbereitem produkt Test a l'etat de fourniture Prueba sobre el material asi come entregado

1) L=longitudinale/länge, T=trasversale/quer, D=Tangenziale/tangential

TEST	Provetta/Probestab		°F		Posiz. Saggio	Snervamento	Snervamento	Resistenza	Allungamento		Strizione		Resilienza	Durezza
	Specimen/Eprouvette	Larg.diam Spess. Diam Diam. Diam Wall Diam. Thickness			Position Location Emplacement	Streckgrenze / Yield Strength / Limite elastique	Streckgrenze / Yield Stress / Limite elastique	Zugfestigkeit / Tensile strength / Resistance à traction	Bruchdehnung / Elongation / Allongement		Einschnürung / Reduction of area / Striction		Kerbschlagarbeit / Impact Value / Resilience	Härte / Hardness / Dureté
	mm				u	Rp 0,2% k.s.i.		Rm k.s.i.	E 4d %		%	RA %		HB
Valori richiesti / Anforderungen/Required values / Valeurs demandées			min max			45	-	90	-	30	-	40	-	-
A	8.75		68	L		106		124		31		67		261

TEST ALLO STATO DI FORNITURA
Test on delivery condition / Prüefung auf lieferbereitem produkt / Test a l'etat de fourniture / Prueba sobre el material asi come entregado

TEST		min	max	
A	Grain size for ASTM E112			7

Mechanical properties according to ASTM A370.

Analisi chimica
Chemische Zusammensetzung/Chemical Analysis/Analyse chimique

Colata / Heat / Schmelze/Coulée	min - max 0.030	- 1.00	- 2.00	18.00 20.00	- 1.00	- 1.00	8.00 10.50	- -	- 0.040	0.020 0.030	- 0.100	- -	- -	- -	- -
	C %	Si %	Mn %	Cr %	Mo %	Cu %	Ni %	Co %	P %	S %	N %				
267512	0,020	0,54	1,82	18,25	0,38	0,43	8,02	0,133	0,035	0,028	0,080				

Produced without class I-II Ozone depleting substances.

Bolzano, 13/11/15
BBL008
(Mod. MCE2)

Il collaudatore di stabilimento / der Werksachverständige / Works Inspector / L'agent d'usine
M.Rizzotto

From: Valbruna Stainless Inc Date: 5/20/2016 To: GTM METALS INC SO#: A764375 Ln#: 2 PO#: 16897 Part: 304D0.5 Heat#: 267512 Tag: V4697206B

Acciaierie Valbruna S.p.A.

ISO 9001 AS 9100 ISO/TS 16949

QUALITY MANAGEMENT SYSTEM CERTIFIED BY LLOYD'S REGISTER

CERTIFICATO DI COLLAUDO
ABNAHMEPRUEFZEUGNIS
INSPECTION CERTIFICATE
CERTIFICAT DE RECEPTION
EN 10204 (2004) , 3.1

36100 VICENZA (Italia) - Viale della scienza, 25 z.i.
Telefono 0444.968211 - Fax 0444.963836
Stab.: 39100 BOLZANO (Italia) - Via A. Volta, 4/37
Telefono 0471.924111 - Fax 0471.924497

Cliente / Bestellen/Purchaser/Client
VALBRUNA STAINLESS INC.
2400 TAYLOR STREET WEST
46801 - FORT WAYNE, IN 46801 - US

Produttore : **STABILIMENTO DI BOLZANO**
Hersteller/Item/Usine productrice

Stato di fornitura : Hot rolled - Annealed Cold Drawn
Lieferzustand / Delivery state
Etat de livraison

Avviso di Spedizione:
Lieferanzeige/Packing list/B.L. D-BZ15008391

Ordine nr: 46972 STOCK CHINO
Bestell
Your order
Commande

Tipo di Elaborazione: E+AOD
Erschmelzungsart/Melting process/Mode d'elaboration

Certificato nr: MEST777188/2015/
Prüfung/Test/Essai

Conferma ordine nr: EI15009884
Werks/Our Order/Ref nr.

Marchio di Fabbrica:
Zeichen des Lieferwerkes
Trade mark
Sigle de l'usine productrice

Punzone del Collaudatore:
Stempel des Werksachverständigen
Inspector's stamp/Poinçon de l'assayeur MR

Solution heat treated free from continuous carbide network.
Micro and macro etch testd : OK
Intergranular corrosion test per ASTM A262 pract. Ed : ok.
Absence of cracks at 20 x magnification after bend test.
Reduction ratio = 226,5 : 1
Annealing temperature : 1940° F for 1h/water.
Material is DFARS Compliant

Sono state soddisfatte tutte le condizioni richieste
Die gestellen Anforderungen sind lt. Anlage erfüllt
The material has been furnished in accordance with the requirements
Le materiel a été trouvé conforme aux exigences

Controllo antimescolanza: OK
Verwechslungprüfung: spectralanalytisch durchgeführt
Antimixing testing performed: OK
Contrôle antimelange fait: r.a s

Controllo visivo e dimensionale: soddisfa le esigenze
Besichtigung und Ausmessung: ohne Beanstandung
Visual inspection and dimensional checks:satisfactory
Contrôle visuel et dimension: satisfaisant

Melted and manufactured in Italy No welding or weld repair Material free from Mercury contamination

We declare that the finished product is checked for radioactive contamination through Portal System when it leaves the production plant.

The Quality Management System is Certified acc. Pressure Equipment Directive '97/23/EC' Annex 1,s.,4.3 by TUEV and LLOYD'S

Any act of tampering, modification, alteration, counterfeiting and/or falsification and/or any other action which modifies the contents of this test certificate shall constitute a violation of applicable civil and criminal laws. Acciaierie Valbruna shall protect its rights and interests before any competent court, authority and jurisdiction.

Maxival and/or Valplus grades/products are manufactured with ladle techniques to control composition, distribution, size and shape of non-metallic inclusions for improved machinability.

The supplied product conforms to requirements expressly requested by the purchaser and conforms to requirements specified by certified norms and standards. Should the product be used for more severe, critical and/ or in any case different applications than those the material is generally intended for, any different and/or supplementary requirements shall be specifically demanded, at least, upon order of the Product by the Purchaser. Acciaierie Valbruna SpA shall not be responsible for any improper use of the Products.

GTM Metals Inc.
Date 10-21-16
GTM Metals SO # 17933
Customer PO # 23679

Bolzano, 13/11/15 BBL008 (Mod. MCE2)	Il collaudatore di stabilimento / der Werksachverständige / Works inspector / L'agent d'usine **M.Rizzotto**	Pagina - 2 di 2

EXP-8

From: Valbruna Stainless Inc Date: 10/14/2016 To: GTM METALS INC SO#: A791564 Ln#: 1 PO#: 17397 Part: 304D4.25 Heat#: 267761 Tag: S4938520D

VALBRUNA
SLATER STAINLESS, INC.
2400 TAYLOR STREET WEST - PO BOX 630
FORT WAYNE IN 46802 USA
PHONE 260.434.2800 - FAX 260.434.2801

Product Certification Report

Report Number: 5221100

Certified on May 23, 2016

Order I.D.	Order Date	Commodity Code			
1600856 020	5/18/16	304D4.25			
Dim 1	**Dim 2**	**Dim 3**	**Heat I.D.**	**Customer I.D.**	**Customer Purchase Order**
4.2500	.0000	.0000	267761	002474	49385
Product Shape	**Product Surface**				**Customer Grade**
Rounds	HR & Rough Turned				304/304L
Length (inches)		**Bill of Lading #**	**Weight**		
132.000 Min. 156.000 Max.		427164		Melt Date: 5/18/15	

Ship To
VALBRUNA STAINLESS, INC.
13950 BENSON AVENUE
CHINO, CA 91710

Sold To
VALBRUNA STAINLESS, INC.
13950 BENSON AVENUE
CHINO, CA 91710

Lifts: 0036

MIL-S-862B
UNS S30400 and S30403
ASTMA 193-15a
ASTMA 484-15
ASMESA 320 13
AMS 5647J
ASTM A314-13a
NACE MR0175/ISO 15156-3 2009
ASTMA 276-16
ASMESA 182 13 Chem Only
ASMESA 479-13
ASTMA 320-14 GR B8
QQ-S-763F
ASTMA 182-15 Chem Only
ASTMA 479-16
ASMESA 193 13 ED Except 7.3.1
AMS 5639H
SAE-AMS QQ-S-763D

CHEMICAL ANALYSIS

C	Mn	P	S	Si	Cr	Ni	Mo	Cu	Co	N
.016	1.85	.030	.026	.61	18.29	8.11	.35	.41	.12	.08

BRINELL (Type A device) (E-10)

HBW
175

TENSILE PROPERTIES ASTM E8-15a

TS (PSI)	.2%YS (PSI)	%EL(2")	%RA
86700	37900	61.3	73.7

MACRO ASTM E340-15/E381-01

MACRO
OK
OK
OK

GRAIN SIZE ASTM E112-13

GRAIN SIZE	Etchant	Magnification X
7	Oxalic	100

ASTM A262-14 PR E(A Utilized)

OXALIC	Structure	Etchant	Magnification X	QUENCH	SENS(F)	SENS(HR)
OK	Step	Oxalic	500	Air	1250	1.50

Free of mercury and low melting alloy contamination.
Solution annealed at 1900F min. and water quenched (heating time & temp appropriate for optimum quality).
No welding or weld repair done.
Electric Furnace melted; AOD refined.
Chemical testing to one or more of the listed ASTM methods:
E415-14, E1019-11, E1086-14.

Results relate only to the items tested. Certification shall not be reproduced except in full, without written approval of Valbruna Stainless Inc. The recording of false, fictitious, or fraudulent statements on this document may be punished as a felony under federal statutes. Including Federal law Title 18, Chapter 47. Consult material safety data sheet (MSDS) for hazard info.
I hereby certify that the reported figures are correct as contained in the records of the corporation.

Manager Laboratory Services Dennis Hackett

email: DHackett@valbruna.us
Dennis Hackett

VALBRUNA
SLATER STAINLESS, INC.
2400 TAYLOR STREET WEST - PO BOX 630
FORT WAYNE IN 46802 USA
PHONE 260 434.2800 - FAX 260.434.2801

Product Certification Report

Report Number: 5221100

Certified on May 23, 2016

Order I.D.	Order Date	Commodity Code			
1600856 020	5/18/16	304D4.25			
Dim 1	**Dim 2**	**Dim 3**	**Heat I.D.**	**Customer I.D.**	**Customer Purchase Order**
4.2500	.0000	.0000	267761	002474	49385
Product Shape	**Product Surface**				**Customer Grade**
Rounds	HR & Rough Turned				304/304L
Length (inches)		**Bill of Lading #**	**Weight**		
132.000 Min. 156.000 Max.		427164		Melt Date: 5/18/15	

Ship To
VALBRUNA STAINLESS, INC.
13950 BENSON AVENUE
CHINO, CA 91710

Sold To
VALBRUNA STAINLESS, INC.
13950 BENSON AVENUE
CHINO, CA 91710

Location of tensile fracture: inside middle of gage length. %elong after fracture.
Chemical Analysis performed at Acciaierie Valbruna, Italy.
No mercury or low melting alloy contamination. No weld repair.
Material melted in Italy, manufactured in the United States.
Material conforms to listed specifications and is DFARS compliant.
Quality system is compliant with ISO 9001:2008. Produced in accordance with EN 10204 3.1.

GTM Metals Inc.
Date 10-21-16
GTM Metals SO # 19833
Customer PO # 23679

Results relate only to the items tested. Certification shall not be reproduced except in full, without written approval of Valbruna Stainless Inc. The recording of false, fictitious, or fraudulent statements on this document may be punished as a felony under federal statutes. Including Federal law Title 18, Chapter 47. Consult material safety data sheet (MSDS) for hazard info.
I hereby certify that the reported figures are correct as contained in the records of the corporation.

Manager Laboratory Services Dennis Hackett

email DHackett@valbruna.us

Dennis Hackett

DESCRIPTION:
1-1/4 S80 SMLS PIPE SA312 T304/304L X 5" LONG HT# HDJ12-349
L2000/EXP PN 7770001799-10
JOB STL001

L.A. TURBINE CO PO#:
20155

HUA GANG

华迪钢业集团有限公司
HUADI STEEL GROUP CO.,LTD
工厂检验证书
MILL TEST CERTIFICATE (EN 10204 3.1)

Lloyd's Register
NO.MID0003289/000244

Industrie Service

Date(日期): 2012.08.31
No.(编号): 2012-08-901

INVOICE NO.: 12HD0427
CONTRACT NO.: 12HD0427
EXECUTIVE STANDARD: ASTM/ASME/ASA312-2010 ANSI B36.10/B36.19
PO NO.: 112096

PURCHASER: WARREN ALLOY VEV&FTG CO LP
DESCRIPTION OF GOODS: SEAMLESS STAINLESS STEEL PIPES
DELIVERY CONDITION: PICKLED&SOLUTION ANNEALED AT 1050 DEG C

Surface condition (表面情况): ACCEPTABLE
size tolerance (尺寸公差): ACCEPTABLE

No.	Heat No. (炉号)	Grade (钢种)		Chemical Composition (%) (化学成分) C	Si	Mn	P	S	Ni	Cr	Mo	Cu	Lot No. (批号)
			Elements										
			Specification	≤0.035	≤1.00	≤2.00	≤0.040	≤0.030	8.0-13.0	18.0-20.0	—	—	
1	HDJ12-349	TP304/304L	Results(product)	0.024	0.33	0.89	0.036	0.002	8-20	18.31	—	—	HD2012082554
2	HDJ12-619	TP304/304L	Results(product)	0.020	0.26	0.76	0.039	0.003	8.45	18.27	—	—	HD2012082517
3	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—

No.	Size(尺寸 mm)	QTY 数量	T.S 抗拉强度	Y.S 屈服强度	Elongation 50mm 延伸率	IGC 晶间腐蚀 A262 E	Flattening Test 压扁 Continuous heating Furnace	Flaring Test 扩口 Continuous heating furnace	Hardness HRB 硬度 ≤90 NARCE MR0175	Ultrasonic Test 超探 Gradual Pcs	Eddy current Test 涡探 Gradual Pcs	Hydrostatic Test 水压 5 sec Gradual Pcs
		PT	(MPa) ≥515	(MPa) ≥205	(%) ≥35							
1	1-1/4" ×SCH80S×17-24FT	238.30	595, 605	340, 350	57, 56	ACCEPTABLE	ACCEPTABLE	—	80, 81, 79	—	ACCEPTABLE	—
2	1-1/2" ×SCH80S×17-24FT	1094.41	615, 629	235, 255	55, 54	ACCEPTABLE	ACCEPTABLE	—	78, 79, 79	—	ACCEPTABLE	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—

ISO9001: 2008 Cert by ABS Group Ltd
Conform to EN10204—3.1

1. WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HERE HAS BEEN MADE IN ACCORDANCE WITH THE STANDARD AND CONFORM TO CONTRACT STIPULATED REQUIREMENTS.
2. THE CERTIFICATE SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT APPROVAL OF THE COMPANY.

ISSUED BY: ZHANGQUN
JUDGED BY: ZHANGFU

华迪钢业集团有限公司 HUADI STEEL GROUP CO.,LTD 质保部 QUALITY DEPT

ADD: YONG QIANG HIGH-INDUSTRY AREA, WENZHOU, ZHEJIANG, CHINA TEL: 86-577-86982882 FAX: 86-577-86988708

EXP-9

NAS TSCI TRUE STEEL & CUTTING, INC.

12273 Brown Avenue

METALLURGICAL TEST REPORT

Agua Mansa-CA
12273 Brown Avenue
Riverside, CA 92509
USA

Certificate: 101286 1

Customer: 005417 900

Mail To:
TRUE STEEL AND CUTTING, INC.
4320 WESTMINSTER AVE.
SANTA ANA, CA 92703

Ship To:
TRUE STEEL AND CUTTING, INC.
4320 WESTMINSTER AVE.
SANTA ANA, CA 92703

Date: 10/05/2015 Page: 1
Steel: 304/304L
Finish: 1
Corrosion: ASTM A262/14 A

Your Order: 8774 NAS Order: IN 0218443 01

PRODUCT DESCRIPTION:

STAINLESS STEEL PLATE, HRAP; UNS 30400/30403
ASTM A240/15a,A480/14b,A666/15;ASME SA240/13,SA480/13a,SA666/13
CHEM ONLY ON FOLLOWING ASTM: A276/13,A479/13a,A484/13a,A312/13
CHEM ONLY ON FOLLOWING ASME: SA312/13,SA479/13
AMS 5511R/5513G XMRK; MIL-S-5059D AMD3(X CRN MEAS); MIL-S-4043B
NACE MR0175/ISO 15156-3:2009 A, MR0103/07;QQS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; RoHS 1 & 2 Compliant
Material is Free of Radioactive Contamination
Steel Making Process: EAF, AOD, & Cont. Casting
Product Mfg.by a Quality Mgt.Sys. in Conf. w/ISO 9001
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

Product Id	Plate#	Skid #	Thickness	Width	Weight	-------Length------	Mark	Pieces	Commodity Code
03W2C3 CB	03W2C3 CB	PF5128	.5000	60.0000	2,100	PLATE 240.00	1	1	

Lab Accreditation Bureau, ISO/IEC 17025, Certificate# L2323

CHEMICAL ANALYSIS

CM(Country of Melt) EG(Spain) US(United States) ZA(South Africa) JP(Japan) Chemical Analysis per ASTM A751/08

HEAT	CM	C %	CR %	CU %	MN %	MO %	N %	NI %	P %	S %
W2C3	US	.0209	18.4285	.3570	1.8245	.2795	.0782	8.0715	.0310	.0010

SI %
.2635

MECHANICAL PROPERTIES

Product Id#	Plate#	Id or Or	UTS 20C KSI	.2% YS 20C KSI	ELONG % %-2"	Hard RB	R of A %
03W2C3 CB	03W2C3 CB	F T	90.13	48.00	50.70	80.50	73.26

GTM Metals Inc.
Date 10-21-16
GTM Metals SO # 17933
Customer PO # 23679

Accepted TSCI 016 Rejected 0
Qty 2 Date 10-14-16
Additional Comments:

NAS hereby certifies that the analysis on this certification is correct. Based upon the results and the accuracy of the test methods used, the material meets the specifications stated. These results relate only to the items tested and this report cannot be reproduced, except in its entirety, without the written approval of NAS.

Technical Dept. Mgr. ABHIJEET BHAVE 10/05/2015

EXP-10

Agua Mansa-CA
12273 Brown Avenue
Riverside, CA 92509
USA

METALLURGICAL TEST REPORT

6870 Highway 42 East
Ghent, KY 41045-9615
(502) 347-6000

Certificate: 171876 1

Customer: 005417 900

Mail To:
TRUE STEEL AND CUTTING, INC.
4320 WESTMINSTER AVE.
SANTA ANA, CA 92703

Ship To:
TRUE STEEL AND CUTTING, INC.
4320 WESTMINSTER AVE.
SANTA ANA, CA 92703

Date: 4/29/2016 Page: 1
Steel: 304/304L
Finish: 1
Corrosion: ASTM A262/14 A 180Bend-OK

Your Order: 9092

NAS Order: IN 0231258 01

PRODUCT DESCRIPTION:

STAINLESS STEEL PLATE, HRAP; UNS 30400/30403
ASTM A240/15a,A480/14b,A666/15;ASME SA240/13,SA480/13a,SA666/13
CHEM ONLY ON FOLLOWING ASTM: A276/13,A479/13a,A484/13a,A312/13
CHEM ONLY ON FOLLOWING ASME: SA312/13,SA479/13
AMS 5511H/5513J XMKR; MIL-S-5059D AMD3(X CHK MEAS); MIL-S-4043B
NACE MR0175/ISO 15156-3:2009 A, MR0103/07;QQS766D-A X NAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; RoHS 1 & 2 Compliant
Material is Free of Radioactive Contamination
Steel Making Process: EAF, AOD, & Cont. Casting
Product Mfg.by a Quality Mgt.Sys. in Conf. w/ISO 9001
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

TSCI
029

Product Id	Plate#	Skid #	Thickness	Width	Weight	-------Length------	Mark	Pieces	Commodity Code
04Y1V8 CB	04Y1V8 CB		1.7575	60.0000	7,265 PLATE	240.00	1	1	

CHEMICAL ANALYSIS

CM(Country of Melt) ES(Spain) US(United States) ZA(South Africa) JP(Japan)

Lab Accreditation Bureau, ISO/IEC 17025, Certificate# L2323
Chemical Analysis per ASTM A751/14a

HEAT	CM	C %	CR %	CU %	MN %	MO %	N %	NI %	P %	S %
Y1V8	US	.0150	18.1565	.3790	1.7615	.3075	.0847	8.0480	.0315	.0017

SI %
.2235

MECHANICAL PROPERTIES

Product Id#	Plate#	Id Loc	Dir	UTS 20C KSI	.2% YS 20C KSI	ELONG % -2"	Hard HB	A 262 Pr A Pr A	R of A %
04Y1V8 CB	04Y1V8 CB	F	T	87.11	38.99	62.83	83.00	OK	71.16

GTM Metals Inc
Date 10-21-16
GTM Metals SO = 17853
Customer PO = 23679

Accepted TSCI 029 Rejected 0
Qty 8 Date 10-21-16
Additional Comments:

NAS hereby certifies that the analysis on this certification is correct. Based upon the results and the accuracy of the test methods used, the material meets the specifications stated. These results relate only to the items tested and this report cannot be reproduced, except in its entirety, without the written approval of NAS.

Technical Dept. Mgr. KRIS LARK 4/29/2016

BXP-11

L.A. TURBINE CO PO#:
23668 JOB LAT574

DESCRIPTION:
6" S80 SMLS SR 90 DEG ELBOW
SA403 T304/304L HT# YX1411-027
PN 7760001650-12 EXPANDER CASE

SO# 1028090, SO Line: 4, Item: 6 80S SMLS SR 90 A/SA403 304/L SKB Heat #: YX1411-027; Customer ID: DUHLOS; Customer PO: G82331

MATERIAL TEST & INSPECTION CERTIFICATE

SUNGKWANG BEND CO., LTD.(SKB)
26, Noksansandan 262-ro, Gangseo-Gu, Busan, Korea
TEL : 82-051-3300-450
FAX : 82-051-3300-335
http://www.skbend.com

CUSTOMER: GLOBAL STAINLESS SUPPLY
PROJECT NAME: N/A

According to
DIN 50049 3.1 / EN 10204 3.1 / ISO 10474 3.1

PURCHASE ORDER NO.	209236	SPEC. FOR MATERIAL	ASTM/ASME A/SA403/WP304/304L-S 12/13ED	CERTIFICATE NO.	QCLR2015110644
PJT NO.	N/A	SPEC. FOR INSPECTION	ASME B16.9	DATE OF ISSUE	2015.10.30
STARTING MATERIAL	SEAMLESS PIPE	SKB NO.	2015062901	VISUAL & DIMENSION	SATISFACTORY

NO.	SEQ/LINE/ITEM NO	DESCRIPTION	QTY	HEAT NO.	MFG ID NO.	PO#/CODE/TAG NO
36		90D ELBOW(S) S80S 6" B.W SMLS SUS	10	YX1411-027	YX1411-027	
38		90D ELBOW(S) S80S 10" B.W SMLS SUS	2	374D0304	374D0304	

CHEMICAL COMPOSITION(%) (L : LADLE, P : PRODUCT)

STD. / HEAT NO.	SPEC.	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	V	Nb	N	Al	B	Zr	Fe	Ti	C.E
	MIN						8.00	18.00											
	MAX	0.030	1.00	2.00	0.045	0.030	11.00	20.00											
374D0304	L	0.01	0.38	1.23	0.025	0.001	8.60	18.45											
	P																		
YX1411-027	L	0.018	0.33	0.89	0.029	0.002	8.15	18.30											
	P																		

TENSILE TEST

SPEC.	Y.S 0.2% offset KSI	T.S KSI	EL. %	R.A %
MIN	30.0	75.0	28.0	
MAX				
	45.6	86.4	58.0	
	41.3	81.5	49.0	

IMPACT TEST / HEAT NO.	TEST TEMP.	SIZE OF SPECIMEN(mm)		ABSORBED ENERGY STD. / VALUE			AVE.	LATERAL EXPANSION STD. / VALUE			AVE.	PERCENT SHEAR STD. / VALUE			AVE.
374D0304			BM												
			HAZ												
			WM												
YX1411-027			BM												
			HAZ												
			WM												

HARDNESS HRC		HEAT TREATMENT	SOLUTION TREATED. 1060℃, 40Min., "Water"		
MIN	22.0	PMI	ACCEPT	N.D.E	N/A
MAX					
HB	153	FLATTENING TEST	N/A	**MEMO	
		BENDING TEST	N/A		
		HYDROSTATIC TEST	N/A		
HB	154	CORROSION TEST	N/A		
		GRAIN SIZE TEST	N/A		
		IGC TEST	N/A		

MATERIAL MEETS THE REQUIREMENTS OF NACE MR0175/ISO15156 & 0103
MADE IN KOREA

WE CERTIFY THIS MATERIAL HAS BEEN MANUFACTURED AND EXAMINED IN ACCORDANCE WITH ALL REQUIREMENTS OF THE SPECIFICATION AND THE RESULTS OF ALL EXAMINATION ARE ACCEPTABLE.

□ REVIEWED BY :
□ WITNESSED BY : _____

CHIEF QUALITY OFFICER

SKE-8903

* 본 검사증명서에 명기된 규격외의 사용시 안전상 문제가 발생할 수 있으며, 검사증명서 위 변조시 사문서 위조(형법231조)로 불이익을 당하실 수 있습니다.

RXP-12

RXP-13

MILL TEST REPORT TA CHEN INTERNATIONAL, INC. This MTR contains 1 page (Page# 1)

Customer: OUHLOS PO#:D7763 SO#:LHHG39 MTR#:ENFL1503015001.61

Item:F64L8W00E Heat#:FL147

E N CORPORATION

Lot 2, 4 & 6, Block 16, Phase IV, Cavite Export Processing Zone Authority, PEZA, Rosario, Cavite, Philippines 4106

TEL : (+63) 46-437-1022-25 FAX : (+63)46-437-1018 21

MILL TEST REPORT

PURCHASER : TA CHEN INTERNATIONAL, INC.

DATE : 2015/03/21
P. O. NO.: L45049-S
S/C NO. : O120TC

PRODUCT : STAINLESS STEEL FORGED FLANGE RF

HEAT NO.	QTY.	DESIGNATION	SPECIFICATION
FL147	2	304L/304 3/4" W/N S-80 600LB	ASME B16.5-20 304SS SP25-1998

CHEMICAL ANALYSIS OF MATERIAL

HEAT NO.	C	Mn	Si	P	S	Cr	Ni	M	N	SPECIFICATION
Maxi	0.030	2.00	1.00	0.045	0.030	18.0 - 20.0	8.0 - 11.0		0.100	ASTM A/SA182-2013
FL147	0.025	1.26	0.48	0.034	0.006	18.04	8.10		0.070	

MECHANICAL CHARACTERISTICS

HEAT NO.	T.S-PSI	Y.S-PSI	%-E.L.	%-R.A.	HEAT-TREAT.	HARDNESS	DIMENSION	P.M.I.
Mini	75,000	30,000	30	50	1040 - 1150 °C	≤90.0 HRB		
FL147	83,400	43,500	60	80	1060 °C	76.0 HRB	OK	OK

MATERIAL RESISTANT TO INTERCRYSTALLINE CORROSION ICC TEST ACCORDING TO ASTM A262-10 PRACTICE E. MATERIAL IS MANUFACTURED MERCURY FREE AND FREE FROM MERCURY CONTAMINATION AND RADIO ACTIVITY. MATERIAL IS IN ACCORDANCE WITH NACE MR0175-SECOND EDITION, MR0103-2007, ISO 15156-2009 COMPLIANT ISO 9001:2008, PED 97/23/EC CERTIFIED EN10204:2005-3.1
MATERIAL RECEIVED SOLUTION TREAT & WATER QUENCHED AT 1080 DEGREE C
MATERIAL WAS MANUFACTURED, SAMPLED, TESTED AND INSPECTED IN ACCORDANCE WITH ASTM A182-13 AND ASTM A961-08A AND HAS BEEN FOUND TO MEET THE REQUIREMENTS. MATERIALS ARE FREE OF WELD REPAIR

Pb CONTENT : < 0.010%

COUNTRY OF ORIGIN : PHILIPPINES
COUNTRY OF MELT : PHILIPPINES

FACTORY INSPECTOR:

DAVID WANG

QUALITY ASSURANCE DEPARTMENT

F64L8W00E

N-1503015001

SM-005-0

LATURBINE P.O 21290

L.A. TURBINE CO PO#:
21290

DESCRIPTION:
3/4 600# RF WN FLNG SA182 T304/
304L S80 PT# 7760000017

EXP-14

SCHOELLER BLECKMANN EDELSTAHLROHR
SEAMLESS STAINLESS
NAHTLOS ZUM ERFOLG

INSPECTION CERTIFICATE
EN 10204 3.1

Number: 563180 Page: 1 / 3	Rev:
Created on: Date: 07.11.2012	Modified on:

SCHOELLER-BLECKMANN Edelstahlrohr GmbH
2630 Ternitz, Rohrstrasse 1
Austria

TL: 2630316/601
FAX: 2630316/894
E-MAIL: nicole.riegler@sber.co.at

119337

CUSTOMER DESCRIPTION

CLIENT SOLD TO	CLIENT SHIP TO
TUBACEX AMERICA, INC. 5430 BRYSTONE DRIVE HOUSTON TX 77041 USA	TUBACEX AMERICA, INC. 5430, BRYSTONE DRIVE TEXAS, HOUSTON 77041 USA

CLIENT ORDER: 620011
SALES ORDER: 115552

MATERIAL:SEAML. STAINL. STEEL TUBES/PIPES
HEAT-TREATED, PICKLED, PICKLED-PASSIVATED
GRADE: TP304,TP304L,
STANDARD: ASME SECT.II PART.A SA312/SA312M-2010 ED.
ASME SECT.II PART.A SA376/SA376M-2010 ED.
ASTM A376/376M-06
ASTM A312/A312M-11
NACE MR0175/ISO 15156-3:2009
CORROSION TESTED ACC. TO MIL-P-24691/3(ASTM A262 PCT.E)
NACE MR0103-2010
TOLERANCES: ASME SECT.II PART.A SA999/SA999M-2007 ED. 2009B ADD.
ASTM A999/A999M-04A
RANDOM LENGTHS 6.100/7.300 MM
PLAIN ENDS,
DIMENSIONS: 26,67 X 3,91 MM / 3/4 "NB X SCH 80S
COLD FINISHED

L.A. TURBINE CO PO#:
20908 JOB LAT560EC

DESCRIPTION:
3/4 S80 SMLS PIPE SA312 304/
304L COFO: AUSTRIA HT# 454550

Sales Item	Client Item	Delivery No	Lot No.	Heat No	Pieces	Weight	Tot Lgth	Un Lgth
90		8170023924	215659	454550	43	1 523,395 LB	1.019,390 FT	20,013-23,950 FT

CHEMICAL COMPOSITION (%) *L. Ladle C:Products

*	Heat	Seq	C	Mn	Si	P	S	Ni	Cr
L	454550	1	0,020	1,60	0,360	0,026	0,0110	10,24	18,50

HEAT TREATMENT
SOLUTION ANNEALED AT 1070 °C , 10 min , AIR

TENSILE TEST

Lot No	Sample	T	Rp0.2	Rm	A2"
		°C	KSI	KSI	%
Min		20	30	75	35
Max		20		99	
215659	1	20	40	89	59

Certified Management System

We hereby certify that the material herein described has been manufactured, sampled, tested, and released in accordance with above standards and specifications and satisfies delivery requirements. This certificate is issued by a computerized system and it is valid without original signature. In case the owner of the certificate would release as a copy of it, he must state its conformity to the issued, assuming the responsibility for any untruthful or TUBACEX, not allowed use. Any forgery or falsification of this certificate shall legally prosecuted.

SCHOELLER-BLECKMANN
EDELSTAHLROHR GMBH

Riegler

FR N RIEGLER
(WORKS INSPECTOR)

SCHOELLER BLECKMANN EDELSTAHLROHR
SEAMLESS-STAINLESS
NAHTLOS ZUM ERFOLG

INSPECTION CERTIFICATE EN 10204 3.1

Number: 563180 Page: 2 / 3	Rev:
Created on: Date: 07.11.2012	Modified on:

TENSILE TEST

Lot No	Sample	T	Rp0.2	Rm	A2"
		°C	KSI	KSI	%
Min		20	30	75	33
Max		20		99	
	2	20	37	87	61

HARDNESS TEST

Lot No	Sample	HRB
Min		
Max		90
215659	1	74
	2	72

METALURGICAL TESTS

INTERGRANULAR CORROSION TEST ACC. TO ASTM A262 PRACT."E": SATISFACTORY
INTERGRANULAR CORROSION TEST ACCORDING TO MIL-P-24691/3
(SENSITIZED 675°C (1250°F) / 1 HOUR / AIRCOOLED): SATISFACTORY

NON-DESTRUCTIVE TESTS

POSITIVE MATERIAL IDENTIFICATION TEST ON EACH TUBE/PIPE BY
"X-RAY-FLUORESCENCE-ANALYZER": SATISFACTORY

HYDROSTATIC PRESSURE TESTED AT 172 bar, 2500 psi DURING 5 SEC
ON EACH TUBE/PIPE: SATISFACTORY

TECHNOLOGICAL TESTS

FLATTENING TEST: SATISFACTORY

THE TUBES/PIPES CONFORM ALSO TO NACE STANDARD
MR0175/ISO 15156-3:2009, MR0103-2010

MATERIAL IDENTIFICATION ON EACH PIPE: SATISFACTORY

WE CERTIFY THAT THIS MATERIAL HAS BEEN MANUFACTURED
AND EXAMINED IN ACCORDANCE WITH ALL REQUIREMENTS OF
THE SPECIFICATION AND ORDER CONFIRMATION AND THAT THE
RESULTS OF ALL EXAMINATIONS ARE ACCEPTABLE.

STEELMAKING PROCESS: EF + AOD

ABBREVIATIONS:
RP0.2 = YIELD STRENGTH
RM = TENSILE STRENGTH

KG = GRAIN SIZE
CONVERSION:

Content Management System

We hereby certify that the material herein described has been manufactured, sampled, tested, and inspected in accordance with above specifications and satisfies mandatory requirements. This certificate is issued by a computerized system and is valid without original signature. In case the owner of the certificate would release as a copy of it, he must state its conformity to the issued, assuming no responsibility for any unlawful or TUBACEX, not allowed use. Any forgery or falsification of this certificate shall legally prosecuted.

SCHOELLER-BLECKMANN
EDELSTAHLROHR GMBH

Riegler

FR. N. RIEGLER
(WORKS INSPECTOR)

SCHOELLER
BLECKMANN
EDELSTAHLROHR
SEAMLESS STAINLESS
NAHTLOS ZUM ERFOLG

INSPECTION CERTIFICATE
EN 10204 3.1

Number: 563180 Page: 3 / 3	Rev:
Created on: Date: 07.11.2012	Modified on:

A2" = ELONGATION 1 MPA = 1 N/MM² = 145.037 PSI

MARKING

Schoeller Bleckmann SBS 26,67 X 3,91 MM / 3/4 "NB X SCH 80S ASME SA312 ASME SA376 ASTM A312 ASTM A376 TP304 TP304L CD SMLS HEAT/ PMI-AV LOTNO/ AUSTRIA T/A

REMARKS

MATERIAL IS FREE OF MERCURY CONTAMINATION.

NO WELD REPAIR HAS BEEN PERFORMED ON THE MATERIAL.

MATERIAL MANUFACTURER APPROVED WITH CERTIFICATE NR. 245/2004/MUC BY TÜV SÜDDEUTSCHLAND (NOTIFIED BODY 0036)TO ISSUE CERTIFICATES OF SPECIFIC PRODUCT CONTROL IN ACCORDING TO PRESSURE EQUIPMENT DIRECTIVE 97/23/EC ANNEX I POINT 4.3.

MATERIAL IS FREE OF RADIOACTIVE CONTAMINATION

Certified Management System

We hereby certify that the material herein described has been manufactured, sampled, tested, and inspected in accordance with above standards and specifications and satisfies delivery requirements. This certificate is issued by a computerized system and it is valid without original signature. In case the owner of this certificate would release as a copy of it, he must check its conformity to the issued, assuming the responsibility for any unlawful or TUBACEX not allowed use. Any forgery or falsification of this certificate shall legally prosecuted.

SCHOELLER-BLECKMANN
EDELSTAHLROHR GMBH

Riegler

FR. N. RIEGLER
(WORKS INSPECTOR)

MILL TEST & INSPECTION CERTIFICATE

ACCORDING TO EN 10204 :2004 3.1

抱牌鋼工股份有限公司
BOTH-WELL STEEL FITTINGS CO., LTD.
高雄市仁武區烏林里仁心路303號
NO.303, REN-SIN ROAD, REN-WU DISTRICT, KAOHSIUNG CITY, TAIWAN R.O.C.(81460)
TEL: +886-7-3711536, 3710497, 3720260 FAX: +886-7-3713864, 3713882
Web site: http://www.bothwell.com.tw e-mail: box@bothwell.com.tw

CUSTOMER : 大成不銹鋼工業股份有限公司
CERT. NO : 131856 L/C NO :
ORDER NO : 9006-N4394 DATE : 06/29/2013
INVOICE NO : BW01310204077 PAGE : 9 ORIGIN : TAIWAN

ITEM	BW HT.CD.	RAW MATERIAL HEAT NO.	DESCRIPTION	QUANTITY	SPECIFICATION FOR MATERIAL	SPECIFICATION FOR FITTING	INSPECTION SURFACE	INSPECTION DIM.
092	T2335	9SC0067	FULL CPLG 1" 3000# NPT	70 PC	ASTM A182 -13 F316 / 316L	ASME B16.11 - 2011	GOOD	GOOD
093	T2354-	3Y435	FULL CPLG 2" 3000# NPT	90 PC				
094	T2267	9SC0022	FULL CPLG 4" 3000# NPT	2 PC				
095	T2415	9SD0021	HALF CPLG 1/2" 3000# NPT	250 PC				
096	T2363	9SC0086	HALF CPLG 3/4" 3000# NPT	300 PC				

ITEM	BW HT.CD.	CHEMICAL COMPOSITION (%) C	Si	Mn	P	S	Cu	Cr	Ni	Mo	V	Cb(Nb)	N	Al	Ti	Zr	CE	MATERIAL SUPPLIER
Min		-	-	-	-	-	-	16.0	10.0	2.00	-	-	-					
Max		0.030	1.00	2.00	0.045	0.030	-	18.0	14.0	3.00	-	-	0.10					
092	T2335	0.024	0.38	1.57	0.028	0.024	-	17.17	10.57	2.03	-	-	0.06					
093	T2354	0.022	0.37	1.66	0.027	0.025	-	16.75	10.00	2.02	-	-	0.05					
094	T2267	0.016	0.410	1.640	0.037	0.026	-	17.210	10.190	2.010	-	-	0.080					
095	T2415	0.024	0.46	1.65	0.029	0.026	-	17.24	10.55	2.03	-	-	0.06					
096	T2363	0.025	0.42	1.57	0.028	0.027	-	17.26	10.51	2.03	-	-	0.07					67.93

ITEM	BW HT.CD.	MECHANICAL PROPERTIES T. S.	Y. S.	EL. KS(%)	R of A KS(%)	Hardness (HBW)(AVG)	Charpy Impact °F / 0 °C MIN./AVG. / (Joule) 1	2	3	AVG.	HEAT TREATMENT
Min		75	30	30	50	-					SOLUTION
Max		-	-	-	-	235					
092	T2335	81.5	38.4	62.4	76.9	163 167					1060°C W.Q.
093	T2354	79.5	34.5	63.4	76.5	163 162					
094	T2267	79.7	38.8	62.6	76.6	151 156					
095	T2415	79.5	33.6	65.2	76.5	150 153					
096	T2363	81.3	35.8	64.4	75.8	163 161					

ADDITIONAL TEST／REMARKS
STEEL MAKING PROCESS : ELECTRIC FURNACE
CONFORMS TO NACE MR0175-09/MR0103-10
PMI SATISFACTORY
MERCURY FREE

WE HEREBY CERTIFY, THAT THE MATERIAL DESCRIBED ABOVE HAS BEEN TESTED AND COMPLIES WITH THE TERMS OF THE ORDER CONTRACT.

C.C. Huang
Q.C.MANAGER
CHEN CHI HUANG

Y.Y. Chang
INSPECTOR
YUAN YAO CHANG

BW-D0839 REV: 2

L.A. TURBINE CO PO#:
20690 JOB LAT561

DESCRIPTION:
1/2" 3M SC HLF COUPLING SA182
T316/316L HT# T2415

EXP-15

EXP-16

Customer Name	Customer PO#	Shipper No	Heat Number
GTM Metals	17393	757183	268423

From: Valbruna Stainless Inc Date: 6/2/2016 To: THYSSENKRUPP MATERIALS NA INC SO#: A765301 Lnl#: 1 PO#: 5400008140 Part: 304SQ1.5 Heat#: 268423
Tag: V45411D1G

Acciaierie Valbruna s.p.a.

36100 VICENZA (Italia) - Viale della scienza, 25 z.i.
Telefono 0444.968211 - Fax 0444.962836
Stab.: 39100 BOLZANO (Italia) - Via A. Volta, 4/37
Telefono 0471.924111 - Fax 0471.924497

QUALITY MANAGEMENT SYSTEM CERTIFIED BY LLOYD'S REGISTER

CERTIFICATO DI COLLAUDO
ABNAHMEPRUEFZEUGNIS
INSPECTION CERTIFICATE
CERTIFICAT DE RECEPTION
EN 10204 (2004) , 3.1

Cliente / Besteller/Purchaser/Client
VALBRUNA STAINLESS INC.
2400 TAYLOR STREET WEST
46801 - FORT WAYNE, IN 46801 - US

Avviso di Spedizione: D-VI16008445

Certificato nr: MEST636382/2016/

Conferma ordine nr: EI16002483

Ordine nr: 45411 STOCK CAROL
STR

Produttore : ACCIAIERIE VALBRUNA S.P.A.

Tipo di Elaborazione: E+AOD

Marchio di Fabbrica:

Stato di fornitura : Hot rolled - Annealed Cold Drawn

Punzone del Collaudatore: MR

Specifiche:

VSI 0 304/304L A,CF
AMS 5647 J S30403 A
ASME SA182 2013 S30400/03 A (0)
ASME SA320 2013 B8 CLASS1 (3)
ASTM A193 2014A B8 CLASS1
ASTM A314 2008 S30400/03
ASTM A473 2001 S30400/03 (5)
NACE MR0103 2010 S30400/03 A

AISI 304/304L
AMS-QQ-S-763 D 304 A,CF
ASME SA193 2013 B8 CLASS1 (1)
ASME SA479 2013 S30400/03 A (4)
ASTM A262 2013 PRACTICE E
ASTM A320 2011A B8 CLASS1
ASTM A479 2015 S30400/03 A
NACE MR0175 2009 S30400/03 A (7)

AMS 5639 H S30400 A
AMS-QQ-S-763 D 304L A,CF
ASME SA276 2013 S30400/03 A,CF (2)
ASTM A182 2014A S30400/03 A (6)
ASTM A276 2015 S30400/03 A,CF
ASTM A370 2014 .
MIL-S-862 B/1 304/304L

(0)SECTION II PT.A 2013 EDITION
(1)SECTION II PT.A 2013 EDITION
(2)SECTION II PT.A 2013 EDITION
(5)For products machined directly from bar refer also
(6)Chemical analysis only.
(7)Technical circular 1/2011 Published 2011-06-14

(6)For products machined directly from bar refer to ASME SA479.
(2)SECTION II PT.A 2013 EDITION
(4)SECTION II PT.A 2013 EDITION
(5)To ASTM A478.
(7)ANSI/NACE MR0175/ISO 15156-3, second edition 2009-10-15

Qualità: 304/304L

Marca: AISI

Tolleranze: ASTM A484-15 TABLE 8

Punzonatura: 304/304L

Per, nr.	Oggetto	Dimensioni - in	Lunghezza - in	Colata	Pezzi	Peso - LB	Lotto nr.
0010	Square	1,5000 x 1,5000	149/ 151	268423		28.572	506503240

TEST ALLO STATO DI FORNITURA
Test on delivery condition Prüfung auf lieferbarem produkt test a fatal de fourniture Prueba sobre el material asi como entregado

TEST	Provetta/	°F		Snervamento Rp 0,2%	Snervamento	Resistenza Rm	Allungamento E 4d %		Strizione RA %		Resilienza	Durezza HB		
Valori richiesti		min max		30	-	75	-	40	-	50	-	140 223		
A	12,5	68	L	70		98		49		68		212		

TEST ALLO STATO DI FORNITURA
Test on delivery condition / Prüfung auf lieferbarem produkt / Test a fatal de fourniture / Prueba sobre el material asi como entregado

TEST		min	max	
A	Grain size for ASTM E112			5

Mechanical properties according to ASTM A370.

Analisi chimica

Colata Heat	min - max	-	-	18,00 20,00	-	-	8,00 10,50	-	-	0,030	0,030	-	-	-	-	-
	C %	Si %	Mn %	Cr %	Mo %	Cu %	Ni %	Co %	P %	S %	N %					
268423	0,018	0,39	1,68	18,52	0,36	0,40	8,05	0,128	0,034	0,028	0,094					

Produced without class I-II Ozone depleting substances.
Solution heat treated free from continuous carbide network.
Micro and macro etch test: OK

Vicenza, 14/03/16
VC0008
(Mod. MCE2)

Il collaudatore di stabilimento / der Werksabnahmebeamte / Works inspector / L'agent d'usine
M.Rizzotto

From: ThyssenKrupp Materials NA
Cust. ONLINE METALS LAX WILL CALL Del.: 2404761013
CstAr 438 CstOr 63383
Wgt.: 96 LB Date 09/13/2016

Tomas Sanchez

Customer Name	Customer PO#	Shipper No	Heat Number
GTM Metals	17393	757183	268423

From: Valbruna Stainless Inc Date: 6/2/2016 To: THYSSENKRUPP MATERIALS NA INC SO#: A756301 Ln#: 1 PO#: 5400308140 Part: 304SQ1.5 Heat#: 268423
Tag: V4841101G

Acciaierie Valbruna S.p.A.

ISO 9001 AD 9100 RINA

QUALITY MANAGEMENT SYSTEM CERTIFIED BY LLOYD'S REGISTER

CERTIFICATO DI COLLAUDO
ABNAHMEPRUEFZEUGNIS
INSPECTION CERTIFICATE
CERTIFICAT DE RECEPTION
EN 10204 (2004) , 3.1

36100 VICENZA (Italia) - Viale delle scienze, 25 z.i.
Telefono 0444.968211 - Fax 0444.983838
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Cliente / Kunde/Purchaser/Client
VALBRUNA STAINLESS INC.
2400 TAYLOR STREET WEST
46801 - FORT WAYNE, IN 46801 - US

Produttore : ACCIAIERIE VALBRUNA S.P.A.

Stato di fornitura : Hot rolled - Annealed Cold Drawn

Avviso di Spedizione: D-VI16006445

Ordine nr: 48411 STOCK CAROL
STR

Tipo di Elaborazione: E+AOD

Certificato nr: MEST836382/2016/

Conferma ordine nr: EI16002463

Marchio di Fabbrica:

Punzone del Collaudatore: MR

Intergranular corrosion test per ASTM A262 pract. E: ok.
Absence of cracks at 20 x magnification after bend test.
Reduction ratio = 20,3 : 1
Annealing temperature: 1940°F for 1 h/water.
Material is DFARS Compliant

Sono state soddisfatte tutte le condizioni richieste

Controllo antimescolanza: OK

Controllo visivo e dimensionale: soddisfa le esigenze

Melted and manufactured in Italy No welding or weld repair Material free from Mercury contamination

We declare that the finished product is checked for radioactive contamination through Portal System when it leaves the production plant.

The Quality Management System is Certified acc. Pressure Equipment Directive '97/23/EC' Annex 1,3.,4.3 by TUEV and LLOYD'S

Any act of tampering, modification, alteration, counterfeiting and/or falsification and/or any other action which modifies the contents of this test certificate shall constitute a violation of applicable civil and criminal laws. Acciaierie Valbruna shall protect its rights and interests before any competent court, authority and jurisdiction.

Mastval and/or Valplus grades/products are manufactured with tools techniques to control composition, distribution, size and shape of non-metallic inclusions for improved mech.mability.

The supplied product conforms to requirements expressly requested by the purchaser and conforms to requirements specified by certified norms and standards. Should the product be used for more severe, critical and/or in any case different applications than those the material is generally intended for, any different and/or supplementary requirements shall be specifically demanded, at least, upon order of the Product by the Purchaser. Acciaierie Valbruna SpA shall not be responsible for any improper use of the Products.

GTM Metals Inc.
Date 10-21-16
GTM Metals SO # 17853
Customer PO # 23679

Vicenza, 14/03/16 VCG008 (Mod. MCE2)	Il collaudatore di stabilimento / der Werksachverständige / Works inspector / L'agent d'usine M.Rizzotti	Pagina - 2 di 2

From: ThyssenKrupp Materials NA
Cust. ONLINE METALS LAX WILL CALL Del.: 2404761013
CstAr 438 CstOr 63383
Wgt.: 96 LB Date 09/13/2016

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

EXPANDER CASE

WELDS VISUAL INSPECTION OF EXP. CASE FABRICATION

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: EXPANDER CASE

PART NUMBER: 7770006232

THIS IS TO CERTIFY THAT VISUAL INSPECTION HAS BEEN PERFORMED IN ACCORDANCE WITH ASME SEC. VIII ON THE **EXPANDER CASE FABRICATION WELDS.** THE INSPECTION RESULTS HAVE BEEN FOUND SATISFACTORY.

INSP. PERFORMED BY: Hung Phung, QC Inspector — **DATE** 3/15/17

INSP. CONFIRMED BY: Frank Loth, Quality Manager — **DATE** 3/15/17

element

Element Materials Technology
18100 S Wilmington Avenue
Rancho Dominguez, CA
90220-5909 USA

P 310 632 8500
F 310 632 4700
T 888 786 7555
info.rd@element.com
element.com

TEST CERTIFICATE - EAR-CONTROLLED DATA

L.A. Turbine Corporation
28557 Industry Drive
VALENCIA, CA 91355

Date: 1/23/2017
Purchase Order Number: 24186
Work Order Number LAT009-01-16-14336

Item No. 1

P/N:	EXPANDER CASE
Lat Job#:	LAT574
Job ID:	LAT574

NONDESTRUCTIVE TESTING

Item No.	Quantity	Method	Quantity Inspected	Quantity Conformed	Quantity Rejected	Date	Insp. Stamp No.
1	2	Penetrant	1	1	0	1/19/2017	P69
		Radiography	1	1	0	1/20/2017	X53

Penetrant Inspect of welds per DWG7770006232 Rev 3
Acceptance per ASME Section VIII Division 1, Appendix 8
PT-1 Rev. V

100% Radiographic of welds per DWG7770006232 Rev 3
Acceptance criteria ASME Section VIII , DIV 1, UW-51-NDE 2015 Edition
RT-1 Rev. 2A
See attached reader sheet for radiographic results

Jose A. Perez
Penetrant Level 2 Rancho Dominguez

Fabian Facio
RT Level II Rancho Dominguez

This document contains technical data whose export and re-export/ retransfer is subject to control by the U.S. Department of Commerce under the Export Administration Act and the Export Administration Regulations. The Department of Commerce's prior written approval may be required for the export or re-export/retransfer of such technical data to any foreign person, foreign entity or foreign organization whether in the United States or abroad.

Respectfully Submitted

Accredited Nadcap™

NDT
Chem Process

Idalia Rodriguez
Quality Administrator #15

The information contained in This certification represents only the material submitted and is certified only for the quantities tested. Reproduction except in full is reserved pending written approval. All testing was performed in a mercury-free environment. All work is performed in accordance to Element Terms & Conditions. **Customer Quality Clauses Apply as Specified.**

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

EXPANDER CASE

HYDROSTATIC PRESSURE TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: EXPANDER CASE

PART NUMBER: 7770006232

THIS IS TO CERTIFY THAT **EXPANDER CASING** OF THE ABOVE REFERENCED PURCHASE ORDER, HAS SUCCESSFULLY PASSED THE HYDROSTATIC PRESSURE TEST PERFORMED AT THE INDICATED CONDITIONS:

DESIGN PRESSURE: 1100 PSIG

TEST PRESSURE: 1650 PSIG

TEST MEDIUM: WATER

HOLDING TIME: 30 MINUTES

PRESSURE GAUGE S/N: LAT 174

CALIBRATION DUE DATE: 08/04/2017

TEST PERFORMED BY: _____ 3-16-17
Michael Martinez, Test Technician — DATE

TEST CONFIRMED BY: _____ 3/16/17
Frank Loth, Quality Manager — DATE

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 2: COMPRESSOR CASE

- MATERIAL CERTIFICATION
- INSPECTION CERTIFICATE
- NDE CERTIFICATION
- HYDROSTATIC TEST CERTIFICATE

COMP-1

Eastham Forge, Inc. ISO 9001: 2008 CERTIFIED

EFI MATERIAL CERTIFICATION

A Subsidiary of Eastham Enterprises, Inc.

1050 Neches Street
Beaumont, Texas 77701
409 835-4212

MTR Reference ID: 9707.00

SOLD TO
LA TURBINE CORPORATION
29151 AVENUE PENN
VALENCIA , CA 91355

SHIP TO
LA TURBINE CORPORATION
29151 AVENUE PENN
VALENCIA,CA
91355

Customer Order #	Line Item	Approval Date	Shop Order #	Ship Wgt EA(lbs)	Quantity	Total
23674	2	11/01/2016	9707.00	3854	1	1

Forge to Finish	Part Number	Forge Ratio	Melt Practice
7770006266	7770006266	17.15 : 1	EFVD

Material Grade	Heat Number	Heat Code	Specifications: ASME SA350-2015 LF2 CL1
1022M	434332	11479-CD	ASTM A388-16 (UT SPEC) ASTM A508-16 (UT ACCEPTANCE/REJECTION CRITERIA)
Serial Number(s)	LAT574		

Producing Mill Name: ACCIAIERIE BERTOLI SAFAU, SpA (ABS)

Mill Austenitic

Chemistry Ladle Analysis Carbon Eq. [C+Mn/6+[Cr+Mo+V]/5+[Cu+Ni]/15] : 0.40693 Grain Size: 7 DI = 0.77

C	Mn	Si	P	S	Cr	Ni	Mo	Al	Cu	Sn
0.175	1.14	0.19	0.013	0.003	0.12	0.06	0.02	0.022	0.08	0.004
Ti	**B**	**V**	**Nb**	**As**	**Ca**	**Sb**	**Co**	**Pb**	**O2ppm**	**H2ppm**
0.0028	0.0001	0.023	0.001	0.004	0.0017	0.001	0.006	0.0020	13.00	1.20
Cr+Mo	**Cr+Ni+Mo+V**	**Fe**								
0.14	0.30									

HEAT TREATMENT PERFORMED

Cycle	Temp	Hours	Quenchant (Start-Stop °F)	Method
NORMALIZE	1650 °F	8.00	AIR COOLED	A

Monitor Method Legend: A: [Furnace TC] B: [Contact TC] C: [Heat Sink TC]

Forging Hardness: 134-134 HBW/P 10/3000 Number of Pieces Checked: 1

QTC DATA & MECHANICAL PROPERTIES

Mechanical Properties: JMS-RMTEE-00010 PROLONGATION QTC Ref . #: 9523.01

QTC Melt Practice: EFVD QTC Forge Ratio: 16.74: 1

QTC Heat Treatment

Cycle	Temp F	Hours	Quenchant (Start-Stop °F)	Method
NORMALIZE	1650 °F	18.00	AIR COOLED	A

Monitor Method Legend:
A: [Furnace Monitoring] B: [Contact TC] C: [Heat Sink TC]

QTC Properties

0.502 Tensile Bar	Actual	10MM x 10MM	Actual
Tensile Str. (Long.)	73 KSI	CVN	LCVN
0.2% Offset Yield Str	46.4 KSI	Temp	MINUS 50 °F
% Elong. IN 2"	34	Ft. Lbs.	12 50 56
% Reduction of Area	66	Lateral_Exp. (in	.011 .042 .047
Surface Hardness **	137-138	% Shear	15 45 50

** HBW 10/3000

***** SEE MATERIAL TEST REPORT NOTES ON ATTACHED PAGE(S) *****

We hereby certify that all test results and process information contained herein are correct and true as contained in the records of the company.

Date : 11/01/2016

By : A. Woodard

ALMA WOODARD

Title : DOCUMENTATION SPECIALIST

FORM 405.01 REV C

EFI MATERIAL CERTIFICATION

A Subsidiary of Eastham Enterprises, Inc.
1050 Neches Street
Beaumont, Texas 77701
409 835-4212

MTR Reference ID: 9707.00

SOLD TO
LA TURBINE CORPORATION
29151 AVENUE PENN
VALENCIA , CA 91355

SHIP TO
LA TURBINE CORPORATION
29151 AVENUE PENN
VALENCIA,CA
91355

Customer Order #	Line Item	Approval Date	Shop Order #	Ship Wgt EA(lbs)	Quantity	Total
23674	2	11/01/2016	9707.00	3854	1	1

Forge to Finish	Part Number	Forge Ratio	Melt Practice
7770006266	7770006266	17.15 : 1	EFVD

Material Grade	Heat Number	Heat Code	Specifications: ASME SA350-2015 LF2 CL1
1022M	434332	11479-CD	ASTM A388-16 (UT SPEC) ASTM A508-16 (UT ACCEPTANCE/REJECTION CRITERIA)
Serial Number(s)	LAT574		

***** Material Test Report Notes *****

DURING PROCESSING AT EASTHAM FORGE, INC., THIS MATERIAL HAS NOT COME INTO CONTACT WITH MERCURY OR ANY RADIOACTIVE CONTAMINATION.

NO WELDING HAS BEEN PERFORMED ON THESE FORGINGS.

NORMALIZING PERFORMED IN FURNACES CALIBRATED AND CERTIFIED TO MEET OR EXCEED THE REQUIREMENTS OF API SPECIFICATION 16A (ISO 13533:2001) 3RD EDITION, DECEMBER, 2004 - ANNEX A AND API 6D 24TH EDITION, APPX. F

MATERIAL, ITEMS OR SERVICES FURNISHED UNDER THIS ORDER HAVE BEEN PRODUCED TO THE SPECIFICATIONS AND REQUIREMENTS STATED ON THIS ORDER AND IN ACCORDANCE WITH THE EASTHAM FORGE, INC. ISO 9001:2008 QUALITY MANAGEMENT SYSTEM; CERTIFICATE OF COMPLIANCE NO: 30087, ORIGINAL CERTIFICATION DATE: 17 JULY 2002 EXPIRATION DATE: 21 FEB 2018

EASTHAM FORGE, INC. IS CERTIFIED TO BE COMPLIANT WITH THE PROVISIONS OF THE PRESSURE EQUIPMENT DIRECTIVE (PED) 97/23/EC 7/2, ANNEX I, PARA 4.3 - CERTIFICATE NO. 41761 - EXPIRATION DATE 1/27/2018

DOCUMENTATION SUPPLIED MEET REQUIREMENTS OF EN 10204:2004, TYPE 3.1

DIMENSIONAL INSPECTION REPORT INCLUDED.

VOLUMETRIC N.D.E. IN ACCORDANCE WITH ASTM A388 PER ASTM A508 SECTIONS 8.3.1.1, 8.3.1.2, & 8.3.1.3

We hereby certify that all test results and process information contained herein are correct and true as contained in the records of the company.

Date : 11/01/2016
By : A. Woodard
ALMA WOODARD
Title : DOCUMENTATION SPECIALIST

FORM 405.01 REV C

EASTHAM FORGE, INC.
MACHINING DIMENSIONAL INSPECTION REPORT

DATE: 10-28-16 QTY: 1 SHOP ORDER: 9707.00

HEAT CODE: 11479-CD HEAT NUMBER: 434332

DWG/DESCRIPTION: 7770006266 PCS ACCEPTED: 1 PCS REJECTED: _____

INSPECTOR: JF REMARKS: _____

SC028 #SC032 #D009

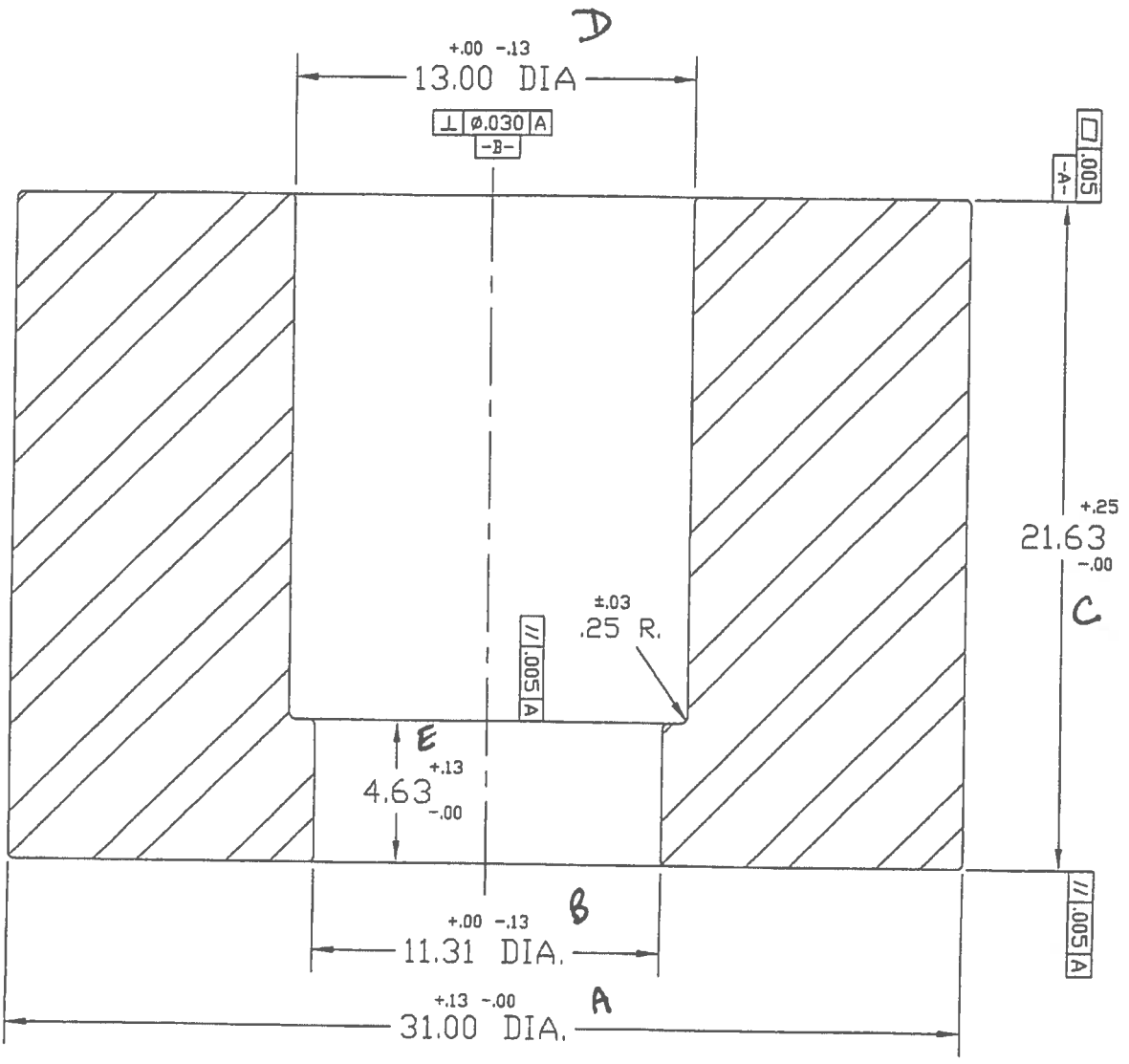
DIM REQ'D	31.0	11.31	21.63	13.0	4.63	R .25	.12 X 45°					
SER #	DIM A	DIM B	DIM C	DIM D	DIM E	DIM F	DIM G	DIM H	DIM I	DIM J	DIM K	DIM L
1	31.078	11.220	21.843	12.906	4.750	✓	✓					

EASTHAM FORGE, INC
REVIEWED BY Q.A.
DATE 102876
BY JF
☒ APPROVED ☐ REJECTED

Form 902.04 REV A

S/09707.00

HEAT TREAT CROSS SECTION = 9°		DRAWING SK-12805-RM



250 FINISH ON ALL SURFACES

BREAK ALL SHARP CORNERS ±.03 .12 X 45°

ALL COAXIAL DIAMETERS RUNOUT TO DATUM A & B RESPECTIVELY WITHIN .010 T.I.R. UNLESS NOTED

EST. R/M WT. = 3,854 LBS.

LETTER	REVISIONS	DATE	CHK'D BY
A	INITIAL ISSUE	9/26/16	JWC

MAT'L	STOCK SIZE	CUT WT.	NET WT.

CONFIDENTIAL
THIS IS A PROPRIETARY DESIGN OF EASTHAM FORGE INC., DATA AND INFORMATION RELATING THERETO IS NOT TO BE USED DISSEMINATED, OR REPRODUCED IN WHOLE OR IN PART WITHOUT WRITTEN CONSENT OF EASTHAM FORGE, INC.

EASTHAM FORGE, INC.
BEAUMONT, TEXAS

R/M DWG. FOR-
EXPANDER CASE

DRAWN BY	JWC	9/26/16	SCALE .1875
CHECKED BY			
RE	RM	DRAWING SK-12805-RM	REV A

TEAM INDUSTRIAL SERVICES, INC.

Field Ticket No. 75615

3875 W. Cardinal Drive Beaumont, Texas 77705
(409) 840-9955 Fax (409) 842-4190

ULTRASONIC INSPECTION REPORT

Customer	Location	Date	S/O #
Eastham Forge, Inc.	BEAUMONT ,TX	11/04/2016	9707.00

Sold To: LA TURBINE CORPORATION
Customer Order Number: 23674
Procedure: UT.ASTM.1 R6
Specification: ASTM A388 / ASTM A508 SECT. 8.3.1.1, 8.3.1.2 & 8.3.1.3
Scope of Examination: 100% VOLUMETRIC
Quantity: 1

Part Number: 7770006266
S/N(s): LAT574
Description: SK-12805-RM
Material: 1022M
Heat Number: 434332
Heat Code: 11479-CD

TEST PARAMETERS

Instrument: EPOCH-650 Serial No.: 150068307 Date of Calibration: 08/14/16

Longitudinal Frequency	2.25	MHZ	Size	1"	Type	SINGLE	Serial No.	01XL5M			
Longitudinal Frequency		MHZ	Size		Type		Serial No.				
Longitudinal Frequency		MHZ	Size		Type		Serial No.				
Shear Wave Frequency		MHZ	Size		Type		Serial No.				

Couplant: SONOTECH UT-X
Calibration Standard(s):
Cable Type/Length: BCB-74-6
1/4" FBH 6"-20" S/N: 101-107
Surface Condition: MACHINED

Calibration Reference Level (dB)	0°	42.0	0°		0°		30°		45°		45°
Transfer Technique (dB)	0°	4.0	0°		0°		30°		45°		45°
Corrected Reference Level (dB)	0°	46.0	0°		0°		30°		45°		45°
Scanning Gain Correction (dB)	0°	6	0°		0°		30°		45°		45°

INSPECTION RESULTS

Acceptable: 1 Unacceptable: 0

Remarks: EASTHAM FORGE, INC.
REVIEWED BY Q.A.
DATE 11/04/16
BY

RAYMOND STEELEY JR.
TECHNICIAN (PRINT)

Raymond Steeley
TECHNICIAN SIGNATURE

LEVEL ☒ II ☐ III

APPROVED ☐ REJECTED

WITNESS

DATE

ASSISTANT

LEVEL ☐ I ☐ II

THIS REPORT IS EXPRESSLY LIMITED TO TEAM INDUSTRIAL SERVICES INTERPRETATION OF THE RESULTS OBTAINED FROM THE TEST SPECIFIED AND DOES NOT CONSTITUTE A RESPRESENTATION, WARRANTY OR GUARANTY OF THE ACTUAL CONDITION OF THE MATERIALS TESTED. TISI expressly disclaims any responsibility for any loss, cost, damage or expense, including personal injury or death, caused by or attributed to TISI misinterpretation of conditions or the performance of any test.

TEAM® Industrial Services
Personnel Qualification and Certification

Employee Name: Raymond W. Steeley **Employee ID#:** 910106

Vision Acuity Expiration Date: 6/16/2017

METHOD	LEVEL	DATE CERTIFIED	EXPIRATION DATE	GENERAL-I/II METHOD-III SCORE	SPECIFIC SCORE	PRACTICAL SCORE	COMPOSITE SCORE %	EXPERIENCE HOURS	TRAINING HOURS	LIMITED TO	COMMENTS
MT	II-L	7/1/2014	7/1/2017	100	90	96	95	5635	20	Yoke	
PT	II-L	7/1/2014	7/1/2017	85	80	97	87	1995	12	Type II	
UT	II	8/5/2014	8/5/2017	92	80	96	89	17304	80		
VT	II	1/21/2015	1/21/2018	80	825	95	86	2170	24		

The above named individuals qualification history has been reviewed and found to be acceptable IAW TEAM's requirements for certification; 33.G.103-S1, SNT-TC-1A-2011 and earlier editions (1992, 2001 and 2006), as published by the American Society for Nondestructive Testing and/or any additional certification standards listed in the comments section above.

Certifying Authority: _____ **Date:** 6/17/2016

Charles M. Lee
Corporate Level III
ASNT Cert # 58053

blr466

10-21-2016 02:42 GTM Metals Inc Cust. PO - 17390 Load - 2651743 BL - 20308875 Heat - W3F560 Order-Line - 14204791 / 1

SSAB

12400 Highway 43 North, Axis, Alabama 36505

Test Certificate

Form TC1: Revision 1: Date 31 Oct 2000

Customer:
KLOECKNER METALS CORPORATION
500 COLONIAL CENTER PARKWAY
SUITE 500
ROSWELL
GA 30076

Customer P.O.No.:6661572 | Mill Order No. 41-363345-02 | Shipping Manifest: AR161614

Product Description: ASTM A516-70(10)/ASME SA516-70(11A)
LCVN 25 FT.LBS.@-50F/A673-P

NORMALIZED

Size: 2.000 X 96.00 X 480.0 (IN)

Ship Date: 08 Jul 13
Cert Date: 08 Jul 13

Cert No: 081389775
(Page 1 of 1)

Tested Pieces:				Tensiles:						Charpy Impact Tests								
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir	Average Hardness	Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
W3F560	C30	2.007 (DISCRT)	L	50	72		37	T							
			T							181 143 150 158		-50F	L	10.	

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	Cev	ORGN
W3F560	.15	1.37	.008	.001	.22	.030	.030	.23	.12	.06	.06	.018	.006	.009	.0002	.43	USA

MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED
DURING THE MANUFACTURE OF THIS PRODUCT
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA.
NORMALIZED PLATES. HEATED AT 1665F FOR 78 MINUTES.
TEST COUPONS TAKEN FROM HEAT TREATED PLATE.
PRODUCTS SHIPPED:
W3F560 C30 6443547 PCES: 1, WGT: 26455

GTM Metals Inc.
Date 10-21-16
GTM Metals SO # 17891
Customer PO # 73679

(P) Cust Part #:

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION

Justin Ward
SENIOR METALLURGIST - PRODUCT

COMP-2

COMP. 3

YONGHYUN BASE MATERIALS

INSPECTION CERTIFICATE

3.1 According to ISO 10474/EN10204

YONGHYUN BASE MATERIALS CO., LTD.
84, BUKJEONGGONGDAN 1-GIL YANGSAN,
GYEONGSANGNAM-DO 626-110
REPUBLIC OF KOREA
Tel. : 82-55-379-2374
Fax.: 82-55-379-2392

Certificate No. : YH-14-IC-0429
Product Name : Seamless Carbon Steel Pipe
Project Name. : YP1400043
Delivery condition : As Rolled / Hot Finished
Finish of pipe ends : Bevelled

Customer :
Customer PO No. : 10P12515
Steel grade : ASTM A106 B/C-13 / A53 B-12 / ASME SA106 B/C & SA53 B-13 Ed. / API 5L-B X42 PSL1-45th Ed.
Issued date : 2014.08.07
Page : 1 of 1

Heat No.	Size (OD x Wall x Length) (Unit: inch, ft)	Quantity (pcs)	Mass (lb)	Mechanical Property													
				T/P No.	*1	Tensile Test *3					Impact Test					Hardness	Remark
						Size of Test Specimen (inch)		Y.S (psi)	T.S (psi)	EL (%)		Temp (Notch)	Size (inch)			HRC	
						W X H	G.L	min.	min.	min.		ft.lbf			Avg	max.	
						3/4 X 0.688	2.0	42100	70000	27			1	2	3	22	
40125890	12.750" X 0.688"(S80) X 40'	6	17,746	2F92	L	3/4 X 0.705	2.0	55881	81050	33	-	-				6	
40219440	12.750" X 0.688"(S80) X 40'	10	35,491	2F90	L	3/4 X 0.709	2.0	60618	82671	30	-	-				6	
								BLANK									

Heat No.	*4	Chemical Composition (%)																
		C	Si	Mn	P	S	Ni	Cr	Mo	Cu	V	Nb	Ti	Nb+V	Nb+V+Ti	B	Ni+Cr+Mo+Cu+V
		max.	min.	max.	max.	max.	max.	max.	max.	max.	max.			max.	max.	max.	max.
		0.28	0.10	1.20	0.030	0.030	0.40	0.40	0.15	0.40	0.08			0.06	0.15	0.001	1.0
40125890	L	0.18	0.24	1.11	0.017	0.005	0.01	0.08	0.02	0.04	0.02	0.01	-	0.03	-	0.0009	0.2
	P	0.20	0.25	1.10	0.018	0.004	0.02	0.07	0.02	0.03	0.02	0.01	0.004	0.03	0.03	0.0008	0.2
	P	0.19	0.25	1.12	0.018	0.004	0.02	0.08	0.02	0.02	0.02	0.01	0.005	0.03	0.04	0.0008	0.1
40219440	L	0.19	0.24	1.11	0.012	0.004	0.01	0.07	0.01	0.04	0.02	0.02	-	0.04	-	0.0008	0.2
	P	0.20	0.25	1.05	0.014	0.004	0.02	0.06	0.01	0.03	0.02	0.01	0.002	0.03	0.03	0.0009	0.1
	P	0.20	0.27	1.07	0.012	0.003	0.02	0.05	0.01	0.02	0.02	0.01	0.003	0.03	0.03	0.0008	0.1
									BLANK								

Heat treatment *2	Ultrasonic Test	Dimension & Visual Inspection	Hydrostatic Test (2,970psi) Holding Time : 6sec.	Flattening Test	
Not applicable	Accepted	Accepted	Accepted	Accepted	

[Remarks]
* Fully killed steel. / * NACE MR0175 / NACE MR0103 / ISO 15156 : Hardness guaranteed. / * No weld repair was performed.

*1: L=Longitudinal, T=Tangential, Tr=Transverse
*2: N=Normalized, Q=Quenched, T=Tempered, S.R= Stress Relieved
A.C=Air Cooled, F.C=Furnace Cooled, W.C=Water Cooled, O.C=Oil Cooled,
*3: Y.S=Yield Strength, T.S=Tensile Strength, E.L=Elongation, R.A=Reduction of Area, W=Width, H=Height, D=Diameter, G.L=Gage Length,
*4: L=Ladle Analysis, P=Product Analysis

L.A. TURBINE CO PO#:
23668 JOB LAT574

DESCRIPTION:
12" S80 (.688) SMLS PIPE SA106
GR B X 14" OAL HT# 40125890
PN 7770006265-3 COMPRESSOR CASE

We hereby certify that the material herein has been made and tested in accordance with the above specification and also with the requirement called for by the above order.

S.H. Lee 8/09-14'
Quality Assurance Team Deputy G/Manager

D.

A4

SSAB

Test Certificate

12400 Highway 43 North, Axis, Alabama 36505, US

Form TC1: Revision 2: Date 23 Apr 2014

10-21-2016 02:42 GTM Metals Inc Load - 2651743 BL - 2030875
Cust. PO - 17390 Heat - E6B314 blr466
Order-Line - 1420791 / 2

Customer:	Customer P.O.No.:7016465	Mill Order No. 41-458348-01	Shipping Manifest: AR221873
KLOECKNER METALS CORPORATION 500 COLONIAL CENTER PARKWAY SUITE 500 ROSWELL GA 30076	Product Description: ASTM A516-70(10/15)/ASME SA516-70(15) A573-70(13), 0.20% MAX CARBON	Ship Date: 21 Mar 16 Cert Date: 21 Mar 16	Cert No: 081549087 (Page 1 of 1)
	Size: 0.750 X 96.00 X 480.0 (IN)		

Tested Pieces:				Tensiles:						Charpy Impact Tests							
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir	Hardness	Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
E6B314	D85	0.747 (DISCRT)	L	49	74		27	T							

Chemical Analysis

Heat Id	C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	ORGN
E6B314	.19	1.00	.014	.001	.24	.028	.027	.22	.12	.12	.03	.001	.007	.009	.0001	USA

KILLED STEEL
MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT.
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA.
PRODUCTS SHIPPED:
E6B314 D85 PCES: 1, LBS: 9801

GTM Metals Inc.
Date 10-26-16
GTM Metals SO # 17946
Customer PO # 23479

(P) Cust Part #:

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION

Justin Ward
SENIOR METALLURGIST - PRODUCT

COMP-4

COMP - 5

10-21-2016 02:42 Load - 2651743 BL - 20308875 blr466

GTM Metals Inc Heat - W4E703

Cust. PO - 17390 Order-Line - 14204791 / 3

SSAB

Test Certificate

12400 Highway 43 North, Axis, Alabama 36505, US

Form TC1· Revision 2: Date 23 Apr 2014

Customer:
KLOECKNER METALS CORPORATION
500 COLONIAL CENTER PARKWAY
SUITE 500
ROSWELL
GA 30076

Customer P.O.No.:6802337 | Mill Order No. 41-399042-02 | Shipping Manifest: AR162377

Product Description: ASTM A516-70(10)/ASME SA516-70(13)
A573 70(13)

Ship Date: 27 May 14 | Cert No: 081445787
Cert Date: 27 May 14 | (Page 1 of 1)

Size: 1.500 X 120.0 X 480.0 (IN)

Tested Pieces:				Tensiles:						Charpy Impact Tests									
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir	Hardness	Abs. Energy(FTLB) 1	2	3	Avg	% Shear 1	2	3	Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
W4E703	A53	1.503 (DISCRT)	L	48	75		23	T													

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	ORGN
W4E703	19	1.07	012	002	24	031	030	27	15	16	06	000	005	009	0003	USA

KILLED STEEL
MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY HAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT.
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA.
PRODUCTS SHIPPED:
W4E703 A53 PCES: 1, LBS: 24503

(P) Cust Part #:

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION

Justin Ward +1 251 662 4400
SENIOR METALLURGIST - PRODUCT

GTM Metals Inc.
Date 10-20-16
GTM Metals SO # 17883
Customer PO # 73679

AKCELİK Demir Çelik Sanayi ve Ticaret A.Ş.

KALİTE BELGESİ
MILL TEST CERTIFICATE / QUALITY CERTIFICATE
(EN 10204 3.1)

TARİH / DATE:	08.11.2015
BELGE NO / DOCUMENT NO:	16

SİPARİŞ BİLGİLERİ / ORDERING INFORMATION

MÜŞTERİ / CUSTOMER	JOHANNESSEN TRADING CO.			KALİTE / QUALITY	GR1018
AKÇELİK SİPARİŞ NO / AKCELIK ORDER NO		AĞIRLIK / WEIGHT (Kg.)		DÖKÜM NO /HEAT NO	1606312
MÜŞTERİ SİPARİŞ NO /CUSTOMER ORDER NO	B-8389	ADET / BUNDLE		TESLİM DURUMU / DELIVERY CONDITION	Cold Drawn
AKÇELİK İRSALİYE NO / DISPATCH NOTE		BOY / LENGTH (Feet)	20(-0/+2 IN)	KESİT / DIMENSION (inches)	Ø 1/2

ÜRÜN KİMYASAL KOMPOZİSYONU / PRODUCT CHEMICAL COMPOSITION

ELEMENT	C		Si		Mn		P		S		Cr		Mo		Ni		Pb													
Aralık / Range	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.												
	0,15	0,20	0,00	0,35	0,60	0,90	0,000	0,030	0,000	0,050	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00												
%	0,16		0,18		0,65		0,011		0,019		-		-		-		-													

MEKANİK ÖZELLİKLER / MECHANICAL PROPERTIES

AKMA MUKAVEMETİ YIELD STRENGTH (psi)	ÇEKME MUKAVEMETİ TENSILE STRENGTH (psi)	% UZAMA ELONGATION (%)	% KESİT DARALMASI REDUCTION OF AREA (%)	ÇENTİK DARBE IMPACT VALUE (J)	SERTLİK HARDNESS	TANE BOYUTU GRAIN SIZE	DEKARBÜRİZASYON DECARBURIZATION (mm)	EZME ORANI REDUCTION RATIO
100078	106313	8,6	-	-	215HB	-	-	-

MİKRO TEMİZLİK / NON - METALLIC INCLUSIONS

DIN 50602

K2:	-	K4:	-	K5:	-

ASTM E 45

A		B		C		D	
İNCE THIN	KALIN HEAVY	İNCE THIN	KALIN HEAVY	İNCE THIN	KALIN HEAVY	İNCE THIN	KALIN HEAVY
-	-	-	-	-	-	-	-

SERTLEŞEBİLİRLİK / END QUENCH TEST (HRC)

1,5	3	5	7	9	11	13	15
-	-	-	-	-	-	-	-
30	28	30	36				
-	-	-	-	-	-	-	-

AÇIKLAMALAR / STATEMENTS

- Description of goods: PRIME NEWLY PRODUCED COLD DRAWN ROUND BARS ACCORDING TO GR.1018, LATEST REVISION ASTM A108 AND A29, IN LENGTHS OF 20 FEET (-0 / +2 IN) WITH UNIFORM PIECE COUNT PER BUNDLE.
- Documentary Credit Number: IMPTX100208
- THE MATERIAL IS PRIME NEWLY PRODUCED COLD DRAWN ROUND BARS ACCORDING TO GR.1018, LATEST REVISION ASTM A108 AND A29, IN LENGTHS OF 20 FEET (-0 / +2 IN) WITH UNIFORM PIECE COUNT PER BUNDLE

Kalite Güvence Temsilcisi
Quality Assurance Representative
Ahmet TAKPAK

KALİTE GÜVENCE QUALITY ASSURANCE

Akçelik, yukarıda belirtilen test değerlerinin üretici firmanın belgelerinde belirtilen değerler olduğunu teminât eder.
(Akçelik guarantee that the test values mentioned above, has same values with which determined in suppliers document.)

İzmir : Tel 0232 376 74 32 Pbx. Fax 0232 376 74 34
Çeyrova : Tel 0262 658 89 52 Pbx. Fax 0262 658 99 75
Konya : Tel 0332 346 19 48 Pbx. Fax 0332 346 23 91
Ankara : Tel 0312 815 49 60 Pbx. Fax 0312 815 49 61
Esenyurt : Tel 0212 886 36 28 Pbx. Fax 0212 886 36 29
www.akcelik.com.tr

GTM Metals Inc.
Date 10-21-15
GTM Metals SO # 17833
Customer PO # 23679

Comp-6

L.A. TURBINE CO PO#:
23668 JOB LAT573

DESCRIPTION:
10" 300# ANSI RF SO FLNG SA105
HEAT# 976 PN 7760000013-7
COMPRESSOR CASE

SO#: 1028090, SO Line: 6, Item: 10 300 RF SO FLG A/SA 105 SUD, Heat # 976, Customer ID: DUHLOS, Customer PO: G9233G

SUDHIR FORGINGS (P) LTD.

SUDHIR FORGINGS PVT.LTD

KANGANWAL ROAD,P.O.JUGIANA,
G.T.ROAD,LUDHIANA (INDIA)

Control No. TC/01
Rev. 01

TEST CERTIFICATE

(in accordance with BS EN 10204 3.1 B)

ITEM	10" 300 SORF	CERTIFICATE No.	SF/FLANGE/0220/015 DATED 1-Feb-2016
QUANTITY	15 PCS.	LAB Ref. No.	976
FINISH	BLACK PAINT	CUSTOMER NAME	FFF; USA
MAT. SPECIFICATION	ASTM A105-10 / ASTM A105-10A	INVOICE No.	SF/2015-16/025
P.O. No.	212870 DT. 9-Feb-2016	INVOICE DATE	1-Feb-2016

Heat No.	Supplier Heat No.	Description	Chemical Analysis											
			C%	Mn%	P%	S%	Si%	Cu%	Ni%	Cr%	Mo%	V%	TOTAL % (Cu+Ni+Cr+Mo+V)	TOTAL % (Cr+Mo)
976	16A-154	Specified	0.25 max	0.60 - 1.05	0.035 max	0.040 max	0.10 - 0.35	0.40 max	0.40 max	0.30 max	0.12 max	0.08 max	1.00 max	0.32 max
		Observed	0.210	0.820	0.033	0.032	0.186	0.020	0.016	0.082	0.009	0 000	0.129	0.091

Heat No.	Supplier Heat No.	Description	Physical / Mechanical Properties				
			UTS MPa	YIELD Mpa	Elongation%	R.A.%	Hardness (HBW)
976	16A-154	Specified	485 min	250 min	22 min	30 min	187 max
		Observed	563.34	317 19	37.28	70 40	156

REMARKS.

- Material is in accordance with NACE STD, MR-0175/ISO-15156
- Flanges satisfy the requirement of latest revision of ANSI /ASME B16.5 ASTM A105-10/ASTM A105-10a MSS SP-25
- The product is free of radiation & The product is free from weld repair
- We certify that the Material Suits the Requirement of P.O./Relevant specifications.
- Flanges have serrated face as per MSS-SP-6 within the limit of 125 - 250 RMS.
- Flanges are painted with black paint & Marked as. SF 10 SORF 300 A105 B16.5 976 INDIA

FOR SUDHIR FORGINGS PVT. LTD

Q.C. Engg.

Q.C. Mgr

COMP-7

Manufacturer: ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/1 ROMAN, NEAMT COUNTY, ROMANIA	**MILL TEST CERTIFICATE** according to EN 10204/3.1/2004	Page 1/5 B 4292/1 31.07.2014	ArcelorMittal

Buyer:	ARCELOR INTERNATIONAL AMERICA LLC. 1 South Dearborn Street, 13th Floor Chicago, IL 60603-9888 USA
Buyer's reference	AMI ORDER: 10087599 PO NUMBER: 10P11874SHE
Contract	50001665

SEAMLESS STEEL PIPE

Total weight:	Total Length:	Pieces	Bundles
118.537 tons 261 330 lbs	1 234.97 meters 4 051.65 feets	105	-

Standard: API 5L-ed.45-2012-PSL 2; ASTM A106/A 106M-2013;ASME SA 106/SA 106M-2013;NACE MR 0175-1&2-2009

Item	Item Client
4	-

Dimensions: 273.00 x 15.09 mm 10.750 X 0.594 inch | Schedule: 80 | Length: 11.00 - 12.20 m | 36.09 - 40.03 feet

Hydro Test:	Bar	PSI	MPa	Time(sec)
	205	2970	20.5	5

Steel Grade: GrB/GrBR/X42R/GrC -

Chemical Analysis(%)

Heat	Bulletin No.	Product Req.		C	Mn	Si	S	P	Cr	Ni	Cu	Mo	V	Nb	Ti	B
			Max	0.24	1.06	0.40	0.015	0.025	0.30	0.30	0.40	0.15	-	-	0.040	0.0010
			Min	-	0.29	0.10	-	-	-	-	-	-	-	-	-	-
51120		Heat analysis		0.18	1.00	0.22	0.005	0.013	0.08	0.08	0.17	0.03	0.010	0.001	0.001	0.0002
49987		Heat analysis		0.18	1.07	0.27	0.005	0.009	0.04	0.06	0.16	0.02	0.005	0.001	0.002	0.0003
51118		Heat analysis		0.18	1.02	0.25	0.006	0.012	0.06	0.09	0.18	0.03	0.007	0.001	0.002	0.0002
51119		Heat analysis		0.18	1.00	0.23	0.004	0.012	0.06	0.09	0.18	0.03	0.007	0.001	0.002	0.0002
51120	14-1605	Product analysis		0.19	1.03	0.22	0.005	0.011	0.08	0.08	0.16	0.02	0.008	0.002	0.000	0.0000
51120	14-1605	Product analysis		0.18	1.03	0.21	0.005	0.011	0.08	0.08	0.16	0.02	0.007	0.002	0.000	0.0000
49987	14-1258	Product analysis		0.18	1.08	0.30	0.004	0.008	0.06	0.07	0.17	0.01	0.009	0.002	0.000	0.0000
49987	14-1258	Product analysis		0.18	1.08	0.29	0.004	0.008	0.06	0.07	0.17	0.01	0.009	0.002	0.000	0.0000
51118	14-1605	Product analysis		0.20	1.02	0.24	0.005	0.009	0.06	0.09	0.17	0.02	0.003	0.002	0.000	0.0000
51118	14-1605	Product analysis		0.20	1.03	0.24	0.005	0.010	0.06	0.09	0.17	0.02	0.002	0.002	0.000	0.0000
51119	14-1706	Product analysis		0.18	1.02	0.18	0.006	0.016	0.07	0.06	0.16	0.01	0.004	0.002	0.000	0.0000
51119	14-1706	Product analysis		0.18	1.02	0.19	0.005	0.016	0.07	0.06	0.15	0.01	0.004	0.002	0.000	0.0000

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Formular 12A, rev.9

L.A. TURBINE CO PO#:
23668 JOB LAT574

DESCRIPTION:
10" S80 (.594) SMLS PIPE SA106
GR B X 13-1/2" OAL HT# 51118
PN 7770006265-8 COMPRESSOR CASE

COMP-8

Manufacturer: ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/I ROMAN, NEAMT COUNTY, ROMANIA	**MILL TEST CERTIFICATE** according to EN 10204/3.1/2004	Page 2/5	ArcelorMittal
		B 4292/1	
		31.07.2014	

Buyer: ARCELOR INTERNATIONAL AMERICA LLC. 1 South Dearborn Street, 13th Floor Chicago, IL 60603-9888 USA	SEAMLESS STEEL PIPE	Total weight: 118.537 tons 261 330 lbs	Total Length: 1 234.97 meters 4 051.65 feets	Pieces 105	Bundles -
Buyer's reference: AMI ORDER: 10087599 PO NUMBER: 10P11874SHE	Standard: API 5L-ed.45-2012-PSL 2; ASTM A106/A 106M-2013;ASME SA 106/SA 106M-2013;NACE MR 0175-1&2-2009				
Contract: 50001665	Dimensions: 273.00 x 15.09 mm 10.750 X 0.594 inch	Schedule: 80	Length: 11.00 - 12.20 m		36.09 - 40.03 feet

Item	Item Client
4	-

Hydro Test:	Bar	PSI	MPa	Time(sec)
	205	2970	20.5	5

Steel Grade: GrB/GrBR/X42R/GrC -

Chemical Analysis(%)

Heat	Bulletin No.	Product Req.		Nb + V	Cr + Mo + Ni + Cu + V	CE_IIW
			Max	0.060	1.000	0.43
			Min	-	-	-
51120		Heat analysis		0.011	0.370	0.39
49987		Heat analysis		0.006	0.285	0.39
51118		Heat analysis		0.008	0.367	0.39
51119		Heat analysis		0.008	0.367	0.38
51120	14-1605	Product analysis		0.010	0.348	0.40
51120	14-1605	Product analysis		0.009	0.347	0.39
49987	14-1258	Product analysis		0.011	0.319	0.39
49987	14-1258	Product analysis		0.011	0.319	0.39
51118	14-1605	Product analysis		0.005	0.343	0.40
51118	14-1605	Product analysis		0.004	0.342	0.41
51119	14-1706	Product analysis		0.006	0.304	0.38
51119	14-1706	Product analysis		0.006	0.294	0.38

$CEpcm = C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo/15+V/10+5B$ $CE_S = C+Mn/6$ $CE_{IIW} = C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15$

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative

Manufacturer:	MILL TEST CERTIFICATE	Page 3/5	ArcelorMittal
ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/1 ROMAN, NEAMT COUNTY, ROMANIA	according to EN 10204/3.1/2004	B 4292/1 31.07.2014	

Buyer:	SEAMLESS STEEL PIPE	Total weight:	Total Length:	Pieces	Bundles
ARCELOR INTERNATIONAL AMERICA LLC. 1 South Dearborn Street, 13th Floor Chicago, IL 60603-9888 USA		118.537 tons 261 330 lbs	1 234.97 meters 4 051.65 feets	105	-

Buyer's reference	Standard:
AMI ORDER: 10087599 PO NUMBER: 10P11874SHE Contract 50001665	API 5L-ed.45-2012-PSL 2; ASTM A106/A 106M-2013;ASME SA 106/SA 106M-2013;NACE MR 0175-1&2-2009

Dimensions: 273.00 x 15.09 mm 10.750 X 0.594 inch	Schedule: 80	Length: 11.00 - 12.20 m	36.09 - 40.03 feet

Item	Item Client	Hydro Test:	Bar	PSI	MPa	Time(sec)	Steel Grade: GrB/GrBR/X42R/GrC
4	-		205	2970	20.5	5	-

Tensile Test

Heat	Orientation	Length		Width/Diameter		Thickness		Section		Mechanical test Bulletin No.	YS MPa	YS (PSI:1000)	UTS MPa	UTS (PSI:1000)	E %	YS/UTS max: -
		mm	inch	mm	inch	mm	inch	mm²	inch²							
51120	Longitudinal Flat	50.8	2	38.10	1.500	15.30	0.602	582.9	22.950	14-2560	371.00	53.8	554.00	80.4	51.50	0.67
51120	Transversal Flat	50.8	2	38.10	1.500	15.70	0.618	598.2	23.550	14-1752B	427.00	61.9	541.00	78.5	34.10	0.79
49987	Longitudinal Flat	50.8	2	38.10	1.500	16.10	0.634	613.4	24.150	14-2560	358.00	51.9	565.00	81.9	54.30	0.63
49987	Transversal Flat	50.8	2	38.20	1.504	15.60	0.614	595.9	23.461	14-1752B	457.00	66.3	556.00	80.6	32.40	0.82
51118	Longitudinal Flat	50.8	2	38.10	1.500	15.20	0.598	579.1	22.800	14-2560	369.00	53.5	558.00	80.9	51.60	0.66
51118	Transversal Flat	50.8	2	38.20	1.504	15.40	0.606	588.3	23.161	14-1752B	455.00	66.0	553.00	80.2	31.90	0.82
51119	Longitudinal Flat	50.8	2	38.10	1.500	15.30	0.602	582.9	22.950	14-2560	405.00	58.7	581.00	84.3	49.70	0.70
51119	Transversal Flat	50.8	2	38.20	1.504	15.60	0.614	595.9	23.461	14-1752B	437.00	63.4	550.00	79.8	32.90	0.79

Impact Test

Heat	Impact Test Bulletin No.	Orientation	Size (mm)	Temp. (°C)	Req.KV (min. J)	KV values (J)			Req.Avr. (min. J)	Avr. fracture energy (J)	KCU min:-J/cm² T:°C			Shear Area min. %			Lateral Expansion min. mm		
51120	14-4241	Transversal	10x10x55	0	-	88	97	77	27.0	87	-	-	-	90	90	90	0.94	1.03	0.84
49987	14-4241	Transversal	10x10x55	0	-	35	36	38	27.0	36	-	-	-	85	85	85	0.36	0.38	0.42
51118	14-4241	Transversal	10x10x55	0	-	111	83	63	27.0	86	-	-	-	90	90	90	1.15	0.93	0.78
51119	14-4241	Transversal	10x10x55	0	-	130	111	114	27.0	118	-	-	-	95	90	90	1.35	1.14	1.18

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative

Manufacturer: ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/1 ROMAN, NEAMT COUNTY, ROMANIA	**MILL TEST CERTIFICATE** according to EN 10204/3.1/2004	Page 4/5 B 4292/1 31.07.2014	ArcelorMittal

Buyer: ARCELOR INTERNATIONAL AMERICA LLC. 1 South Dearborn Street, 13th Floor Chicago, IL 60603-9888 USA	SEAMLESS STEEL PIPE	Total weight: 118.537 tons 261 330 lbs	Total Length: 1 234.97 meters 4 051,65 feets	Pieces 105	Bundles -
Buyer's reference AMI ORDER: 10087599 PO NUMBER: 10P11874SHE	Standard: API 5L-ed.45-2012-PSL 2; ASTM A106/A 106M-2013;ASME SA 106/SA 106M-2013;NACE MR 0175-1&2-2009				
Contract 50001665	Dimensions: 273.00 x 15.09 mm 10.750 X 0.594 inch	Schedule: 80	Length: 11.00 - 12.20 m	36.09 - 40.03 feet	

Item	Item Client	Hydro Test:	Bar	PSI	MPa	Time(sec)	Steel Grade: GrB/GrBR/X42R/GrC -
4	-		205	2970	20.5	5	

ardness Test

Heat	Hardness Test Bulletin No.	HB max.-	HV 10 max.-	HV 10 max.-					HRC max.22
				OD	Midwall	ID	End A	End B	
51120	14-1791	-	-	-	-	-	-	-	<22
49987	14-1791	-	-	-	-	-	-	-	<22
51118	14-1791	-	-	-	-	-	-	-	<22
51119	14-1791	-	-	-	-	-	-	-	<22

Technological/Microstructure Test

Heat	Flattening Test Bulletin No.	Flattening Test
51120	14-2083	OK
49987	14-2083	OK
51118	14-2083	OK
51119	14-2083	OK

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative

Manufacturer: ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/1 ROMAN, NEAMT COUNTY, ROMANIA	**MILL TEST CERTIFICATE** according to EN 10204/3.1/2004	Page 5/5 B 4292/1 31.07.2014	ArcelorMittal

Buyer: ARCELOR INTERNATIONAL AMERICA LLC. 1 South Dearborn Street, 13th Floor Chicago, IL 60603-9888 USA	SEAMLESS STEEL PIPE	Total weight: 118.537 tons 261 330 lbs	Total Length: 1 234.97 meters 4 051.65 feets	Pieces 105	Bundles -

Buyer's reference	AMI ORDER: 10087599 PO NUMBER: 10P11874SHE
Contract	50001665

Standard:	API 5L-ed.45-2012-PSL 2; ASTM A106/A 106M-2013;ASME SA 106/SA 106M-2013;NACE MR 0175-1&2-2009

Dimensions: 273.00 x 15.09 mm 10.750 X 0.594 inch	Schedule: 80	Length: 11.00 - 12.20 m	36.09 - 40.03 feet

Item	Item Client
4	-

Hydro Test:	Bar	PSI	MPa	Time(sec)
	205	2970	20.5	5

Steel Grade: GrB/GrBR/X42R/GrC
-

Heat	Pieces	Length (m)	Weight (kg)
51120	17	-	-
49987	62	-	-
51118	17	-	-
51119	9	-	-

Remarks Manufacturing process – hot rolling.
Steel is fully killed and produced by electric furnace, Arcelor Mittal Hunedoara S A – Piata Iancu de Hunedoara, nr.1 – Hunedoara .
Visual inspection and dimensional check without objection.
Electromagnetic testing : Le+Li (12.5 % from W.T.) – satisfactory.
Wet magnetical particles testing on the pipe ends – satisfactory.
Magnetism residual checked– satisfactory.
Hydrostatic test hold for min.5 sec. no leakage noticed .
For each reduction of 0.01% below the specified carbon maximum, on increase of 0.05% manganese above the specified maximum will be permitted up to a maximum of 1.35%.

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative

Doina Nistor

Digitally signed by Doina Nistor
Date: 2014.08.12 12:12:41 +03:00
Reason: Acrobat, Location: Roman

comp - 10

Phoenix * Capitol * Camco CapProducts

Certified Mill Test Report

Heat Code: 128FFFF
Heat Number: 133510
Item: 12202005: 1/2 FS 3M THD COUPLING

Material: ASTM A105-2011a / ASME SA105-2010 Edition

Chemistry Properties

C	Mn	P	S	Si	Cu	Cr
0.2100	0.9400	0.0060	0.0290	0.2200	0.1700	0.0980
Ni	**Mo**	**V**	**Co**	**Al**	**Cb**	**N**
0.0640	0.0180	0.0340				
Pb	**Sn**	**Ta**	**Ti**	**C Eq. Long**		
				0.4123		

Additional Chemical Properties

Mechanical Properties

Tensile(PSI)	Yield(PSI)	Elong. % in 2 in. or 4D	Reduction	HBW	HBW 2
84500	55000	26%	60	170	174

Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Avg.	Test Temp.

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements. We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

L.A. TURBINE CO PO#:
20690 JOB LAT561

DESCRIPTION:
1/2 3M SCRD COUPLING SA105
MR0715 NACE CERT HT# 128FFFF

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

COMPRESSOR CASE

WELDS VISUAL INSPECTION OF COMP. CASE FABRICATION

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: COMPRESSOR CASE

PART NUMBER: 7770006265

THIS IS TO CERTIFY THAT VISUAL INSPECTION HAS BEEN PERFORMED IN ACCORDANCE WITH ASME SEC. VIII ON THE **COMPRESSOR CASE FABRICATION WELDS.** THE INSPECTION RESULTS HAVE BEEN FOUND SATISFACTORY.

INSP. PERFORMED BY: _____ 3-8-17
Hung Phung, QC Inspector **DATE**

INSP. CONFIRMED BY: _____ 3/8/17
Frank Loth, Quality Manager **DATE**

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

COMPRESSOR INLET SPACER

WELDS VISUAL INSPECTION OF FABRICATION

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: COMPRESSOR INLET SPACER

PART NUMBER: 7770006269

THIS IS TO CERTIFY THAT VISUAL INSPECTION HAS BEEN PERFORMED IN ACCORDANCE WITH ASME SEC. VIII ON THE **COMPRESSOR INLET SPACER FABRICATION WELDS.** THE INSPECTION RESULTS HAVE BEEN FOUND SATISFACTORY.

INSP. PERFORMED BY: Hung Phung, QC Inspector — 1/20/17 **DATE**

INSP. CONFIRMED BY: Frank Loth, Quality Manager — 1/20/17 **DATE**

element

Element Materials Technology
18100 S Wilmington Avenue
Rancho Dominguez, CA
90220-5909 USA

P 310 632 8500
F 310 632 4700
T 888 786 7555
info.rd@element.com
element.com

****CORRECTED TEST CERTIFICATE - EAR-CONTROLLED DATA****

L.A. Turbine Corporation
28557 Industry Drive
VALENCIA, CA 91355

Date 1/31/2017
Purchase Order Number 24566
Work Order Number LAT009-01-25-14729

Item No. 1

P/N:	COMPRESSOR CASE
Description:	LAT569
Lat Job#:	LAT574
Job ID:	LAT574

NONDESTRUCTIVE TESTING

Item No.	Quantity	Method	Quantity Inspected	Quantity Conformed	Quantity Rejected	Date	Insp. Stamp No.
1	1	Magnetic Particle	1	1	0	1/31/2017	M62

Magnetic Particle Inspection Per ASME Section V Article 7 2015 Edition &
ASME Section VIII Division 1 Appendix 6 2015 Edition
Per DWG7770006265 Rev1
MT-1 Rev. Q
Standard Attachment #6 Rev 1

Gustavo Moran Sr.
Magnetic Particle Level 2 Rancho Dominguez

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MH 2/7/17 Corrected Cert per original PO fixed description

Accredited Nadcap™

NDT

Chem Process

Respectfully Submitted

Gustavo Moran Sr.
Magnetic Particle Level 2 Rancho Dominguez

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Customer Quality Clauses Apply as Specified.

element

Element Materials Technology
18100 S Wilmington Avenue
Rancho Dominguez, CA
90220-5909 USA

P 310 632 8500
F 310 632 4700
T 888 786 7555
info.rd@element.com
element.com

TEST CERTIFICATE - EAR-CONTROLLED DATA

L.A. Turbine Corporation
28557 Industry Drive
VALENCIA, CA 91355

Date: 12/29/2016
Purchase Order Number: 24093
Work Order Number LAT009-12-22-13657

Item No. 1	P/N:	LAT574
	Description:	COMPRESSOR INLET SPACER
	Lat Job#:	LAT574
	Job ID:	LAT574
	DWG	DWG7770006269 Rev0
Item No. 2	P/N:	LAT573
	Description:	COMPRESSOR INLET SPACER
	Lat Job#:	LAT573
	Job ID:	LAT573
	DWG	DWG7770006206 Rev0

NONDESTRUCTIVE TESTING

Item No.	Quantity	Method	Quantity Inspected	Quantity Conformed	Quantity Rejected	Date	Insp. Stamp No.
1	1	Magnetic Particle	1	1	0	12/29/2016	M49
2	1	Magnetic Particle	1	1	0	12/29/2016	M49

Magnetic Particle Inspection Per ASME Section V Article 7 2015 Edition &
ASME Section VIII Division 1 Appendix 6 2015 Edition
Per DWG7770006206 Rev0
MT-1 Rev. Q
Standard Attachment #6 Rev.1
Magnetic Particle Inspection Per ASME Section V Article 7 2015 Edition &
ASME Section VIII Division 1 Appendix 6 2015 Edition
Per DWG7770006269 Rev0
MT-1 Rev. Q
Standard Attachment #6 Rev.1

Filiberto Reyes – MT Level II Rancho Dominguez

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Respectfully Submitted

Accredited Nadcap™

NDT

Chem Process

Filiberto Reyes – MT Level II Rancho Dominguez

The information contained in This certification represents only the material submitted and is certified only for the quantities tested. Reproduction except in full is reserved pending written approval. All testing was performed in a mercury-free environment. All work is performed in accordance to Element Terms & Conditions.

Customer Quality Clauses Apply as Specified.

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

COMPRESSOR CASING

HYDROSTATIC PRESSURE TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: COMPRESSOR CASING

PART NUMBER: 7770006265

THIS IS TO CERTIFY THAT **COMPRESSOR CASING** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER, HAS SUCCESSFULLY PASSED THE HYDROSTATIC PRESSURE TEST PERFORMED AT THE INDICATED CONDITIONS:

DESIGN PRESSURE: 650 PSIG

TEST PRESSURE: 975 PSIG

TEST MEDIUM: WATER

HOLDING TIME: 30 MINUTES

PRESSURE GAUGE S/N: LAT 060

CALIBRATION DUE DATE: 08/04/2017

TEST PERFORMED BY: _____ 3-16-17

Michael Martinez, Test Technician — DATE

TEST CONFIRMED BY: _____ 3/16/17

Frank Loth, Quality Manager — DATE

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Valencia, CA 91355

Tel: 661-294-8290

Fax: 888-674-6503

Certificate

COMPRESSOR INLET SPACER

HYDROSTATIC PRESSURE TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: COMPRESSOR INLET SPACER

PART NUMBER: 7770006269

THIS IS TO CERTIFY THAT **COMPRESSOR INLET SPACER** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER, HAS SUCCESSFULLY PASSED THE HYDROSTATIC PRESSURE TEST PERFORMED AT THE INDICATED CONDITIONS:

DESIGN PRESSURE: 650 PSIG

TEST PRESSURE: 975 PSIG

TEST MEDIUM: WATER

HOLDING TIME: 60 MINUTES

PRESSURE GAUGE S/N: LAT 060

CALIBRATION DUE DATE: 08/04/2017

TEST PERFORMED BY: _____ 3-16-17

Michael Martinez, Test Technician — DATE

TEST CONFIRMED BY: _____ 3/16/17

Frank Loth, Quality Manager — DATE

L.A.Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 3: BEARING HOUSING

- MATERIAL CERTIFICATION
- INSPECTION CERTIFICATE
- HYDROSTATIC TEST CERTIFICATE

OKLAHOMA FORGE, INC.

Certification of Analysis and Tests

INVOICE NUMBER
116-96502
Date: 11/09/16

Toll Free (866)909-5553
Local(918)446-5553 FAX (918)446-4150
e:Mail ~ sales@oklahomaforge.com
Web Site ~ www.oklahomaforge.com
5259 S. 49TH West Ave
Tulsa, OK 74107

Sold To	Your Purchase Order	Sales Order
L.A. TURBINE CORPORATION 28557 INDUSTRY DRIVE VALENCIA, CA 91355 USA	Number 23673 By LINDA DENNIS Dated 10/17/2016	Number 116-73934 Shipped Via CUSTOMER PICK UP Ship Date 11/09/2016

Item#	PART DESCRIPTION				Quantity
	Your Part Number	Shop Order Number	Shape	Dimensions	
		Supplier	Heat Number	Material Specifications	
	Chemical Analysis				
	Physical Properties			Charpy Impact (Ft.Lbs.)	
1	7770006247	116-73934-01	RING	23.000"OD x 3.000"ID x 12.500"TH	2
		NUCOR	165384	A/SA350-13 LF2 CL1 NORMALIZED	

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.17	1.18	.008	.0042	.22	.07	.11	.24	.02	.02	.0050	.026		.42	Sn-.009:Ti -.002

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
49,000	74,000	33	68	149			FINE	CVN	-50F	77	86	95	50

Notes:

I CERTIFY THAT THERE IS A TRUE COPY OF THE ORIGINAL TEST SHEET NOW ON FILE AT THE OFFICE OF OKLAHOMA FORGE, INC. AND THAT THIS MATERIAL WAS MELTED AND MANUFACTURED IN THE USA.

W. Upton

Anneal by heating to 1550 degrees F for one hour/inch of thinnest section. Slow cool furnace to 1200 degrees F then air cool by opening door.
Normalize by heating to 1675 degrees F, Hold at 1675 degrees F for one hour/inch of thinnest section and air cool.
Solution Anneal by heating to 1900-2050 degrees F and Water Quenching. BS EN 10204 3.1B.

F040-4/2014

13H-2

MILL TEST REPORT **TA CHEN INTERNATIONAL, INC.** This MTR contains 1 page (Page# 1)

Customer: DUHLOS PO#:H3487 SO#:LRHB54 **MTR#:ENFL1608024061.GI**

Item:F64L8W010 Heat#:GL849

ENFL1608024061

E N CORPORATION
Lot 2, 4 & 6, Block 16, Phase IV, Cavite Export Processing Zone Authority, PEZA, Rosario, Cavite, Philippines 4106
TEL : (+63) 46-437-1022-25 FAX : (+63)46-437-1018, 21

MILL TEST REPORT

PURCHASER : TA CHEN INTERNATIONAL, INC.

DATE : 2016/08/20
P. O. NO.: L58934-S
S/C NO. : Q150TC

PRODUCT : STAINLESS STEEL FORGED FLANGE RF

HEAT NO.	QTY.	DESIGNATION	SPECIFICATION
GL849	50	304L/304 1" W/N S-80 600LB	ASME B16.5-2013/MSS SP25-2013

CHEMICAL ANALYSIS OF MATERIAL

HEAT NO.	C	Mn	Si	P	S	Cr	Ni	Mo	N	SPECIFICATION
Maxi	0.030	2.00	1.00	0.045	0.030	18.0 - 20.0	8.0 - 11.0		0.100	ASTM A/SA182-2015
GL849	0.022	1.73	0.36	0.029	0.002	18.30	8.01		0.077	

MECHANICAL CHARACTERISTICS

HEAT NO.	T.S-PSI	Y.S-PSI	%-E.L.	%-R.A.	HEAT-TREAT.	HARDNESS	DIMENSION	P.M.I.
Mini	75,000	30,000	30	50	1040 - 1150 °C	≤90.0 HRB		
GL849	75,400	39,900	56	75	1060 °C	79.0 HRB	OK	OK

MATERIAL RESISTANT TO INTERCRYSTALLINE CORROSION ICC TEST ACCORDING TO ASTM A262-10 PRACTICE E. MATERIAL IS MANUFACTURED MERCURY FREE AND FREE FROM MERCURY CONTAMINATION AND RADIO ACTIVITY. MATERIAL IS IN ACCORDANCE WITH NACE MR0175-SECOND EDITION, MR0103-2007, ISO 15156-2009 COMPLIANT ISO 9001:2008, PED 97/23/EC CERTIFIED. EN10204:2005-3.1
MATERIAL RECEIVED SOLUTION TREAT & WATER QUENCHED AT 1060 DEGREE C.
MATERIAL WAS MANUFACTURED, SAMPLED, TESTED AND INSPECTED IN ACCORDANCE WITH ASTM A182-2015 AND ASTM A961-08A AND HAS BEEN FOUND TO MEET THE REQUIREMENTS. MATERIALS ARE FREE OF WELD REPAIR

Pb CONTENT, < 0.010%

COUNTRY OF ORIGIN. PHILIPPINES

COUNTRY OF MELT: TAIWAN

FACTORY INSPECTOR:

DAVID WANG
QUALITY ASSURANCE DEPARTMENT

F64L8W010

N-1608024061

SM-005-0

BA - 3

Pennsylvania Extruded Tube Company

P.O. Box 1280, Scranton, PA 18501 PH. (570) 585-7777

www.smt.sandvik.com
www.smt.sandvik.com/nafta

MATERIAL CERTIFICATE

Cert#: 201437017

Plant Location: 982 Griffin Pond Road, Clarks Summit, PA 18411

Sold To: 20000090
NIPPON & SUMIKIN EXTRUDED TUBE
NEW YORK, NY

Ship To:
GLOBAL STAINLESS SUPPLY
HOUSTON, TX

Customer Order No: 991948
Pexco Order No: 260877/3

Certification Date: 20141030

Quantity: 280 Pcs. @ 5652.82 FT

Work Order/Lot: 253501

PO# 203905

ASTM A312-13b, ASME SA-312, ASTM A376-13, ASME SA-376, ASME SECTION II 2013 Edition, NACE MR0175 / ISO 15156, NACE MR0103-2010

Hot Finished Seamless Pipe
Type TP304/TP304L

Size: 1" SCH 80
Heat: 540432

Material Manufacturer: Pennsylvania Extruded Tube Co. USA

ANALYSIS %

	C	Si	Mn	P	S	Cr	Ni
Heat	.014	.29	1.77	.028	.010	18.41	10.12
Prod	.015	.31	1.80	.030	.009	18.46	10.24

	Mo	Co	Cu	N
Heat	.39	.13	.22	.026
Prod	.40	.12	.22	.035

Mechanical Tests:

Yield Strength 0.2%		Yield Strength 1.0%		Tensile Strength		Elongation in %				Reduction Of Area
psi	MPa	psi	MPa	psi	MPa	E2"	E10"	E4d	E5d	%
50400	347.6		N/A	90400	623.4	50	N/A	N/A	N/A	N/A
52000	358.6			90300	622.8	49				

Hardness Test Results: 82HRBW, 88HRBW
Hydrostatic Test (psi): 2500

Tensile Test sample width (1=Full-Size 2=1/2" Strip): 2
Flattening Test per ASTM A999: Acceptable
Intergranular Corrosion Test per Mil-P-24691/3(A262 Pr E).
No. of samples: 1 Result: Acceptable
Hydro Pressure Test (5-second holdtime), psi: 2500
Country Of Origin: United States
The product was manufactured, sampled, tested, and inspected in accordance with ASTM A312/A376/A999 latest revisions and has been found to meet such requirements.
Material is in compliance with Global Stainless Supply Pipe Specification Form GSS 7.4.2-02 Revision Dtd 7/27/2011 and PEXCO counters/clarifications/exceptions dtd. 10/13/2011.
Inspection Certificate IAW EN 10204 3.1
Hardness test meets NACE MR0175/ISO 15156 and MR0103 requirements.
Heat number is traceable to the original melt.
Material has been hydrostatically tested in accordance with the referenced product specifications and ASTM A999 latest revision and has passed the specified test.
The grades 304L, 316L and TP317/317L are not covered by ASTM A376 or ASME SA376 specifications. Therefore, these specifications do not apply to these grades.

L.A. TURBINE CO PO#:
20908 JOB LAT560EC

DESCRIPTION:
1" S80 SMLS PIPE SA312 304/304L
COFO: USA HT# 540432

MATCERT

Material has not come in contact with Mercury or Mercury containing compounds. No weld repair or welding performed.
Material manufactured by Pennsylvania Extruded Tube Company (PEXCO), U.S.A. and meets the requirements of NAFTA Origin.
Material has been pickled and passivated.
Positive Material Identification performed and acceptable.
Material has been manufactured in accordance with PEXCO's Quality Manual R11 dated 11/25/13 (ISO 9001:2008 Certificate Certificate No.0109185, expiration date 3/31/15).
All material subjected to a solution annealing heat treatment at a temperature of 1900 deg.F minimum followed by rapid water quenching to below 800 deg.F in less than three (3) minutes.(via direct quench hot finish extrusion)
This is to certify that the contents of this Certificate are correct and accurate as contained in PEXCO's records, and that all above test results and operations performed are in compliance with the requirements of the purchase order and the specifications as outlined above. Test results represent the actual attributes of the items purchased unless stated otherwise in this Certificate.
Melt Source: AB SANDVIK MT, SWEDEN
Melt Method: Electric Arc Furnace-AOD Refining

Dana Kegerreis, Quality Mgr.
10 (90GSS R9) (35) HF (INFORLPI)

Authorized Representative

PO#: 262859 Pack#: 228865 Order#: 913440 Lot#: ulm.b0613 Desc: 2 300 RF WN FLG XH A/SA 105 NORM ULM

CLIENTE / Customer / Client

FORGINGS FLANGES&FITTINGS LLC.
8900 RAILWOOD DRIVE,
SUITE B
HOUSTON, TX 77078
USA

CERTIFICADO DE INSPECCION

Inspection Certificate - Certificat de Réception

DIN EN 10204 / 3.1
ISO 10474 / 3.1

FECHA / Date: 28/11/2013

N.º / No.: 161650

HOJA / Page: 1

ISO 14001 CERTIFIED SQS 1822164 · ISO 9001 CERTIFIED SQS 9003236 · OHSAS 18001 CERTIFIED SQS 9003947

ULMA

ULMA FORJA, S.COOP.
Management Systems certified by LRQA®

B.º Zubillaga, 3 - Apdo. 14
20560 OÑATI (Gipuzkoa) SPAIN
Tel.: 34 - 943 780552
Fax: 34 - 943 781806
E-mail: ulma@ulmapiping.com

Packing List: 106419

PRODUCTO / Article - Produit: FLANGES

SU PEDIDO N.º / Your Order No. / Votre Cde. N.º: 174150-HOUSTON

59846

DE / el. - de: 03/03/2013

NORMAS APLICABLES / Requirements - Normas Applicables: ASME B16.5-13

MATERIAL CORRESPONDIENTE / Material Correspondent - Qualité: ASME SA105M-13, ASTM A105M-13

MODO DE FUSION (*) / Steel Making - Elaboration de l'acier (E = Elec. Y = Oxigeno básico): NACE MR0175/ISO15156-2-09 & MR0103-12

Certified acc. PED 97/23/EC+AD2000-WO by TÜV Rheinland N.º 01 202 EAO 02 7443

MARCA DEL FABRICANTE / Mark of factory / Marque du fabricant

DEPARTAMENTO / Section / Département: QUALITY ASSURANCE

PARTIDA / Item / Poste	CANTIDAD / Quantity / Quantité	DESCRIPCION / Description / Description	OBSERVACIONES / Remarks / Observations (*)	COLADA N.º / Heat No / N.º Coulée	RESISTENCIA / T.Strength / Resist Rupt / N/mm²	LIMITE ELASTIC / Y.Strength / 0.2 % / N/mm²	ALARGAM. / Elongation / Allongement / Lo: 4 d / %	ESTRICCION / Red. Area / Striction / %	RESILIENCIA / Impact test / Résilience / Joules	CHARPY V 10x10mm PROBETA · EPROUVETTE		
										MEDIA / Average / Moyenne	ºC	DUREZA / Hardness / Dureté HBW
2 F16WA020	462	WN 2 150LB XS/80 RF A105N	NE	B11T3	509	315	31,30	51,80				149 164
14 F36WA020	116	WN 2 300LB XS/80 RF A105N	NE	29T1	518	301	29,00	65,80				150 158
14 F36WA020	20	WN 2 300LB XS/80 RF A105N	NE	A89T3	509	316	31,80	50,80				154 158
14 F36WA020	122	WN 2 300LB XS/80 RF A105N	NE	B06T3	509	314	32,40	50,70				147 154
14 F36WA020	462	WN 2 300LB XS/80 RF A105N	NE	B58T3	511	315	31,10	52,80				153 160
14 F36WA020	960	WN 2 300LB XS/80 RF A105N	NE	B60T3	510	306	29,80	54,20				145 152

COLADA N.º / Heat No / N.ºCoulée	COMPOSICION QUIMICA - STEEL MAKER'S LADLE ANALYSIS - ANALYSE CHIMIQUE																Origin of Steel
	C %	Si %	Mn %	P %	S %	Cr %	Ni %	Mo %	Nb %	V %	Cu %	Al %	Ti %	CEq %			
29T1	0,190	0,150	0,860	0,017	0,013	0,090	0,090	0,020	0,003	0,001	0,330	0,000	0,000	0,384			France
A89T3	0,184	0,228	0,929	0,011	0,020	0,201	0,124	0,028	0,003	0,002	0,325	0,000	0,000	0,415			Spain
B06T3	0,210	0,180	0,880	0,014	0,012	0,050	0,130	0,020	0,006	0,001	0,270	0,000	0,000	0,398			France
B11T3	0,200	0,180	0,870	0,019	0,008	0,070	0,150	0,025	0,003	0,002	0,310	0,000	0,000	0,395			France
B58T3	0,210	0,180	0,850	0,016	0,013	0,080	0,120	0,015	0,005	0,001	0,240	0,000	0,000	0,397			France
B60T3	0,220	0,190	0,900	0,017	0,012	0,070	0,080	0,014	0,005	0,001	0,230	0,000	0,000	0,408			France

- Las dimensiones y la condición superficial se hallaron satisfactorias.
- Dimension and surface condition were found acceptable.
- Les dimensions et état de surface sont satisfaisants.

- Los materiales citados cumplen las normas aplicables.
- Manufacturing requirements are satisfied.
- Les normes applicables sont respectées.

EL INSPECTOR
Works Inspector - L'Inspecteur

ULMA FORJA S. COOP.
Dpto. de Garantía de calidad
Quality Assurance Dept.

(*) OBSERVACIONES: Remarks / Observations: N_NORMALIZED AT 900 C AND ALLOWED TO COOL IN STILL AIR

L.A. TURBINE CO PO#:
20900 JOB LAT560EC

DESCRIPTION:
2" 300# RF WN FLNG S80 BORE
SA105 COFO: SPAIN HT# B06T3

B14-4

L.H. TURBINE CO PO#:
20908 JOB LAT560EC

DESCRIPTION:
2" S80 SMLS PIPE SA106 GRADE B
COFC: USA HT# FA3863

UNITED STATES STEEL CORPORATION

TUBULAR PRODUCTS
CERTIFIED TEST REPORT
(IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 "type 3.1")

DATE: 11/30/14
TIME: 04:06:01
SERIAL NO: L0054112
EBS NO: 2000855998 1

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	VEHICLE ID
DR91449 01	R03446	10P14558-CA 2014-09-09	GONX310910

SOLD TO ADDRESS	MAIL TO ADDRESS	VENDOR
KELLY PIPE CO LLC 8200 E 96TH AVE HENDERSON CO 80640-8524	KELLY PIPE CO LLC 8200 E 96TH AVE HENDERSON CO 80640-8524	UNITED STATES STEEL CORP LORAIN TUBULAR OPERATIONS 2199 EAST 28TH ST. LORAIN, OH 44055

SPECIFICATION AND GRADE

SMLS STANDARD AND LINE PIPE API 5L 45TH EDITION DATED 12/1/12 GRADE B/X42 R N OR Q PSL-1, ASTM A106-14 GRADE B/C, ASTM A53-12 GRADE B, ASME SA106-2013 GRADE B/C, ASME SA53-2013 GRADE B REG MILL COAT PE BEV 30 DEGREE APPLICABLE REQUIREMENTS OF NACE MR0103-2012 ED AND NACE MR0175/ISO 15156-2 2009 ED

MATERIAL COND: AS ROLLED

O.D.: 2.375 (60.325) in (mm)

WALL: 0.218 (5.537) in (mm)

PRODUCT IDENTIFICATION	TENSILE TEST TYPE/ ORIENTATION	TEST COND.	GAUGE WIDTH	YIELD PSI	EXT %	TENSILE PSI	Y/T	ELONG % (IN 2")	HARDNESS SCALE:	MIN HYDRO PSI	DWELL(SEC)
			IN	MIN: 42100 MAX:		MIN: 70000 MAX:	MAX:	MIN: 22.0 MAX:	MIN: MAX:	2970	5
FA3863	STRIP/L/B	AR	0.750	53500	.50	78500	0.68	32.7		2970	5
		**	END OF DATA THIS SHEET			**					

LEGEND: L - LONGITUDINAL, T - TRANSVERSE, U - UPSET, NM - NORMALIZED, QT - QUENCH & TEMPERED, SR - STRESS RELIEVED, AR - AS ROLLED, TR - THERMOMECHANICAL ROLLED, B - BODY, W - WELD

PRODUCT IDENTIFICATION	TYPE	C	MN	P	S	SI	CU	NI	CR	MO	AL	N	V	B	TI	CB	CO	C.E.*
FA3863	HEAT	.19	1.06	.008	.005	.24	.14	.09	.09	.01	.027		.00	.0004	.002	.002		
FA3863	PROD	.18	1.06	.004	.004	.24	.14	.08	.09	.01	.029		.00	.0004	.001	.004		
FA3863	PROD	.18	1.03	.004	.004	.24	.14	.08	.09	.01	.026		.00	.0000	.002	.001		
		** END OF DATA THIS SHEET **																

*C.E. IS BASED ON THE FOLLOWING EQUATION(S):

DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT. ELEMENTS REPORTED IN MASS FRACTION (%)

BH.5

UNITED STATES STEEL CORPORATION

TUBULAR PRODUCTS

CERTIFIED TEST REPORT

(IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 "type 3.1")

DATE: 11/30/14
TIME: 04:06:01
SERIAL NO: L0054112
EBS NO: 2000855990 1

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	
DR91449 01	R03446	10P14558-CA 2014-09-09	0019008

MATERIAL COND: AS ROLLED

O.D.: 2.375(60.325) in (mm)

WALL: 0.218 (5.537) in (mm)

PRODUCT IDENTIFICATION	FLAT	BEND	GRAIN SIZE	MIN COLLAPSE	CHARPY V-NOTCH IMPACT TESTING												
					DIR	TEST LOC.	TEMP	SIZE	TEST COND.	FT-LBS				% SHEAR			
										1	2	3	AVG	1	2	3	AVG
					DEG												
FA3863		OK	**	END OF DATA THIS SHEET **													

LEGEND L - LONGITUDINAL T - TRANSVERSE B - BODY W - WELD HAZ - HEAT AFFECTED ZONE

TEST / INSPECTION	YES	TESTING / INSPECTION INFORMATION RESULTS / COMMENTS
FULL LENGTH VISUAL	X	
FULL LENGTH EMI		OD _____ OD/D _____ L _____ L/T _____
FULL LENGTH MPI		
FULL LENGTH UT		ID _____ OD/D _____ L _____ L/T _____
END AREA INSPECTION (PLAIN END)		MPI _____ UT _____
SPECIAL END AREA (SEA) INSP		MPI _____ UT _____
FULL LENGTH DRIFT		DRIFT MANDREL SIZE:

ADDITIONAL NOTES/COMMENTS

MELTED AND MANUFACTURED IN THE USA, NO REPAIRS BY WELDING, NO MERCURY COMPOUNDS ARE ADDED TO THE STEEL AND ALL MERCURY BEARING EQUIPMENT IS PROTECTED BY A DOUBLE BOUNDARY OF CONTAINMENT. MANUFACTURED IN AN ISO 9001 CERTIFIED FACILITY - CERTIFICATE #32022.

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, SAMPLED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS THE REQUIREMENTS IN SUCH RESPECTS.

PREPARED BY THE OFFICE OF: BRAD KOURY - MANAGER, Q.A.

DATE 11/30/14

**

UNITED STATES STEEL CORPORATION

TUBULAR PRODUCTS
ADDITIONAL COMMENTS SHEET

DATE: 11/30/14
TIME: 04:06:03
PAGE: 1 OF 1

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	HEAT	
DR91449 01		10P14558-CA	2014-09-09	SERIAL NUMBER: L0054112

SOLD TO ADDRESS	MAIL TO ADDRESS	VENDOR
KELLY PIPE CO LLC 8200 E 96TH AVE HENDERSON CO 80640-8524		UNITED STATES STEEL CORP LORAIN TUBULAR OPERATIONS 2199 EAST 28TH ST. LORAIN, OR 44055

HEAT FA3863 - MELTED AT:NUCOR STEEL NEBRASKA, NORFOLK, NEBRASKA 68702
END OF DATA

pl 004475

CLIENTE / Customer / Client

FORGINGS FLANGES&FITTINGS LLC.
8999 RAILWOOD DRIVE.
SUITE B
HOUSTON, TX 77078
USA

CERTIFICADO DE INSPECCION

Inspection Certificate - Certificat de Réception

DIN EN 10204 / 3.1
ISO 10474 / 3.1

FECHA / Date: 17/11/2011 — N.º / No.: 14193 — HOJA / Page: 4

ULMA FORJA, S.COOP
B° Zubillaga, 3 - Apdo. 1ª
20560 OÑATI (Gipuzkoa) SPAIN
Tel.: 34 - 943 780358
Fax: 34 - 943 781801
E-mail: ulma@ulmaforging.com
68321

PRODUCTO / Article - Produit: FLANGES

SU PEDIDO N.º / Your Order No / Votre Cde. N.º: 172788-CALIFORNIA

DE / of - de: 31/10/2011

NORMAS APLICABLES / Requirements - Normes Applicables: ASME B16.5-09

MATERIAL CORRESPONDIENTE / Material Correspondent - Qualité: ASTMA105N-10 / ASME SA105H-10

MODO DE FUSION (*) / Steel Making - Elaboration de l'acier: HACE MR-01-78/ISO15156-2-08 & MR-01-03/03

E = Elec Y = Oxigeno básico

Certified acc: PED 97/23/EC+AD2000-W
by TÜV Rheinland
N° 01 202 EQ 02 744.

MARCA DEL FABRICANTE / Mark of factory / Marque de fabricant:

DEPARTAMENTO / Section / Département: QUALITY ASSURANCE

PARTIDA / Item / Poste	CANTIDAD / Quantity / Quantité	DESCRIPCION / Description / Description	OBSERVACIONES / Remarks / Observations (*)	COLADA N.º / Heat No / N.º Coulée	RESISTENCIA / Tensile Strength / Resist. Rupt. (N/mm²)	LIMITE ELAST. / Y.Strength 0.2 % / Résist.	ALARGAM. / Elongation / Allongement Lo. 4 d %	ESTRICCION / Red. Area / Striction %	RESILIENCIA / Impact test / Résilience Joules	MEDIA / Average / Moyenne °C	DUREZA / Hardness / Dureté HB
101 F1TA060	285	THR 1/2 150LB RF A105H	NE	806T1	518	385	37,00	65,80			140 146
107 F8TA06E	150	THR 3/4 600LB RF A105H	NE	1163T1	511	295	34,40	67,40			145 149
107 F8TA06E	30	THR 3/4 600LB RF A105N	NE	345A8	513	311	31,40	62,30			148 156
109 F8TA01D	30	THR 1.1/2 600LB RF A105H	NE	173A1	521	317	32,00	58,70			151 156
113 F118SWA010	375	SW 1 150LB S160 RF A105N	NE	807T1	495	303	35,80	65,80			142 146
116 F38SWA810	675	SW 1 300LB S80 RF A105N	NE	1425T1	510	340	33,30	67,60			144 160
118 F818SWA000	60	SW 1/2 600LB S160 RF A105N	NE	1414T1	512	315	33,50	65,50			144 160
124 F6RJ18SWA610	30	SW 1 600LB S160 RTJ A105N	NE	870A0	504	302	35,60	64,00			145 156

COMPOSICION QUIMICA - STEEL MAKER'S LADLE ANALYSIS - ANALYSE CHIMIQUE

COLADA N.º / Heat No / N.º Coulée	C %	Si %	Mn %	P %	S %	Cr %	Ni %	Mo %	Nb %	V %	Cu %	Al %	Ti %	N %	CEq %
1163T1	0,190	0,240	0,980	0,014	0,004	0,060	0,040	0,015	0,003	0,004	0,050	0,001	0,000	0,000	0,371
1414T1	0,210	0,240	0,890	0,020	0,007	0,050	0,020	0,005	0,001	0,005	0,050	0,006	0,000	0,000	0,392
1425T1	0,190	0,270	0,850	0,009	0,013	0,040	0,250	0,060	0,002	0,004	0,050	0,008	0,000	0,000	0,369
173A1	0,230	0,280	0,850	0,011	0,005	0,050	0,100	0,010	0,002	0,002	0,220	0,024	0,000	0,000	0,413
345A8	0,190	0,180	1 030	0,004	0,020	0,020	0,040	0,010	0,008	0,003	0,070	0,034	0,000	0,000	0,378
870A0	0,200	0,230	0,860	0,010	0,005	0,100	0,090	0,010	0,002	0,002	0,210	0,021	0,000	0,000	0,388
806T1	0,220	0,220	0,990	0,020	0,004	0,040	0,010	0,002	0,001	0,002	0,010	0,014	0,000	0,000	0,395
807T1	0,180	0,240	1,030	0,018	0,005	0,060	0,030	0,006	0,002	0,008	0,070	0,002	0 000	0,000	0,377

- Las dimensiones y la condición superficial se hallan satisfactorias
- Dimension and surface condition were found acceptable
- Les dimensions et l'état de surface sont satisfaisants

- Los materiales citados cumplen las normas aplicable.
- Manufacturing requirements are satisfied.
- Les normes appliquées sont respectées

EL INSPECTOR / Works Inspector - L'Inspecteur

ULMA FORJA S.COOP
Dpto. Gestión de calidad
Quality Assurance Dept.

(*) OBSERVACIONES / Remarks / Observations: N_NORMALIZED AT 900 C AND ALLOWED TO COOL IN STILL AIR

L.A. TURBINE CO PO#:
20908 JOB LAT560EC

DESCRIPTION:
1" 300# RF SW FLANGE S80 BORE
SA105 COFO: SPAIN HT# 1425T1

PO#: 262859 PACK#: 228704 ORD#: 913440 CUST: OTH#: 1425T1 DESC: 1" 300 RF SW FLG XH A/SA 105 NORM: ULM

BH-6

ВН-7

ИНТЕРПАЙП
НИКО ТЬЮБ

ОБЩЕСТВО С ОГРАНИЧЕННОЙ ОТВЕТСТВЕННОСТЬЮ
"ИНТЕРПАЙП НИКО ТЬЮБ"
Украина, г. Никополь, пр. Трубников, 56
Тел./факс +38 (05662) 2-10-70

ИНСПЕКЦИОННЫЙ СЕРТИФИКАТ № 4646
INSPECTION CERTIFICATE № 4646
EN 10204-2004/3.1 / ISO 10474-2013

Грузополучатель / BUYER: North American Interpipe, Inc. 1800 West Loop South, Suite 1350, Houston, Texas 77027, USA

Страна / Country: USA

Транспортное средство № / Vehicle №: 57801502

Дата / Date: 29.11.2015г.

Контракт № / Contract #: COC15/1298

Заводской заказ № / Production order #: 007267

Номер заказа клиента / Customer's ref: #PO#10P18683SS

Лист / Sheet 1 Листов / Sheets 2

Наименование и код товара / Description and code of goods	Наименование стандартов / Specifications	Класс поставки / Class of delivery	Тип резьбы / Thread type
Трубы стальные бесшовные горячекатаные для нефтегазопроводов / Carbon steel seamless hot-rolled pipes for oil and gas pipelines	API 5L - 2012/ ASTM A106/A106M-2014/ ASME SA106-2013/ ASTM A53/A53M-2012/ ASME SA53-2013/ NACE MR0175-2009/ NACE MR0103-2012	PSL-1	

№ пак. / Bun No	Номер ленты / Bunds #	Номер труб / Pipe #	Марка стали / Grade — краткое обозначение / Brief Designation	Номер плавки / Heat #	Номер партии / Inspection Lot #	Размеры / Dimensions — диаметр OD дюйм / inch	Толщина стенки WT дюйм / inch	Длина length фут / ft	Общая длина / Total length фут / ft	шт / pieces	Количество / Quantity — Фактический вес / Actual weight — брутто / gross фунт / lb	нетто / net фунт / lb
1.	15-14-10661		B/ C/ X42	1153245	7960	1.315	0.179	20.0-21.0	3359.4	161	7 518	7 496
2.	15-14-10662		B/ C/ X42	1153245	7960	1.315	0.179	20.0-21.0	3359.4	161	7 551	7 529
3.	15-12-29061		B/ C/ X42	1153245	7965	1.315	0.179	20.0-21.0	3354.1	161	7 518	7 496
4.	15-14-10634		B/ C/ X42	1153245	7932	1.315	0.179	20.0-21.0	3359.4	161	7 562	7 540
5.	15-12-29017		B/ C/ X42	1153246	7940	1.315	0.179	20.0-21.0	3354.1	161	7 518	7 496
6.	15-12-29060		B/ C/ X42	1153245	7965	1.315	0.179	20.0-21.0	3354.1	161	7 518	7 496
7.	15-12-29059		B/ C/ X42	1153245	7961	1.315	0.179	20.0-21.0	3354.1	161	7 562	7 540
8.	15-14-10646		B/ C/ X42	1153245	7944	1.315	0.179	20.0-21.0	2918.9	140	6 548	6 526
		NPS 1	Sch 80					ТОТАЛ/ИТОГО	28413.5	1267	59 295	59 119
								BUNDLES/ПАКЕТОВ 8				
9.	15-14-10009		B/ C/ X42	1153246	7482	1.660	0.140	20.0-21.0	1878.8	91	4 409	4 387
10.	15-14-10008		B/ C/ X42	1153246	7482	1.660	0.140	20.0-21.0	1879.6	91	4 409	4 387
11.	15-14-10002		B/ C/ X42	1153246	7476	1.660	0.140	20.0-21.0	1883.9	91	4 409	4 387
12.	15-14-10012		B/ C/ X42	1153246	7488	1.660	0.140	20.0-21.0	826.1	40	1 962	1 940
		NPS 1 1/4	Sch 40					ТОТАЛ/ИТОГО	6470.4	313	15 189	15 101
								BUNDLES/ПАКЕТОВ 4				
13.	15-12-28099		B/ C/ X42	1153248	7727	2.375	0.218	20.0-21.0	1237.8	61	6 261	6 239
14.	15-12-28102		B/ C/ X42	1153248	7727	2.375	0.218	20.0-21.0	1236.8	61	6 250	6 228
15.	15-12-28104		B/ C/ X42	1153248	7727	2.375	0.218	20.0-21.0	1238.8	61	6 261	6 239
16.	15-12-28115		B/ C/ X42	1153248	7730	2.375	0.218	20.0-21.0	1238.8	61	6 272	6 250
17.	15-12-28094		B/ C/ X42	1153248	7727	2.375	0.218	20.0-21.0	1237.8	61	6 272	6 250
18.	15-12-28095		B/ C/ X42	1153248	7727	2.375	0.218	20.0-21.0	1237.8	61	6 283	6 261
19.	15-12-28112		B/ C/ X42	1153248	7730	2.375	0.218	20.0-21.0	1236.8	61	6 261	6 239
		NPS 2	Sch 80					ТОТАЛ/ИТОГО	8668.6	427	43 860	43 706
								BUNDLES/ПАКЕТОВ 7				

L.A. TURBINE CO PO#:
23686 DIRECT SUPPLIES

DESCRIPTION:
1" S80 SMLS PIPE SA106 GRD B
HEAT# 1153245

INTERPIPE
NIKO TUBE

LIMITED LIABILITY COMPANY
"INTERPIPE NIKO TUBE"
UKRAINE, Nikopol, 56, Trubnikov ave. Tel./fax +38 (05662) 2-10-70

ИНСПЕКЦИОННЫЙ СЕРТИФИКАТ № 4646

INSPECTION CERTIFICATE № 4646

Лист : Sheet | Листов : Sheets

Химический состав по сертификатным данным на заготовку и результаты контроля химического состава металла труб

Heat analysis acc. to the billet manufacturer certificate & results of chemical analysis of pipes

Номер плавки Heat #	Лаборатория Laboratory	Химический состав в % Chemical composition %												Завод изготовитель заготовки Steel supplier
		C	Mn	Si	S	P	Cr	Ni	Cu	Mo	Ti	V	Nb	
min		-	-	-	-	-	-	-	-	-	-	-	-	
max		-	-	-	-	-	-	-	-	-	-	-	-	
1153245	DneprSteel	0,1840	0,7820	0,2390	0,0030	0,0080	0,0930	0,1200	0,1530	0,0140	0,0050	0,0050	0,0100	"MP"DNEPROSTEEL"LLC
	NIKOTUBE*	0,1800	0,7900	0,2400	0,0050	0,0080	0,1000	0,1200	0,1500	0,0140	0,0030	0,0010	0,0010	
	NIKOTUBE*	0,1800	0,7900	0,2400	0,0050	0,0070	0,1000	0,1200	0,1600	0,0140	0,0030	0,0010	0,0010	
1153246	DneprSteel	0,1870	0,7970	0,2460	0,0030	0,0090	0,0980	0,1210	0,1740	0,0140	0,0050	0,0050	0,0100	"MP"DNEPROSTEEL"LLC
	NIKOTUBE*	0,1800	0,7800	0,2400	0,0040	0,0050	0,1000	0,1200	0,1600	0,0180	0,0030	0,0010	0,0010	
	NIKOTUBE*	0,1800	0,7600	0,2400	0,0050	0,0060	0,0900	0,1200	0,1700	0,0180	0,0030	0,0010	0,0010	
1153248	DneprSteel	0,1850	0,7870	0,2220	0,0030	0,0100	0,1120	0,1100	0,1780	0,0130	0,0050	0,0050	0,0100	"MP"DNEPROSTEEL"LLC
	NIKOTUBE*	0,1900	0,7900	0,2200	0,0040	0,0100	0,1100	0,1000	0,2000	0,0140	0,0030	0,0010	0,0010	
	NIKOTUBE*	0,1900	0,7800	0,2200	0,0050	0,0110	0,1100	0,1000	0,2000	0,0140	0,0030	0,0010	0,0010	

Анализ плавки согласно сертификата завода-изготовителя/Heat analysis acc.to the manufacturer certificate. *-control analysis of pipes/*-контрольный анализ от труб.

Сталь произведена методом плавления электродуговой печи с последующей непрерывной разливкой / Steel has beenproduced by the EAF with continuous casting process

Результаты испытаний труб - Test results for pipes

Номер плавки Inspection Lot #	Механические свойства Mechanical Properties															
	Испытание на растяжение Tensile test										Испытание на удар /Impact test					
	Предел прочности Tensile strength PSI	Предел текучести Yield strength PSI	Относительное удлинение Elongation %	Отношение Ratio	Ориентация* образцов Specimens orientation*	Ширина образца Width of specimen inch/mm	Диаметр образца Diameter of specimen inch/mm	Длина образца Length of specimen inch/mm	Твердость, Hardness Среднее значение Average		Результаты испытаний уменьшенных образцов пересчитаны на полноразмерные Non-fullsize specimens results convert to fullsize (10x10mm)				
									HRB	HRC	Ориентация* orientation*	Температура Type of temperature	Ср.значение Average	Площадь сдвига,% shear area,%	Размер образцов Specimens size
min	70000	42100	20.0	-					-	-					
max	-	-	-	-					100	22					
7832	77500	54000	31.0		L				83	<22					
7844	76500	61000	27.0		L	3/4"		2	83	<22					
7848	74000	55000	32.5		L	3/4		2	83	<22					
7850	77500	54000	31.0		L	3/4		2	84	<22					
7861	80500	57000	30.0		L	3/4		2	81	<22					
7865	74500	52000	34.0		L	3/4		2	78	<22					
7476	72000	49300	35.0		L	3/4		2	80	<22					
7482	76000	53500	36.0		L	3/4		2	82	<22					
7489	74500	52000	33.5		L	3/4		2	78	<22					
7727	75500	48500	31.0		L	3/4		2	80	<22					
7730	73000	48000	34.0		L	3/4		2	78	<22					

* L - Продольный образец / Longitudinal specimen; T - поперечный образец / transverse specimen

Прочие виды контроля / Other tests

Вид испытания / Type of test	Параметры / Criteria	Результаты контроля /Test results
Загиб / Bend test	Pipes are bending test. Трубы прошли испытания на загиб.	Удовлетворительно / Satisfactory
Испытание гидравлическим давлением / Hydrostatic test	100% / 20,6 MPa / 5 sec 100% / 2970 PSI / 5 sec	Удовлетворительны / Satisfactory
Визуальный контроль / Visual inspection	По стандарту / As per Standart	Удовлетворительно / Satisfactory
Контроль геометрических параметров / Dimensional inspection	По стандарту / As per Standart	Удовлетворительно / Satisfactory

Состояние поставки / Delivery condition

Общие условия / General condition	Трубы изготовлены и испытаны в соответствии с требованиями API 5L - 2012/ ASTM A106/A106M-2014/ ASME SA106-2013/ ASTM A53/A53M-2012/ ASME SA53-2013/ NACE MR0175-2009/ NACE MR0103-2012, результаты удовлетворительные. Tubes produced and test according to requirements API 5L - 2012/ ASTM A106/A106M-2014/ASME SA106-2013/ ASTM A53/A53M-2012/ ASME SA53-2013/ NACE MR0175-2009/ NACE MR0103-2012,results satisfactory.
Покрытие / Coating	Трубы покрыты черным лаком / Pipes are coated with black varnish
Фаска (если требуется) / Bevelled ends if required	Pipes in size 2.375"x0.218" are beveled. Трубы размером 60.3х5,54 отгружены с фаской
Защита концов / Protection of pipe ends	Трубы отгружены с колпачками./Pipes have caps.
Дополнительная информация / Additional information	Ремонт сваркой запрещен. / Weld repair is not permited

Страна происхождения: Украина.
Country of origin: Ukraine.

Ваши предложения по улучшению продукции просим направлять на эл.адрес / Please send Your proposals for improving the product by e-mail or fax or by phone
Alexander.Borodin@nsp.interpipe.biz fax +38(0566)239378 phone +38(0566)539371
e-mail: info@us.interpipe.biz Phone: 17133330333 Fax: 17133330330

Этот сертификат качества относится только к перечисленной в нем продукции. Недопустимо внесение изменений или другое неправомерное использование сертификата.
This certificate is only for the listed products. Modification or unauthorized use of the certificate is strictly prohibited. Violations can be considered as forgery and is subject to prosecution

Дата: 11-29-2015
Date:

Инспектор :
Inspector:

Подпись:
Signature:

REVIEWED by
I.KLOKOV
01.12.2015

CHECKED

BH-8

MILL TEST REPORT TA CHEN INTERNATIONAL, INC. This MTR contains 1 page (Page# 1)

Customer: OUHLOS PO#:D7763 SO#:LHHG39 MTR#:ENFL1503015001.GI

Item:F64L8W00E Heat#:FL147

E N CORPORATION

Lot 2, 4 & 6, Block 16, Phase IV, Cavite Export Processing Zone Authority, PEZA, Rosario, Cavite, Philippines 4106

TEL : (+63) 46-437-1022-25 FAX : (+63)46-437-1018 21

MILL TEST REPORT

PURCHASER : TA CHEN INTERNATIONAL, INC.

DATE : 2015/03/21
P. O. NO.: L45049-S
S/C NO. : O120TC

PRODUCT : STAINLESS STEEL FORGED FLANGE RF

HEAT NO.	QTY.	DESIGNATION	SPECIFICATION
FL147	2	304L/304 3/4" W/N S-80 600LB	ASME B16.5-20*304SS SP25-1998

CHEMICAL ANALYSIS OF MATERIAL

HEAT NO.	C	Mn	Si	P	S	Cr	Ni	M	N	SPECIFICATION
Maxi	0.030	2.00	1.00	0.045	0.030	18.0 - 20.0	8.0 - 11.0		0.100	ASTM A/SA182-2013
FL147	0.025	1.26	0.46	0.034	0.006	18.04	8.10		0.070	

MECHANICAL CHARACTERISTICS

HEAT NO.	T.S-PSI	Y.S-PSI	%-E.L.	%-R.A.	HEAT-TREAT.	HARDNESS	DIMENSION	P.M.I.
Mini	75,000	30,000	30	50	1040 - 1150 °C	≤90.0 HRB		
FL147	83,400	43,500	60	80	1060 °C	76.0 HRB	OK	OK

MATERIAL RESISTANT TO INTERCRYSTALLINE CORROSION IGC TEST ACCORDING TO ASTM A262-10 PRACTICE E. MATERIAL IS MANUFACTURED MERCURY FREE AND FREE FROM MERCURY CONTAMINATION AND RADIO ACTIVITY. MATERIAL IS IN ACCORDANCE WITH NACE MR0175-SECOND EDITION, MR0103-2007, ISO 15156-2009 COMPLIANT. ISO 9001:2008, PED 97/23/EC CERTIFIED. EN10204:2005-3.1
MATERIAL RECEIVED SOLUTION TREAT & WATER QUENCHED AT 1060 DEGREE C
MATERIAL WAS MANUFACTURED, SAMPLED, TESTED AND INSPECTED IN ACCORDANCE WITH ASTM A182-13 AND ASTM A961-08A AND HAS BEEN FOUND TO MEET THE REQUIREMENTS. MATERIALS ARE FREE OF WELD REPAIR

Pb CONTENT : < 0.010%

COUNTRY OF ORIGIN : PHILIPPINES
COUNTRY OF MELT : PHILIPPINES

FACTORY INSPECTOR:

DAVID WANG

QUALITY ASSURANCE DEPARTMENT

F64L8W00E

N-1503015001

SM-005-0

LATURBINE P.O 21290

L.A. TURBINE CO PO#:
21290

DESCRIPTION:
3/4 600# RF WN FLNG SA182 T304/
304L S80 PT# 7760000017

BH - 9 & 10

SCHOELLER BLECKMANN EDELSTAHLROHR
SEAMLESS STAINLESS
NAHTLOS ZUM ERFOLG

INSPECTION CERTIFICATE EN 10204 3.1

Number: 583180 Page: 1 / 3	Rev:
Created on: Date: 07.11.2012	Modified on:

SCHOELLER-BLECKMANN Edelstahlrohr GmbH
2630 Ternitz, Rohrstrasse 1
Austria

TL: 2630316/601
FAX: 2630316/394
E-MAIL: nicole.riegler@sber.co.at

119337

CUSTOMER DESCRIPTION

CLIENT SOLD TO	CLIENT SHIP TO
TUBACEX AMERICA, INC. 5430 BRYSTONE DRIVE HOUSTON TX 77041 USA	TUBACEX AMERICA, INC. 5430, BRYSTONE DRIVE TEXAS, HOUSTON 77041 USA

CLIENT ORDER: 620011
SALES ORDER: 115552

MATERIAL:SEAML. STAINL. STEEL TUBES/PIPES
HEAT-TREATED, PICKLED, PICKLED-PASSIVATED
GRADE: TP304,TP304L,
STANDARD: ASME SECT.II PART.A SA312/SA312M-2010 ED.
ASME SECT.II PART.A SA376/SA376M-2010 ED.
ASTM A376/376M-06
ASTM A312/A312M-11
NACE MR0175/ISO 15156-3:2009
CORROSION TESTED ACC. TO MIL-P-24691/3(ASTM A262 PCT.E)
NACE MR0103-2010
TOLERANCES: ASME SECT.II PART.A SA999/SA999M-2007 ED. 2009B ADD.
ASTM A999/A999M-04A
RANDOM LENGTHS 6.100/7.300 MM
PLAIN ENDS,
DIMENSIONS: 26,67 X 3,91 MM / 3/4 "NB X SCH 80S
COLD FINISHED

L.A. TURBINE CO PO#:
20908 JOB LAT560EC

DESCRIPTION:
3/4 S80 SMLS PIPE SA312 304/
304L COFO: AUSTRIA HT# 454550

Sales Item	Client Item	Delivery No	Lot No.	Heat No	Pieces	Weight	Tot Lgth	Un Lgth
90		8170023924	215659	454550	43	1 523,395 LB	1 019,390 FT	20,013-23,950 FT

CHEMICAL COMPOSITION (%) *L. Ladle C:Products

*	Heat	Seq	C	Mn	Si	P	S	Ni	Cr
L	454550	1	0,020	1,60	0,360	0,026	0,0110	10,24	18,50

HEAT TREATMENT
SOLUTION ANNEALED AT 1070 °C , 10 min , AIR

TENSILE TEST

Lot No	Sample	T	Rp0.2	Rm	A2"
		°C	KSI	KSI	%
Min		20	30	75	35
Max		20		99	
215659	1	20	40	89	59

We hereby certify that the material herein described has been manufactured, sampled, tested, and inspected in accordance with above standards and specifications and satisfies ordering requirements. This certificate is issued by a computerized system and it is valid without original signature. In case the owner of the certificate would release as a copy of it, he must stamp by controversy to the actual, assuming the responsibility for any unlawful of TUBACEX, not allowed use. Any forgery or falsification of this certificate shall legally prosecuted.

SCHOELLER-BLECKMANN
EDELSTAHLROHR GMBH

Riegler

FR N RIEGLER
(WORKS INSPECTOR)

SCHOELLER BLECKMANN EDELSTAHLROHR
SEAMLESS-STAINLESS
NAHTLOS ZUM ERFOLG

INSPECTION CERTIFICATE EN 10204 3.1

Number: 563180 Page: 2 / 3	Rev:
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TENSILE TEST

Lot No	Sample	T	Rp0.2	Rm	A1"
		°C	KSI	KSI	%
Min		20	30	75	35
Max		30		99	
	2	20	37	87	61

HARDNESS TEST

Lot No	Sample	HRB
Min		
Max		90
215659	1	74
	2	72

METALURGICAL TESTS

INTERGRANULAR CORROSION TEST ACC. TO ASTM A262 PRACT."E": SATISFACTORY
INTERGRANULAR CORROSION TEST ACCORDING TO MIL-P-24691/3
(SENSITIZED 675°C (1250°F) / 1 HOUR / AIRCOOLED): SATISFACTORY

NON-DESTRUCTIVE TESTS

POSITIVE MATERIAL IDENTIFICATION TEST ON EACH TUBE/PIPE BY
"X-RAY-FLUORESCENCE-ANALYZER": SATISFACTORY

HYDROSTATIC PRESSURE TESTED AT 172 bar, 2500 psi DURING 5 SEC
ON EACH TUBE/PIPE: SATISFACTORY

TECHNOLOGICAL TESTS

FLATTENING TEST: SATISFACTORY

THE TUBES/PIPES CONFORM ALSO TO NACE STANDARD
MR0175/ISO 15156-3:2009, MR0103-2010

MATERIAL IDENTIFICATION ON EACH PIPE: SATISFACTORY

WE CERTIFY THAT THIS MATERIAL HAS BEEN MANUFACTURED
AND EXAMINED IN ACCORDANCE WITH ALL REQUIREMENTS OF
THE SPECIFICATION AND ORDER CONFIRMATION AND THAT THE
RESULTS OF ALL EXAMINATIONS ARE ACCEPTABLE.

STEELMAKING PROCESS: EF + AOD

ABBREVIATIONS:
RP0.2 = YIELD STRENGTH
RM = TENSILE STRENGTH
KG = GRAIN SIZE
CONVERSION:

Certified Management System

We hereby certify that the material herein described has been manufactured, sampled, tested, and inspected in accordance with above standards and specifications and satisfies purchase requirements. This certificate is issued by a computerized system and it is valid without original signature. In case the owner of the certificate would require an original copy of it, he must send it correctly to the issuer, assuming the responsibility for any unlawful or TUBACEX not allowed use. Any forgery or falsification of this certificate shall legally prosecuted.

SCHOELLER-BLECKMANN
EDELSTAHLROHR GMBH

Riegler

FR. N. RIEGLER
(WORKS INSPECTOR)

SCHOELLER BLECKMANN EDELSTAHLROHR
SEAMLESS STAINLESS
NAHTLOS ZUM ERFOLG

INSPECTION CERTIFICATE EN 10204 3.1

Number: 563180 Page: 3 / 3	Rev:
Created on: Date: 07.11.2012	Modified on:

A2" = ELONGATION 1 MPA = 1 N/MM² = 145.037 PSI

MARKING

Schoeller Bleckmann SBS 26,67 X 3,91 MM / 3/4 "NB X SCH 80S ASME SA312 ASME SA376 ASTM A312 ASTM A376 TP304 TP304L CD SMLS HEAT/ PMI-AV LOTNO/ AUSTRIA T/A

REMARKS

MATERIAL IS FREE OF MERCURY CONTAMINATION.

NO WELD REPAIR HAS BEEN PERFORMED ON THE MATERIAL.

MATERIAL MANUFACTURER APPROVED WITH CERTIFICATE NR. 245/2004/MUC BY TÜV SÜDDEUTSCHLAND (NOTIFIED BODY 0036)TO ISSUE CERTIFICATES OF SPECIFIC PRODUCT CONTROL IN ACCORDING TO PRESSURE EQUIPMENT DIRECTIVE 97/23/EC ANNEX I POINT 4.3.

MATERIAL IS FREE OF RADIOACTIVE CONTAMINATION

Certified Management System

We hereby certify that the material herein described has been manufactured, sampled, tested, and inspected in accordance with above standards and specifications and satisfies mandatory requirements. This certificate is issued by a computerized system and it is valid without original signature. In case the owner of the certificate would dispose on a copy of it, he must insist to conformity to the issued, assuming the responsibility for any unlawful or TUBACEX not allowed use. Any forgery or falsification of this certificate shall legally prosecuted.

SCHOELLER-BLECKMANN EDELSTAHLROHR GMBH

Riegler

FR N RIEGLER

(WORKS INSPECTOR)

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

BEARING HOUSING

FABRICATION WELDS VISUAL INSPECTION

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: BEARING HOUSING

PART NUMBER: 7770006246 (MAIN)

THIS IS TO CERTIFY THAT VISUAL INSPECTION HAS BEEN PERFORMED IN ACCORDANCE WITH ASME SEC. VIII ON THE **BEARING HOUSING** THE INSPECTION RESULTS HAVE BEEN FOUND SATISFACTORY.

INSP. PERFORMED BY: _____ 3/10/17
Hung Phung, QC Inspector — DATE

INSP. CONFIRMED BY: _____ 3/10/17
Frank Loth, Quality Manager — DATE

L.A. Turbine™
Rethinking Turboexpanders

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Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

BEARING HOUSING

FABRICATION WELDS VISUAL INSPECTION

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: BEARING HOUSING

PART NUMBER: 7770006246 (SPARE)

THIS IS TO CERTIFY THAT VISUAL INSPECTION HAS BEEN PERFORMED IN ACCORDANCE WITH ASME SEC. VIII ON THE **BEARING HOUSING** THE INSPECTION RESULTS HAVE BEEN FOUND SATISFACTORY.

INSP. PERFORMED BY: _____ 3/15/17
Hung Phung, QC Inspector **DATE**

INSP. CONFIRMED BY: _____ 3/15/17
Frank Loth, Quality Manager **DATE**

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

BEARING HOUSING

HYDROSTATIC PRESSURE TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: BEARING HOUSING

PART NUMBER: 7770006248 (MAIN)

THIS IS TO CERTIFY THAT **BEARING HOUSING** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER, HAS SUCCESSFULLY PASSED THE HYDROSTATIC PRESSURE TEST PERFORMED AT THE INDICATED CONDITIONS:

DESIGN PRESSURE: 650 PSIG

TEST PRESSURE: 975 PSIG

TEST MEDIUM: WATER

HOLDING TIME: 30 MINUTES

PRESSURE GAUGE S/N: LAT 060

CALIBRATION DUE DATE: 08/04/2017

TEST PERFORMED BY:  3-16-17

Michael Martinez, Test Technician — DATE

TEST CONFIRMED BY:  3/16/17

Frank Loth, Quality Manager — DATE

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

BEARING HOUSING

HYDROSTATIC PRESSURE TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: BEARING HOUSING

PART NUMBER: 7770006248 (SPARE)

THIS IS TO CERTIFY THAT **BEARING HOUSING** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER, HAS SUCCESSFULLY PASSED THE HYDROSTATIC PRESSURE TEST PERFORMED AT THE INDICATED CONDITIONS:

DESIGN PRESSURE: 650 PSIG

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TEST MEDIUM: WATER

HOLDING TIME: 30 MINUTES

PRESSURE GAUGE S/N: LAT 060

CALIBRATION DUE DATE: 08/04/2017

TEST PERFORMED BY: _____ 3-17-17

Michael Martinez, Test Technician — DATE

TEST CONFIRMED BY: _____ 3/17/17

Frank Loth, Quality Manager — DATE

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 4: EXPANDER WHEEL

- MATERIAL CERTIFICATION
- RESONANCE TEST CERTIFICATE
- OVERSPEED TEST CERTIFICATE
- DYE PENETRANT TEST CERTIFICATE
- DYNAMIC BALANCING TEST CERTIFICATE

ALUMINUM PRECISION PRODUCTS, INC.
1001 MCWANE BOULEVARD OXNARD, CA 93033
(805) 488-4401 FAX (805) 986-3334

CERTIFIED TEST REPORT
CERTIFICATION OF CONFORMANCE

CUST NO.	ROUTING	BUYER
10111	Customer Arranged	LINDA DENNIS

ORDER DATE	SOURCE REQ	CUSTOMER P.O. NO.	JOB NO.	CERT NO.
12/05/2013	N	15407	005G724-G122058	63991

SHIP TO
L.A. TURBINE
28557 INDUSTRY DRIVE
VALENCIA CA 91355

SCHEDULED DELIVERY

Qty	Date	Qty	Date
20	12/31/14		

SOLD TO
L.A. TURBINE
28557 INDUSTRY DRIVE
VALENCIA CA 91355

WE HERBY CERTIFY THAT THE MATERIAL COVERED BY THIS REPORT HAS BEEN INSPECTED IN ACCORDANCE WITH , AND HAS BEEN FOUND TO MEET THE APPLICABLE REQUIREMENTS DESCRIBED HEREIN, INCLUDING ANY SPECIFICATIONS FORMING A PART OF THE DESCRIPTION. TEST REPORTS ARE ON FILE SUBJECT TO EXAMINATION.
ALUMINUM PRECISION PRODUCTS, INC.

APP-QC QA 3512

Authorized Q.A. Signature

DATE: 09/29/2014

09.29.14

PART NO. /DESCRIPTION	REV	GENERAL SPECIFICATIONS
7 OD X 4 L (5)		AMS 2658 C AMS 2772 F AMS 4108 F AMS-H-6088 C ASTM B557 -10 ASTM B594 CL AA -13 ASTM E112 -13 ASTM E18 -14 ASTM E8/E8M -13a S9000-A1 -3

ALLOY	TEMPER:	ELEMENT	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Zr	Other	Total
7050	T6	MIN:	0.00	0.00	2.00	0.00	1.90	0.00	5.70	0.00	0.08	0.00	0.00
		MAX:	0.12	0.15	2.60	0.10	2.60	0.04	6.70	0.06	0.15	0.05	0.15

QTY	HEAT NO	MATERIAL SUPPLIER	STOCK CODE NUMBER
20	XC04	VISTA METALS	F54433

PROCESS	PERFORMED BY	PROCESS SPECIFICATION	COMMENTS	REPORT/CERT NO.
Heat No: XC04				
TENSILE TEST	APP - Oxnard CA	ASTM E112 -13		4205
ULTRASONIC	Mitchell Labs-PicoRivera CA	ASTM B594 CL AA -13		26591
OUTSIDE TEST	Durkee Testing-Paramount CA	ASTM E112 -12		353952A

GENERAL COMMENTS
Production Lot #
4931-1-1
2 TEST PIECES SHIPPED TO CUSTOMER ON 3/28/14

ALUMINUM PRECISION PRODUCTS
OXNARD DIVISION
1001 McWane Blvd, Oxnard, CA 93033 Tel 805-488-4401 FAX 805-986-5670

Mar 11, 2014

Report No. 4205

Tensile of Aluminum (RNDS) MANUAL ELONG

Test Date 11-Mar-14 Testing Machine SFM-100KN 1

DF/HF	5G724	**Traveler #**	4931-1-1
Heat Lot ID	XC04	**Alloy-Temper**	7050-T6
HRBW	88 (84-92)	**Conductivity % IACS**	41.3 (38-44)
Customer PO #	15407	**P/N**	7 O.D. X 4 L (5)
Job #	INVENTORY	**Operator**	MARK
Section Thickness	4-5	**Specification**	AMS-4108-F
Lab Temperature Deg F	70	**Lab Relative Humidity**	60
Lot Qty	22		

Load Cell S/N (TVI109253), Units (LBS) 22480

Displacement Sensor EZ.2-1 (5437)

Crosshead Speed (Inches / min) or Rate 2000

Test No	Specimen ID	Diameter (In)	Min Ult (Ksi)	Min YLD (ksi)	Min Elong (%)	Peak Load (lbs)	Peak Stress (psi)	Yld @ 0.20% (lb)	Yld @ 0.20% (psi)	Elong @ Break %
9517	L1	0.2510	70	60	9.0	3,483	70,389	3,013	60,886.82	12.50
9518	LT1	0.2510	69	58	4.0	3,512	70,986	2,987	60,376.88	12.80
	Mean	0.2510	70	59	6.5	3,498	70,687	3,000	60,631.85	12.65
	Std Dev	0.0001	1	1	3.5	21	422	18	360.51	0.21

APP-QD 8040A LAB

By : MT Date : 3-10-14

APP-QD QA 8506

Test Performed in Accordance with ASTM B 557, Rev. 2010

We hereby certify the test results conform to specification

This certification represents only the samples listed on this report. This report is confidential property of Aluminum Precision Products and its client. This report may only be reproduced in full if a written permission is granted from Aluminum Precision Product's Quality Assurance Department.

ALUMINUM PRECISION PRODUCTS, INC. – OXNARD DIVISION

1001 MCWANE BOULEVARD
OXNARD, CALIFORNIA 93033
PHONE: (805) 486-4401 FAX: (805) 986-5670

HEAT TREAT CERTIFICATION

APP-OXNARD SHOP TRAVELER #	CUSTOMER NAME	CERTIFICATION NO.
4931-1-1	L. A. TURBINE CORPORATION	4931-1-1/XC04 (SHOP TRAVELER NUMBER - HEAT LOT NUMBER)

PART #	REV. LEVEL	ALLOY – TEMPER
7.00" OD X 4.0" L (5)	N/A	PRODUCTION PARTS 7050-T6 TEST PC 7050-T74
APP-OXNARD DIE #	**REV. LEVEL**	**MATERIAL STOCK LOT NO.**
5G724	N/A	F54433V

REQUIRED SOLUTION HEAT TREAT AND ARTIFICIAL AGE CYCLES IAW

SPECIFICATION(S): AMS 2772 F / AMS-H-6088C / S9000-A1-3

SOLUTION TEMPERATURE °F +/- 10° F	SOLUTION SOAK TIME	WATER QUENCH TEMPERATURE °F +/- 10° F	GLYCOL QUENCH TEMPERATURE °F	QUENCH DELAY TIME MAXIMUM 15 SECONDS	AGE TEMPERATURE °F +/- 10° F	AGE SOAK TIME
890°F	6.0 HRS. MIN. SOAK	80°F	N/A	15 SEC.	1ST STEP 200°F	4 HRS
					2ND STEP 250°F	24 HRS

ACTUAL SOLUTION HEAT TREAT AND ARTIFICIAL AGE CYCLES

SOLUTION TEMPERATURE °F +/- 10° F	SOLUTION SOAK TIME	QUENCH MEDIUM	QUENCH TEMPERATURE °F +/- 10° F	QUENCH DELAY TIME TIME	AGE TEMPERATURE °F +/- 10° F	AGE SOAK TIME
890°F	6.1 HRS. SOAK	WATER	START: 74.7°F RISE: 78.8°F	11 SEC.	1ST STEP 200°F	4 HRS
					2ND STEP 250°F	24 HRS.

SOLUTION HEAT TREAT DATE	HEAT LOT #	QUANTITY SOLUTIONED (ACCEPTED)
03/04/2014	XC04	20 PCS. & 2 TEST PCS.
ARTIFICIAL AGE DATE		**QUANTITY AGED (ACCEPTED)**
03/06/2014		20 PCS. & 2 TEST PCS.

COMMENTS:
PO #15407
6" LOAD COUPLE USED FOR ARTIFICIAL AGE ONLY. ALL PARTS AGED TO 7050-T6

TEST PIECE WAS AGED FOR 8.0 HOURS AT 350° TO ACHIEVE 7050-T74 03-10-2014

CERTIFIED BY: _____ SIGNATURE

APP-OX QA 6512 STAMP

03/10/2014 DATE

JIM HAUN
NAME

FORM: app-ox-078, rev. d 11-18-2009

Serial # **3198**

DT# **106801**

Aluminum Precision Prod - Oxnard

1001 McWane Blvd.

Oxnard, CA 93033

PO#: M49722

Vista Metals Corp
13425 Whittram Ave
Fontana, CA 92335
(909)823-4278

Certificate of Inspection and Conformance

Certified report of chemical analysis
(all values are percent concentration)

Test Method: ASTM E-1251 & QP10-02

Heat	Diameter	Alloy	AL	SI	Fe	Cu	Mn	Mg	Cr	Ni	Zn	V	Ti	Rb	Sn	Na	B	Zr	Li	Ca	Be	Bi
F54433	14.25	7050	88.61	0.06	0.10	2.31	0.01	2.28	0.02	0.00	6.46	0.0097	0.04	0.0018	0.0010	0.0001	0.0035	0.10	0.0000	0.0002	0.00041	0.0001

RECEIVED
BY: M. Lopez
PO: 8133
2-11-13

Serial # **3198**

DT# **106801**

Aluminum Precision Prod - Oxnard

1001 McWane Blvd.

Oxnard, CA 93033

PO#: M49722

Vista Metals Corp
13425 Whittram Ave
Fontana, CA 92335
(909)823-4278

Certificate of Inspection and Conformance

Certified report of chemical analysis
(all values are percent concentration)

Test Method: ASTM E-1251 & QP10-02

Applicable Specs:

ER 1000 REV F, SQA-001 REV D, SQA-004 REV E CHEMISTRY ONLY.

Notes:

RECEIVED
BY: M. LOPEZ
DEPT: 8133 DATE: 2-11-13

Mercury Free

Vista Metals Corp certifies that the material in this shipment meets the requirements of all the applicable specifications/purchase order and verifiable evidence of inspections and testing is available for inspection.
Made in the U.S.A.

Submitted By: VM 44

Q.C. Stamp Signature

FEB - 9 2013

Durkee Testing Laboratories

Durkee Testing Laboratories, Inc.
P.O. Box 1401 * 15700 Texaco Street, Paramount, CA 90723
Phone: 562-531-7111, FAX: 562-531-7137

Customer:	Cust. P.O.	Shipper:	Lab No.	Log No.
Aluminum Precision Products Oxnard Division 1001 McWane Blvd. Oxnard, CA 93033	M52851		L6312	353952A
	Specs: AMS 4108F			Date Rec.: 3/12/2014
				Date Comp.: 3/24/2014

Item	Description	Material
1-01	Fracture Toughness	7050-T74

Process: RECEIVED: (1) SAMPLE IDENTIFIED AS FOR PART NO./ DWG. NO.: 7 OD X 4L (5), APP NO.: 005G724 JOB #005G724-4931-1-1, HEAT NO.: XC04, HAND FORGINGS, APP REPORTED: HRB: 88.0, E.C.: 41.3% IACS,

APP-OD QA 8506

Fracture Toughness Test per ASTM-E-399-12e2

Test Coupon **L-T** | **KIC = Kq** | Report Contains Invalidities: **NO**

Specimen Direction:	**L-T**	Specimen Dimensions:		Pre-crack Temp.	75
Kq (KSI x in^1/2):	**29.97**	B Thickness (Inch):	**1.001**	Testing Temperature:	75
KIC (KSI x in^1/2):	**29.97**	W Width (Inch):	**1.995**	Relative Humidity:	41
Minimum KIC reqmnt.	**25.00**				

Fatigue Crack Summary

	Load (kips)	Cycles	Crack Length (inch) Side 1	Side 2
Phase I	2.60	5000	0.060	0.060
Phase II	2.15	2000	0.075	0.070
Phase III	1.80	2000	0.085	0.080

Crack Length Data

Initial Crack Length (inch):	0.850
Side 1	0.935
Quarter Point 1 (25%):	0.985
Center Point (50%):	0.990
Quarter Point 2 (75%):	0.975
Side 2	0.930
Average	0.983

Fracture Test Data

Pq (kips)	4.48		
Pmax (kips)	4.48	Pmax/Pq Ratio	1.00
Yield Strength (KSI)	61.00		
Modulus of E (KSI)	10000		
Rsc (Specimen Strength Ratio)	0.710		

Validity Checks

*(7.3.2.1) Valid — **A:** Final a/w Must be Between .45 & .55 — 0.493

*(8.2.2) Valid — **B:** The Difference Between any Two of the Three Crack Length Measurements Shall Not Exceed 10% of the Average

Maximum Difference	0.015
10% of Average	0.098

*(8.2.2) Valid — **C:** No Part of the Crack Front Shall be Closer to the Machined Starter Notch than 2.5%W or .050.

2.5%W	0.050
Side 1	0.085
Side 2	0.080

Durkee Testing Laboratories, Inc.
P.O. Box 1401 * 15700 Texaco Street, Paramount, CA 90723
Phone: 562-531-7111, FAX: 562-531-7137

Customer:	Cust. P.O.	Shipper:	Lab No.	Log No.
Aluminum Precision Products Oxnard Division 1001 McWane Blvd. Oxnard, CA 93033	M52851		L6312	353952A
	Specs: AMS 4108F			Date Rec.: 3/12/2014
				Date Comp.: 3/24/2014

Item	Description	Material
1-01	Fracture Toughness	7050-T74

APP-CD QA B506

*(8.2.2) Valid	D:	Surface Crack Measurements (S1-S2) Shall not Differ From the Average Crack Length by More Than 15%		
		Side 1		0.935
		Side 2		0.930
		85% of Average a		0.836
		115% of Average a		1.131
*(8.2.2) Valid	E:	The Difference Between the Two Surface Crack Measurements Shall not Exceed 10% of the Average Crack Length		
		Difference Between S1 and S2		0.005
		10% of Average Crack Length		0.098
*(8.2.4) Valid	F:	Crack Plane Shall be Parallel to Both Specimen Width and Thickness Direction Within +/- 10 Degrees		
		Actual to Width		Satisfactory
		Actual to Thickness		Satisfactory
*(8.3) Valid	G:	Loading Rate Must be Between 30 and 150 KSI x in^1/2/min.		
		Loading Rate (KSI x in^1/2/min.)		66.79
*(8.4) Valid	H:	The Initial Slope of the Load Displacement Curve Shall be Between the Ratio of .7 to 1.5		
		Slope of Plot		1.10
*(9.1.2) Valid	I:	Ratio of Pmax/Pq Must not Exceed 1.10		1.00
*(9.1.3) Valid	J:	Specimen ligament size, W-a, shall be Greater than 2.5(kq/ys)^2		
		Crack Length a 0.983	W-a =	1.012
		Specimen size (W) 1.995		
		2.5(Kq/YS)^2		0.603
*(A2.1.2) Valid	K:	Maximum Stress Intensity Kf (max) For Final Pre-Cracking Must Be Less Than .6Kq		
		Kf(max)		12.03
		0.6Kq		17.982
*(A2.3.3) Valid	L:	Kf(max) / E Shall Not Exceed 0.002(^1/2)		
		Kf(max) / E		0.00120

Durkee Testing Laboratories

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Phone: 562-531-7111, FAX: 562-531-7137

Customer:	Cust. P.O.	Shipper:	Lab No.	Log No.
Aluminum Precision Products Oxnard Division 1001 McWane Blvd. Oxnard, CA 93033	M52851		L6312	353952A
	Specs: AMS 4108F			Date Rec.: 3/12/2014
				Date Comp.: 3/24/2014

Item	Description	Material
1-01	Fracture Toughness	7050-T74

Interpretation:

All validity criteria satisfied therefore; KIC equals Kq

Test Machine: Instron 8502

Astersiked (*) references are to relevent paragraphs of Specification ASTM-E-399-12e2

Material, As Tested, Conforms to Specification Listed

BY:RC/

Accredited Nadcap Materials Testing Laboratory
CertificationNumber:
3628151640. EXP: 01/31/2016

Respectfully Submitted By,

AL MENDOZA
METALLURGICAL SUPERVISOR

Durkee Testing Laboratories, Inc.

P.O. BOX 1401•15700 Texaco Street•Paramount, CA 90723 • (562) 531-7111

ITAR & EAR Controlled

ENT BY: JG

CUSTOMER	CUST P.O.	SHIPPER / W.O.	LAB NO.	LOG NO.
ALUMINUM PRECISION PRODUCTS OXNARD DIVISION 1001 MCWANE BLVD. OXNARD, CA 93033	M52851		L6312	353952A
	SPECS: AMS 4108F ASTM-E-112-12 P.O. REQUIREMENTS			DATE REC. 03/12/14 DATE COMP. 03/24/14

Item	Quantity	Cust Item	Test	Description	Material
1-02	1	1	METALLURGICAL	GRAIN SIZE W/PHOTO	7050-T6 ALUMINUM

APP-CD QA 8506

METALLURGICAL EVALUATION TEST REPORT

RECEIVED: (1) SAMPLE FOR PART NO. / DWG NO: 7 OD X 4L (5)
APP NO.: 005G724, JOB #005G724-4931-1-1,
HEAT NO: XC04, HAND FORGINGS, FOR L.A. TURBINE CORPORATION
APP REPORTED: HRB: 88.0, E.C.:41.3% IACS

REF.: BISCUIT DWG. DTD 06/17/2013, PO #15407

GRAIN SIZE: #6.0

P.O. REQUIREMENTS: #3.0 TO #10.0

ETCH: KALLING'S 30 SECONDS

MAGNIFICATION: @ 100x

MATERIAL, AS TESTED, CONFORMS TO SPECIFICATION REQUIREMENTS.

Results provided on this Certified Test Report related only to items tested. This report shall not be reproduced except in full without the written permission of Durkee Testing Laboratories, Inc.

The recording of false, fictitious, or fraudulent statements or entries on this report may be punished as a felony under the federal law.

Respectfully submitted,

By: AL MENDOZA
METALLURGICAL SUPERVISOR

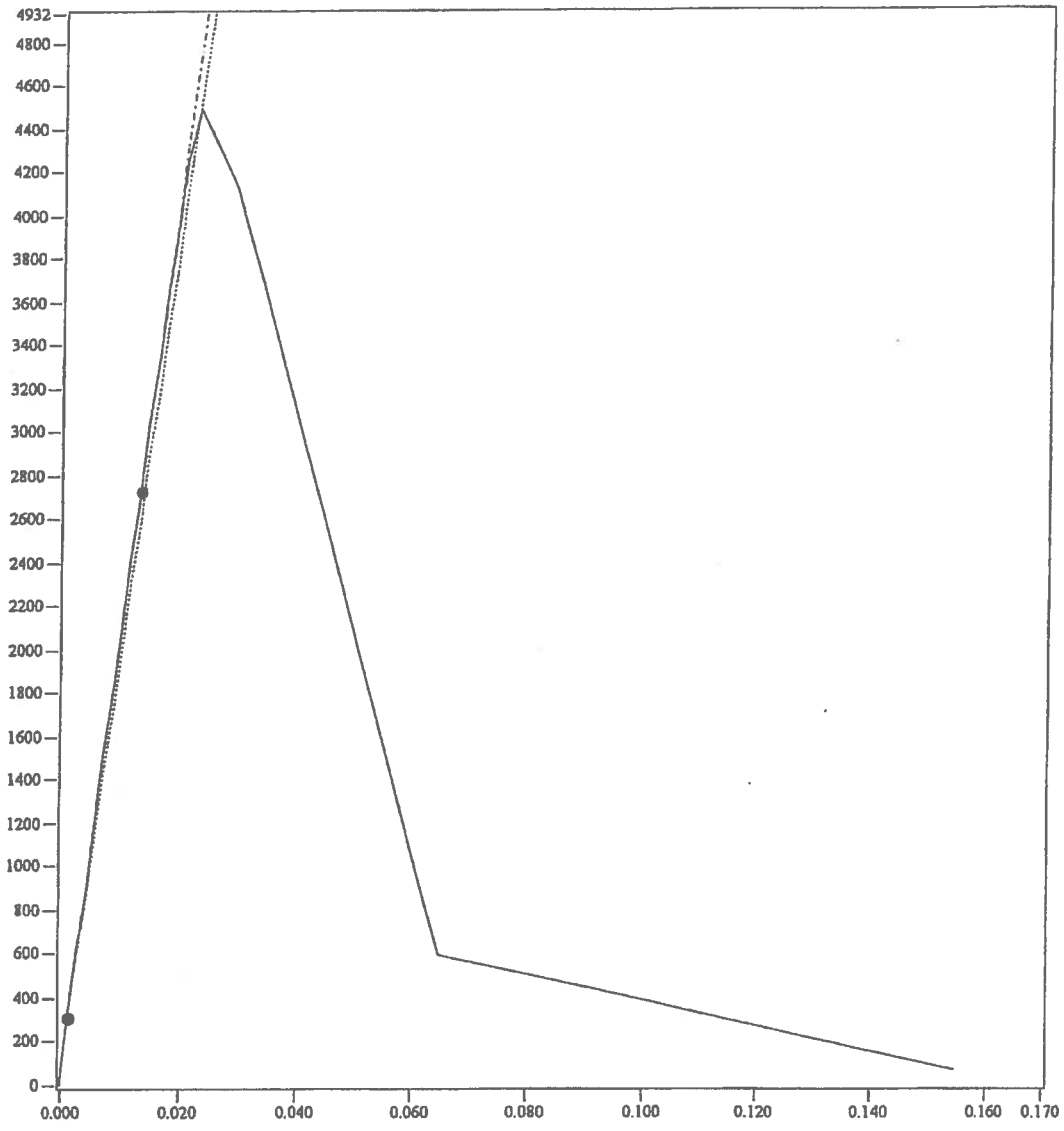
By: RC

Accredited Nadcap Materials Testing Laboratory
Certification Number: 3629131648, Exp.01/31/2016

LABORATORY ACCREDITATION BUREAU ACCREDITED ISO/IEC 17025
Certification Number: L2565 Testing, Exp.06/30/2016

Operator's Name: Daniel Johnson
Test Date: Sat, Mar 22, 2014
Specimen ID: LT
Material Specification: Aluminum
Material Condition: 7050 T74
Test Param File: 353952-1

Load lbs Versus Extension in



Mitchell Laboratories
NONDESTRUCTIVE TESTING
10573 Beech Ave Unit C, Bldg. B
Fontana, CA 92337
Ph. (909) 429-8802
Fx. (909) 429-8803
www.mitchell-labs.com

CERTIFICATION OF CONFORMANCE

CONTROL NUMBER: 26591-1

SOLD TO	SHIP TO
Aluminum Precision Products 1001 McWane Blvd Oxnard, CA 93003 *United States*	Aluminum Precision Products 1001 McWane Blvd Oxnard, CA 93003 *United States*

CUSTOMER P.O NUMBER	CUSTOMER PHONE NO.	CUSTOMER FAX NO.	ORDER. DATE	DATE SHIPPED
M52858	(805) 488-4401	(805) 986-5870	03/12/14	03/13/14

MATERIAL	LOT NO.	TERMS	BUYER
7050-T6	N/A	NET30	

ITEM	QTY. ORDERED	PART NUMBER / PROCESS / REVISION / DESCRIPTION	QTY. ACCEPTED	QTY. REJECTED
1	1	7" OD X 4" L UT PANCAKE TAG# 767 WT: 23 # EA APP NO.: 005G724 JOB: 005G724-4931-1-1 REFERENCE PO# 15407 HT: XC04 PRIME: UNKNOWN UT: ASTM B594-13, CLASS AA	1	0

WE HEREBY CERTIFY THE PARTS LISTED HAVE BEEN TESTED IN CONFORMANCE WITH THE SPECIFICATIONS NOTED. THIS REPORT REPRESENTS OUR INTERPRETATION OF THE RESULTS OBTAINED FROM THE TEST AND IS NOT TO BE CONSTRUED AS A GUARANTY OR WARRANTY OF THE CONDITION OF THE MATERIALS TESTED.

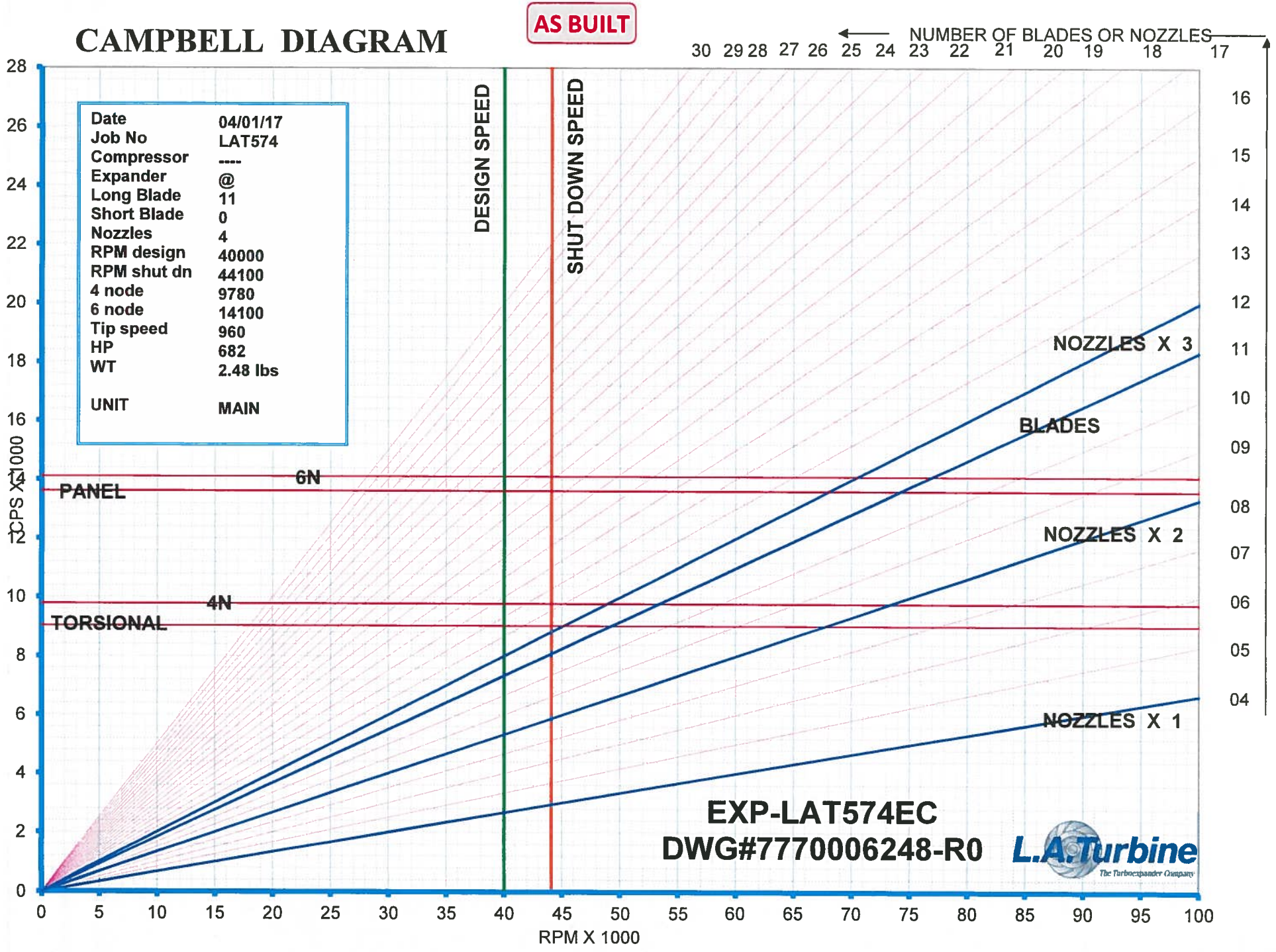
PARTS, MATERIALS, ETC., AS PROCESSED BY US SHALL BE PRESUMED TO BE ACCEPTED AS SATISFACTORY BY YOU IF WE ARE NOT NOTIFIED OF SHORTAGES OR OTHER DISCREPANCIES WITH TEN (10) WORKING DAYS OF YOUR RECEIPT OF THE SAME.

THESE PARTS HAVE NOT COME INTO CONTACT WITH MERCURY OR MERCURY COMPOUNDS AT ANY TIME DURING PROCESSING AT MITCHELL LABORATORIES.

O. Valdovinos (UT Level 2)

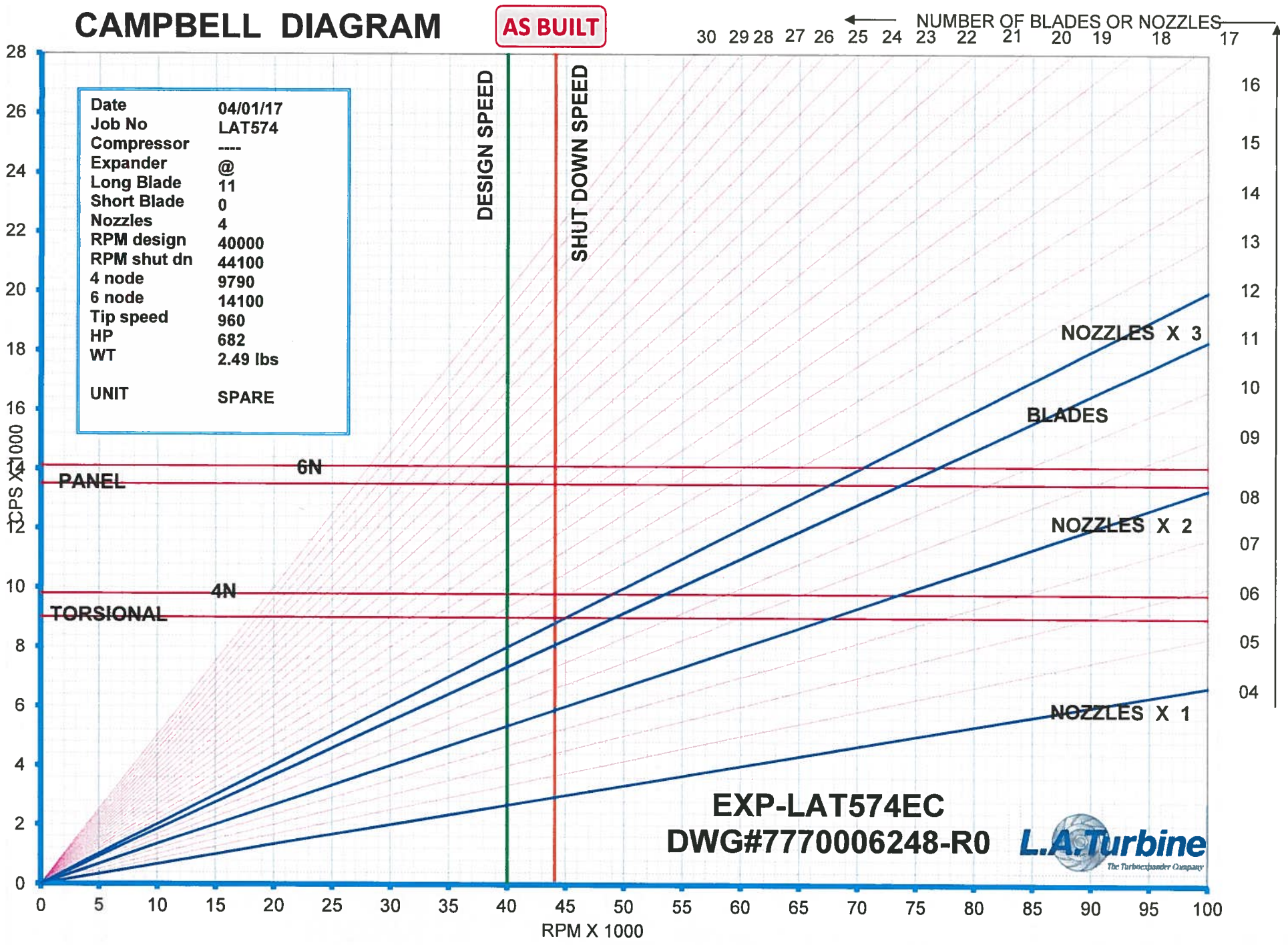
CAMPBELL DIAGRAM

AS BUILT



CAMPBELL DIAGRAM

AS BUILT



Dynomill Inc.
2018 Edwards Ave
S. El Monte, CA 91733
(626) 454-1805

Certificate of Overspeed Test

PURCHASE No.: 24640

CERTIFICATION FOR : LA TURBINE CORPORATION

THIS IS TO CERTIFY THAT

NAME OF THE PART: EXPANDER WHEEL (SPARE)

PART NUMBER: 7770006248

PROJECT NUMBER: LAT574

Dynomill Inc., hereby certifies that the above referenced parts meet the following requirements:

Spin test to 52000 RPM, Duration 10 Seconds.

CERTIFICATE No.: 150

COMMENT:

SPIN TEST DATE: 2/6/2017

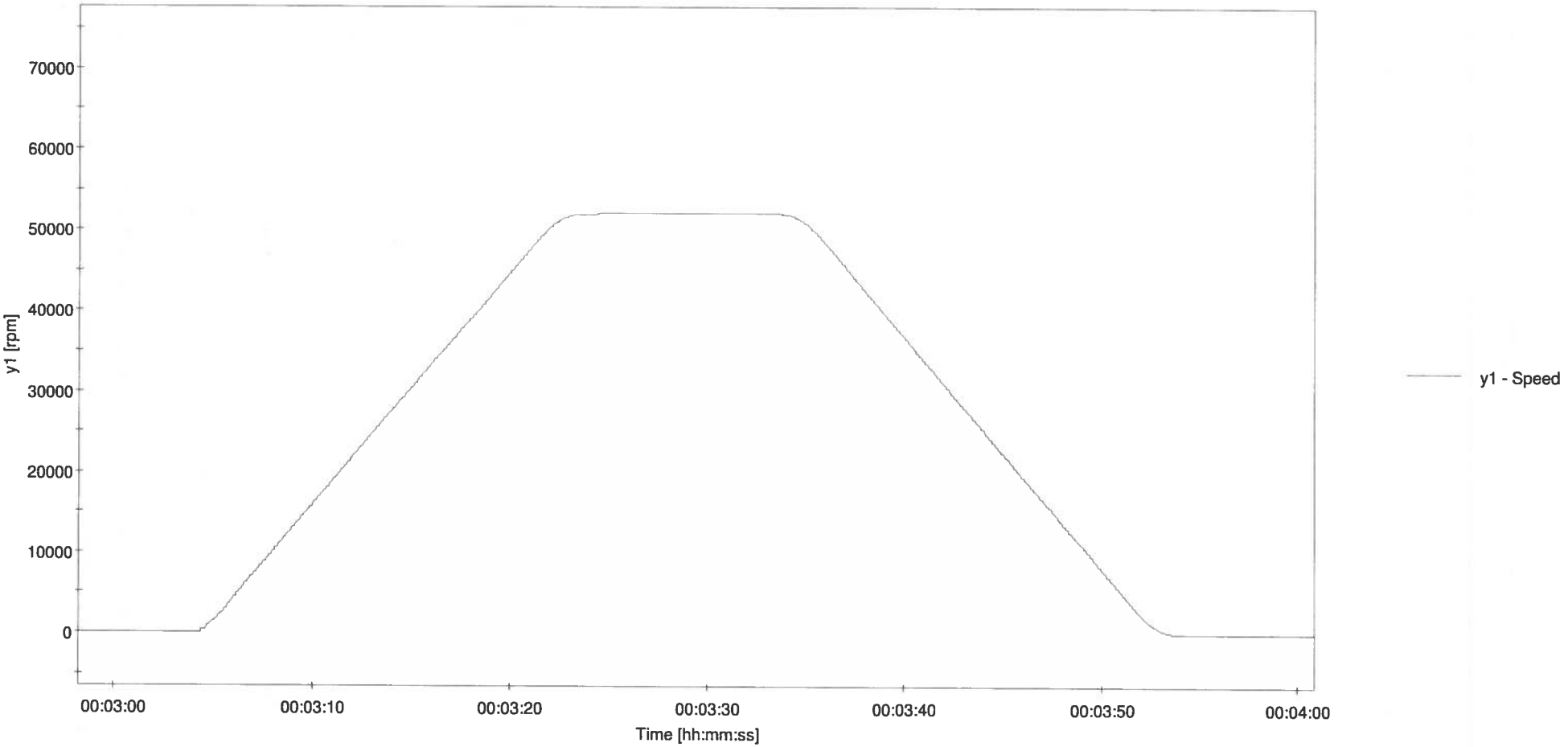
APPROVED BY:

Lam Nguyen
Assistant QC Manager

Copyright © 1998 - 2012 Schenck RoTec GmbH

Sequence Control Data:	**l.a. turbine**
Rotor ID:	**LAT574-SPARE-7770006248-EXPANDER WHEEL.**
Results:	**170203_110017**
Spin Test:	**Started at Friday, February 03, 2017 11:00:17 AM** **Spin Test terminated by user: Friday, February 03, 2017 11:04:19 AM**
Total Cycles:	**178**
Spin Speed:	**52000 rpm**
Holding Time:	**10 s**
Operator:	**Sammy Nguyen**

CAST : Computer Aided Spin Test



Dynomill Inc.
2018 Edwards Ave
S. El Monte, CA 91733
(626) 454-1805

Certificate of Overspeed Test

PURCHASE No.: 24634

CERTIFICATION FOR : LA TURBINE CORPORATION

THIS IS TO CERTIFY THAT

NAME OF THE PART: EXPANDER WHEEL (MAIN)

PART NUMBER: 7770006248

PROJECT NUMBER: LAT574

Dynomill Inc., hereby certifies that the above referenced parts meet the following requirements:

Spin test to 52000 RPM, Duration 10 Seconds.

CERTIFICATE No.: 148

COMMENT:

SPIN TEST DATE: 2/6/2017

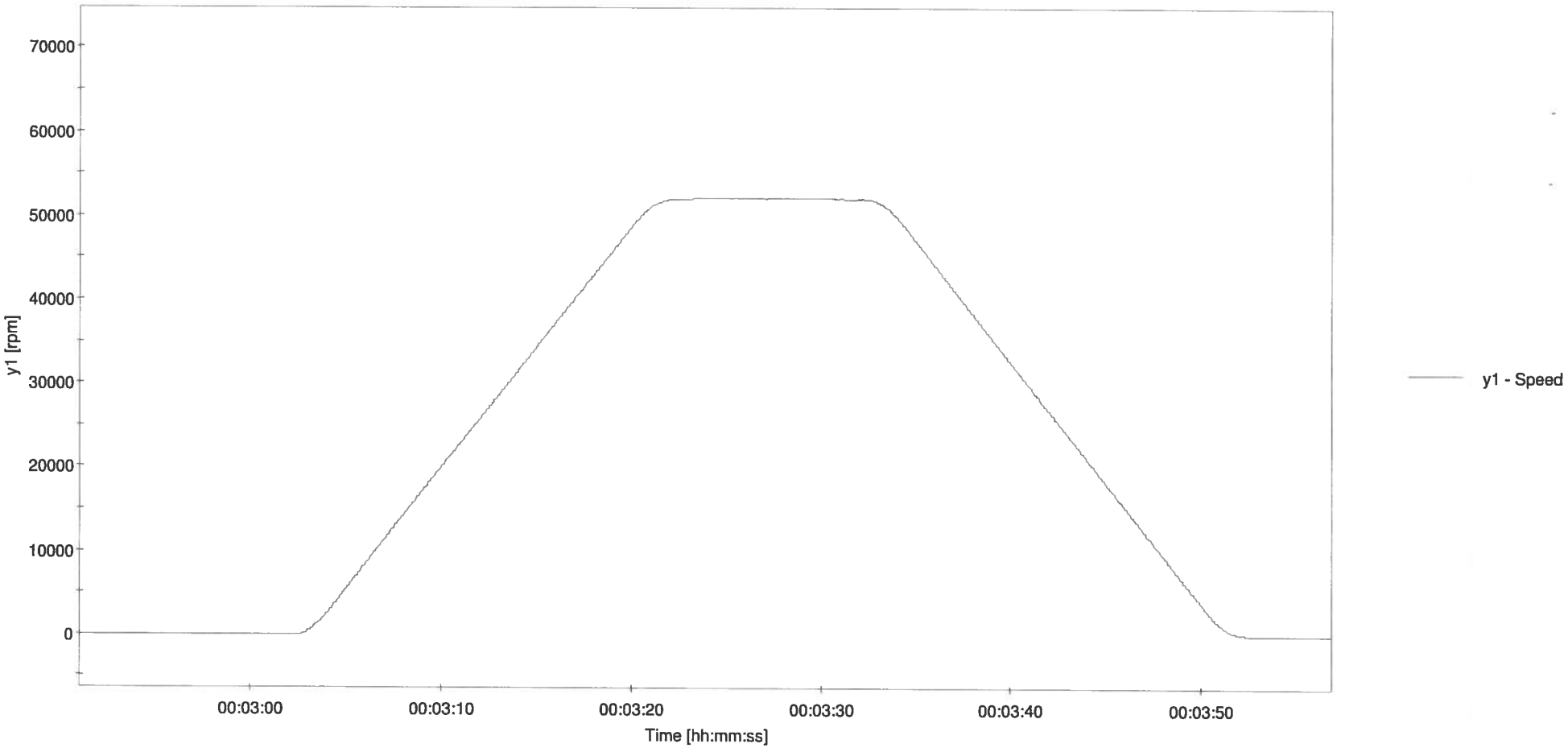
APPROVED BY:

Lam Nguyen
Assistant QC Manager

Copyright © 1998 - 2012 Schenck RoTec GmbH

Sequence Control Data:	**I.a. turbine**
Rotor ID:	**LAT574-MAIN-7770006248-EXPANDER WHEEL.**
Results:	**170203_100054**
Spin Test:	**Started at Friday, February 03, 2017 10:00:54 AM** **Spin Test terminated by user: Friday, February 03, 2017 10:04:55 AM**
Total Cycles:	**177**
Spin Speed:	**52000 rpm**
Holding Time:	**10 s**
Operator:	**Sammy Nguyen**

CAST : Computer Aided Spin Test



L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

EXPANDER WHEEL

DYE PENETRANT TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: EXPANDER WHEEL

PART NUMBER: 7770006248 (MAIN)

THIS IS TO CERTIFY THAT DYE PENETRANT TEST HAS BEEN PERFORMED IN ACCORDANCE WITH ASME SEC. V ON THE **EXPANDER WHEEL** AFTER THE OVERSPEED TEST. THE TEST RESULTS HAVE BEEN FOUND ACCEPTABLE IN ACCORDANCE WITH REQUIREMENTS SPECIFIED IN ASME SEC. VIII.

TEST PERFORMED BY:

Hung Phung, QC Inspector — Date: 2/7/17

TEST CONFIRMED BY:

Frank Loth, Quality Manager — Date: 2/7/17

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

EXPANDER WHEEL

DYE PENETRANT TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: EXPANDER WHEEL

PART NUMBER: 7770006248 (SPARE)

THIS IS TO CERTIFY THAT DYE PENETRANT TEST HAS BEEN PERFORMED IN ACCORDANCE WITH ASME SEC. V ON THE **EXPANDER WHEEL** AFTER THE OVERSPEED TEST. THE TEST RESULTS HAVE BEEN FOUND ACCEPTABLE IN ACCORDANCE WITH REQUIREMENTS SPECIFIED IN ASME SEC. VIII.

TEST PERFORMED BY:

Hung Phung, QC Inspector — Date: 2/7/17

TEST CONFIRMED BY:

Frank Loth, Quality Manager — Date: 2/7/17

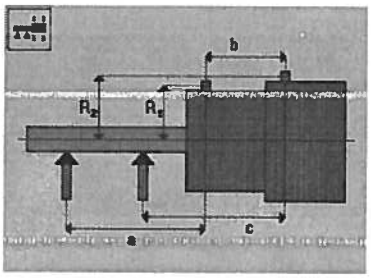
L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 EXP MAIN*** *Rebalance*

Rotor geometry

Balancing mode	Dynamic
Distance a	11.87 in
Distance b	2.00 in
Distance c	4.12 in
Radius 1	1.75 in
Radius 2	1.25 in



Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Plane 1	1.00 moz·in
Plane 2	1.00 moz·in

Measuring results - # 2

Rotor ID	
Speed	1529 rpm
Date/Time	21.03.17 / 09:17:21
Averaging run	1
Compensation	Index

Unbalance

Plane 1	0.27	moz·in	287°	In Tol
Plane 2	0.40	moz·in	109°	In Tol

Correction

Plane 1		0.157	moz	107°	In Tol
Plane 2		0.322	moz	289°	In Tol

Rotor balanced within tolerance

L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 EXP MAIN***

Rotor geometry

Balancing mode	Static
Radius 2	1.25 in

Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Static	1.00 moz·in

Measuring results - # 1

Rotor ID	
Speed	1529 rpm
Date/Time	21.03.17 / 09:18:59
Averaging run	1
Compensation	Index

Unbalance

Static	0.13	moz·in	114°	In Tol

Correction

Static	0.103	moz	294°	In Tol

Rotor balanced within tolerance

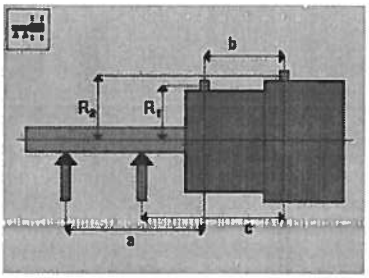
L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 EXP SPARE***

Rotor geometry

Balancing mode	Dynamic
Distance a	11.56 in
Distance b	2.00 in
Distance c	4.50 in
Radius 1	1.75 in
Radius 2	1.25 in



Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Plane 1	1.00 moz·in
Plane 2	1.00 moz·in

Measuring results - # 2

Rotor ID	
Speed	1593 rpm
Date/Time	16.03.17 / 10:38:32
Averaging run	1
Compensation	Index

Unbalance

Plane 1	0.28	moz·in	221°	In Tol
Plane 2	0.20	moz·in	34°	In Tol

Correction

Plane 1		0.163	moz	41°	In Tol
Plane 2		0.159	moz	214°	In Tol

Rotor balanced within tolerance

L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 EXP SPARE***

Rotor geometry

Balancing mode	Static
Radius 2	1.25 in

Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Static	1.00 moz·in

Measuring results - # 1

Rotor ID	
Speed	1593 rpm
Date/Time	16.03.17 / 10:40:08
Averaging run	1
Compensation	Index

Unbalance

Static	0.09	moz·in	237°	In Tol

Correction

Static	0.073	moz	57°	In Tol

Rotor balanced within tolerance

L.A.Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 5: COMPRESSOR WHEEL

- MATERIAL CERTIFICATION
- RESONANCE TEST CERTIFICATE
- OVERSPEED TEST CERTIFICATE
- DYE PENETRANT TEST CERTIFICATE
- DYNAMIC BALANCING TEST CERTIFICATE

ALUMINUM PRECISION PRODUCTS, INC.
1001 MCWANE BOULEVARD OXNARD, CA 93033
(805) 488-4401 FAX (805) 986-3334

CERTIFIED TEST REPORT
CERTIFICATION OF CONFORMANCE

CUST NO.	ROUTING	BUYER
10111	Customer Arranged	LINDA DENNIS

ORDER DATE	SOURCE REQ	CUSTOMER P.O. NO.	JOB NO.	CERT NO.
12/05/2013	N	15407	005G724-G122058	63991

SHIP TO
L.A. TURBINE
28557 INDUSTRY DRIVE
VALENCIA CA 91355

SOLD TO
L.A. TURBINE
28557 INDUSTRY DRIVE
VALENCIA CA 91355

SCHEDULED DELIVERY

Qty	Date	Qty	Date
20	12/31/14		

WE HERBY CERTIFY THAT THE MATERIAL COVERED BY THIS REPORT HAS BEEN INSPECTED IN ACCORDANCE WITH , AND HAS BEEN FOUND TO MEET THE APPLICABLE REQUIREMENTS DESCRIBED HEREIN, INCLUDING ANY SPECIFICATIONS FORMING A PART OF THE DESCRIPTION. TEST REPORTS ARE ON FILE SUBJECT TO EXAMINATION.
ALUMINUM PRECISION PRODUCTS, INC.

APP-200 QA 8512

Authorized Q.A. Signature

DATE: 09/29/2014

09.29.14

PART NO. /DESCRIPTION	REV	GENERAL SPECIFICATIONS
7 OD X 4 L (5)		AMS 2658 C AMS 2772 F AMS 4108 F AMS-H-6088 C ASTM B557 -10 ASTM B594 CL AA -13 ASTM E112 -13 ASTM E18 -14 ASTM E8/E8M -13a S9000-A1 -3

ALLOY	TEMPER	ELEMENT	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Zr	Other	Total
7050	T6	MIN	0.00	0.00	2.00	0.00	1.90	0.00	5.70	0.00	0.08	0.00	0.00
		MAX	0.12	0.15	2.60	0.10	2.60	0.04	6.70	0.06	0.15	0.05	0.15

QTY	HEAT NO	MATERIAL SUPPLIER	STOCK CODE NUMBER
20	XC04	VISTA METALS	F54433

PROCESS	PERFORMED BY	PROCESS SPECIFICATION	COMMENTS	REPORT/CERT NO.
Heat No: XC04				
TENSILE TEST	APP - Oxnard CA	ASTM E112 -13		4205
ULTRASONIC	Mitchell Labs-PicoRivera CA	ASTM B594 CL AA -13		26591
OUTSIDE TEST	Durkee Testing-Paramount CA	ASTM E112 -12		353952A

GENERAL COMMENTS
Production Lot #
4931-1-1
2 TEST PIECES SHIPPED TO CUSTOMER ON 3/28/14

ALUMINUM PRECISION PRODUCTS
OXNARD DIVISION
1001 McWane Blvd, Oxnard, CA 93033 Tel 805-488-4401 FAX 805-986-5670

Mar 11, 2014
Report No. 4205

Tensile of Aluminum (RNDS) MANUAL ELONG

Test Date 11-Mar-14 Testing Machine SFM-100KN 1

DF/HF	5G724	**Traveler #**	4931-1-1
Heat Lot ID	XC04	**Alloy-Temper**	7050-T6
HRBW	88 (84-92)	**Conductivity % IACS**	41.3 (38-44)
Customer PO #	15407	**P/N**	7 O.D. X 4 L (5)
Job #	INVENTORY	**Operator**	MARK
Section Thickness	4-5	**Specification**	AMS-4108-F
Lab Temperature Deg F	70	**Lab Relative Humidity**	60
Lot Qty	22		

Load Cell S/N (TVI109253), Units (LBS) 22480
Displacement Sensor EZ.2-1 (5437)
Crosshead Speed (Inches / min) or Rate 2000

Test No	Specimen ID	Diameter (In)	Min Ult (Ksi)	Min YLD (ksi)	Min Elong (%)	Peak Load (lbs)	Peak Stress (psi)	Yld @ 0.20% (lb)	Yld @ 0.20% (psi)	Elong @ Break %
9517	L1	0.2510	70	60	9.0	3,483	70,389	3,013	60,886.82	12.50
9518	LT1	0.2510	69	58	4.0	3,512	70,986	2,987	60,376.88	12.80
	Mean	0.2510	70	59	6.5	3,498	70,687	3,000	60,631.85	12.65
	Std Dev	0.0001	1	1	3.5	21	422	18	360.51	0.21

By : APP-QD 8040A LAB MT Date : 3-10-14 APP-QD QA 8500

Test Performed in Accordance with ASTM B 557, Rev. 2010

We hereby certify the test results conform to specification

This certification represents only the samples listed on this report. This report is confidential property of Aluminum Precision Products and its client. This report may only be reproduced in full if a written permission is granted from Aluminum Precision Product's Quality Assurance Department.

ALUMINUM PRECISION PRODUCTS, INC. – OXNARD DIVISION

1001 MCWANE BOULEVARD
OXNARD, CALIFORNIA 93033
PHONE: (805) 488-4401 FAX: (805) 986-5670

HEAT TREAT CERTIFICATION

APP-OXNARD SHOP TRAVELER #	CUSTOMER NAME	CERTIFICATION NO.
4931-1-1	L. A. TURBINE CORPORATION	4931-1-1/XC04 (SHOP TRAVELER NUMBER - HEAT LOT NUMBER)

PART #	REV. LEVEL	ALLOY – TEMPER
7.00" OD X 4.0" L (5)	N/A	PRODUCTION PARTS 7050-T6 TEST PC 7050-T74
APP-OXNARD DIE #	**REV. LEVEL**	**MATERIAL STOCK LOT NO.**
5G724	N/A	F54433V

REQUIRED SOLUTION HEAT TREAT AND ARTIFICIAL AGE CYCLES IAW

SPECIFICATION(S): AMS 2772 F / AMS-H-6088C / S9000-A1-3

SOLUTION TEMPERATURE °F +/- 10° F	SOLUTION SOAK TIME	WATER QUENCH TEMPERATURE °F +/- 10° F	GLYCOL QUENCH TEMPERATURE °F	QUENCH DELAY TIME MAXIMUM 15 SECONDS	AGE TEMPERATURE °F +/- 10° F	AGE SOAK TIME
890°F	6.0 HRS. MIN. SOAK	80°F	N/A	15 SEC.	1ST STEP 200°F	4 HRS
					2ND STEP 250°F	24 HRS

ACTUAL SOLUTION HEAT TREAT AND ARTIFICIAL AGE CYCLES

SOLUTION TEMPERATURE °F +/- 10° F	SOLUTION SOAK TIME	QUENCH MEDIUM	QUENCH TEMPERATURE °F +/- 10° F	QUENCH DELAY TIME TIME	AGE TEMPERATURE °F +/- 10° F	AGE SOAK TIME
890°F	6.1 HRS. SOAK	WATER	START: 74.7°F RISE: 78.8°F	11 SEC.	1ST STEP 200°F	4 HRS
					2ND STEP 250°F	24 HRS.

SOLUTION HEAT TREAT DATE	HEAT LOT #	QUANTITY SOLUTIONED (ACCEPTED)
03/04/2014	XC04	20 PCS. & 2 TEST PCS.
ARTIFICIAL AGE DATE		**QUANTITY AGED (ACCEPTED)**
03/06/2014		20 PCS. & 2 TEST PCS.

COMMENTS:
PO #15407
6" LOAD COUPLE USED FOR ARTIFICIAL AGE ONLY. ALL PARTS AGED TO 7050-T6

TEST PIECE WAS AGED FOR 8.0 HOURS AT 350° TO ACHIEVE 7050-T74 03-10-2014

CERTIFIED BY: _____ SIGNATURE

APP-OX QA 8512 STAMP

03/10/2014 DATE

JIM HAUN
NAME

FORM: app-ox-078, rev. d 11-18-2009

Serial # **3198**

DT# **106801**

Aluminum Precision Prod - Oxnard

1001 McWane Blvd.

Oxnard, CA 93033

PO#: M49722

Vista Metals Corp
13425 Whittram Ave
Fontana, CA 92335
(909)823-4278

Certificate of Inspection and Conformance

Certified report of chemical analysis
(all values are percent concentration)

Highest caliber. So is the metal.™

Test Method: ASTM E-1251 & QP10-02

Heat	Diameter	Alloy	Al	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	V	Ti	Pb	Sn	Na	B	Zr	Li	Ca	Be	Bi
F54433	14.25	7050	88.61	0.06	0.10	2.31	0.01	2.28	0.02	0.00	6.46	0.0097	0.04	0.0018	0.0010	0.0001	0.0035	0.10	0.0000	0.0002	0.00041	0.0001

RECEIVED
BY: M.LOPEZ
8133
2-11-13

Serial # **3198**

DT# **106801**

Aluminum Precision Prod - Oxnard

1001 McWane Blvd.

Oxnard, CA 93033

PO#: M49722

Vista Metals Corp
13425 Whittram Ave
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Certificate of Inspection and Conformance

Certified report of chemical analysis
(all values are percent concentration)

·Highest caliber. So is the metal.™

Test Method: ASTM E-1251 & QP10-02

Applicable Specs:

ER 1000 REV F, SQA-001 REV D, SQA-004 REV E CHEMISTRY ONLY.

Notes:

RECEIVED
BY M. Lopez
EMP.# 8193 DATE 2-11-13

Mercury Free

Vista Metals Corp certifies that the material in this shipment meets the requirements of all the applicable specifications/purchase order and verifiable evidence of inspections and testing is available for inspection.
Made in the U.S.A.

Submitted By: VM 44

Q.C. Stamp Signature

FEB - 9 2013

Durkee Testing Laboratories, Inc.
P.O. Box 1401 * 15700 Texaco Street, Paramount, CA 90723
Phone: 562-531-7111, FAX: 562-531-7137

Customer:	Cust. P.O.	Shipper:	Lab No.	Log No.
Aluminum Precision Products Oxnard Division 1001 McWane Blvd. Oxnard, CA 93033	M52851		L6312	353952A
	Specs: AMS 4108F			Date Rec.: 3/12/2014
				Date Comp.: 3/24/2014

Item	Description	Material
1-01	Fracture Toughness	7050-T74

Process: RECEIVED: (1) SAMPLE IDENTIFIED AS FOR PART NO./ DWG. NO.: 7 OD X 4L (5), APP NO.: 005G724 JOB #005G724-4931-1-1, HEAT NO.: XC04, HAND FORGINGS,
APP REPORTED: HRB: 88.0, E.C.: 41.3% IACS,

APP-QD QA 8506

Fracture Toughness Test per ASTM-E-399-12e2

Test Coupon **L-T** | **KIC = Kq** | Report Contains Invalidities: **NO**

Specimen Direction:	**L-T**	Specimen Dimensions:		Pre-crack Temp.	75
Kq (KSI x in^1/2):	**29.97**	B Thickness (Inch):	**1.001**	Testing Temperature:	75
KIC (KSI x in^1/2):	**29.97**	W Width (Inch):	**1.995**	Relative Humidity:	41
Minimum KIC reqmnt.	**25.00**				

Fatigue Crack Summary

	Load (kips)	Cycles	Crack Length (inch) Side 1	Side 2
Phase I	2.60	5000	0.060	0.060
Phase II	2.15	2000	0.075	0.070
Phase III	1.80	2000	0.085	0.080

Crack Length Data

Initial Crack Length (inch):	0.850
Side 1	0.935
Quarter Point 1 (25%):	0.985
Center Point (50%):	0.990
Quarter Point 2 (75%):	0.975
Side 2	0.930
Average	0.983

Fracture Test Data

Pq (kips)	4.48		
Pmax (kips)	4.48	Pmax/Pq Ratio	1.00
Yield Strength (KSI)	61.00		
Modulus of E (KSI)	10000		
Rsc (Specimen Strength Ratio)	0.710		

Validity Checks

*(7.3.2.1) Valid — A: Final a/w Must be Between .45 & .55 — 0.493

*(8.2.2) Valid — B: The Difference Between any Two of the Three Crack Length Measurements Shall Not Exceed 10% of the Average
Maximum Difference 0.015
10% of Average 0.098

*(8.2.2) Valid — C: No Part of the Crack Front Shall be Closer to the Machined Starter Notch than 2.5%W or .050.
2.5%W 0.050
Side 1 0.085
Side 2 0.080

Durkee Testing Laboratories, Inc.
P.O. Box 1401 * 15700 Texaco Street, Paramount, CA 90723
Phone: 562-531-7111, FAX: 562-531-7137

Customer:	Cust. P.O.	Shipper:	Lab No.	Log No.
Aluminum Precision Products Oxnard Division 1001 McWane Blvd. Oxnard, CA 93033	M52851		L6312	353952A
	Specs: AMS 4108F			Date Rec.: 3/12/2014
				Date Comp.: 3/24/2014

Item	Description	Material
1-01	Fracture Toughness	7050-T74

*(8.2.2) Valid	D:	Surface Crack Measurements (S1-S2) Shall not Differ From the Average Crack Length by More Than 15%		
		Side 1		0.935
		Side 2		0.930
		85% of Average a		0.836
		115% of Average a		1.131
*(8.2.2) Valid	E:	The Difference Between the Two Surface Crack Measurements Shall not Exceed 10% of the Average Crack Length		
		Difference Between S1 and S2		0.005
		10% of Average Crack Length		0.098
*(8.2.4) Valid	F:	Crack Plane Shall be Parallel to Both Specimen Width and Thickness Direction Within +/- 10 Degrees		
		Actual to Width		Satisfactory
		Actual to Thickness		Satisfactory
*(8.3) Valid	G:	Loading Rate Must be Between 30 and 150 KSI x in^1/2/min.		
		Loading Rate (KSI x in^1/2/min.)		66.79
*(8.4) Valid	H:	The Initial Slope of the Load Displacement Curve Shall be Between the Ratio of .7 to 1.5		
		Slope of Plot		1.10
*(9.1.2) Valid	I:	Ratio of Pmax/Pq Must not Exceed 1.10		1.00
*(9.1.3) Valid	J:	Specimen ligament size, W-a, shall be Greater than 2.5(kq/ys)^2		
		Crack Length a 0.983		
		Specimen size (W) 1.995	W-a =	1.012
		2.5(Kq/YS)^2		0.603
*(A2.1.2) Valid	K:	Maximum Stress Intensity Kf (max) For Final Pre-Cracking Must Be Less Than .6Kq		
		Kf(max)		12.03
		0.6Kq		17.982
*(A2.3.3) Valid	L:	Kf(max) / E Shall Not Exceed 0.002(^1/2)		
		Kf(max) / E		0.00120

Durkee Testing Laboratories, Inc.
P.O. Box 1401 * 15700 Texaco Street, Paramount, CA 90723
Phone: 562-531-7111, FAX: 562-531-7137

Customer:	Cust. P.O.	Shipper:	Lab No.	Log No.
Aluminum Precision Products Oxnard Division 1001 McWane Blvd. Oxnard, CA 93033	M52851		L6312	353952A
	Specs: AMS 4108F			Date Rec.: 3/12/2014
				Date Comp.: 3/24/2014

Item	Description	Material
1-01	Fracture Toughness	7050-T74

Interpretation:

All validity criteria satisfied therefore; KIC equals Kq

Test Machine: Instron 8502

Astersiked (*) references are to relevent paragraphs of Specification ASTM-E-399-12e2

Material, As Tested, Conforms to Specification Listed

BY:RC/

Accredited Nadcap Materials Testing Laboratory
CertificationNumber:
3628151640. EXP: 01/31/2016

Respectfully Submitted By,

AL MENDOZA
METALLURGICAL SUPERVISOR

Durkee Testing Laboratories, Inc.

P.O. BOX 1401•15700 Texaco Street•Paramount, CA 90723 • (562) 531-7111

ITAR & EAR Controlled

ENT BY JG

CUSTOMER	CUST P.O	SHIPPER / W.O	LAB NO	LOG NO
ALUMINUM PRECISION PRODUCTS OXNARD DIVISION 1001 MCWANE BLVD. OXNARD, CA 93033	M52851		L6312	353952A
	SPECS: AMS 4108F P.O. REQUIREMENTS	ASTM-E-112-12		DATE REC. 03/12/14 DATE COMP. 03/24/14

Item	Quantity	Cust Item	Test	Description	Material
1-02	1	1	METALLURGICAL	GRAIN SIZE W/PHOTO	7050-T6 ALUMINUM

APP-CD QA 850G

METALLURGICAL EVALUATION TEST REPORT

RECEIVED: (1) SAMPLE FOR PART NO. / DWG NO: 7 OD X 4L (5)
APP NO.: 005G724, JOB #005G724-4931-1-1,
HEAT NO: XC04, HAND FORGINGS, FOR L.A. TURBINE CORPORATION
APP REPORTED: HRB: 88.0, E.C.:41.3% IACS

REF.: BISCUIT DWG. DTD 06/17/2013, PO #15407

GRAIN SIZE: #6.0

P.O. REQUIREMENTS: #3.0 TO #10.0

ETCH: KALLING'S 30 SECONDS

MAGNIFICATION: @ 100x

MATERIAL, AS TESTED, CONFORMS TO SPECIFICATION REQUIREMENTS.

Results provided on this Certified Test Report related only to items tested. This report shall not be reproduced except in full without the written permission of Durkee Testing Laboratories, Inc.

The recording of false, fictitious, or fraudulent statements or entries on the test report may be punished as a felony under the federal law.

Respectfully Submitted,

By: AL MENDOZA
METALLURGICAL SUPERVISOR

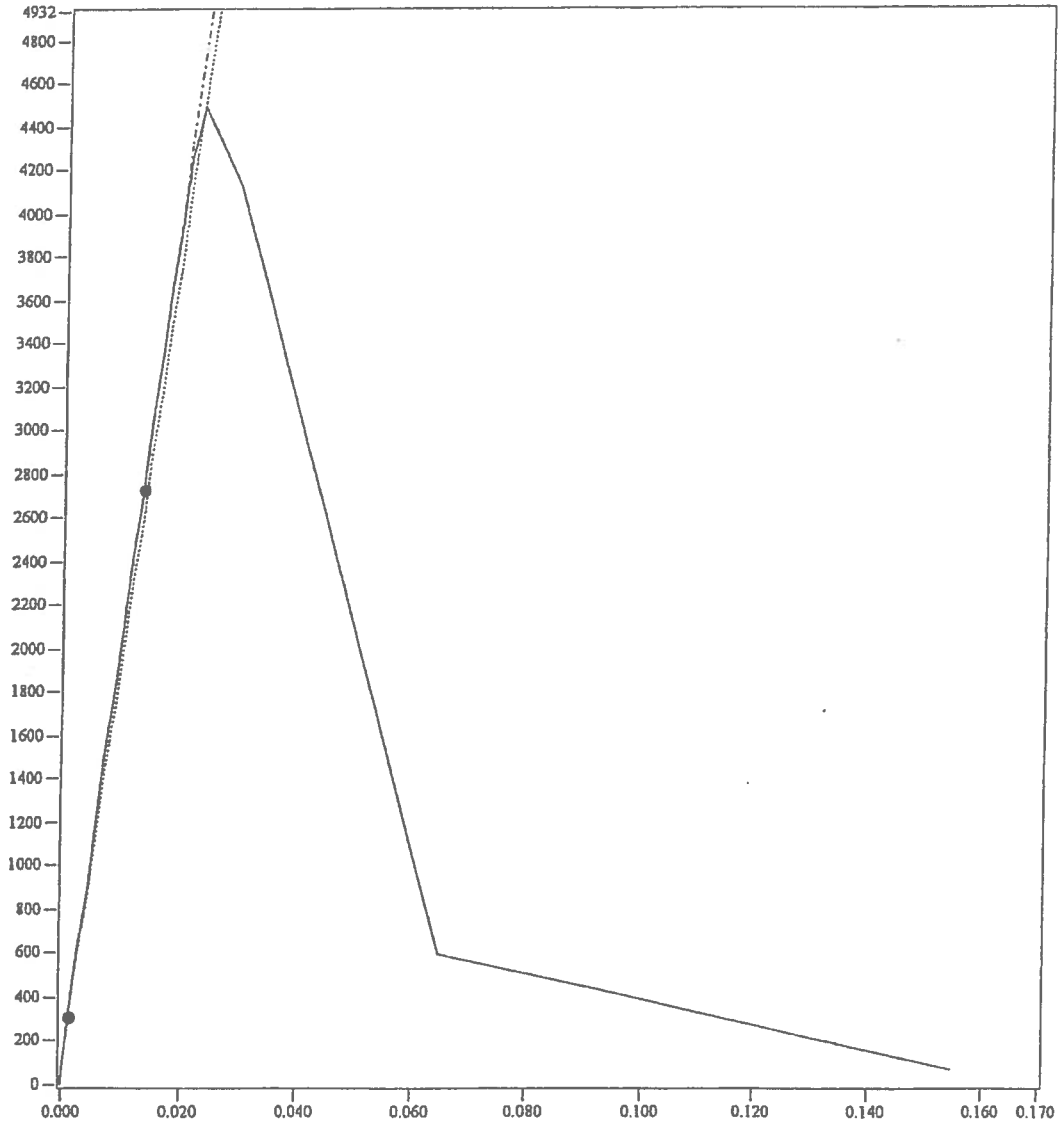
By:RC

Accredited Nadcap Materials Testing Laboratory
Certification Number: 3629181648, Exp.01/31/2016

LABORATORY ACCREDITATION BUREAU ACCREDITED ISO/IEC 17025
Certification Number: L2345 Testing, Exp.06/31/2016

Operator's Name: Daniel Johnson
Test Date: Sat, Mar 22, 2014
Specimen ID: LT
Material Specification: Aluminum
Material Condition: 7050 T74
Test Param File: 353952-1

Load lbs Versus Extension in



Mitchell Laboratories
NONDESTRUCTIVE TESTING
10573 Beech Ave Unit C, Bldg. B
Fontana, CA 92337
Ph. (909) 429-8802
Fx. (909) 429-8803
www.mitchell-labs.com

CERTIFICATION OF CONFORMANCE

CONTROL NUMBER: 26591-1

SOLD TO	SHIP TO
Aluminum Precision Products 1001 McWane Blvd Oxnard, CA 93003 *United States*	Aluminum Precision Products 1001 McWane Blvd Oxnard, CA 93003 *United States*

CUSTOMER P.O NUMBER	CUSTOMER PHONE NO.	CUSTOMER FAX NO.	ORDER. DATE	DATE SHIPPED
M52858	(805) 488-4401	(805) 986-5870	03/12/14	03/13/14

MATERIAL	LOT NO.	TERMS	BUYER
7050-T6	N/A	NET30	

ITEM	QTY. ORDERED	PART NUMBER / PROCESS / REVISION / DESCRIPTION	QTY. ACCEPTED	QTY. REJECTED
1	1	7" OD X 4" L UT PANCAKE TAG# 767 WT: 23 # EA APP NO.: 005G724 JOB: 005G724-4931-1-1 REFERENCE PO# 15407 HT: XC04 PRIME: UNKNOWN UT: ASTM B594-13, CLASS AA	1	0

WE HEREBY CERTIFY THE PARTS LISTED HAVE BEEN TESTED IN CONFORMANCE WITH THE SPECIFICATIONS NOTED. THIS REPORT REPRESENTS OUR INTERPRETATION OF THE RESULTS OBTAINED FROM THE TEST AND IS NOT TO BE CONSTRUED AS A GUARANTY OR WARRANTY OF THE CONDITION OF THE MATERIALS TESTED.

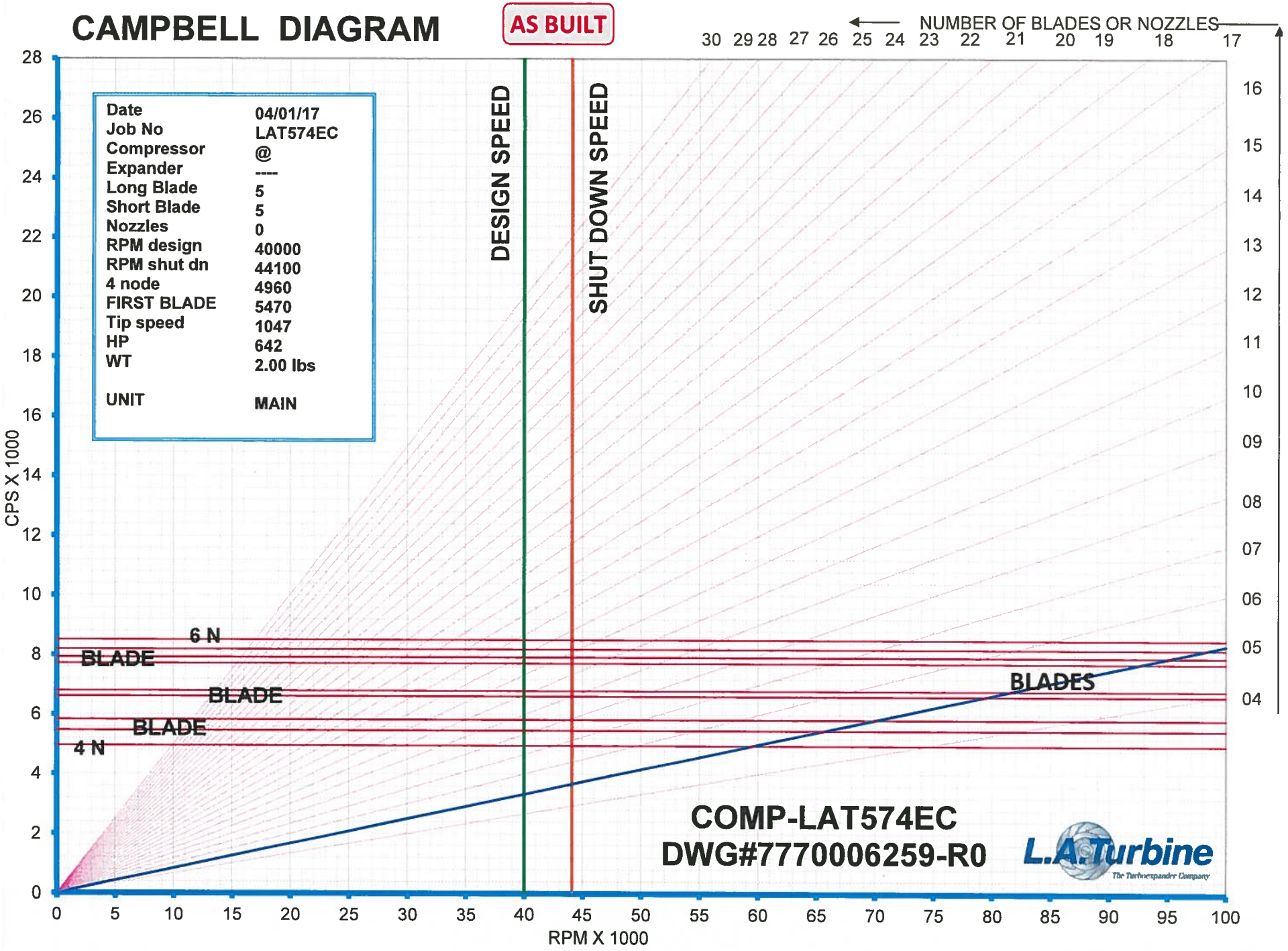
PARTS, MATERIALS, ETC., AS PROCESSED BY US SHALL BE PRESUMED TO BE ACCEPTED AS SATISFACTORY BY YOU IF WE ARE NOT NOTIFIED OF SHORTAGES OR OTHER DISCREPANCIES WITH TEN (10) WORKING DAYS OF YOUR RECEIPT OF THE SAME.

THESE PARTS HAVE NOT COME INTO CONTACT WITH MERCURY OR MERCURY COMPOUNDS AT ANY TIME DURING PROCESSING AT MITCHELL LABORATORIES.

O. Valdovinos (UT Level 2)

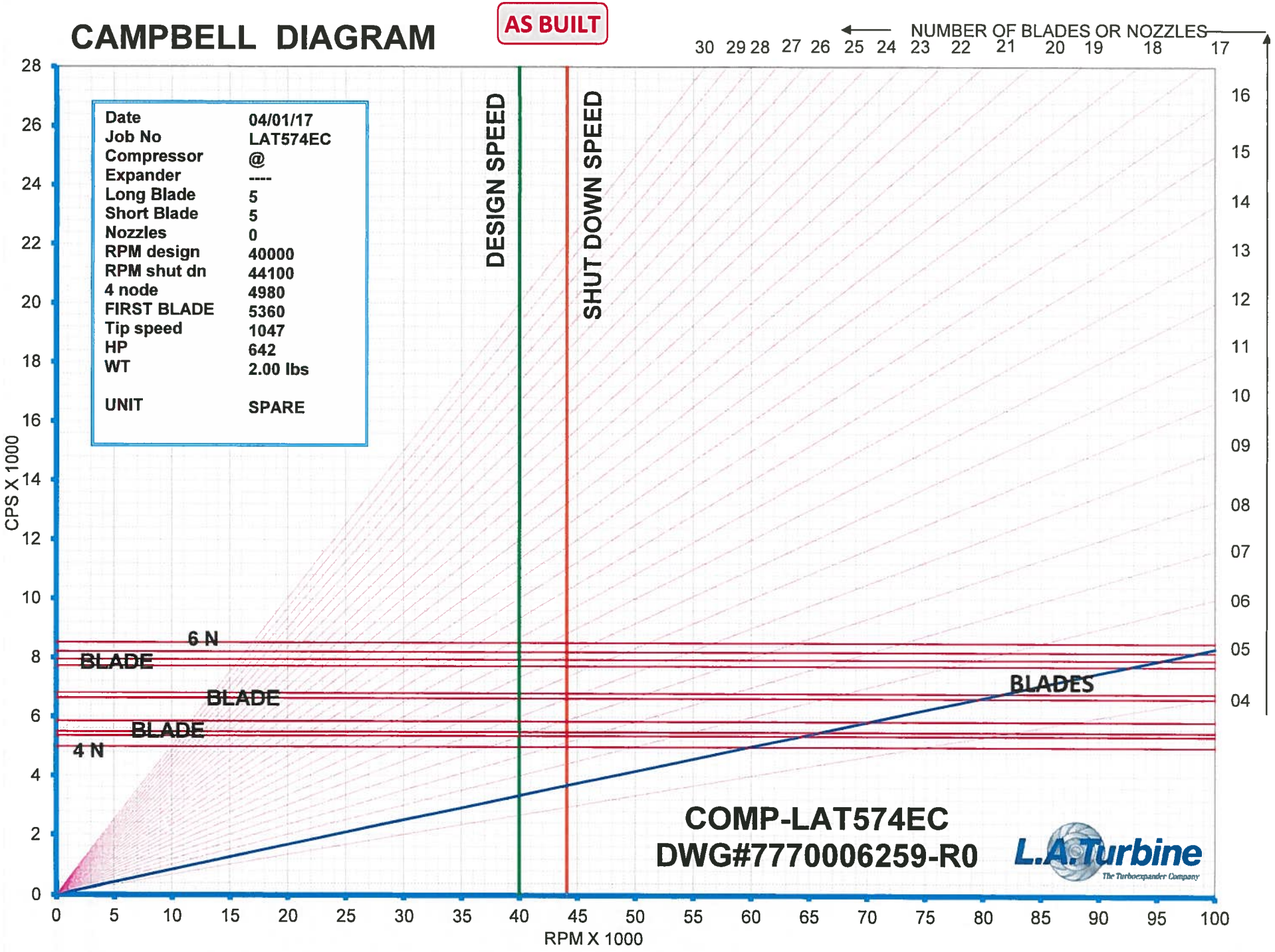
CAMPBELL DIAGRAM

AS BUILT



CAMPBELL DIAGRAM

AS BUILT



Dynomill Inc.
2018 Edwards Ave
S. El Monte, CA 91733
(626) 454-1805

Certificate of Overspeed Test

PURCHASE No.: 24624

CERTIFICATION FOR : LA TURBINE CORPORATION

THIS IS TO CERTIFY THAT

NAME OF THE PART: COMPRESSOR WHEEL (MAIN)

PART NUMBER: 7770006259

PROJECT NUMBER: LAT574

Dynomill Inc., hereby certifies that the above referenced parts meet the following requirements:

Spin test to 52000 RPM, Duration 10 Seconds.

CERTIFICATE No.: 145

SPIN TEST DATE: 2/1/2017

COMMENT:

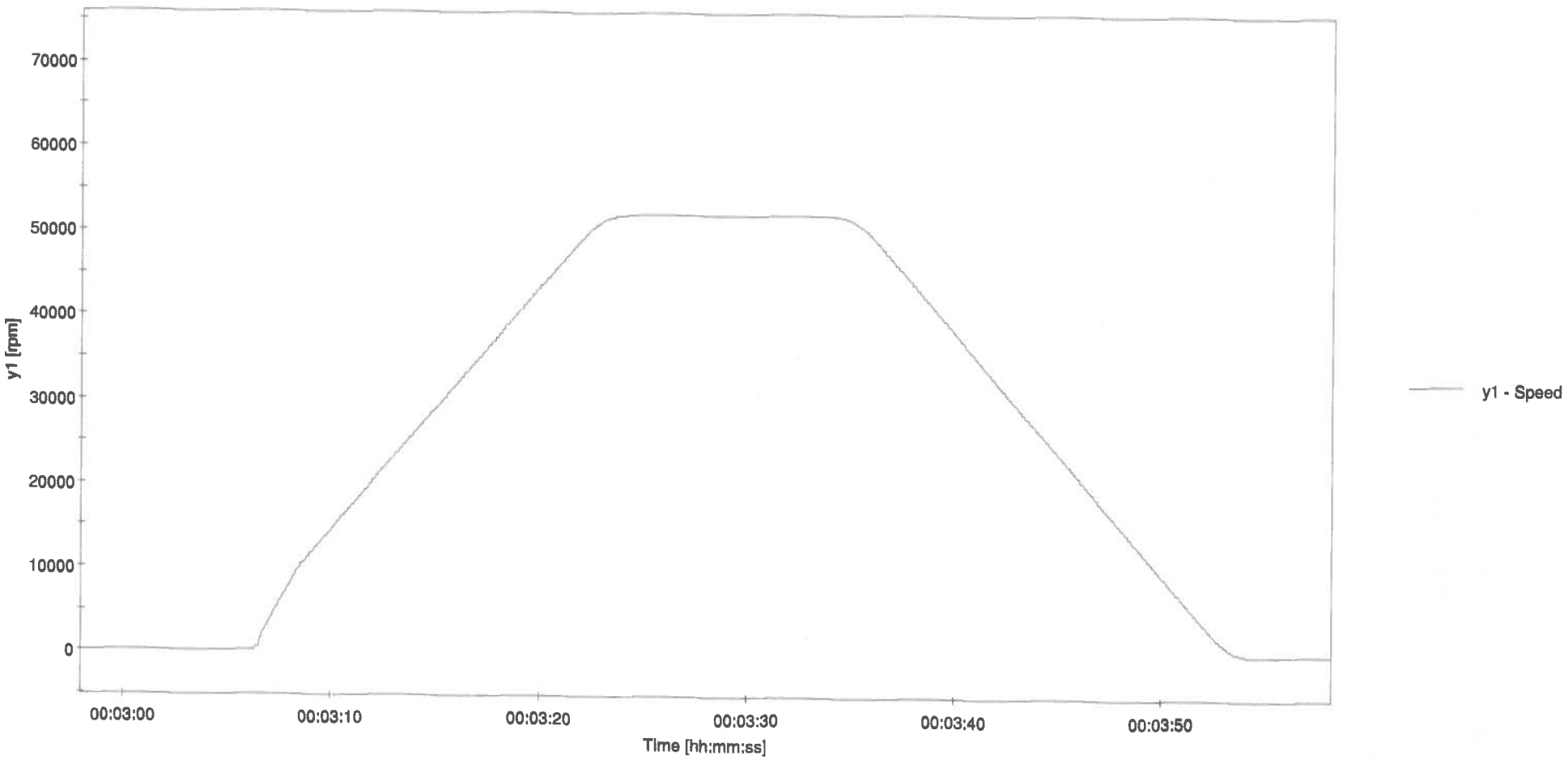
APPROVED BY:

Lam Nguyen
Assistant QC Manager

Copyright © 1998 - 2012 Schenck RoTec GmbH

Sequence Control Data:	**L.A. TURBINE**
Rotor ID:	**LAT574-MAIN-7770006259-COMPRESSOR WHEEL.**
Results:	**170201_113451**
Spin Test:	**Started at Wednesday, February 01, 2017 11:34:51 AM** **Spin Test terminated by user: Wednesday, February 01, 2017 11:38:53 AM**
Total Cycles:	**171**
Spin Speed:	**52000 rpm**
Holding Time:	**10 s**
Operator:	**Sammy Nguyen**

CAST : Computer Aided Spin Test



Dynomill Inc. Phone: 626-454-1805
2018 Edwards Avenue \ South El Monte \ CA 91733

Dynomill Inc.
2018 Edwards Ave
S. El Monte, CA 91733
(626) 454-1805

Certificate of Overspeed Test

PURCHASE No.: 24634

CERTIFICATION FOR : LA TURBINE CORPORATION

THIS IS TO CERTIFY THAT

NAME OF THE PART: COMPRESSOR WHEEL (SPARE)

PART NUMBER: 7770006259

PROJECT NUMBER: LAT574

Dynomill Inc., hereby certifies that the above referenced parts meet the following requirements:

Spin test to 52000 RPM, Duration 10 Seconds.

CERTIFICATE No.: 149

COMMENT:

SPIN TEST DATE: 2/6/2017

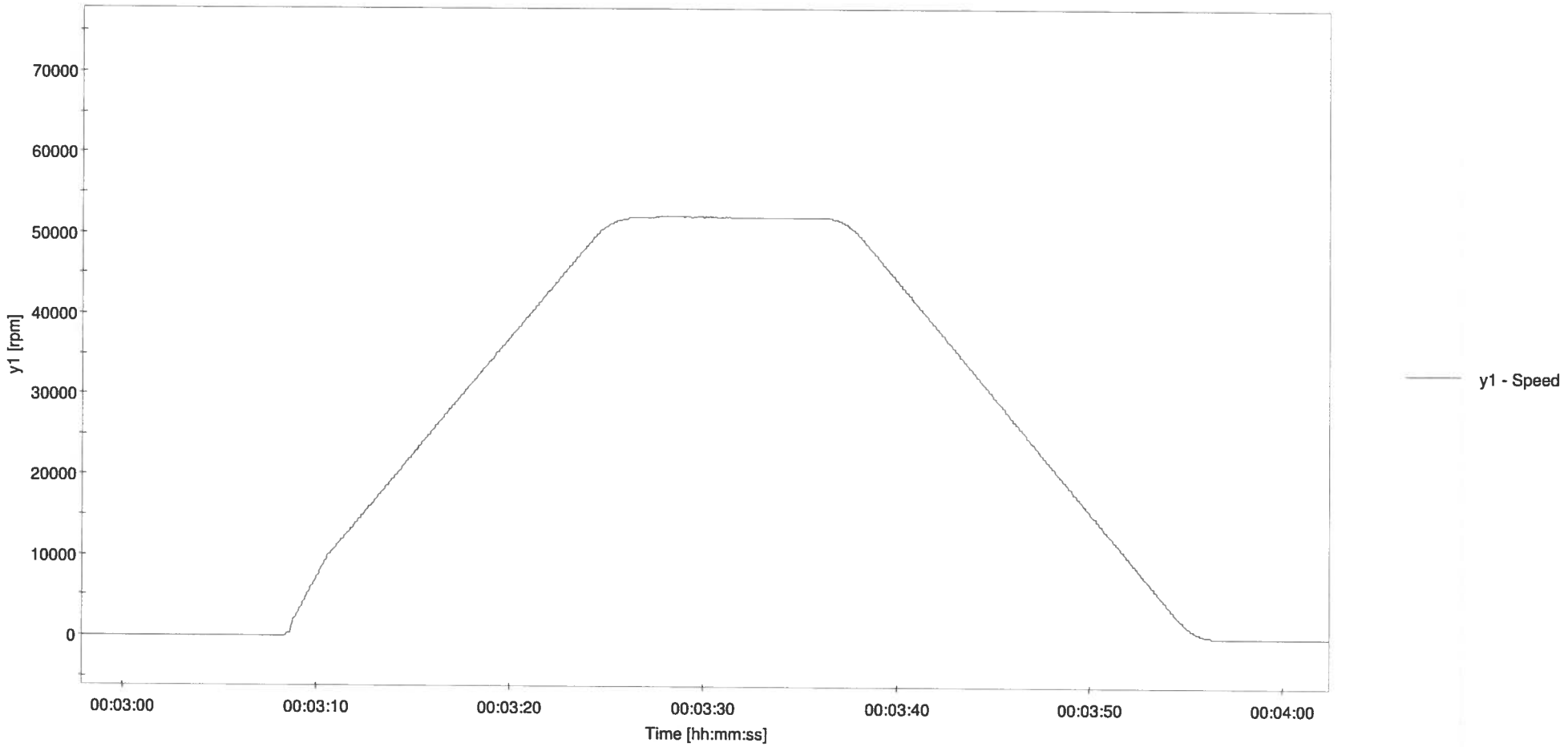
APPROVED BY:

Lam Nguyen
Assistant QC Manager

Copyright © 1998 - 2012 Schenck RoTec GmbH

Sequence Control Data:	**l.a. turbine**
Rotor ID:	**LAT574-SPARE-7770006259-COMPRESSOR WHEEL**
Results:	**170203_082350**
Spin Test:	**Started at Friday, February 03, 2017 8:23:50 AM** **Spin Test terminated by user: Friday, February 03, 2017 8:27:56 AM**
Total Cycles:	**176**
Spin Speed:	**52000 rpm**
Holding Time:	**10 s**
Operator:	**Sammy Nguyen**

CAST : Computer Aided Spin Test



Dynomill Inc. Phone: 626-454-1805
2018 Edwards Avenue \ South El Monte \ CA 91733

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

COMPRESSOR WHEEL

DYE PENETRANT TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: COMPRESSOR WHEEL

PART NUMBER: 7770006259 (MAIN)

THIS IS TO CERTIFY THAT DYE PENETRANT TEST HAS BEEN PERFORMED IN ACCORDANCE WITH ASME SEC. V ON THE **COMPRESSOR WHEEL** AFTER THE OVERSPEED TEST. THE TEST RESULTS HAVE BEEN FOUND ACCEPTABLE IN ACCORDANCE WITH REQUIREMENTS SPECIFIED IN ASME SEC. VIII.

TEST PERFORMED BY:

Hung Phung, QC Inspector — Date: 2/3/17

TEST CONFIRMED BY:

Frank Loth, Quality Manager — Date: 2/3/17

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

COMPRESSOR WHEEL

DYE PENETRANT TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: COMPRESSOR WHEEL

PART NUMBER: 7770006259 (SPARE)

THIS IS TO CERTIFY THAT DYE PENETRANT TEST HAS BEEN PERFORMED IN ACCORDANCE WITH ASME SEC. V ON THE **COMPRESSOR WHEEL** AFTER THE OVERSPEED TEST. THE TEST RESULTS HAVE BEEN FOUND ACCEPTABLE IN ACCORDANCE WITH REQUIREMENTS SPECIFIED IN ASME SEC. VIII.

TEST PERFORMED BY: Hung Phung, QC Inspector — Date: 2/7/17

TEST CONFIRMED BY: Frank Loth, Quality Manager — Date: 2/7/17

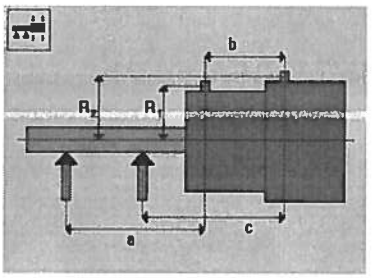
L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 COMP MAIN ***

Rotor geometry

Balancing mode	Dynamic
Distance a	11.50 in
Distance b	2.75 in
Distance c	4.75 in
Radius 1	2.25 in
Radius 2	1.75 in



Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Plane 1	0.80 moz·in
Plane 2	0.80 moz·in

Measuring results - # 2

Rotor ID	
Speed	1691 rpm
Date/Time	14.03.17 / 06:44:36
Averaging run	1
Compensation	Index

Unbalance

Plane 1	0.28	moz·in	16°	In Tol
Plane 2	0.30	moz·in	224°	In Tol

Correction

Plane 1		0.124	moz	196°	In Tol
Plane 2		0.171	moz	44°	In Tol

Rotor balanced within tolerance

L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 COMP MAIN ***

Rotor geometry

Balancing mode	Static
Radius 2	1.75 in

Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Static	0.80 moz·in

Measuring results - # 1

Rotor ID	
Speed	1691 rpm
Date/Time	14.03.17 / 06:45:39
Averaging run	1
Compensation	Index

Unbalance

Static	0.14	moz·in	292°	In Tol

Correction

Static	0.079	moz	112°	In Tol

Rotor balanced within tolerance

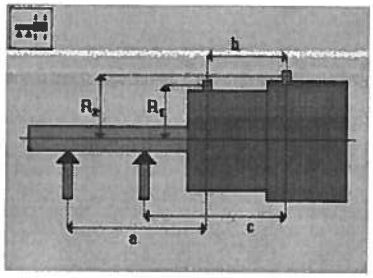
L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 COMP SPARE ***

Rotor geometry

Balancing mode	Dynamic
Distance a	11.81 in
Distance b	2.37 in
Distance c	4.37 in
Radius 1	2.10 in
Radius 2	1.75 in



Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Plane 1	0.80 moz·in
Plane 2	0.80 moz·in

Measuring results - # 1

Rotor ID	
Speed	1517 rpm
Date/Time	21.03.17 / 07:23:01
Averaging run	1
Compensation	Index

Unbalance

Plane 1	0.58	moz·in	319°	In Tol
Plane 2	0.44	moz·in	98°	In Tol

Correction

Plane 1		0.274	moz	139°	In Tol
Plane 2		0.252	moz	278°	In Tol

Rotor balanced within tolerance

L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 COMP SPARE ***

Rotor geometry

Balancing mode	Static
Radius 2	1.75 in

Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Static	0.80 moz·in

Measuring results - # 1

Rotor ID	
Speed	1517 rpm
Date/Time	21.03.17 / 07:20:44
Averaging run	1
Compensation	Index

Unbalance

Static	0.38	moz·in	9°	In Tol

Correction

Static		0.216	moz	189°	In Tol

Rotor balanced within tolerance

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 6: SHAFT

- MATERIAL CERTIFICATION
- SHAFT RUN OUT TEST CERTIFICATE
- DYNAMIC BALANCING TEST CERTIFICATE

From: Valbruna Stainless Inc Date: 8/10/2016 To: GTM METALS INC SO#: A779348 Ln#: 1 PO#: 17181 Part: 6304 5 Heat#: 266890 Tag: S481937A

VALBRUNA
SLATER STAINLESS, INC.
2400 TAYLOR STREET WEST - PO BOX 630
FORT WAYNE IN 46802 USA
PHONE 260.434.2800 - FAX 260.434.2801

Product Certification Report

Report Number: 5212850

Certified on Apr 19, 2016

Order I.D.	Order Date	Commodity Code				
1600315 007	2/19/16					
Dim 1	**Dim 2**	**Dim 3**	**Heat I.D.**	**Customer I.D.**	**Customer Purchase Order**	
4.5000	.0000	.0000	266890	002474	48193	
Product Shape	**Product Surface**				**Customer Grade**	
Rounds	HR & Rough Turned				630	
Length (inches)		**Bill of Lading #**	**Weight**			
132.000 Min. 156.000 Max.		426919		Melt Date: 3/09/15		

Ship To
VALBRUNA STAINLESS, INC.
13950 BENSON AVENUE
CHINO, CA 91710

Sold To
VALBRUNA STAINLESS, INC.
13950 BENSON AVENUE
CHINO, CA 91710

Lifts: 0040

API 6A AISI 17400 EN 10204 DTD 2004 3.1
UNS S17400
AMS 5643T (except finish) ASTMA 564-13 Type 630 ASTM A484-15
ASMESA-564-13

CHEMICAL ANALYSIS

C	Mn	P	S	Si	Cr	Ni	Mo	Cu	N	Cb	Ta	Cb+Ta
.04	.48	.028	.023	.45	15.99	4.40	.29	3.21	.03	.28	.001	.28

BRINELL (Type A device) (E-10)

HBW
339

TENSILE PROPERTIES ASTM E8-15a
CAPABILITY

Cap HB	TS (PSI)	.2%YS (PSI)	%EL(4d)	%RA	AGE(F)
424	196200	172300	16.6	53.5	900

MAGNETIC PARTICLE to AMS2303F

	FREQ	SEV
AVG	.09	.06

PRODUCTION HEAT TREATMENT

SOL-ANN(F)	SOL-ANN(HR)	QUENCH
1900	6.75	Air

MACRO ASTM E340-15/E381-01

MACRO
OK
OK
OK

GRAIN SIZE ASTM E112-13

GRAIN SIZE	Etchant	Magnification X
5	Marbles	100

PERCENT FERRITE (AMS 2315)

	% FERRITE	Etchant	Magnification X
AVG	1.4	Marbles	100

Reduction ratio 5 To 1 Min.
Electric Furnace melted; AOD refined.

Results relate only to the items tested. Certification shall not be reproduced except in full, without written approval of Valbruna Stainless Inc. The recording of false, fictitious, or fraudulent statements on this document may be punished as a felony under federal statutes. Including Federal law Title 18, Chapter 47. Consult material safety data sheet (MSDS) for hazard info.
I hereby certify that the reported figures are correct as contained in the records of the corporation.

Manager Laboratory Services Dennis Hackett

email: DHackett@valbruna.us

From Valbruna Stainless Inc Date: 8/10/2016 To: GTM METALS INC SO#: A779348 Ln#: 1 PO#: 17181 Part: 6304.5 Heat#: 266890 Tag: S481937A

VALBRUNA
SLATER STAINLESS, INC.
2400 TAYLOR STREET WEST - PO BOX 630
FORT WAYNE IN 46802 USA
PHONE 260 434 2800 - FAX 260 434.2801

Product Certification Report

Report Number: 5212850

Order I.D.	Order Date	Commodity Code			
1600315 007	2/19/16				
Dim 1	**Dim 2**	**Dim 3**	**Heat I.D.**	**Customer I.D.**	**Customer Purchase Order**
4.5000	.0000	.0000	266890	002474	48193
Product Shape	**Product Surface**				**Customer Grade**
Rounds	HR & Rough Turned				630
Length (inches)		**Bill of Lading #**	**Weight**		
132.000 Min. 156.000 Max.		426919		Melt Date: 3/09/15	

Ship To
VALBRUNA STAINLESS, INC.
13950 BENSON AVENUE
CHINO, CA 91710

Sold To
VALBRUNA STAINLESS, INC.
13950 BENSON AVENUE
CHINO, CA 91710

Ultrasonic tested to ASTM A388- Satisfactory.
Chemical testing to one or more of the listed ASTM methods:
E415-14, E1019-11, E1086-14.
Location of tensile fracture: inside middle of gage length. %elong after fracture.
Chemical Analysis performed at Acciaierie Valbruna, Italy.
No mercury or low melting alloy contamination. No weld repair.
Material melted in Italy, manufactured in the United States.
Material conforms to listed specifications and is DFARS compliant.
Quality system is compliant with ISO 9001:2008. Produced in accordance with EN 10204 3.1.

Results relate only to the items tested. Certification shall not be reproduced except in full, without written approval of Valbruna Stainless Inc The recording of false, fictitious, or fraudulent statements on this document may be punished as a felony under federal statutes. Including Federal law Title 18, Chapter 47. Consult material safety data sheet (MSDS) for hazard info.
I hereby certify that the reported figures are correct as contained in the records of the corporation.

Manager Laboratory Services
email DHackett@valbruna.us
Dennis Hackett

GTM Metals Inc.
Date 8-17-16
GTM Metals SO # 17548
Customer PO # 23280

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Valencia, CA 91355

Tel: 661-294-8290

Fax: 888-674-6503

Certificate

SHAFT RUN OUT TEST CERTIFICATE

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: SHAFT

PART NUMBER: 7770006254 (MAIN)

THIS IS TO CERTIFY THAT THE SHAFT RUN OUT TEST HAS BEEN SUCCESSFULLY CONDUCTED ON THE **SHAFT** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER. THE TEST RECORDS ARE SHOWN IN THE ATTACHED TEST REPORT. THE MECHANICAL OPERATION OF THE EQUIPMENT WAS FOUND TO BE SATISFACTORY.

TEST PERFORMED BY: Guillermo Garcia — 02/17/17

Guillermo Garcia, Test Technician — DATE

CERTIFIED BY: — 2/17/17

Frank Loth, Quality Manager — DATE

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

SHAFT RUN OUT TEST CERTIFICATE

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

PART DESCRIPTION: SHAFT

PART NUMBER: 7770006254 (SPARE)

THIS IS TO CERTIFY THAT THE SHAFT RUN OUT TEST HAS BEEN SUCCESSFULLY CONDUCTED ON THE **SHAFT** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER. THE TEST RECORDS ARE SHOWN IN THE ATTACHED TEST REPORT. THE MECHANICAL OPERATION OF THE EQUIPMENT WAS FOUND TO BE SATISFACTORY.

TEST PERFORMED BY: Guillermo Garcia — 02/10/17
Guillermo Garcia, Test Technician — DATE

CERTIFIED BY: — 2/10/17
Frank Loth, Quality Manager — DATE

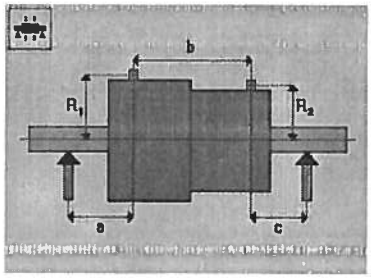
L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 MAIN SHAFT BALANCE ***

Rotor geometry

Balancing mode	Dynamic
Distance a	1.68 in
Distance b	6.18 in
Distance c	1.68 in
Radius 1	1.50 in
Radius 2	1.50 in



Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Plane 1	2.00 moz·in
Plane 2	2.00 moz·in

Measuring results - # 1

Rotor ID	
Speed	1353 rpm
Date/Time	28.02.17 / 11:59:47
Averaging run	1

Unbalance

Plane 1	1.20	moz·in	18°	In Tol
Plane 2	0.88	moz·in	117°	In Tol

Correction

Plane 1		0.802	moz	198°	In Tol
Plane 2		0.586	moz	297°	In Tol

Rotor balanced within tolerance

L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 MAIN SHAFT BALANCE ***

Rotor geometry

Balancing mode	Static
Radius 2	1.50 in

Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Static	2.00 moz·in

Measuring results - # 1

Rotor ID	
Speed	1353 rpm
Date/Time	28.02.17 / 12:02:04
Averaging run	1

Unbalance

Static	1.36	moz·in	57°	In Tol

Correction

Static	0.910	moz	237°	In Tol

Rotor balanced within tolerance

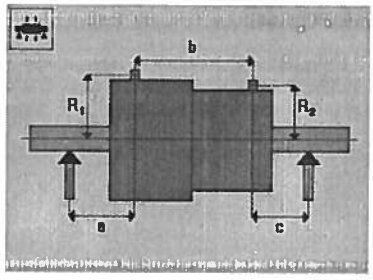
L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 MAIN SHAFT & WASHERS**

Rotor geometry

Balancing mode	Dynamic
Distance a	1.25 in
Distance b	7.00 in
Distance c	1.25 in
Radius 1	1.31 in
Radius 2	1.31 in



Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Plane 1	2.00 moz·in
Plane 2	2.00 moz·in

Measuring results - # 1

Rotor ID	
Speed	1360 rpm
Date/Time	28.02.17 / 13:26:05
Averaging run	1

Unbalance

Plane 1	0.96	moz·in	327°	In Tol
Plane 2	0.57	moz·in	168°	In Tol

Correction

Plane 1		0.734	moz	147°	In Tol
Plane 2		0.433	moz	348°	In Tol

Rotor balanced within tolerance

L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 MAIN SHAFT & WASHERS**

Rotor geometry

Balancing mode	Static
Radius 2	1.31 in

Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Static	2.00 moz·in

Measuring results - # 1

Rotor ID	
Speed	1360 rpm
Date/Time	28.02.17 / 13:24:48
Averaging run	1

Unbalance

Static	0.47	moz·in	302°	In Tol

Correction

Static	0.361	moz	122°	In Tol

Rotor balanced within tolerance

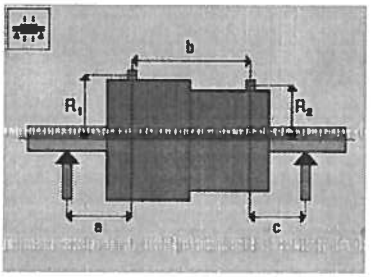
L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 SPARE SHAFT BALANCE** after thrust holes

Rotor geometry

Balancing mode	Dynamic
Distance a	1.50 in
Distance b	6.18 in
Distance c	1.50 in
Radius 1	1.50 in
Radius 2	1.50 in



Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Plane 1	2.00 moz·in
Plane 2	2.00 moz·in

Measuring results - # 1

Rotor ID	
Speed	1308 rpm
Date/Time	09.03.17 / 11:32:10
Averaging run	1

Unbalance

Plane 1	1.11	moz·in	286°	In Tol
Plane 2	1.05	moz·in	32°	In Tol

Correction

Plane 1		0.739	moz	106°	In Tol
Plane 2		0.698	moz	212°	In Tol

Rotor balanced within tolerance

L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 SPARE SHAFT BALANCE**

Rotor geometry

Balancing mode	Static
Radius 2	1.50 in

Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Static	2.00 moz·in

Measuring results - # 1

Rotor ID	
Speed	1308 rpm
Date/Time	09.03.17 / 11:33:36
Averaging run	1

Unbalance

Static	1.29	moz·in	337°	In Tol

Correction

Static	0.861	moz	157°	In Tol

Rotor balanced within tolerance

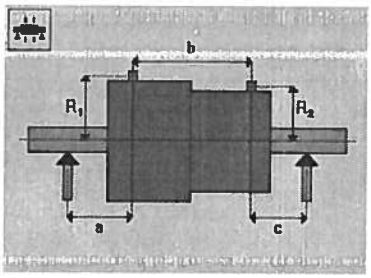
L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 SHAFT & WASHER BALAN** *Balance spare*

Rotor geometry

Balancing mode	Dynamic
Distance a	1.10 in
Distance b	6.98 in
Distance c	1.10 in
Radius 1	1.31 in
Radius 2	1.31 in



Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Plane 1	2.00 moz·in
Plane 2	2.00 moz·in

Measuring results - # 1

Rotor ID	
Speed	1370 rpm
Date/Time	09.03.17 / 13:37:35
Averaging run	1

Unbalance

Plane 1	1.12	moz·in	277°	In Tol
Plane 2	1.17	moz·in	33°	In Tol

Correction

Plane 1		0.858	moz	97°	In Tol
Plane 2		0.896	moz	213°	In Tol

Rotor balanced within tolerance

L.A. Turbine Corporation
28557 Industry Drive
Valencia, CA 91355
Phone 661 - 294-8290

Balancing Report

Equipment	**CAB706**
User	**MIKE MARTINEZ**
Commission number	
Rotor type	**LAT574 SHAFT & WASHER BALAN**

Rotor geometry

Balancing mode	Static
Radius 2	1.31 in

Tolerance

Tolerance planes	In correction planes
Tolerance definitions	User-defined
Tolerance values	
Static	2.00 moz·in

Measuring results - # 1

Rotor ID	
Speed	1370 rpm
Date/Time	09.03.17 / 13:38:43
Averaging run	1

Unbalance

Static	1.23	moz·in	337°	In Tol

Correction

Static	0.935	moz	157°	In Tol

Rotor balanced within tolerance

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 7: OIL TANK RESERVOIR

- MATERIAL CERTIFICATION
- HYDROSTATIC TEST CERTIFICATE

LAT574

SOUTH GATE ENGINEERING

13477 YORBA AVE. CHINO, CA 91710
PHONE: 909.628.2779 FAX: 909.628.6779
www.SouthGateEngineering.com

TRANSMITTAL

TO: LA Turbine Corp.
28557 Industry Drive
Valencia Ca. 91355

Date: 12/22/2016

ATTN: Linda Dennis

Please note the enclosed SGE Job Package completed for your P.O. # 23748
This Job Package should include the following items as indicated below by an X :

1.	FORM U-1A MANUFACTURERS DATA REPORT	X
2.	Traveler	X
3.	Design Data Sheet	X
4.	Engineering Calculations	X
5.	MTRs (on requested materials)	X
6.	NDE Reports	X
7.	Facsimile of Nameplate	X
8.	Paint Report	X
9.	Drawings & Bill of Materials	X

Reference: SGE Job # ***12388***

Thank You,

Michael LaCorte

Michael LaCorte
Quality Manager

National Board Number: 16726

Mfg. Representative: [signature] Date: 12/8/16

Authorized Inspector: [signature] Date: 12/12/16

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS

(Alternate Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only)

As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by South Gate Engineering, LLC (SGE) 13477 Yorba Ave. Chino, CA 91710 USA
(Name and address of Manufacturer)

2. Manufactured for L.A. Turbine Corporation 28557 Industry Drive Valencia CA 91355
(Name and address of Purchaser)

3. Location of installation UNKNOWN
(Name and address)

4. Type Horizontal (Horizontal or vertical, tank) | 25372 (Manufacturer's serial number) | - (CRN) | 12388 (Drawing number) | 16726 (National Board number) | 2016 (Year built)

5. ASME Code, Section VIII, Division 1 2015 Edition [Edition and Addenda. if applicable (date)] | - (Code Case numbers) | - [Special service per UG-120(d)]

6. Shell SA-516 Gr 70 (Material spec. number, grade) | 3/4" (Nominal thickness) | 1/16" (Corr. allow.) | 2' - 2 1/2" (Inner diameter) | 4' - 8" [Length (overall)]

Body Flanges on Shells												
									Bolting			
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

7. Seams TYPE 1 [Long. (welded, dbl., sngl., lap, butt)] | Full [R. T. (spot or full)] | 100 (Eff., %) | - (H. T. temp.) | - (Time, hr) | TYPE 1 [Girth (welded, dbl., sngl., lap, butt)] | Full [R. T. (spot or full)] | 100 (Eff., %) | 1 (No. of courses)

8. Heads: (a) Material SA-516 Gr 70 (Spec. no., grade) (b) Material SA-516 Gr 70 (Spec. no., grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side To Pressure (Convex or Concave)
(a)	END	.6563"	1/16"	-	-	2:1	-	-	-	Concave / Convex
(b)	END	.6563"	1/16"	-	-	2:1	-	-	-	Concave / Convex

Body Flanges on Heads												
									Bolting			
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
(a)	-	-	-	-	-	-	-	-	-	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-

9. MAWP 650 (Internal) | 15 (External) at max. temp. 200 (Internal) | 200 (External).

Min. design metal temp. -20 at 650. Hydro., ~~pneu.~~, ~~or~~ ~~comb.~~ test pressure 975.

Proof test -.

10. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Pump Suction	2	2"	RFSO	SA-106 B	SA-105	.344"	1/16"	-	UW-16	UW-16	-
Return Line / Drain	2	2"	RFSO	SA-106 B	SA-105	.344"	1/16"	-	UW-16	UW-16	-
Fill / Level	5	3/4"	RFSO	SA-106 B	SA-105	.219"	1/16"	-	UW-16	UW-16	-
Heater / Mics	2	3"	RFSO	SA-106 B	SA-105	.300"	1/16"	SA-516.70	UW-16	UW-16	-
SRV	1	1"	RFSO	SA-106 B	SA-105	.250"	1/16"	-	UW-16	UW-16	-
Drain	1	1-1/2"	RFSO	SA-106 B	SA-105	.281"	1/16"	-	UW-16	UW-16	-
Inspection	1	6"	RFSO	SA-106 B	SA-105	.432"	1/16"	SA-516.70	UW-16	UW-16	End Head

11. Supports: Skirt - (Yes or no) | Lugs - (Number) | Legs - (Number) | Other Saddles (Describe) | Attached Shell / UW-16 (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: Item 10. Thermowell / 1 / 1-1/2" / RFSO / SA-106B / SA-105 / .281" / 1/16" / UW-16 / UW-16
(Name of part, item number, Manufacturer's name and identifying stamp)

PO 23599 / Safety & Relief Devices by Others / Impact Test Exempt per UCS-66/UG-20(F) / "Non-Corrosive Service"

South Gate Engineering
custom - fabricated ASME pressure vessels

SHOP TRAVELER

Work Order
012388 - 01

Description	Order	Quantity	UO	Due	Sales Order
HOT28-56U	10/31/16	1.00	EA	12/14/16	0012388-001

Part Number/Rev/Loc 12388-TU
Customer Name
Cust P O Number 23748
S/N - 25372
Cust Number LATURB
Prod Line OT
N/B# - 16726

Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	LABOR Setup	LABOR Runtime	LABOR Total	MATERIAL Unit/Part	MATERIAL Total
000001			Please find attached vessel data sheet(s) for our revised quote 0006219 per your requeston 9/21/16. Vessel will be designed per your drawing LAT573EC-20-D66 (copy of job 12373). Tank is 28" OD x 56" side shell, overall length is 74". Tank is designed and stamped per ASME code, Section VIII, Div 1 for 650 PSI/FV at -20/200 degrees with 1/16" corrosion allowance. Interior is sandblasted to SP-6 and treated with WD-40 Rust inhibitor. Exterior is pblasted to SP-6 and primed with 4 to 6 mils of Carboline 890. (Carboline 890 is rated for 250 degrees Fcontinuous service) Schedule: Engineering: 2 weeks (ARO) Fab & coating: 7-9 weeks (ARAD) Not Included: Freight, Sales or Local Taxes PE stamped calculations Relief valve, trim or accessories not mentioned on our data sheet. Foundation,Anchorage and Embedment Design shall be the responsibility of others. S/N 25372 Cust Part Oil Reservoir								

000200 L Q.C 25 — Start 11/18/16 — Due 11/18/16 — Hrs 0.02

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
		QC	10/31/16		11-1-16

Q.C/AI REVIEW HOLD

000300 L SBHF 135 — Start 11/18/16 — Due 11/21/16 — Hrs 4.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
	11/21/16				

LAY OUT HEADS VERIFY

Work Order	Description	Due	Quantity	Ship	Quantity	Sales Order
012388 - 01	HOT28-56U	12/14/16	1.00			0012388-001

S/N - 25372

							LABOR			MATERIAL	
Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	Setup	Runtime	Total	Unit/Part	Total

000400 L SBHF 140 — Start 11/21/16 Due 11/22/16 — Hrs 6.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
AC	11/22/16	[illegible]	11/22/16		

FIT CONECTIONS AND CLIPS ON HD
Q.C. TO VERIFY PARTS FIT UP ONHEADS

000500 L SBHF 145 — Start 11/22/16 Due 11/23/16 — Hrs 8.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
AC	11/23/16				

WELD CONECTIONS & CLIPS ON HDS

000600 L SBHS 172 — Start 11/23/16 Due 11/24/16 — Hrs 2.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
AC	11/23/16				

BEVEL SHELLS/HEADS

000700 L SBHS 175 — Start 11/24/16 Due 11/24/16 — Hrs 4.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
AC	11/28/16	[illegible]	11/28/16		

FIT HEADS AND SHELL VERIFY
Q.C. TO VERIFY HEADS TO SHELL FIT UP

000800 L SBHS 180 — Start 11/24/16 Due 11/25/16 — Hrs 6.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
AC	11/28/16				

WELD INSIDE

Work Order	Description	Due	Quantity	Ship	Quantity	Sales Order
012388 - 01	HOT28-56U	12/14/16	1.00			0012388-001

S/N - 25372

Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	LABOR Setup	LABOR Runtime	LABOR Total	MATERIAL Unit/Part	MATERIAL Total
000900	L	SBHS 185		11/25/16	11/25/16				2.00		

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
CfC	11/29/16				

AIR ARC

Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	LABOR Setup	LABOR Runtime	LABOR Total	MATERIAL Unit/Part	MATERIAL Total
001000	L	SBHS 190		11/25/16	11/28/16				3.00		

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
CfC	11/30/16				

GRIND/PREP FOR SUB-ARC

Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	LABOR Setup	LABOR Runtime	LABOR Total	MATERIAL Unit/Part	MATERIAL Total
001100	L	SBHS 195		11/28/16	11/29/16				12.00		

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
CfC	12/01/16				

SUB-ARC

Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	LABOR Setup	LABOR Runtime	LABOR Total	MATERIAL Unit/Part	MATERIAL Total
001200	O	Q.C		11/30/16	11/30/16						

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
			12/5/16		12/6/16

X'RAY

Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	LABOR Setup	LABOR Runtime	LABOR Total	MATERIAL Unit/Part	MATERIAL Total
001300	L	SBFU 200		12/01/16	12/01/16				6.00		

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
CfC	12/30/16				

LAY OUT CONNECTIONS AND CLIPS

Work Order	Description	Due	Quantity	Ship	Quantity	Sales Order
012388 - 01	HOT28-56U	12/14/16	1.00			0012388-001

S/N - 25372

Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	LABOR Setup	LABOR Runtime	LABOR Total	MATERIAL Unit/Part	MATERIAL Total

001400 L SBFU 205 — Start 12/01/16 Due 12/05/16 — Hrs 12.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
AC	11/30/16	GL	11/30/16		

FIT CONNECTIONS AND CLIPS
Q.C. TO VERIFY CONNECTIONS ANDCLIPS FIT UP ON SHELLS BEFORE WELD

001500 L SBFU 210 — Start 12/05/16 Due 12/06/16 — Hrs 16.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
AC	12/02/16				

WELD CONNECTIONS AND CLIPS

001600 L SBFU 225 — Start 12/06/16 Due 12/07/16 — Hrs 2.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
AC	12/05/16				

TRIM/FIT LEGS/SADDLES

001700 L SBFU 230 — Start 12/07/16 Due 12/07/16 — Hrs 3.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
AC	12/05/16				

WELD LEGS/SADDLES

001800 L SBFU 235 — Start 12/07/16 Due 12/07/16 — Hrs 1.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
AC	12/05/16				

AIR TEST REPADS

Work Order	Description	Due	Quantity	Ship	Quantity	Sales Order
012388 - 01	HOT28-56U	12/14/16	1.00			0012388-001

S/N - 25372

Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	LABOR Setup	LABOR Runtime	LABOR Total	MATERIAL Unit/Part	MATERIAL Total

001900 L SBFU 240

Start 12/07/16 Due 12/07/16 Hrs 4.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
CFC	12/05/16				

PICK UP AND GRIND

002000 O Q.C

Start 12/08/16 Due 12/08/16 Hrs 1.0000 1.0000

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
			12/2/16		

MT ALL CAT. (C & D) WELDS.

002100 O Q.C

Start 12/09/16 Due 12/09/16 Hrs

12-1-16 Closing head

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
CFC	12/06/16		12/6/16		12/6/16

Q.C/AI INTERNAL HOLD, VERIFY MTRS

002200 L HYDR 290

Start 12/12/16 Due 12/13/16 Hrs 6.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
MA	12/06/16		12/6/16		12/6/16

Q.C/AI HYDROTEST HOLD
HYDRO @ 975 PSI
GAUGE # 10 0- 3000

002300 L Q.C 65

Start 12/13/16 Due 12/13/16 Hrs 0.02

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
			12/6/16		12/6/16

Q.C/AI NAME PLATE HOLD

Work Order	Description	Due	Quantity	Ship	Quantity	Sales Order
012388 - 01	HOT28-56U	12/14/16	1.00			0012388-001

S/N - 25372

							LABOR			MATERIAL	
Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	Setup	Runtime	Total	Unit/Part	Total
002400	L	Q.C	70	12/13/16	12/13/16				0.02		

Foreman Initial	Date	QC Initial	Date	A.I Initial	Date
			12/6/16		

Q.C/AI DATA REPORT HOLD

South Gate Engineering
custom - fabricated ASME pressure vessels
13477 Yorba Avenue
Chino, CA 91710
Ph:(909) 628-2779
Fax:(909) 628-6779
www.southgateengineering.com

ACKNOWLEDGEMENT

Sales Order
0012388

SOLD TO: L.A. TURBINE CORPORATION
28557 INDUSTRY DRIVE
VALENCIA CA 91355
Phone: 661-294-8290 Fax: 888-674-6503
Linda Dennis

SHIP TO: L.A. TURBINE CORPORATION
28557 INDUSTRY DRIVE
VALENCIA CA 91355
Phone: 661-294-8290 Fax: 888-674-6503
Linda Dennis

Sales Order	Ship No.	Cust No	Order Date	Tax	Promised	Salesman	Customer P. O. No.	Mark Shipment
012388	0000	LATURB	10/26/16	E	12/23/16	RAUL GURROLA	23748	

F.O.B.	Ship Date	Shipped Via	Terms	Quote No.	Quote Reference No.	Ins
			NET 90			N

em	Tax	Quantity Ordered	UM	Part Number	Description	Price	Extension $
01	E	1	EA	12388-TU	HOT28-56U Please find attached vessel data sheet(s) for our revised quote 0006219 per your request on 9/21/16. Vessel will be designed per your drawing LAT573EC-20-D66 (copy of job 12373). Tank is 28" OD x 56" side shell, overall length is 74". Tank is designed and stamped per ASME code, Section VIII, Div 1 for 650 PSI/FV at -20/200 degrees with 1/16" corrosion allowance. Interior is sandblasted to SP-6 and treated with WD-40 Rust inhibitor. Exterior is pblasted to SP-6 and primed with 4 to 6 mils of Carboline 890. (Carboline 890 is rated for 250 degrees F continuous service) Schedule:		

erms and Conditions
oreign Projects- final payment must be received prior to shipping equipment. Storage for custom tanks will be incurred after 30 days; Storage for stock tanks will be incurred after 90 ays, Customer supplied materials that do not arrive in time to hold fabrication schedule will be supplied by SGE and added to final invoice. A surcharge of 5% of purchase order value w ncurred for jobs placed on hold after fabrication has commenced. Submittal/approval cycle of engineering documentation is done once at no charge, after which, additional e ering costs will be added to final invoice. SGE will not allow any back charges unless prior notification and acceptance is received by customer by SGE. SGE will be reimbursed r any and all costs associated with collection including but not limited to attorneys fees. We reserve the right to review customer terms and conditions prior to the acceptance of any urchase order. Any terms and conditions received after work has commenced are null and void. Upon Notification from customer of order cancellation, a fee equal to costs incurred to ate plus reasonable profit will apply. An accrual of 1.1/2% of invoice value will be added each month beginning 5 days after invoice due date for payments not received in our office. erms are subject to change should credit risk profile change. Shipping quotes are estimates that are subject to change based on actual weight & dimensions, revisions to origin or estination, stand by charges and/or fuel surcharges applied at time of shipment.

South Gate Engineering, LLC

Design Data Sheet

JOB NO. 12388 DATE : 10/27/2016 MODEL NO.: HOT28-56U

DRAWING NO. 12388 REV. LEVEL : 0

CONSTRUCTION CODE: ASME SEC VIII DIV.1 [X] DIV.2 [ ] SEC. I [ ] EDITION 2015 S/N 25372

MAXIMUM ALLOW WORKING PRESSURE: (Internal) 650 @ 200 ° F

MAXIMUM ALLOW WORKING PRESSURE: (External) 15 PSI @ 200 ° F

MINIMUM DESIGN METAL TEMPERATURE: -20 ° F @ 650 PSI

HYDROSTATIC TEST PRESSURE: 975 TEST TEMPERATURE: AMB.

RADIOGRAPHY (RT): RT-1 HEAT TREAT (HT): NONE

LETHAL SERVICE (L): N/A FIRED, UNFIRED STEAM BOILER: N/A

SHELL (S OR RES): N/A IMPACT TEST (IT) EXEMPT PER: UCS-66/UG-20(F)

NOTES:

	SHELL		HEAD (Crown / Knuckle / Elliptical Ratio) 2:1 SE		HEAD 2:1 SE
MATERIAL:	SA-516,70		SA-516,70		SA-516,70
THICKNESS:	3/4"		3/4"(0.6563"MIN)		3/4"(0.6563"MIN)
CIRC. STRESS:	100%	CALC: (E)	100%	CALC: (E)	100%
LONG STRESS:	100%	JOINT: (E)	100%	JOINT: (E)	100%
X-RAY(SGE TYPE):	4S		2H		2H
CORR. ALLOWANCE:	1/16"		1/16"		1/16"

ADDITIONAL REQUIRMENTS

Weld Map:		Hardness Testing:		Canadian Registration:	
Welder Map:		Dye Pen Testing:		Domestic Materials Required:	
NDE Map:		Mag Part Testing:	X	Tag Number / Part Number:	
MTRs:		Ultrasonic Testing:			
Flngs:	X	REMARKS:	MTR'S FOR REQUIRED FOR PRESSURE RETAINING MATERIALS ONLY.		
Pipe:	X		MARK DATA REPORT "NON CORROSIVE SERVICE"		
Cplngs:	X		MT ALL CATEGORY C AND D WELDS.		
Hardware:					

Positive Material Identification:		Applicable Specification:	
Ultrasonic Testing:		Applicable Specification:	
Hardness Testing:		Applicable Specification:	
Mag Part Testing:	X	Applicable Specification:	PER CUSTOMER DRAWINGS
Dye Pen Testing:		Applicable Specification:	

Hold Points:

Fit-Up:		Blast Profile:		Other:	
Weld Prep:		Salt testing:			
Pre-Hydro:		Lining Inspection:			
Hydrotest:	X	Pre-Shippment:			

REMARKS: HYDROTEST REPORT.

10/22/16

South Gate Engineering, LLC
13477 Yorba Avenue Chino, CA 91710

Date Printed: 10/27/2016

CUSTOMER

L.A. TURBINE CORPORATION
28557 INDUSTRY DRIVE.
VALENCIA, CA 91355

VESSEL LOCATION

UNKNOWN

VESSEL DESCRIPTION

HORIZONTAL OIL RESERVOIR

Vessel designed per the ASME Boiler & Pressure Vessel Code,
Section VIII, Division 1, 2015 Edition
with DesignCalcs, Version: 2016.2

Job No: 12388
Vessel Number: HOT28-56U
Purchase Order Number: 23748

NAMEPLATE INFORMATION

Vessel MAWP:	650.00 PSI and Full Vacuum at 200 °F
MDMT:	-20 °F at 650.00 PSI
Serial Number(s):	25372
National Board Number(s):	WILL ADVISE
Year Built:	2016
Radiography:	RT 1
Postweld Heat Treated:	NONE
Construction Type:	W

Signatures

ENGINEERING MANAGER: _____ Date: 10/27/16

South Gate Engineering, LLC

SHELL, 28" O.D. x 56"L

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 1

Vessel Number: HOT28-56U
Mark Number: S1

Date Printed: 10/27/2016

Cylindrical Shell Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.55	PSI	Long. Joint Efficiency:	100	%
Shell Material:	SA-516 Gr. 70		Factor B Chart:	CS-2	
			Material Stress (hot):	20000	PSI
Shell Length:	56.0000	in.	Material Stress (cold):	20000	PSI
			Compressive Stress:	17223	PSI
Corrosion Allowance:	0.0625	in.	Actual Circumferential Stress:	12987	PSI
External Corrosion Allowance:	0.0000	in.	Actual Longitudinal Stress:	6168	PSI
Outside Diameter (new):	28.0000	in.			
Outside Diameter (corroded):	28.0000	in.	Specific Gravity:	1.00	
Shell Surface Area:	34.21	Sq. Ft.	Weight of Fluid:	1117.13	lb.
Shell Estimated Volume:	133.72	Gal.	Total Flooded Shell Weight:	2123.89	lb.
Circ. Joint Efficiency:	100	%	Shell Weight:	1006.75	lb.

Minimum Design Metal Temperature Data

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

External Pressure Data

Design Pressure (Pa):	15.00	PSI	Design Temperature:	200	°F
Dimension L:	60.9100	in.			
Ext. Minimum t:	0.1841	in.	Ext. Nominal t:	0.7500	in.
Minimum L/Do:	2.1754		Nominal L/Do:	2.1754	
Minimum Do/t:	230.2630		Nominal Do/t:	40.7273	
Minimum Factor A:	0.0001798		Nominal Factor A:	0.0023524	
Minimum Factor B:	2591	PSI	Nominal Factor B:	15423	PSI

Design Thickness Calculations

Longitudinal Stress Calculations per Paragraph UG-27(c)(2)

$$t = \frac{PR}{2SE + 0.4P} = \frac{650.55 * 13.3125}{2 * 20000 * 1.00 + 0.4 * 650.55} = 0.2151 + 0.0625_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}}$$ = minimum of **0.2776** in.

Circumferential Stress Calculations per Appendix 1-1

$$t = \frac{PR_o}{SE + 0.4P} = \frac{650.55 * 14.0000}{20000 * 1.00 + 0.4 * 650.55} = 0.4495 + 0.0625_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}}$$ = minimum of **0.5120** in.

Maximum External Pressure Calculation per Paragraph UG-28

$$\textbf{Pa} \text{ (using } \textit{nominal} \text{ t)} = \frac{4B}{3(D_o / t)} = \frac{4 * 15423}{3 * (28.0000 / 0.6875)}$$ = maximum external pressure of **504.92** PSI

Extreme Fiber Elongation Calculation per Paragraph UCS-79 and Table UG-79-1

$$\textbf{Elongation} = \frac{50t}{Rf} = \frac{50 * 0.7500}{13.6250}$$ = elongation of **2.75** %

External loads do not control design.

Nominal Shell Thickness Selected = **0.7500** in.

South Gate Engineering, LLC

FRONT HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 1

Vessel Number: HOT28-56U
Mark Number: H1

Date Printed: 10/27/2016

Ellipsoidal Head Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.55	PSI	Joint Efficiency:	100	%
Head Material:	SA-516 Gr. 70		Factor B Chart:	CS-2	
			Material Stress (hot):	20000	PSI
Corrosion Allowance:	0.0625	in.	Material Stress (cold):	20000	PSI
External Corrosion Allowance:	0.0000	in.	Actual Head Stress:	14606	PSI
Head Location:	Right		Straight Flange :	2.0000	in.
Outside Diameter :	28.0000	in.	Head Depth (ho) :	7.3750	in.
Thin Out :	0.0937	in.			
$K = \frac{1}{6}[2 + (D/2h)^2]$:	0.99				
Head Surface Area:	6.81	Sq. Ft.	Specific Gravity:	1.00	
Head Estimated Volume:	15.32	Gal.	Weight of Fluid:	127.79	lb.
Head Weight:	205.93	lb.	Total Flooded Head Weight:	333.72	lb.

Minimum Design Metal Temperature Data

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

External Pressure Data

Design Pressure (Pa):	15.00	PSI	Design Temperature:	200	°F
Ext. Minimum t:	0.2500	in.	Ext. Nominal t:	0.7500	in.
Minimum t - Ca - ext. Ca - Thin Out:	0.0938	in.	Nominal t - Ca - ext. Ca. - Thin Out:	0.5938	in.
Minimum Factor A:	0.0004926		Nominal Factor A:	0.0031187	
Minimum Factor B:	7108	PSI	Nominal Factor B:	16271	PSI

Design Thickness Calculations

Design Thickness Calculations per Appendix 1-4(c)

$$t = \frac{PD_oK}{2SE + 2P(K - 0.1)} = \frac{650.55 * 28.0000 * 0.99}{2 * 20000 * 1.00 + 2 * 650.55 * (0.99 - 0.1)}$$

$= 0.4382 + 0.0625_{\text{(corrosion)}} + 0.0000_{\text{(ext. corrosion)}} + 0.0937_{\text{(thin out)}}$ = minimum of **0.5944** in.

Maximum External Pressure Calculation per Paragraph UG-33

$$Pa \text{ (using } nominal \text{ t)} = \frac{B}{\frac{Ro}{t}} = \frac{16271}{\frac{23.8000}{0.5938}}$$

= maximum external pressure of **405.95** PSI

Extreme Fiber Elongation Calculation per Paragraph UCS-79 and Table UG-79-1

$$\text{elongation} = \frac{75t}{R_f} = \frac{75 * 0.7500}{4.6325}$$

= elongation of **12.10 %**

$$t_{min(external)} = \frac{1.67PD_o K}{2SE + 2(1.67P)(K - 0.1)} = \frac{1.67 * 15.00 * 28.0000 * 0.99}{2 * 20000 * 1.0 + 2(1.67 * 15.00) * (0.99 - 0.1)}$$

= Greater of(0.0173(Calc),0.0938(MinT)) + 0.0625 $_{(corrosion)}$ + 0.0000 $_{(ext.\ corrosion)}$ + 0.0937 $_{(Thinout)}$

= minimum of **0.2500 in.**

Nominal Head Thickness Selected = **0.7500** in.
Minimum Thickness after forming, t_s (uncorroded) = **0.6563** in.

South Gate Engineering, LLC

REAR HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 2

Vessel Number: HOT28-56U
Mark Number: H2

Date Printed: 10/27/2016

Ellipsoidal Head Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.55	PSI	Joint Efficiency:	100	%
Head Material:	SA-516 Gr. 70		Factor B Chart:	CS-2	
			Material Stress (hot):	20000	PSI
Corrosion Allowance:	0.0625	in.	Material Stress (cold):	20000	PSI
External Corrosion Allowance:	0.0000	in.	Actual Head Stress:	14606	PSI
Head Location:	Left		Straight Flange :	2.0000	in.
Outside Diameter :	28.0000	in.	Head Depth (ho) :	7.3750	in.
Thin Out :	0.0937	in.			
$K = \frac{1}{6}[2 + (D/2h)^2]$:	0.99				
Head Surface Area:	6.81	Sq. Ft.	Specific Gravity:	1.00	
Head Estimated Volume:	15.32	Gal.	Weight of Fluid:	127.79	lb.
Head Weight:	205.93	lb.	Total Flooded Head Weight:	333.72	lb.

Minimum Design Metal Temperature Data

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

External Pressure Data

Design Pressure (Pa):	15.00	PSI	Design Temperature:	200	°F
Ext. Minimum t:	0.2500	in.	Ext. Nominal t:	0.7500	in.
Minimum t - Ca - ext. Ca - Thin Out:	0.0938	in.	Nominal t - Ca - ext. Ca. - Thin Out:	0.5938	in.
Minimum Factor A:	0.0004926		Nominal Factor A:	0.0031187	
Minimum Factor B:	7108	PSI	Nominal Factor B:	16271	PSI

Design Thickness Calculations

Design Thickness Calculations per Appendix 1-4(c)

$$t = \frac{PD_oK}{2SE + 2P(K - 0.1)} = \frac{650.55 * 28.0000 * 0.99}{2 * 20000 * 1.00 + 2 * 650.55 * (0.99 - 0.1)}$$

$= 0.4382 + 0.0625_{(corrosion)} + 0.0000_{(ext.\ corrosion)} + 0.0937_{(thin\ out)}$ = minimum of **0.5944** in.

Maximum External Pressure Calculation per Paragraph UG-33

$$Pa \text{ (using } nominal \text{ t)} = \frac{B}{\frac{Ro}{t}} = \frac{16271}{\frac{23.8000}{0.5938}}$$

= maximum external pressure of **405.95** PSI

Extreme Fiber Elongation Calculation per Paragraph UCS-79 and Table UG-79-1

$$\text{elongation} = \frac{75t}{R_f} = \frac{75 * 0.7500}{4.6325}$$

= elongation of **12.10 %**

$$t_{min(external)} = \frac{1.67PD_o K}{2SE + 2(1.67P)(K - 0.1)} = \frac{1.67 * 15.00 * 28.0000 * 0.99}{2 * 20000 * 1.0 + 2(1.67 * 15.00) * (0.99 - 0.1)}$$

= Greater of(0.0173(Calc),0.0938(MinT)) + 0.0625 (corrosion) + 0.0000 (ext. corrosion) + 0.0937 (Thinout)

= minimum of **0.2500 in.**

Nominal Head Thickness Selected = **0.7500** in.
Minimum Thickness after forming, t_s (uncorroded) = **0.6563** in.

South Gate Engineering, LLC

2"-300# RFSO, PUMP SUCTION (N1A/N1B)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 1
ID Number: N1

Vessel Number: HOT28-56U
Mark Number: N1

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.07	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	4.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	6.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	2		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	1.6870	in.	Nozzle Wall Thickness(new):	0.3440	in.
Nozzle ID (corroded):	1.8120	in.	Nozzle Wall Thickness(corroded):	0.2815	in.
External Limit of Reinforcement:	0.7038	in.	Upper Weld Leg Size(Weld 41):	0.3125	in.
Internal Limit of Reinforcement:	0.5475	in.	Internal Weld Leg Size(Weld 43):	0.3750	in.
Parallel Limit of Reinf (2Lpar):	3.7500	in.	Outside Groove Weld Depth:	0.7500	in.

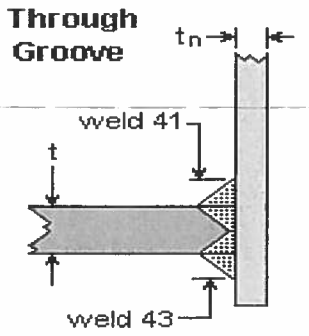
Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Shell 1 - SHELL, 28" O.D. x 56"L

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000	PSI	Shell wall thickness(corroded):	0.6875	in.

Nozzle Detail Information



Upper Weld Leg Size(Weld 41): 0.3125 in.

Internal Weld Leg Size(Weld 43): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3440 in.

Outside Groove Weld Depth: 0.7500 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 2 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

South Gate Engineering, LLC

2"-300# RFSO, PUMP SUCTION (N1A/N1B)

Job No: 12388
Number: 1
ID Number: N1

Vessel Number: HOT28-56U
Mark Number: N1

Date Printed: 10/27/2016

Required Shell Thickness per Paragraph UG-37(a)

$$tr = \frac{PRo}{SE + 0.4P} = \frac{650.07 * 14.0000}{20000 * 1 + 0.4 * 650.07}$$ = **0.4492** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.07 * 0.9060}{17100 * 1 - 0.6 * 650.07}$$ = **0.0352** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 2.3750 * 15.00}{4 * 2972}$$ = **0.0092** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{650.07 * 0.9060}{17100 * 1.00 - 0.6 * 650.07} + 0.0625 + 0.0000$$ = **0.0977** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{650.07 * 14.0000}{20000 * 1 + 0.4 * 650.07} + 0.0625 + 0.0000$$ = **0.5117** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{15.00 * 14.0000}{20000 * 1 + 0.4 * 15.00} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0105_{(\text{Calculated})}, 0.0938_{(\text{Minimum Allowed})}) + 0.0625_{(\text{corrosion})} + 0.0000_{(\text{ext. corrosion})}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1975** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1975** in.

$t_{UG-45} = \max(t_a, t_b)$ = **0.1975** in.

Wall thickness = tn * 0.875(pipe) = **0.3010** is greater than or equal to UG-45 value of **0.1975**

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.2815 = **0.2815** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2815 * 0.7)) + 0}}{0.7} = \frac{0.1970}{0.7}$ = **0.2815** in.

Weld 41, actual weld leg = **0.3125** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.2815 = **0.2815** in.

Weld 43 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2815 * 0.7)) + 0.0625}}{0.7} = \frac{0.2595}{0.7}$ = **0.3708** in.

Weld 43, actual weld leg = **0.3750** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 2.0935 * 0.2815 * 11970 = **11100** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 2.3750 * 0.3125 * 8379 = **9760** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 2.3750 * 0.7500 * 12654 = **35400** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 2.3750 * 0.2857 * 8379 = **8930** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [0.8506 - 0.4126 + 2 * 0.2815 * 0.8550 * (1.00 * 0.6875 - 1.00 * 0.4492)] * 20000 = **11100** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.2964 + 0.0000 + 0.0835 + 0.0000) * 20000 = **7600** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.2964 + 0.2050 + 0.0835 + 0.0698 + 2 * 0.2815 * 0.6875 * 0.8550) * 20000 = **19700** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.2964 + 0.2050 + 0.0000 + 0.0835 + 0.0000 + 0.0698 + 2 * 0.2815 * 0.6875 * 0.8550) * 20000 = **19700** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 9760 + 11100 = **20860** lb.
Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear =
9760 + 35400 + 8930 = **54090** lb.
Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 9760 + 8930 + 35400 = **54090** lb.

South Gate Engineering, LLC
2"-300# RFSO, RETURN LINE (N2)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 2
ID Number: N2

Vessel Number: HOT28-56U
Mark Number: N2

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.00	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	6.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	22.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	2		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	1.6870	in.	Nozzle Wall Thickness(new):	0.3440	in.
Nozzle ID (corroded):	1.8120	in.	Nozzle Wall Thickness(corroded):	0.2815	in.
Developed Opening:	1.7020	in.	Tangential Dimension L:	1.7800	in.
External Limit of Reinforcement:	0.7038	in.	Upper Weld Leg Size(Weld 41):	0.3125	in.
Internal Limit of Reinforcement:	0.5475	in.	Internal Weld Leg Size(Weld 43):	0.3750	in.
Parallel Limit of Reinf (2Lpar):	3.7500	in.	Outside Groove Weld Depth:	0.7500	in.

Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Shell 1 - SHELL, 28" O.D. x 56"L

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000	PSI	Shell wall thickness(corroded):	0.6875	in.

Nozzle Detail Information

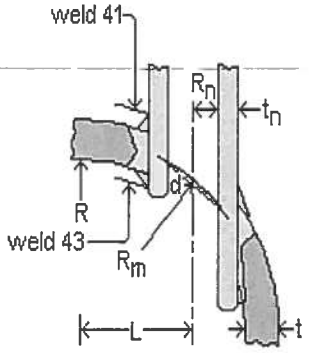


Fig. UW-16.1 (e)

Upper Weld Leg Size(Weld 41): 0.3125 in.

Internal Weld Leg Size(Weld 43): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3440 in.

Outside Groove Weld Depth: 0.7500 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 2 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$tr = \frac{PRo}{SE + 0.4P} = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00}$$ = **0.4492** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.00 * 0.9060}{17100 * 1 - 0.6 * 650.00}$$ = **0.0352** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 2.3750 * 15.00}{4 * 2510}$$ = **0.0108** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{650.00 * 0.9060}{17100 * 1.00 - 0.6 * 650.00} + 0.0625 + 0.0000$$ = **0.0977** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00} + 0.0625 + 0.0000$$ = **0.5117** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{15.00 * 14.0000}{20000 * 1 + 0.4 * 15.00} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0105_{(\text{Calculated})}, 0.0938_{(\text{Minimum Allowed})}) + 0.0625_{(\text{corrosion})} + 0.0000_{(\text{ext. corrosion})}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1975** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1975** in.

$t_{UG-45} = \max(t_a, t_b)$ = **0.1975** in.

Wall thickness = tn * 0.875(pipe) = **0.3010** is greater than or equal to UG-45 value of **0.1975**

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.2815 = **0.2815** in.

$$\text{Weld 41 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2815 * 0.7)) + 0}}{0.7} = \frac{0.1970}{0.7} = \textbf{0.2815} \text{ in.}$$

Weld 41, actual weld leg = **0.3125** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.2815 = **0.2815** in.

$$\text{Weld 43 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2815 * 0.7)) + 0.0625}}{0.7} = \frac{0.2595}{0.7} = \textbf{0.3708} \text{ in.}$$

Weld 43, actual weld leg = **0.3750** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 2.0935 * 0.2815 * 11970 = **11100** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 2.3750 * 0.3125 * 8379 = **9760** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 2.3750 * 0.7500 * 12654 = **35400** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 2.3750 * 0.2857 * 8379 = **8930** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [0.8578 - 0.4161 + 2 * 0.2815 * 0.8550 * (1.00 * 0.6875 - 1.00 * 0.4492)] * 20000 = **11100** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.2964 + 0.0000 + 0.0835 + 0.0000) * 20000 = **7600** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.2964 + 0.2050 + 0.0835 + 0.0698 + 2 * 0.2815 * 0.6875 * 0.8550) * 20000 = **19700** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.2964 + 0.2050 + 0.0000 + 0.0835 + 0.0000 + 0.0698 + 2 * 0.2815 * 0.6875 * 0.8550) * 20000 = **19700** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 9760 + 11100 = **20860** lb.
Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear =
9760 + 35400 + 8930 = **54090** lb.
Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 9760 + 8930 + 35400 = **54090** lb.

South Gate Engineering, LLC
3"-300# RFSO, MIST ELIMINATOR (N4)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 3
ID Number: N4

Vessel Number: HOT28-56U
Mark Number: N4

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00 PSI		Design Temperature:	200	°F
Static Head:	0.00 PSI		Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	7.0000 in.		Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000 in.		Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000	in.
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375	in.
External Limit of Reinforcement:	0.9688 in.		Upper Weld Leg Size(Weld 41):	0.2500	in.
Internal Limit of Reinforcement:	0.0000 in.		Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	6.0500 in.		Outside Groove Weld Depth:	0.7500	in.

Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Reinforcing Pad Information

Reinforcing Material:	SA-516 Gr. 70		Allowable Stress at Design Temperature(S_p):	20000	PSI
			Allowable Stress at Ambient Temperature:	20000	PSI
Reinforcing Plate Thickness(t_e):	0.3750 in.		Repad to Vessel Weld Leg Size(Weld 42):	0.3125	in.
OD, Reinforcing Plate(D_p):	8.5000 in.		Repad to Nozzle Groove Weld Depth:	0.3750	in.

Host Component: Shell 1 - SHELL, 28" O.D. x 56"L

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000 PSI		Shell wall thickness(corroded):	0.6875	in.

Nozzle Detail Information

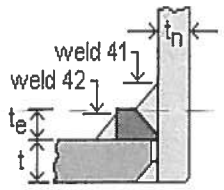


Fig. UW-16.1 (j)

Upper Weld Leg Size(Weld 41): 0.2500 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.7500 in.

Repad to Vessel Weld Leg Size(Weld 42): 0.3125 in.

Repad Thickness(t_e): 0.3750 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$tr = \frac{PRo}{SE + 0.4P} = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00}$$ = **0.4492** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.00 * 1.5125}{17100 * 1 - 0.6 * 650.00}$$ = **0.0588** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 3.5000 * 15.00}{4 * 2657}$$ = **0.0150** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

fr2 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

fr3 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

fr4 $= \min\left(\frac{Sp}{Sv}, 1.0000\right) = \min\left(\frac{20000}{20000}, 1.0000\right) = 1.0000$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{650.00 * 1.5125}{17100 * 1.00 - 0.6 * 650.00} + 0.0625 + 0.0000$$ = **0.1213** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00} + 0.0625 + 0.0000$$ = **0.5117** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{15.00 * 14.0000}{20000 * 1 + 0.4 * 15.00} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0105_{(\text{Calculated})}, 0.0938_{(\text{Minimum Allowed})}) + 0.0625_{(\text{corrosion})} + 0.0000_{(\text{ext. corrosion})}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2515** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.2515** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2515**

Limits of Reinforcement (UG-40)

L_{par} = max(d, R_n + t + t_n) = max(3.0250, 1.5125 + 0.6875 + 0.2375) = **3.0250** in.
L_{noro} = min(2.5 t, 2.5 t_n + t_e) = min(2.5 * 0.6875, 2.5 * 0.2375 + 0.3750) = **0.9688** in.
L_{nori} = min(2.5 t, 2.5 t_i) = min(2.5 * 0.6875, 2.5 * 0.0000) = **0.0000** in.

Nozzle Reinforcement Calculations (Internal Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{1.0000 * [3.0250 * 0.4492 * 1.00 + 2 * 0.2375 * 0.4492 * 1.00 * (1 - 0.8550)], 0}
= **1.3898** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 3.0250 - 3.0250) * (1.0000 * 0.6875 - 1.00 * 0.4492) - 2 * 0.2375 * (1.0000 * 0.6875 - 1.00 * 0.4492) * (1 - 0.8550), 0]
= **0.7044** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(7.0000, 0.9688) * [min(0.2375, 3.0250 - 0.5 * 3.0250) - 0.0588] * 0.8550, 0} = **0.2960** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.0000, 0.0000) * min(0.0000, 3.0250 - 0.5 * 3.0250) * 0.8550, 0} = **0.0000** sq. in.

A41 = f_{r3} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.2500^2 - (0.2500 - 0.2500)^2 - (0.2500 - 0.2500)^2] = **0.0534** sq. in.

A42 = f_{r4} $L_{42pareff}$ $L_{42noreff}$ =
1.0000 * 0.0000 * 0.3125 = **0.0000** sq. in.

A43 = f_{r2} $L_{43pareff}$ $L_{43noreff}$ =
0.8550 * 0.0000 * 0.0000 = **0.0000** sq. in.

A5 = max{C [min(D_p , 2 L_{par}) - d - 2 t_n] min(t_e, L_{noro}) f_{r4}, 0} =
max{1 * [min(8.5000 , 2 * 3.0250) - 3.0250 - 2 * 0.2375] * min (0.3750, 0.9688) * 1.0000, 0} = **0.9563** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 2.0102 sq. in., which is >= A (1.3898)

Nozzle Reinforcement Calculations (External Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{0.5000 * [3.0250 * 0.1216 * 1.00 + 2 * 0.2375 * 0.1216 * 1.00 * (1 - 0.8550)], 0}
= **0.1881** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 3.0250 - 3.0250) * (1.0000 * 0.6875 - 1.00 * 0.1216) - 2 * 0.2375 * (1.0000 * 0.6875 - 1.00 * 0.1216) * (1 - 0.8550), 0]
= **1.6729** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(7.0000, 0.9688) * [min(0.2375, 3.0250 - 0.5 * 3.0250) - 0.0150] * 0.8550, 0}
= **0.3686** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.0000, 0.0000) * min(0.0000, 3.0250 - 0.5 * 3.0250) * 0.8550, 0}
= **0.0000** sq. in.

A41 = f_{r3} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.2500^2 - (0.2500 - 0.2500)^2 - (0.2500 - 0.2500)^2]
= **0.0534** sq. in.

A42 = f_{r4} $L_{42pareff}$ $L_{42noreff}$ =
1.0000 * 0.0000 * 0.3125
= **0.0000** sq. in.

A43 = f_{r2} $L_{43pareff}$ $L_{43noreff}$ =
0.8550 * 0.0000 * 0.0000
= **0.0000** sq. in.

A5 = max{C [min(D_p , 2 L_{par}) - d - 2 t_n] min(t_e, L_{noro}) f_{r4}, 0} =
max{1 * [min(8.5000 , 2 * 3.0250) - 3.0250 - 2 * 0.2375] * min (0.3750, 0.9688) * 1.0000, 0}
= **0.9563** sq. in.

Area Available (External Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 3.0511 sq. in., which is **>=** A (0.1881)

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, te, or tn = smaller of 0.75, 0.3750, or 0.2375 = **0.2375** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2375 * 0.7)) + 0}}{0.7} = \frac{0.1662}{0.7}$ = **0.2375** in.

Weld 41, actual weld leg = **0.2500** in.

Weld 42 tmin = smaller of 0.75, t, or te = smaller of 0.75, 0.6875, or 0.3750 = **0.3750** in.

Weld 42 Leg min. = $\frac{0.5 * \text{tmin + ext. CA}}{0.7} = \frac{0.5 * 0.3750 + 0.0000}{0.7}$ = **0.2679** in.

Weld 42, actual weld leg = **0.3125** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Outer fillet, Weld 42, in shear = 0.49 * Material Stress = 0.49 * 20000 = **9800** PSI
Repad groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 3.2625 * 0.2375 * 11970 = **14600** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 3.5000 * 0.2500 * 8379 = **11500** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 3.5000 * 0.6875 * 12654 = **47800** lb.
Outer fillet in shear = ½ * π * Plate OD * weld leg * outer fillet in shear unit stress = ½ * π * 8.5000 * 0.3125 * 9800 = **40900** lb.
Repad groove weld = ½ * π * Nozzle OD * Groove Depth * repad groove weld in tension unit stress =
½ * π * 3.5000 * 0.3750 * 12654 = **26100** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [1.3898 - 0.7044 + 2 * 0.2375 * 0.8550 * (1.00 * 0.6875 - 1.00 * 0.4492)] * 20000 = **15600** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.2960 + 0.9563 + 0.0534 + 0.0000) * 20000 = **26100** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.2960 + 0.0000 + 0.0534 + 0.0000 + 2 * 0.2375 * 0.6875 * 0.8550) * 20000 = **12600** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.2960 + 0.0000 + 0.9563 + 0.0534 + 0.0000 + 0.0000 + 2 * 0.2375 * 0.6875 * 0.8550) * 20000 = **31700** lb.

Check Strength Paths

Path 1-1 = Outer fillet in shear + Nozzle wall in shear = 40900 + 14600 = **55500** lb.
Path 2-2 = Upper fillet in shear + Repad groove weld + Groove weld in tension + Inner fillet in shear =
11500 + 26100 + 47800 + 0 = **85400** lb.
Path 3-3 = Outer fillet in shear + Inner fillet in shear + Groove weld in tension = 40900 + 0 + 47800 = **88700** lb.

Plate Strength = A5 * Sp = 0.9563 * 20000 = **19125** lb.

Outer fillet weld strength(40900) is greater than plate strength(19125).

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 4
ID Number: N10

Vessel Number: HOT28-56U
Mark Number: N10

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00 PSI		Design Temperature:	200	°F
Static Head:	0.40 PSI		Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	5.0000 in.		Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	1.0000 in.		Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	3		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	2.9000 in.		Nozzle Wall Thickness(new):	0.3000	in.
Nozzle ID (corroded):	3.0250 in.		Nozzle Wall Thickness(corroded):	0.2375	in.
Developed Opening:	3.1994 in.		Tangential Dimension L:	9.0000	in.
External Limit of Reinforcement:	0.9688 in.		Upper Weld Leg Size(Weld 41):	0.2500	in.
Internal Limit of Reinforcement:	0.4375 in.		Internal Weld Leg Size(Weld 43):	0.3750	in.
Parallel Limit of Reinf (2Lpar):	6.6715 in.		Outside Groove Weld Depth:	0.7500	in.

Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

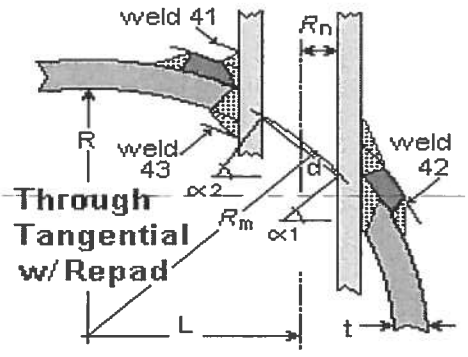
Reinforcing Pad Information

Reinforcing Material:	SA-516 Gr. 70		Allowable Stress at Design Temperature(S_p):	20000	PSI
			Allowable Stress at Ambient Temperature:	20000	PSI
Reinforcing Plate Thickness(t_e):	0.3750 in.		Repad to Vessel Weld Leg Size(Weld 42):	0.3125	in.
OD, Reinforcing Plate(D_p):	8.5000 in.		Repad to Nozzle Groove Weld Depth:	0.3750	in.

Host Component: Head 2 - REAR HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.

Material:	SA-516 Gr. 70		Head wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000 PSI		Head wall thickness - thin out (corroded):	0.5938	in.

Nozzle Detail Information



Upper Weld Leg Size(Weld 41): 0.2500 in.

Internal Weld Leg Size(Weld 43): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3000 in.

Outside Groove Weld Depth: 0.7500 in.

Repad to Vessel Weld Leg Size(Weld 42): 0.3125 in.

Repad Thickness(t_e): 0.3750 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 3 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$tr = \frac{P\ K1\ Do}{(2SE + 0.8P)} = \frac{650.40 * 0.9000 * 28.0000}{(2 * 20000 * 1 + 0.8 * 650.40)}$$ = **0.4045** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.40 * 1.5125}{17100 * 1 - 0.6 * 650.40}$$ = **0.0589** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 3.5000 * 15.00}{4 * 3189}$$ = **0.0125** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

fr2 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

fr3 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

fr4 $= \min\left(\frac{Sp}{Sv}, 1.0000\right) = \min\left(\frac{20000}{20000}, 1.0000\right) = 1.0000$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + ext.\ Ca = \frac{650.40 * 1.5125}{17100 * 1.00 - 0.6 * 650.40} + 0.0625 + 0.0000$$ = **0.1214** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{P\ K\ Do}{(2SE + 2P(K - 0.1))} + Ca + ext.\ Ca = \frac{650.40 * 0.9900 * 28.0000}{(2 * 20000 * 1 + 2 * 650.40 * (0.9900 - 0.1))} + 0.0625 + 0.0000$$ = **0.5005** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{P\ K\ Do}{(2SE + 2P(K - 0.1))} + Ca + ext.\ Ca = \frac{15.00 * 0.9900 * 28.0000}{(2 * 20000 * 1 + 2 * 15.00 * (0.9900 - 0.1))} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0104_{(Calculated)}, 0.0938_{(Minimum\ Allowed)}) + 0.0625_{(corrosion)} + 0.0000_{(ext.\ corrosion)}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.2515** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.2515** in.

$t_{UG-45} = \max(t_a, t_b)$ = **0.2515** in.

Wall thickness = tn * 0.875(pipe) = **0.2620** is greater than or equal to UG-45 value of **0.2515**

Limits of Reinforcement (UG-40)

L_{par} = max(d, R_n + t + t_n) = max(3.3357, 1.5125 + 0.5938 + 0.2375) = **3.3357** in.
L_{noro} = min(2.5 t, 2.5 t_n + t_e) = min(2.5 * 0.5938, 2.5 * 0.2375 + 0.3750) = **0.9688** in.
L_{nori} = min(2.5 t, 2.5 t_i) = min(2.5 * 0.5938, 2.5 * 0.1750) = **0.4375** in.

Nozzle Reinforcement Calculations (Internal Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{1.0000 * [3.3357 * 0.4045 * 1.00 + 2 * 0.2375 * 0.4045 * 1.00 * (1 - 0.8550)], 0}
= **1.3772** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 3.3357 - 3.3357) * (1.0000 * 0.5938 - 1.00 * 0.4045) - 2 * 0.2375 * (1.0000 * 0.5938 - 1.00 * 0.4045) * (1 - 0.8550), 0]
= **0.6184** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(5.0000, 0.9688) * [min(0.2375, 3.3357 - 0.5 * 3.3357) - 0.0589] * 0.8550, 0} = **0.2959** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.9375, 0.4375) * min(0.1750, 3.3357 - 0.5 * 3.3357) * 0.8550, 0} = **0.1309** sq. in.

A41 = f_{r3} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.2500^2 - (0.2500 - 0.2500)^2 - (0.2500 - 0.2500)^2] = **0.0534** sq. in.

A42 = f_{r4} $L_{42pareff}$ $L_{42noreff}$ =
1.0000 * 0.0000 * 0.3125 = **0.0000** sq. in.

A43 = f_{r2} [L_{43}^2 - (L_{43} - $L_{43pareff}$)^2 - (L_{43} - $L_{43noreff}$)^2] =
0.8550 * [0.2857^2 - (0.2857 - 0.2857)^2 - (0.2857 - 0.2857)^2] = **0.0698** sq. in.

A5 = max{C [min(D_p , 2 L_{par}) - d - 2 t_n] min(t_e, L_{noro}) f_{r4}, 0} =
max{1 * [min(8.5000 , 2 * 3.3357) - 3.3357 - 2 * 0.2375] * min (0.3750, 0.9688) * 1.0000, 0} = **1.0728** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 2.2412 sq. in., which is >= A (1.3772)

Nozzle Reinforcement Calculations (External Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{0.5000 * [3.3357 * 0.0938 * 1.00 + 2 * 0.2375 * 0.0938 * 1.00 * (1 - 0.8550)], 0}
= **0.1597** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 3.3357 - 3.3357) * (1.0000 * 0.5938 - 1.00 * 0.0938) - 2 * 0.2375 * (1.0000 * 0.5938 - 1.00 * 0.0938) * (1 - 0.8550), 0]
= **1.6334** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(5.0000, 0.9688) * [min(0.2375, 3.3357 - 0.5 * 3.3357) - 0.0125] * 0.8550, 0}
= **0.3727** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.9375, 0.4375) * min(0.1750, 3.3357 - 0.5 * 3.3357) * 0.8550, 0}
= **0.1309** sq. in.

A41 = f_{r3} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.2500^2 - (0.2500 - 0.2500)^2 - (0.2500 - 0.2500)^2]
= **0.0534** sq. in.

A42 = f_{r4} $L_{42pareff}$ $L_{42noreff}$ =
1.0000 * 0.0000 * 0.3125
= **0.0000** sq. in.

A43 = f_{r2} [L_{43}^2 - (L_{43} - $L_{43pareff}$)^2 - (L_{43} - $L_{43noreff}$)^2] =
0.8550 * [0.2857^2 - (0.2857 - 0.2857)^2 - (0.2857 - 0.2857)^2]
= **0.0698** sq. in.

A5 = max{C [min(D_p , 2 L_{par}) - d - 2 t_n] min(t_e, L_{noro}) f_{r4}, 0} =
max{1 * [min(8.5000 , 2 * 3.3357) - 3.3357 - 2 * 0.2375] * min (0.3750, 0.9688) * 1.0000, 0}
= **1.0728** sq. in.

Area Available (External Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 3.3331 sq. in., which is **>=** A (0.1597)

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, te, or tn = smaller of 0.75, 0.3750, or 0.2375 = **0.2375** in.

$$\text{Weld 41 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2375 * 0.7)) + 0}}{0.7} = \frac{0.1662}{0.7} = \textbf{0.2375} \text{ in.}$$

Weld 41, actual weld leg = **0.2500** in.

Weld 42 tmin = smaller of 0.75, t, or te = smaller of 0.75, 0.6875, or 0.3750 = **0.3750** in.

$$\text{Weld 42 Leg min.} = \frac{0.5 * \text{tmin} + \text{ext. CA}}{0.7} = \frac{0.5 * 0.3750 + 0.0000}{0.7} = \textbf{0.2679} \text{ in.}$$

Weld 42, actual weld leg = **0.3125** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.2375 = **0.2375** in.

$$\text{Weld 43 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2375 * 0.7)) + 0.0625}}{0.7} = \frac{0.2287}{0.7} = \textbf{0.3268} \text{ in.}$$

Weld 43, actual weld leg = **0.3750** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100	= **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100	= **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100	= **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100	= **8379** PSI
Outer fillet, Weld 42, in shear = 0.49 * Material Stress = 0.49 * 20000	= **9800** PSI
Repad groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100	= **12654** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress = ½ * π * 3.2625 * 0.2375 * 11970	= **14600** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 3.5000 * 0.2500 * 8379	= **11500** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress = ½ * π * 3.5000 * 0.7500 * 12654	= **52200** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 3.5000 * 0.2857 * 8379	= **13200** lb.
Outer fillet in shear = ½ * π * Plate OD * weld leg * outer fillet in shear unit stress = ½ * π * 8.5000 * 0.3125 * 9800	= **40900** lb.
Repad groove weld = ½ * π * Nozzle OD * Groove Depth * repad groove weld in tension unit stress = ½ * π * 3.5000 * 0.3750 * 12654	= **26100** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [1.3772 - 0.6184 + 2 * 0.2375 * 0.8550 * (1.00 * 0.5938 - 1.00 * 0.4045)] * 20000 = **16700** lb.

W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.2959 + 1.0728 + 0.0534 + 0.0000) * 20000 = **28400** lb.

W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.2959 + 0.1309 + 0.0534 + 0.0698 + 2 * 0.2375 * 0.5938 * 0.8550) * 20000 = **15800** lb.

W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.2959 + 0.1309 + 1.0728 + 0.0534 + 0.0000 + 0.0698 + 2 * 0.2375 * 0.5938 * 0.8550) * 20000 = **37300** lb.

Check Strength Paths

Path 1-1 = Outer fillet in shear + Nozzle wall in shear = 40900 + 14600 = **55500** lb.

Path 2-2 = Upper fillet in shear + Repad groove weld + Groove weld in tension + Inner fillet in shear =
11500 + 26100 + 52200 + 13200 = **103000** lb.

Path 3-3 = Outer fillet in shear + Inner fillet in shear + Groove weld in tension = 40900 + 13200 + 52200 = **106300** lb.

Plate Strength = A5 * Sp = 1.0728 * 20000 = **21456** lb.

Outer fillet weld strength(40900) is greater than plate strength(21456).

South Gate Engineering, LLC
6"-300# RFSO, INSPECTION (N9)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 5
ID Number: N9

Vessel Number: HOT28-56U
Mark Number: N9

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00 PSI		Design Temperature:	200	°F
Static Head:	0.00 PSI		Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	5.2500 in.		Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.7500 in.		Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625 in.		Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000 in.		Nozzle Path:	None	
Nozzle Pipe Size:	6		Nozzle Pipe Schedule:	80	
Nozzle ID (new):	5.7610 in.		Nozzle Wall Thickness(new):	0.4320	in.
Nozzle ID (corroded):	5.8860 in.		Nozzle Wall Thickness(corroded):	0.3695	in.
Developed Opening:	6.6259 in.		Tangential Dimension L:	9.5000	in.
External Limit of Reinforcement:	1.2988 in.		Upper Weld Leg Size(Weld 41):	0.3750	in.
Internal Limit of Reinforcement:	0.7675 in.		Internal Weld Leg Size(Weld 43):	0.5000	in.
Parallel Limit of Reinf (2Lpar):	13.5310 in.		Outside Groove Weld Depth:	0.7500	in.

Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

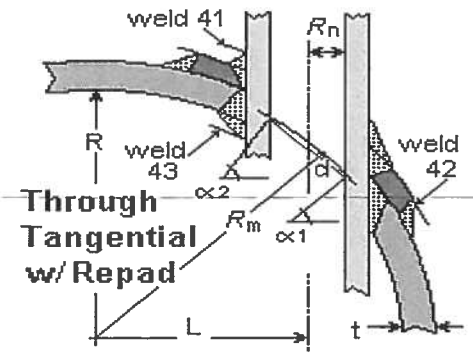
Reinforcing Pad Information

Reinforcing Material:	SA-516 Gr. 70		Allowable Stress at Design Temperature(S_p):	20000	PSI
			Allowable Stress at Ambient Temperature:	20000	PSI
Reinforcing Plate Thickness(t_e):	0.3750 in.		Repad to Vessel Weld Leg Size(Weld 42):	0.3125	in.
OD, Reinforcing Plate(D_p):	12.5000 in.		Repad to Nozzle Groove Weld Depth:	0.3750	in.

Host Component: Head 2 - REAR HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.

Material:	SA-516 Gr. 70		Head wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000 PSI		Head wall thickness - thin out (corroded):	0.5938	in.

Nozzle Detail Information



Upper Weld Leg Size(Weld 41): 0.3750 in.

Internal Weld Leg Size(Weld 43): 0.5000 in.

Nozzle Wall Thickness(t_n): 0.4320 in.

Outside Groove Weld Depth: 0.7500 in.

Repad to Vessel Weld Leg Size(Weld 42): 0.3125 in.

Repad Thickness(t_e): 0.3750 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 6 Schedule: 80
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$tr = \frac{P\ K1\ Do}{(2SE + 0.8P)} = \frac{650.00 * 0.9000 * 28.0000}{(2 * 20000 * 1 + 0.8 * 650.00)}$$ = **0.4042** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.00 * 2.9430}{17100 * 1 - 0.6 * 650.00}$$ = **0.1145** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 6.6250 * 15.00}{4 * 3910}$$ = **0.0191** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

fr2 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

fr3 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

fr4 $= \min\left(\frac{Sp}{Sv}, 1.0000\right) = \min\left(\frac{20000}{20000}, 1.0000\right) = 1.0000$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{650.00 * 2.9430}{17100 * 1.00 - 0.6 * 650.00} + 0.0625 + 0.0000$$ = **0.1770** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{P\ K\ Do}{(2SE + 2P(K - 0.1))} + Ca + \text{ext. } Ca = \frac{650.00 * 0.9900 * 28.0000}{(2 * 20000 * 1 + 2 * 650.00 * (0.9900 - 0.1))} + 0.0625 + 0.0000$$ = **0.5003** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{P\ K\ Do}{(2SE + 2P(K - 0.1))} + Ca + \text{ext. } Ca = \frac{15.00 * 0.9900 * 28.0000}{(2 * 20000 * 1 + 2 * 15.00 * (0.9900 - 0.1))} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0104_{(\text{Calculated})}, 0.0938_{(\text{Minimum Allowed})}) + 0.0625_{(\text{corrosion})} + 0.0000_{(\text{ext. corrosion})}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.3075** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.3075** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.3075** in.

Wall thickness = tn * 0.875(pipe) = **0.3780** is greater than or equal to UG-45 value of **0.3075**

Limits of Reinforcement (UG-40)

L_{par} = max(d, R_n + t + t_n) = max(6.7655, 2.9430 + 0.5938 + 0.3695) = **6.7655** in.
L_{noro} = min(2.5 t, 2.5 t_n + t_e) = min(2.5 * 0.5938, 2.5 * 0.3695 + 0.3750) = **1.2988** in.
L_{nori} = min(2.5 t, 2.5 t_i) = min(2.5 * 0.5938, 2.5 * 0.3070) = **0.7675** in.

Nozzle Reinforcement Calculations (Internal Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{1.0000 * [6.7655 * 0.4042 * 1.00 + 2 * 0.3695 * 0.4042 * 1.00 * (1 - 0.8550)], 0}
= **2.7779** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 6.7655 - 6.7655) * (1.0000 * 0.5938 - 1.00 * 0.4042) - 2 * 0.3695 * (1.0000 * 0.5938 - 1.00 * 0.4042) * (1 - 0.8550), 0]
= **1.2624** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(5.2500, 1.2988) * [min(0.3695, 6.7655 - 0.5 * 6.7655) - 0.1145] * 0.8550, 0} = **0.5663** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.6875, 0.7675) * min(0.3070, 6.7655 - 0.5 * 6.7655) * 0.8550, 0} = **0.3609** sq. in.

A41 = f_{r3} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.3750^2 - (0.3750 - 0.3750)^2 - (0.3750 - 0.3750)^2] = **0.1202** sq. in.

A42 = f_{r4} [L_{42}^2 - (L_{42} - $L_{42pareff}$)^2 - (L_{42} - $L_{42noreff}$)^2] =
1.0000 * [0.3125^2 - (0.3125 - 0.3125)^2 - (0.3125 - 0.3125)^2] = **0.0977** sq. in.

A43 = f_{r2} [L_{43}^2 - (L_{43} - $L_{43pareff}$)^2 - (L_{43} - $L_{43noreff}$)^2] =
0.8550 * [0.4107^2 - (0.4107 - 0.4107)^2 - (0.4107 - 0.4107)^2] = **0.1442** sq. in.

A5 = max{C [min(D_p , 2 L_{par}) - d - 2 t_n] min(t_e, L_{noro}) f_{r4}, 0} =
max{1 * [min(12.5000 , 2 * 6.7655) - 6.7655 - 2 * 0.3695] * min (0.3750, 1.2988) * 1.0000, 0} = **1.8733** sq. in.

Area Available (Internal Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 4.4251 sq. in., which is >= A (2.7779)

Nozzle Reinforcement Calculations (External Pressure)

A = max{C [d t_r F + 2 t_n t_r F (1 - f_{r1})], 0} = max{0.5000 * [6.7655 * 0.0938 * 1.00 + 2 * 0.3695 * 0.0938 * 1.00 * (1 - 0.8550)], 0}
= **0.3223** sq. in.

A1 = max[(2 L_{par} - d) (E_1 t - F t_r) - 2 t_n (E_1 t - F t_r) (1 - f_{r1}), 0] =
max[(2 * 6.7655 - 6.7655) * (1.0000 * 0.5938 - 1.00 * 0.0938) - 2 * 0.3695 * (1.0000 * 0.5938 - 1.00 * 0.0938) * (1 - 0.8550), 0]
= **3.3292** sq. in.

A2 = max{2 min(h_o, L_{noro}) [min(t_n, L_{par} - 0.5 d) - t_{rn}] f_{r2}, 0} =
max{2 * min(5.2500, 1.2988) * [min(0.3695, 6.7655 - 0.5 * 6.7655) - 0.0191] * 0.8550, 0}
= **0.7782** sq. in.

A3 = max{2 min(h, L_{nori}) min(t_i, L_{par} - 0.5 d) f_{r2}, 0} =
max{2 * min(0.6875, 0.7675) * min(0.3070, 6.7655 - 0.5 * 6.7655) * 0.8550, 0}
= **0.3609** sq. in.

A41 = f_{r3} [L_{41}^2 - (L_{41} - $L_{41pareff}$)^2 - (L_{41} - $L_{41noreff}$)^2] =
0.8550 * [0.3750^2 - (0.3750 - 0.3750)^2 - (0.3750 - 0.3750)^2]
= **0.1202** sq. in.

A42 = f_{r4} [L_{42}^2 - (L_{42} - $L_{42pareff}$)^2 - (L_{42} - $L_{42noreff}$)^2] =
1.0000 * [0.3125^2 - (0.3125 - 0.3125)^2 - (0.3125 - 0.3125)^2]
= **0.0977** sq. in.

A43 = f_{r2} [L_{43}^2 - (L_{43} - $L_{43pareff}$)^2 - (L_{43} - $L_{43noreff}$)^2] =
0.8550 * [0.4107^2 - (0.4107 - 0.4107)^2 - (0.4107 - 0.4107)^2]
= **0.1442** sq. in.

A5 = max{C [min(D_p , 2 L_{par}) - d - 2 t_n] min(t_e, L_{noro}) f_{r4}, 0} =
max{1 * [min(12.5000 , 2 * 6.7655) - 6.7655 - 2 * 0.3695] * min (0.3750, 1.2988) * 1.0000, 0}
= **1.8733** sq. in.

Area Available (External Pressure) = A1 + A2 + A3 + A41 + A42 + A43 + A5 = 6.7037 sq. in., which is **>=** A (0.3223)

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, te, or tn = smaller of 0.75, 0.3750, or 0.3695 = **0.3695** in.

$$\text{Weld 41 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.3695 * 0.7)) + 0}}{0.7} = \frac{0.2500}{0.7} = \textbf{0.3571} \text{ in.}$$

Weld 41, actual weld leg = **0.3750** in.

Weld 42 tmin = smaller of 0.75, t, or te = smaller of 0.75, 0.6875, or 0.3750 = **0.3750** in.

$$\text{Weld 42 Leg min.} = \frac{0.5 * \text{tmin} + \text{ext. CA}}{0.7} = \frac{0.5 * 0.3750 + 0.0000}{0.7} = \textbf{0.2679} \text{ in.}$$

Weld 42, actual weld leg = **0.3125** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.3695 = **0.3695** in.

$$\text{Weld 43 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.3695 * 0.7)) + 0.0625}}{0.7} = \frac{0.3125}{0.7} = \textbf{0.4464} \text{ in.}$$

Weld 43, actual weld leg = **0.5000** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Outer fillet, Weld 42, in shear = 0.49 * Material Stress = 0.49 * 20000 = **9800** PSI
Repad groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 6.2555 * 0.3695 * 11970 = **43400** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 6.6250 * 0.3750 * 8379 = **32700** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 6.6250 * 0.7500 * 12654 = **98700** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 6.6250 * 0.4107 * 8379 = **35800** lb.
Outer fillet in shear = ½ * π * Plate OD * weld leg * outer fillet in shear unit stress = ½ * π * 12.5000 * 0.3125 * 9800 = **60100** lb.
Repad groove weld = ½ * π * Nozzle OD * Groove Depth * repad groove weld in tension unit stress =
½ * π * 6.6250 * 0.3750 * 12654 = **49400** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [2.7779 - 1.2624 + 2 * 0.3695 * 0.8550 * (1.00 * 0.5938 - 1.00 * 0.4042)] * 20000 = **32700** lb.

W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.5663 + 1.8733 + 0.1202 + 0.0977) * 20000 = **53200** lb.

W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.5663 + 0.3609 + 0.1202 + 0.1442 + 2 * 0.3695 * 0.5938 * 0.8550) * 20000 = **31300** lb.

W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.5663 + 0.3609 + 1.8733 + 0.1202 + 0.0977 + 0.1442 + 2 * 0.3695 * 0.5938 * 0.8550) * 20000 = **70800** lb.

Check Strength Paths

Path 1-1 = Outer fillet in shear + Nozzle wall in shear = 60100 + 43400 = **103500** lb.

Path 2-2 = Upper fillet in shear + Repad groove weld + Groove weld in tension + Inner fillet in shear =
32700 + 49400 + 98700 + 35800 = **216600** lb.

Path 3-3 = Outer fillet in shear + Inner fillet in shear + Groove weld in tension = 60100 + 35800 + 98700 = **194600** lb.

Plate Strength = A5 * Sp = 1.8733 * 20000 = **37466** lb.

Outer fillet weld strength(60100) is greater than plate strength(37466).

South Gate Engineering, LLC

2"-300# RFSO, BEARING DRAIN (N11)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 6
ID Number: N11

Vessel Number: HOT28-56U
Mark Number: N11

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.00	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	5.9375	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	5.3125	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	2		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	1.6870	in.	Nozzle Wall Thickness(new):	0.3440	in.
Nozzle ID (corroded):	1.8120	in.	Nozzle Wall Thickness(corroded):	0.2815	in.
Developed Opening:	2.0932	in.	Tangential Dimension L:	11.0000	in.
External Limit of Reinforcement:	0.7038	in.	Upper Weld Leg Size(Weld 41):	0.3125	in.
Internal Limit of Reinforcement:	0.5475	in.	Internal Weld Leg Size(Weld 43):	0.3750	in.
Parallel Limit of Reinf (2Lpar):	4.4851	in.	Outside Groove Weld Depth:	0.7500	in.

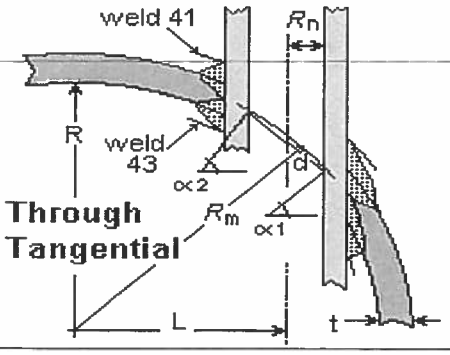
Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Head 1 - FRONT HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.

Material:	SA-516 Gr. 70		Head wall thickness(new):	0.7500	in.
Material Stress(S_V):	20000	PSI	Head wall thickness - thin out (corroded):	0.5938	in.

Nozzle Detail Information



Upper Weld Leg Size(Weld 41): 0.3125 in.

Internal Weld Leg Size(Weld 43): 0.3750 in.

Nozzle Wall Thickness(t_n): 0.3440 in.

Outside Groove Weld Depth: 0.7500 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 2 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$tr = \frac{P\ K1\ Do}{(2SE + 0.8P)} = \frac{650.00 * 0.9000 * 28.0000}{(2 * 20000 * 1 + 0.8 * 650.00)}$$ = **0.4042** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.00 * 0.9060}{17100 * 1 - 0.6 * 650.00}$$ = **0.0352** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 2.3750 * 15.00}{4 * 2530}$$ = **0.0108** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + ext.\ Ca = \frac{650.00 * 0.9060}{17100 * 1.00 - 0.6 * 650.00} + 0.0625 + 0.0000$$ = **0.0977** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{P\ K\ Do}{(2SE + 2P(K - 0.1))} + Ca + ext.\ Ca = \frac{650.00 * 0.9900 * 28.0000}{(2 * 20000 * 1 + 2 * 650.00 * (0.9900 - 0.1))} + 0.0625 + 0.0000$$ = **0.5003** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{P\ K\ Do}{(2SE + 2P(K - 0.1))} + Ca + ext.\ Ca = \frac{15.00 * 0.9900 * 28.0000}{(2 * 20000 * 1 + 2 * 15.00 * (0.9900 - 0.1))} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0104_{(Calculated)}, 0.0938_{(Minimum\ Allowed)}) + 0.0625_{(corrosion)} + 0.0000_{(ext.\ corrosion)}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1975** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1975** in.

$t_{UG-45} = \max(t_a, t_b)$ = **0.1975** in.

Wall thickness = tn * 0.875(pipe) = **0.3010** is greater than or equal to UG-45 value of **0.1975**

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.2815 = **0.2815** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2815 * 0.7)) + 0}}{0.7} = \frac{0.1970}{0.7}$ = **0.2815** in.

Weld 41, actual weld leg = **0.3125** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.2815 = **0.2815** in.

Weld 43 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2815 * 0.7)) + 0.0625}}{0.7} = \frac{0.2595}{0.7}$ = **0.3708** in.

Weld 43, actual weld leg = **0.3750** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 2.0935 * 0.2815 * 11970 = **11100** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 2.3750 * 0.3125 * 8379 = **9760** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 2.3750 * 0.7500 * 12654 = **35400** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 2.3750 * 0.2857 * 8379 = **8930** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [0.9394 - 0.4097 + 2 * 0.2815 * 0.8550 * (1.00 * 0.5938 - 1.00 * 0.4042)] * 20000 = **12400** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.2964 + 0.0000 + 0.0835 + 0.0000) * 20000 = **7600** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.2964 + 0.2050 + 0.0835 + 0.0698 + 2 * 0.2815 * 0.5938 * 0.8550) * 20000 = **18800** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.2964 + 0.2050 + 0.0000 + 0.0835 + 0.0000 + 0.0698 + 2 * 0.2815 * 0.5938 * 0.8550) * 20000 = **18800** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 9760 + 11100 = **20860** lb.
Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear =
9760 + 35400 + 8930 = **54090** lb.
Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 9760 + 8930 + 35400 = **54090** lb.

South Gate Engineering, LLC

THERMOWELL, 1 1/2"-600# RFSO (N12)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 7
ID Number: N12

Vessel Number: HOT28-56U
Mark Number: N12

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.33	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	4.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.7500	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1 1/2		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	1.3380	in.	Nozzle Wall Thickness(new):	0.2810	in.
Nozzle ID (corroded):	1.4630	in.	Nozzle Wall Thickness(corroded):	0.2185	in.
Developed Opening:	1.4008	in.	Tangential Dimension L:	7.0000	in.
External Limit of Reinforcement:	0.5463	in.	Upper Weld Leg Size(Weld 41):	0.2500	in.
Internal Limit of Reinforcement:	0.3900	in.	Internal Weld Leg Size(Weld 43):	0.3125	in.
Parallel Limit of Reinf (2Lpar):	3.0876	in.	Outside Groove Weld Depth:	0.7500	in.

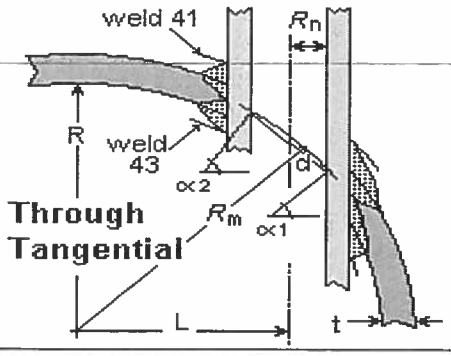
Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Head 1 - FRONT HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.

Material:	SA-516 Gr. 70		Head wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000	PSI	Head wall thickness - thin out (corroded):	0.5938	in.

Nozzle Detail Information



Upper Weld Leg Size(Weld 41): 0.2500 in.

Internal Weld Leg Size(Weld 43): 0.3125 in.

Nozzle Wall Thickness(t_n): 0.2810 in.

Outside Groove Weld Depth: 0.7500 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 1 1/2 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Head Thickness per Paragraph UG-37(a)

$$tr = \frac{P\ K1\ Do}{(2SE + 0.8P)} = \frac{650.33 * 0.9000 * 28.0000}{(2 * 20000 * 1 + 0.8 * 650.33)}$$ = **0.4044** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.33 * 0.7315}{17100 * 1 - 0.6 * 650.33}$$ = **0.0285** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 1.9000 * 15.00}{4 * 2614}$$ = **0.0082** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + ext.\ Ca = \frac{650.33 * 0.7315}{17100 * 1.00 - 0.6 * 650.33} + 0.0625 + 0.0000$$ = **0.0910** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{P\ K\ Do}{(2SE + 2P(K - 0.1))} + Ca + ext.\ Ca = \frac{650.33 * 0.9900 * 28.0000}{(2 * 20000 * 1 + 2 * 650.33 * (0.9900 - 0.1))} + 0.0625 + 0.0000$$ = **0.5005** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{P\ K\ Do}{(2SE + 2P(K - 0.1))} + Ca + ext.\ Ca = \frac{15.00 * 0.9900 * 28.0000}{(2 * 20000 * 1 + 2 * 15.00 * (0.9900 - 0.1))} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0104_{(Calculated)}, 0.0938_{(Minimum\ Allowed)}) + 0.0625_{(corrosion)} + 0.0000_{(ext.\ corrosion)}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1895** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1895** in.

$t_{UG-45} = \max(t_a, t_b)$ = **0.1895** in.

Wall thickness = tn * 0.875(pipe) = **0.2460** is greater than or equal to UG-45 value of **0.1895**

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.2185 = **0.2185** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2185 * 0.7)) + 0}}{0.7} = \frac{0.1530}{0.7}$ = **0.2185** in.

Weld 41, actual weld leg = **0.2500** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.2185 = **0.2185** in.

Weld 43 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2185 * 0.7)) + 0.0625}}{0.7} = \frac{0.2155}{0.7}$ = **0.3078** in.

Weld 43, actual weld leg = **0.3125** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 1.6815 * 0.2185 * 11970 = **6900** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 1.9000 * 0.2500 * 8379 = **6250** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 1.9000 * 0.7500 * 12654 = **28300** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 1.9000 * 0.2232 * 8379 = **5580** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [0.6450 - 0.2781 + 2 * 0.2185 * 0.8550 * (1.00 * 0.5938 - 1.00 * 0.4044)] * 20000 = **8750** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.1775 + 0.0000 + 0.0534 + 0.0000) * 20000 = **4620** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.1775 + 0.1040 + 0.0534 + 0.0426 + 2 * 0.2185 * 0.5938 * 0.8550) * 20000 = **12000** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.1775 + 0.1040 + 0.0000 + 0.0534 + 0.0000 + 0.0426 + 2 * 0.2185 * 0.5938 * 0.8550) * 20000 = **12000** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 6250 + 6900 = **13150** lb.
Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear =
6250 + 28300 + 5580 = **40130** lb.
Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 6250 + 5580 + 28300 = **40130** lb.

South Gate Engineering, LLC
DRAIN, 1 1/2"-300# RFSO (N8)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 8
ID Number: N8

Vessel Number: HOT28-56U
Mark Number: N8

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.55	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	4.5000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.0000	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1 1/2		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	1.3380	in.	Nozzle Wall Thickness(new):	0.2810	in.
Nozzle ID (corroded):	1.4630	in.	Nozzle Wall Thickness(corroded):	0.2185	in.
External Limit of Reinforcement:	0.5463	in.	Upper Weld Leg Size(Weld 41):	0.2500	in.
Internal Limit of Reinforcement:	0.3900	in.	Internal Weld Leg Size(Weld 43):	0.0000	in.
Parallel Limit of Reinf (2Lpar):	3.2750	in.	Outside Groove Weld Depth:	0.7500	in.

Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Shell 1 - SHELL, 28" O.D. x 56"L

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000	PSI	Shell wall thickness(corroded):	0.6875	in.

Nozzle Detail Information

Upper Weld Leg Size(Weld 41): 0.2500 in.

~~Nozzle Wall Thickness(t_n): 0.2810 in.~~

Outside Groove Weld Depth: 0.7500 in.

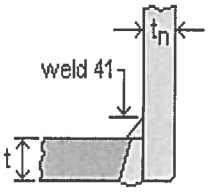


Fig. UW-16.1 (d)

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 1 1/2 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$tr = \frac{PRo}{SE + 0.4P} = \frac{650.55 * 14.0000}{20000 * 1 + 0.4 * 650.55}$$ = **0.4495** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.55 * 0.7315}{17100 * 1 - 0.6 * 650.55}$$ = **0.0285** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 1.9000 * 15.00}{4 * 2568}$$ = **0.0085** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{650.55 * 0.7315}{17100 * 1.00 - 0.6 * 650.55} + 0.0625 + 0.0000$$ = **0.0910** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{650.55 * 14.0000}{20000 * 1 + 0.4 * 650.55} + 0.0625 + 0.0000$$ = **0.5120** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{15.00 * 14.0000}{20000 * 1 + 0.4 * 15.00} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0105_{(\text{Calculated})}, 0.0938_{(\text{Minimum Allowed})}) + 0.0625_{(\text{corrosion})} + 0.0000_{(\text{ext. corrosion})}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1895** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1895** in.

$t_{UG-45} = \max(t_a, t_b)$ = **0.1895** in.

Wall thickness = tn * 0.875(pipe) = **0.2460** is greater than or equal to UG-45 value of **0.1895**

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.2185 = **0.2185** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.2185 * 0.7)) + 0}}{0.7} = \frac{0.1530}{0.7}$ = **0.2185** in.

Weld 41, actual weld leg = **0.2500** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 1.6815 * 0.2185 * 11970 = **6900** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 1.9000 * 0.2500 * 8379 = **6250** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 1.9000 * 0.6875 * 12654 = **26000** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [0.6861 - 0.3864 + 2 * 0.2185 * 0.8550 * (1.00 * 0.6875 - 1.00 * 0.4495)] * 20000 = **7770** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.1775 + 0.0000 + 0.0534 + 0.0000) * 20000 = **4620** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.1775 + 0.0000 + 0.0534 + 0.0000 + 2 * 0.2185 * 0.6875 * 0.8550) * 20000 = **9760** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.1775 + 0.0000 + 0.0000 + 0.0534 + 0.0000 + 0.0000 + 2 * 0.2185 * 0.6875 * 0.8550) * 20000 = **9760** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 6250 + 6900 = **13150** lb.
Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear =
6250 + 26000 + 0 = **32250** lb.
Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 6250 + 0 + 26000 = **32250** lb.

South Gate Engineering, LLC
FILL PUMP, 1 1/2"-300# RFSO (N3)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 9
ID Number: N3

Vessel Number: HOT28-56U
Mark Number: N3

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.00	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	7.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	16.3125	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	3/4		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.6120	in.	Nozzle Wall Thickness(new):	0.2190	in.
Nozzle ID (corroded):	0.7370	in.	Nozzle Wall Thickness(corroded):	0.1565	in.
External Limit of Reinforcement:	0.3913	in.	Upper Weld Leg Size(Weld 41):	0.2500	in.
Internal Limit of Reinforcement:	0.2350	in.	Internal Weld Leg Size(Weld 43):	0.2500	in.
Parallel Limit of Reinf (2Lpar):	2.4250	in.	Outside Groove Weld Depth:	0.7500	in.

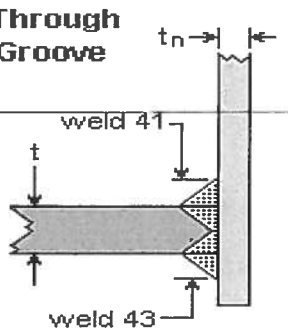
Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Shell 1 - SHELL, 28" O.D. x 56"L

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000	PSI	Shell wall thickness(corroded):	0.6875	in.

Nozzle Detail Information



Upper Weld Leg Size(Weld 41): 0.2500 in.

Internal Weld Leg Size(Weld 43): 0.2500 in.

Nozzle Wall Thickness(t_n): 0.2190 in.

Outside Groove Weld Depth: 0.7500 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3/4 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$tr = \frac{PRo}{SE + 0.4P} = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00}$$ = **0.4492** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.00 * 0.3685}{17100 * 1 - 0.6 * 650.00}$$ = **0.0143** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 1.0500 * 15.00}{4 * 1596}$$ = **0.0075** in.

Strength Reduction Factors

$$fr1 = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad fr2 = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{650.00 * 0.3685}{17100 * 1.00 - 0.6 * 650.00} + 0.0625 + 0.0000$$ = **0.0768** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00} + 0.0625 + 0.0000$$ = **0.5117** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{15.00 * 14.0000}{20000 * 1 + 0.4 * 15.00} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0105_{(\text{Calculated})}, 0.0938_{(\text{Minimum Allowed})}) + 0.0625_{(\text{corrosion})} + 0.0000_{(\text{ext. corrosion})}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1615** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1615** in.

$t_{UG-45} = \max(t_a, t_b)$ = **0.1615** in.

Wall thickness = tn * 0.875(pipe) = **0.1920** is greater than or equal to UG-45 value of **0.1615**

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1565 = **0.1565** in.

$$\text{Weld 41 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1565 * 0.7)) + 0}}{0.7} = \frac{0.1096}{0.7}$$ = **0.1565** in.

Weld 41, actual weld leg = **0.2500** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1565 = **0.1565** in.

$$\text{Weld 43 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1565 * 0.7)) + 0.0625}}{0.7} = \frac{0.1720}{0.7}$$ = **0.2458** in.

Weld 43, actual weld leg = **0.2500** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 0.8935 * 0.1565 * 11970 = **2630** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 1.0500 * 0.2500 * 8379 = **3450** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 1.0500 * 0.7500 * 12654 = **15600** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 1.0500 * 0.1607 * 8379 = **2220** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [0.3514 - 0.3616 + 2 * 0.1565 * 0.8550 * (1.00 * 0.6875 - 1.00 * 0.4492)] * 20000 = **1070** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.0951 + 0.0000 + 0.0534 + 0.0000) * 20000 = **2970** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.0951 + 0.0378 + 0.0534 + 0.0221 + 2 * 0.1565 * 0.6875 * 0.8550) * 20000 = **7850** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.0951 + 0.0378 + 0.0000 + 0.0534 + 0.0000 + 0.0221 + 2 * 0.1565 * 0.6875 * 0.8550) * 20000 = **7850** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 3450 + 2630 = **6080** lb.
Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear =
3450 + 15600 + 2220 = **21270** lb.
Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 3450 + 2220 + 15600 = **21270** lb.

South Gate Engineering, LLC
SRV, 1"-300# RFSO (N5)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 10
ID Number: N5

Vessel Number: HOT28-56U
Mark Number: N5

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.00	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	7.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.7500	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	1		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.8150	in.	Nozzle Wall Thickness(new):	0.2500	in.
Nozzle ID (corroded):	0.9400	in.	Nozzle Wall Thickness(corroded):	0.1875	in.
External Limit of Reinforcement:	0.4688	in.	Upper Weld Leg Size(Weld 41):	0.2500	in.
Internal Limit of Reinforcement:	0.3125	in.	Internal Weld Leg Size(Weld 43):	0.3125	in.
Parallel Limit of Reinf (2Lpar):	2.6900	in.	Outside Groove Weld Depth:	0.7500	in.

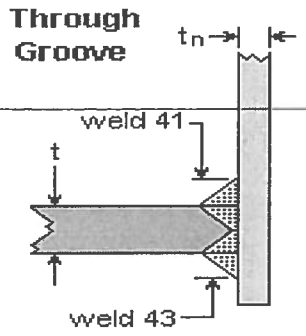
Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Shell 1 - SHELL, 28" O.D. x 56"L

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.7500	in.
Material Stress(S_V):	20000	PSI	Shell wall thickness(corroded):	0.6875	in.

Nozzle Detail Information



Upper Weld Leg Size(Weld 41): 0.2500 in.

Internal Weld Leg Size(Weld 43): 0.3125 in.

Nozzle Wall Thickness(t_n): 0.2500 in.

Outside Groove Weld Depth: 0.7500 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 1 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$tr = \frac{PRo}{SE + 0.4P} = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00}$$ = **0.4492** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.00 * 0.4700}{17100 * 1 - 0.6 * 650.00}$$ = **0.0183** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 1.3150 * 15.00}{4 * 1765}$$ = **0.0084** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{650.00 * 0.4700}{17100 * 1.00 - 0.6 * 650.00} + 0.0625 + 0.0000$$ = **0.0808** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00} + 0.0625 + 0.0000$$ = **0.5117** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{15.00 * 14.0000}{20000 * 1 + 0.4 * 15.00} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0105_{(\text{Calculated})}, 0.0938_{(\text{Minimum Allowed})}) + 0.0625_{(\text{corrosion})} + 0.0000_{(\text{ext. corrosion})}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1785** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1785** in.

$t_{UG-45} = \max(t_a, t_b)$ = **0.1785** in.

Wall thickness = tn * 0.875(pipe) = **0.2190** is greater than or equal to UG-45 value of **0.1785**

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1875 = **0.1875** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1875 * 0.7)) + 0}}{0.7} = \frac{0.1313}{0.7}$ = **0.1875** in.

Weld 41, actual weld leg = **0.2500** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1875 = **0.1875** in.

Weld 43 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1875 * 0.7)) + 0.0625}}{0.7} = \frac{0.1938}{0.7}$ = **0.2768** in.

Weld 43, actual weld leg = **0.3125** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 1.1275 * 0.1875 * 11970 = **3970** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 1.3150 * 0.2500 * 8379 = **4320** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 1.3150 * 0.7500 * 12654 = **19600** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 1.3150 * 0.2232 * 8379 = **3860** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [0.4467 - 0.3743 + 2 * 0.1875 * 0.8550 * (1.00 * 0.6875 - 1.00 * 0.4492)] * 20000 = **2980** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.1356 + 0.0000 + 0.0534 + 0.0000) * 20000 = **3780** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.1356 + 0.0668 + 0.0534 + 0.0426 + 2 * 0.1875 * 0.6875 * 0.8550) * 20000 = **10400** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.1356 + 0.0668 + 0.0000 + 0.0534 + 0.0000 + 0.0426 + 2 * 0.1875 * 0.6875 * 0.8550) * 20000 = **10400** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 4320 + 3970 = **8290** lb.
Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear =
4320 + 19600 + 3860 = **27780** lb.
Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 4320 + 3860 + 19600 = **27780** lb.

South Gate Engineering, LLC

LEVEL SWITCH, 3/4"-300# RFSO (N7A)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 11
ID Number: N7A

Vessel Number: HOT28-56U
Mark Number: N7A

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.00	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	2.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.7500	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	3/4		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.6120	in.	Nozzle Wall Thickness(new):	0.2190	in.
Nozzle ID (corroded):	0.7370	in.	Nozzle Wall Thickness(corroded):	0.1565	in.
Developed Opening:	0.6120	in.	Tangential Dimension L:	0.1540	in.
External Limit of Reinforcement:	0.3913	in.	Upper Weld Leg Size(Weld 41):	0.2500	in.
Internal Limit of Reinforcement:	0.2350	in.	Internal Weld Leg Size(Weld 43):	0.2500	in.
Parallel Limit of Reinf (2Lpar):	2.4250	in.	Outside Groove Weld Depth:	0.7500	in.

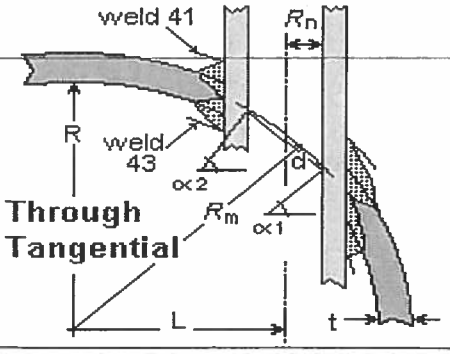
Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Shell 1 - SHELL, 28" O.D. x 56"L

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000	PSI	Shell wall thickness(corroded):	0.6875	in.

Nozzle Detail Information



Upper Weld Leg Size(Weld 41): 0.2500 in.

Internal Weld Leg Size(Weld 43): 0.2500 in.

Nozzle Wall Thickness(t_n): 0.2190 in.

Outside Groove Weld Depth: 0.7500 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 3/4 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$tr = \frac{PRo}{SE + 0.4P} = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00}$$ = **0.4492** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.00 * 0.3685}{17100 * 1 - 0.6 * 650.00}$$ = **0.0143** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 1.0500 * 15.00}{4 * 2807}$$ = **0.0044** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{650.00 * 0.3685}{17100 * 1.00 - 0.6 * 650.00} + 0.0625 + 0.0000$$ = **0.0768** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00} + 0.0625 + 0.0000$$ = **0.5117** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{15.00 * 14.0000}{20000 * 1 + 0.4 * 15.00} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0105_{(\text{Calculated})}, 0.0938_{(\text{Minimum Allowed})}) + 0.0625_{(\text{corrosion})} + 0.0000_{(\text{ext. corrosion})}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1615** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1615** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1615** in.

Wall thickness = tn * 0.875(pipe) = **0.1920** is greater than or equal to UG-45 value of **0.1615**

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1565 = **0.1565** in.

$$\text{Weld 41 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1565 * 0.7)) + 0}}{0.7} = \frac{0.1096}{0.7}$$ = **0.1565** in.

Weld 41, actual weld leg = **0.2500** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1565 = **0.1565** in.

$$\text{Weld 43 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1565 * 0.7)) + 0.0625}}{0.7} = \frac{0.1720}{0.7}$$ = **0.2458** in.

Weld 43, actual weld leg = **0.2500** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 0.8935 * 0.1565 * 11970 = **2630** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 1.0500 * 0.2500 * 8379 = **3450** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 1.0500 * 0.7500 * 12654 = **15600** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 1.0500 * 0.1607 * 8379 = **2220** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [0.3514 - 0.3616 + 2 * 0.1565 * 0.8550 * (1.00 * 0.6875 - 1.00 * 0.4492)] * 20000 = **1070** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.0951 + 0.0000 + 0.0534 + 0.0000) * 20000 = **2970** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.0951 + 0.0378 + 0.0534 + 0.0221 + 2 * 0.1565 * 0.6875 * 0.8550) * 20000 = **7850** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.0951 + 0.0378 + 0.0000 + 0.0534 + 0.0000 + 0.0221 + 2 * 0.1565 * 0.6875 * 0.8550) * 20000 = **7850** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 3450 + 2630 = **6080** lb.
Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear =
3450 + 15600 + 2220 = **21270** lb.
Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 3450 + 2220 + 15600 = **21270** lb.

South Gate Engineering, LLC

LEVEL SWITCH, 3/4"-300# RFSO (N7B)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 12
ID Number: N7B

Vessel Number: HOT28-56U
Mark Number: N7B

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.47	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	2.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.7500	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	3/4		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.6120	in.	Nozzle Wall Thickness(new):	0.2190	in.
Nozzle ID (corroded):	0.7370	in.	Nozzle Wall Thickness(corroded):	0.1565	in.
Developed Opening:	0.6120	in.	Tangential Dimension L:	0.1540	in.
External Limit of Reinforcement:	0.3913	in.	Upper Weld Leg Size(Weld 41):	0.2500	in.
Internal Limit of Reinforcement:	0.2350	in.	Internal Weld Leg Size(Weld 43):	0.2500	in.
Parallel Limit of Reinf (2Lpar):	2.4250	in.	Outside Groove Weld Depth:	0.7500	in.

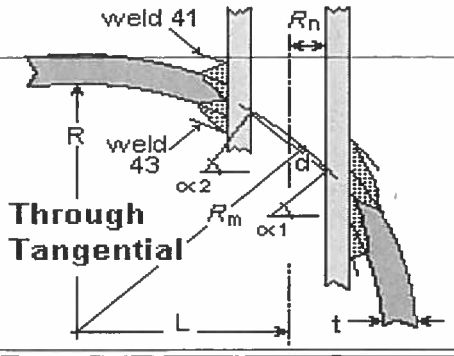
Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Shell 1 - SHELL, 28" O.D. x 56"L

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000	PSI	Shell wall thickness(corroded):	0.6875	in.

Nozzle Detail Information



Upper Weld Leg Size(Weld 41): 0.2500 in.

Internal Weld Leg Size(Weld 43): 0.2500 in.

Nozzle Wall Thickness(t_n): 0.2190 in.

Outside Groove Weld Depth: 0.7500 in.

tangential to the vessel wall, attached by a groove weld.
Pipe Size: 3/4 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$tr = \frac{PRo}{SE + 0.4P} = \frac{650.47 * 14.0000}{20000 * 1 + 0.4 * 650.47} = \mathbf{0.4495} \text{ in.}$$

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.47 * 0.3685}{17100 * 1 - 0.6 * 650.47} = \mathbf{0.0143} \text{ in.}$$

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 1.0500 * 15.00}{4 * 2807} = \mathbf{0.0044} \text{ in.}$$

Strength Reduction Factors

$$\mathbf{fr1} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550 \qquad \mathbf{fr2} = \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{650.47 * 0.3685}{17100 * 1.00 - 0.6 * 650.47} + 0.0625 + 0.0000 = \mathbf{0.0768} \text{ in.}$$

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{650.47 * 14.0000}{20000 * 1 + 0.4 * 650.47} + 0.0625 + 0.0000 = \mathbf{0.5120} \text{ in.}$$

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{15.00 * 14.0000}{20000 * 1 + 0.4 * 15.00} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0105_{(\text{Calculated})}, 0.0938_{(\text{Minimum Allowed})}) + 0.0625_{(\text{corrosion})} + 0.0000_{(\text{ext. corrosion})} = \mathbf{0.1563}$ in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1615** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1615** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1615** in.

Wall thickness = tn * 0.875(pipe) = **0.1920** is greater than or equal to UG-45 value of **0.1615**

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1565 = **0.1565** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1565 * 0.7)) + 0}}{0.7} = \frac{0.1096}{0.7}$ = **0.1565** in.

Weld 41, actual weld leg = **0.2500** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1565 = **0.1565** in.

Weld 43 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1565 * 0.7)) + 0.0625}}{0.7} = \frac{0.1720}{0.7}$ = **0.2458** in.

Weld 43, actual weld leg = **0.2500** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress = ½ * π * 0.8935 * 0.1565 * 11970 = **2630** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 1.0500 * 0.2500 * 8379 = **3450** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress = ½ * π * 1.0500 * 0.7500 * 12654 = **15600** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 1.0500 * 0.1607 * 8379 = **2220** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [0.3517 - 0.3612 + 2 * 0.1565 * 0.8550 * (1.00 * 0.6875 - 1.00 * 0.4495)] * 20000 = **1080** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.0951 + 0.0000 + 0.0534 + 0.0000) * 20000 = **2970** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.0951 + 0.0378 + 0.0534 + 0.0221 + 2 * 0.1565 * 0.6875 * 0.8550) * 20000 = **7850** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv = (0.0951 + 0.0378 + 0.0000 + 0.0534 + 0.0000 + 0.0221 + 2 * 0.1565 * 0.6875 * 0.8550) * 20000 = **7850** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 3450 + 2630 = **6080** lb.
Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear = 3450 + 15600 + 2220 = **21270** lb.
Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 3450 + 2220 + 15600 = **21270** lb.

South Gate Engineering, LLC
LEVEL GAUGE, 3/4"-300# RFSO (N6A)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 13
ID Number: N6A

Vessel Number: HOT28-56U
Mark Number: N6A

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.00	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	3.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.7500	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	3/4		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.6120	in.	Nozzle Wall Thickness(new):	0.2190	in.
Nozzle ID (corroded):	0.7370	in.	Nozzle Wall Thickness(corroded):	0.1565	in.
External Limit of Reinforcement:	0.3913	in.	Upper Weld Leg Size(Weld 41):	0.2500	in.
Internal Limit of Reinforcement:	0.2350	in.	Internal Weld Leg Size(Weld 43):	0.2500	in.
Parallel Limit of Reinf (2Lpar):	2.4250	in.	Outside Groove Weld Depth:	0.7500	in.

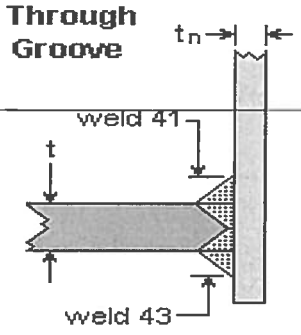
Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Shell 1 - SHELL, 28" O.D. x 56"L

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000	PSI	Shell wall thickness(corroded):	0.6875	in.

Nozzle Detail Information



Upper Weld Leg Size(Weld 41): 0.2500 in.

Internal Weld Leg Size(Weld 43): 0.2500 in.

Nozzle Wall Thickness(t_n): 0.2190 in.

Outside Groove Weld Depth: 0.7500 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3/4 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

Required Shell Thickness per Paragraph UG-37(a)

$$tr = \frac{PRo}{SE + 0.4P} = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00}$$ = **0.4492** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.00 * 0.3685}{17100 * 1 - 0.6 * 650.00}$$ = **0.0143** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 1.0500 * 15.00}{4 * 2405}$$ = **0.0050** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{650.00 * 0.3685}{17100 * 1.00 - 0.6 * 650.00} + 0.0625 + 0.0000$$ = **0.0768** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{650.00 * 14.0000}{20000 * 1 + 0.4 * 650.00} + 0.0625 + 0.0000$$ = **0.5117** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{15.00 * 14.0000}{20000 * 1 + 0.4 * 15.00} + 0.0625 + 0.0000$$

$= \text{Greater Of } (0.0105_{(\text{Calculated})}, 0.0938_{(\text{Minimum Allowed})}) + 0.0625_{(\text{corrosion})} + 0.0000_{(\text{ext. corrosion})}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1615** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1615** in.

$t_{UG\text{-}45} = \max(t_a, t_b)$ = **0.1615** in.

Wall thickness = tn * 0.875(pipe) = **0.1920** is greater than or equal to UG-45 value of **0.1615**

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1565 = **0.1565** in.

$$\text{Weld 41 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1565 * 0.7)) + 0}}{0.7} = \frac{0.1096}{0.7} = \textbf{0.1565} \text{ in.}$$

Weld 41, actual weld leg = **0.2500** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1565 = **0.1565** in.

$$\text{Weld 43 Leg min.} = \frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1565 * 0.7)) + 0.0625}}{0.7} = \frac{0.1720}{0.7} = \textbf{0.2458} \text{ in.}$$

Weld 43, actual weld leg = **0.2500** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 0.8935 * 0.1565 * 11970 = **2630** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 1.0500 * 0.2500 * 8379 = **3450** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 1.0500 * 0.7500 * 12654 = **15600** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 1.0500 * 0.1607 * 8379 = **2220** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [0.3514 - 0.3616 + 2 * 0.1565 * 0.8550 * (1.00 * 0.6875 - 1.00 * 0.4492)] * 20000 = **1070** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.0951 + 0.0000 + 0.0534 + 0.0000) * 20000 = **2970** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.0951 + 0.0378 + 0.0534 + 0.0221 + 2 * 0.1565 * 0.6875 * 0.8550) * 20000 = **7850** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.0951 + 0.0378 + 0.0000 + 0.0534 + 0.0000 + 0.0221 + 2 * 0.1565 * 0.6875 * 0.8550) * 20000 = **7850** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 3450 + 2630 = **6080** lb.
Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear =
3450 + 15600 + 2220 = **21270** lb.
Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 3450 + 2220 + 15600 = **21270** lb.

South Gate Engineering, LLC
LEVEL GAUGE, 3/4"-300# RFSO (N6B)

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388
Number: 14
ID Number: N6B

Vessel Number: HOT28-56U
Mark Number: N6B

Date Printed: 10/27/2016

Nozzle Design Information

Design Pressure:	650.00	PSI	Design Temperature:	200	°F
Static Head:	0.67	PSI	Nozzle Efficiency (E):	100	%
Nozzle Material:	SA-106 Gr. B		Joint Efficiency (E_1):	1.00	
			Factor B Chart:	CS-2	
External Projection:	3.0000	in.	Allowable Stress at Design Temperature (S_n):	17100	PSI
Internal Projection:	0.7500	in.	Allowable Stress at Ambient Temperature:	17100	PSI
Inside Corrosion Allowance:	0.0625	in.	Correction Factor (F):	1.00	
External Corrosion Allowance:	0.0000	in.	Nozzle Path:	None	
Nozzle Pipe Size:	3/4		Nozzle Pipe Schedule:	160	
Nozzle ID (new):	0.6120	in.	Nozzle Wall Thickness(new):	0.2190	in.
Nozzle ID (corroded):	0.7370	in.	Nozzle Wall Thickness(corroded):	0.1565	in.
External Limit of Reinforcement:	0.3913	in.	Upper Weld Leg Size(Weld 41):	0.2500	in.
Internal Limit of Reinforcement:	0.2350	in.	Internal Weld Leg Size(Weld 43):	0.2500	in.
Parallel Limit of Reinf (2Lpar):	2.4250	in.	Outside Groove Weld Depth:	0.7500	in.

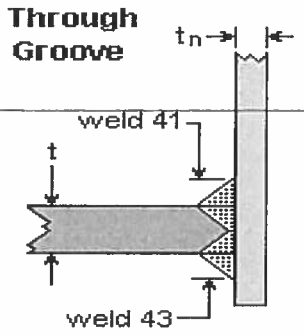
Minimum Design Metal Temperature

Minimum Design Metal Temperature: -20 °F
Material is exempt from impact testing per UG-20(f), 1 through 5

Host Component: Shell 1 - SHELL, 28" O.D. x 56"L

Material:	SA-516 Gr. 70		Shell wall thickness(new):	0.7500	in.
Material Stress(S_v):	20000	PSI	Shell wall thickness(corroded):	0.6875	in.

Nozzle Detail Information



Upper Weld Leg Size(Weld 41): 0.2500 in.

Internal Weld Leg Size(Weld 43): 0.2500 in.

Nozzle Wall Thickness(t_n): 0.2190 in.

Outside Groove Weld Depth: 0.7500 in.

Nozzle passes through the vessel, attached by a groove weld.
Pipe Size: 3/4 Schedule: 160
Nozzle is adequate for UG-45 requirements.
Opening is adequately reinforced for Internal Pressure.
Opening is adequately reinforced for External Pressure.
Reinforcement calculations are not required per UG-36(c)(3)(a)See Uw-14 for exceptions.
Weld Strength Paths are adequate.

South Gate Engineering, LLC

LEVEL GAUGE, 3/4"-300# RFSO (N6B)

Job No: 12388
Number: 14
ID Number: N6B

Vessel Number: HOT28-56U
Mark Number: N6B

Date Printed: 10/27/2016

Required Shell Thickness per Paragraph UG-37(a)

$$tr = \frac{PRo}{SE + 0.4P} = \frac{650.67 * 14.0000}{20000 * 1 + 0.4 * 650.67}$$ = **0.4496** in.

Nozzle Required Thickness Calculations

Required Nozzle Thickness for Internal Pressure per Paragraph UG-37(a)

$$trn = \frac{PRn}{SE - 0.6P} = \frac{650.67 * 0.3685}{17100 * 1 - 0.6 * 650.67}$$ = **0.0143** in.

Required Nozzle Thickness for External Pressure per Paragraph UG-37(a)

$$trn = \frac{3 * Do * Pa}{4B} = \frac{3 * 1.0500 * 15.00}{4 * 2405}$$ = **0.0050** in.

Strength Reduction Factors

fr1 $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$ **fr2** $= \min\left(\frac{Sn}{Sv}, 1.0000\right) = \min\left(\frac{17100}{20000}, 1.0000\right) = 0.8550$

UG-45 Thickness Calculations

Nozzle Thickness for Pressure Loading (plus corrosion)

$$t_a = \frac{PRn}{SE - 0.6P} + Ca + \text{ext. } Ca = \frac{650.67 * 0.3685}{17100 * 1.00 - 0.6 * 650.67} + 0.0625 + 0.0000$$ = **0.0768** in.

Nozzle Thickness for Internal Pressure (plus corrosion) Based on Host

$$t_{b1} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{650.67 * 14.0000}{20000 * 1 + 0.4 * 650.67} + 0.0625 + 0.0000$$ = **0.5121** in.

Nozzle Thickness for External Pressure (plus corrosion) Based on Host

$$t_{b2} = \frac{PRo}{SE + 0.4P} + Ca + \text{ext. } Ca = \frac{15.00 * 14.0000}{20000 * 1 + 0.4 * 15.00} + 0.0625 + 0.0000$$

= Greater Of ($0.0105_{(Calculated)}$, $0.0938_{(Minimum\ Allowed)}$) + $0.0625_{(corrosion)}$ + $0.0000_{(ext.\ corrosion)}$ = **0.1563** in.

Minimum Thickness (plus corrosion) per Table UG-45

t_{b3} = minimum thickness (Table UG-45) + Ca + ext. Ca = **0.1615** in.

Nozzle Minimum Thickness Based on Host and Table UG-45

$t_b = \min[t_{b3}, \max(t_{b1}, t_{b2})]$ = **0.1615** in.

$t_{UG-45} = \max(t_a, t_b)$ = **0.1615** in.

Wall thickness = tn * 0.875(pipe) = **0.1920** is greater than or equal to UG-45 value of **0.1615**

Nozzle Weld Strength Calculations

Attachment Weld Strength per Paragraph UW-16 (Corroded Condition)

Weld 41 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1565 = **0.1565** in.

Weld 41 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ext. CA}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1565 * 0.7)) + 0}}{0.7} = \frac{0.1096}{0.7}$ = **0.1565** in.

Weld 41, actual weld leg = **0.2500** in.

Weld 43 tmin = smaller of 0.75, t, or tn = smaller of 0.75, 0.6875, or 0.1565 = **0.1565** in.

Weld 43 Leg min. = $\frac{\text{(smaller of 0.25 or (tmin * 0.7)) + ca}}{0.7} = \frac{\text{(smaller of 0.25 or (0.1565 * 0.7)) + 0.0625}}{0.7} = \frac{0.1720}{0.7}$ = **0.2458** in.

Weld 43, actual weld leg = **0.2500** in.

Unit Stresses per Paragraphs UG-45(c) and UW-15

Nozzle wall in shear = 0.70 * Sn = 0.70 * 17100 = **11970** PSI
Upper fillet, Weld 41, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI
Vessel groove weld, in tension = 0.74 * Material Stress = 0.74 * 17100 = **12654** PSI
Inner fillet, Weld 43, in shear = 0.49 * Material Stress = 0.49 * 17100 = **8379** PSI

Strength of Connection Elements

Nozzle wall in shear = ½ * π * mean nozzle diameter * tn * Nozzle wall in shear unit stress =
½ * π * 0.8935 * 0.1565 * 11970 = **2630** lb.
Upper fillet in shear = ½ * π * Nozzle OD * weld leg * upper fillet in shear unit stress = ½ * π * 1.0500 * 0.2500 * 8379 = **3450** lb.
Groove Weld in Tension = ½ * π * Nozzle OD * groove depth * groove weld tension unit stress =
½ * π * 1.0500 * 0.7500 * 12654 = **15600** lb.
Inner fillet in shear = ½ * π * Nozzle OD * weld leg * inner fillet in shear unit stress = ½ * π * 1.0500 * 0.1607 * 8379 = **2220** lb.

Load to be carried by welds, per UG-41(b)(1) and Fig. UG-41.1 sketch (a)

W = [A - A1 + 2 tn fr1(E1t - Ftr)] Sv = [0.3518 - 0.3610 + 2 * 0.1565 * 0.8550 * (1.00 * 0.6875 - 1.00 * 0.4496)] * 20000 = **1090** lb.
W1-1 = (A2 + A5 + A41 + A42) * Sv = (0.0951 + 0.0000 + 0.0534 + 0.0000) * 20000 = **2970** lb.
W2-2 = (A2 + A3 + A41 + A43 + 2 tn t fr1) Sv = (0.0951 + 0.0378 + 0.0534 + 0.0221 + 2 * 0.1565 * 0.6875 * 0.8550) * 20000 = **7850** lb.
W3-3 = (A2 + A3 + A5 + A41 + A42 + A43 + 2 tn t fr1) * Sv =
(0.0951 + 0.0378 + 0.0000 + 0.0534 + 0.0000 + 0.0221 + 2 * 0.1565 * 0.6875 * 0.8550) * 20000 = **7850** lb.

Check Strength Paths

Path 1-1 = Upper fillet in shear + Nozzle wall in shear = 3450 + 2630 = **6080** lb.
Path 2-2 = Upper fillet in shear + Groove weld in tension + Inner fillet in shear =
3450 + 15600 + 2220 = **21270** lb.
Path 3-3 = Upper fillet in shear + Inner fillet in shear + Groove weld in tension = 3450 + 2220 + 15600 = **21270** lb.

ASME Flange Design Information

Host	Description	Type	Size (in.)	Material	ASME Class	Material Group	MAP (PSI)
2"-300# RFSO, PUMP SU	NOZZLES N1A/N1B	Slip On	2	SA-105	300	1.1	680.00
2"-300# RFSO, RETURN L	NOZZLE N2	Slip On	2	SA-105	300	1.1	680.00
3"-300# RFSO, MIST ELI	NOZZLE N4	Slip On	3	SA-105	300	1.1	680.00
3"-300# RFSO, HEATER (	NOZZLE N10	Slip On	3	SA-105	300	1.1	680.00
6"-300# RFSO, INSPECTI	NOZZLE N9	Slip On	6	SA-105	300	1.1	680.00
2"-300# RFSO, BEARING	NOZZLE N11	Slip On	2	SA-105	300	1.1	680.00
THERMOWELL, 1 1/2"-600	NOZZLE N12	Slip On	1	SA-105	600	1.1	1360.00
DRAIN, 1 1/2"-300# RFS	NOZZLE N8	Slip On	1.5	SA-105	300	1.1	680.00
FILL PUMP, 1 1/2"-300#	NOZZLE N3	Slip On	0.75	SA-105	300	1.1	680.00
SRV, 1"-300# RFSO (N5)	NOZZLE N5	Slip On	1	SA-105	300	1.1	680.00
LEVEL SWITCH, 3/4"-300	NOZZLE N7B	Slip On	0.75	SA-105	300	1.1	680.00
LEVEL SWITCH, 3/4"-300	NOZZLE N7A	Slip On	0.75	SA-105	300	1.1	680.00
LEVEL GAUGE, 3/4"-300#	NOZZLE N6A	Slip On	0.75	SA-105	300	1.1	680.00
LEVEL GAUGE, 3/4"-300#	NOZZLE N6B	Slip On	0.75	SA-105	300	1.1	680.00

Loading Summary

Type	Starting Point (in.)	Ending Point (in.)	Depth (in.)	Density (lb./Ft^3)	Wind Diameter (in.)
Liquid	-	-	15.2500	62.4000	-

MDMT Report by Components

Design MDMT is -20 °F

Component	Material	Curve	Pressure	MDMT
SHELL, 28" O.D. x 56"L	SA-516 Gr. 70			Exempt per UG-20(f), 1-5
LEVEL SWITCH, 3/4"-300# RFSO (N7A)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
2"-300# RFSO, RETURN LINE (N2)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
LEVEL SWITCH, 3/4"-300# RFSO (N7B)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
DRAIN, 1 1/2"-300# RFSO (N8)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
LEVEL GAUGE, 3/4"-300# RFSO (N6A)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
LEVEL GAUGE, 3/4"-300# RFSO (N6B)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
SRV, 1"-300# RFSO (N5)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
FILL PUMP, 1 1/2"-300# RFSO (N3)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
2"-300# RFSO, PUMP SUCTION (N1A/N1B	SA-106 Gr. B			Exempt per UG-20(f), 1-5
3"-300# RFSO, MIST ELIMINATOR (N4)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
FRONT HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.	SA-516 Gr. 70			Exempt per UG-20(f), 1-5
THERMOWELL, 1 1/2"-600# RFSO (N12)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
2"-300# RFSO, BEARING DRAIN (N11)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
REAR HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.	SA-516 Gr. 70			Exempt per UG-20(f), 1-5
3"-300# RFSO, HEATER (N10)	SA-106 Gr. B			Exempt per UG-20(f), 1-5
6"-300# RFSO, INSPECTION (N9)	SA-106 Gr. B			Exempt per UG-20(f), 1-5

The required design MDMT of -20 °F has been met or exceeded for the calculated MDMT values.

ASME Flanges Are Not Included in MDMT Calculations.

MAWP Report by Components

Component	Design Pressure	Static Head	Vessel MAWP New & Cold UG-98(a)	Component MAWP Hot & Corroded UG-98(b)	Vessel MAWP Hot & Corroded UG-98(a)
SHELL, 28" O.D. x 56"L	650.00 PSI	0.55 PSI	866.25 PSI	795.38 PSI	795.38 PSI
2"-300# RFSO, PUMP SUCTION (N1A/	650.00 PSI	0.07 PSI	1094.89 PSI	1001.89 PSI	1001.82 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.07 PSI	739.93 PSI	680.00 PSI	679.93 PSI
2"-300# RFSO, RETURN LINE (N2)	650.00 PSI	0.00 PSI	1094.96 PSI	1001.89 PSI	1001.89 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.00 PSI	740.00 PSI	680.00 PSI	680.00 PSI
3"-300# RFSO, MIST ELIMINATOR (N4	650.00 PSI	0.00 PSI	866.25 PSI	795.38 PSI	795.38 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.00 PSI	740.00 PSI	680.00 PSI	680.00 PSI
DRAIN, 1 1/2"-300# RFSO (N8)	650.00 PSI	0.55 PSI	1094.41 PSI	1001.89 PSI	1001.34 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.55 PSI	739.45 PSI	680.00 PSI	679.45 PSI
FILL PUMP, 1 1/2"-300# RFSO (N3)	650.00 PSI	0.00 PSI	1094.96 PSI	1001.89 PSI	1001.89 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.00 PSI	740.00 PSI	680.00 PSI	680.00 PSI
SRV, 1"-300# RFSO (N5)	650.00 PSI	0.00 PSI	1094.96 PSI	1001.89 PSI	1001.89 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.00 PSI	740.00 PSI	680.00 PSI	680.00 PSI
LEVEL SWITCH, 3/4"-300# RFSO (N7A	650.00 PSI	0.00 PSI	1094.96 PSI	1001.89 PSI	1001.89 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.00 PSI	740.00 PSI	680.00 PSI	680.00 PSI
LEVEL SWITCH, 3/4"-300# RFSO (N7B	650.00 PSI	0.47 PSI	1094.49 PSI	1001.89 PSI	1001.42 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.47 PSI	739.53 PSI	680.00 PSI	679.53 PSI
LEVEL GAUGE, 3/4"-300# RFSO (N6A)	650.00 PSI	0.00 PSI	1094.96 PSI	1001.89 PSI	1001.89 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.00 PSI	740.00 PSI	680.00 PSI	680.00 PSI
LEVEL GAUGE, 3/4"-300# RFSO (N6B)	650.00 PSI	0.67 PSI	1094.29 PSI	1001.89 PSI	1001.22 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.67 PSI	739.33 PSI	680.00 PSI	679.33 PSI
FRONT HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.	0.00 PSI	0.55 PSI	978.32 PSI	890.82 PSI	890.27 PSI
2"-300# RFSO, BEARING DRAIN (N11)	650.00 PSI	0.00 PSI	1063.99 PSI	960.73 PSI	960.73 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.00 PSI	740.00 PSI	680.00 PSI	680.00 PSI
THERMOWELL, 1 1/2"-600# RFSO (N12	650.00 PSI	0.33 PSI	1063.66 PSI	960.73 PSI	960.40 PSI
ASME Flange Class: 600 Gr:1.1	650.00 PSI	0.33 PSI	1479.68 PSI	1360.00 PSI	1359.68 PSI
REAR HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.	50.00 PSI	0.55 PSI	951.16 PSI	839.66 PSI	839.66 PSI
3"-300# RFSO, HEATER (N10)	650.00 PSI	0.40 PSI	1007.53 PSI	854.43 PSI	854.03 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.00 PSI	740.00 PSI	680.00 PSI	680.00 PSI
6"-300# RFSO, INSPECTION (N9)	650.00 PSI	0.00 PSI	951.16 PSI	839.66 PSI	839.66 PSI
ASME Flange Class: 300 Gr:1.1	650.00 PSI	0.40 PSI	739.60 PSI	680.00 PSI	679.60 PSI

NC = Not Calculated Inc = Incomplete

Summary

Component with the lowest vessel MAWP(New & Cold) : **ASME Flange Class: 300 Gr:1.1**
The lowest vessel MAWP(New & Cold) : **739.33** PSI

Component with the lowest vessel MAWP(Hot & Corroded) : **ASME Flange Class: 300 Gr:1.1**
The lowest vessel MAWP(Hot & Corroded) : **679.33** PSI

Pressures are exclusive of any external loads.

Flange pressures listed here do not consider external loadings

Summary Information

	Dry Weight	Flooded Weight
Shell	1006.75 lb.	2123.89 lb.
Head	411.86 lb.	667.44 lb.
Nozzle	103.01 lb.	103.01 lb.
ASME Flange	114.00 lb.	114.00 lb.
MISC. INTERNALS	364.38 lb.	364.38 lb.
	0.00 lb.	0.00 lb.
	0.00 lb.	0.00 lb.
	0.00 lb.	0.00 lb.
	0.00 lb.	0.00 lb.
Totals	2000.00 lb.	3372.71 lb.

	Volume
Shell	133.72 Gal.
Head	30.64 Gal.
Nozzle	1.67 Gal.
	0.00 Gal.
	0.00 Gal.
Totals	166.04 Gal.

	Area
Shell	34.21 Sq. Ft.
Head	13.62 Sq. Ft.
Nozzle	4.27 Sq. Ft.
	0.00 Sq. Ft.
	0.00 Sq. Ft.
Totals	52.10 Sq. Ft.

South Gate Engineering, LLC

Customer: **L.A. TURBINE CORPORATION**
Job No: 12388

Vessel Number: HOT28-56U

Date Printed: 10/27/2016

Hydrostatic Test Information Par. UG-99(b)
Gauge at Top

Component	Const.	x	STest	/	SDesign	x	Pressure	=	Component Hydro Test Pressure
2"-300# RFSO, PUMP SU	1.3	x	17100	/	17100	x	650.00	=	**845.00**
2"-300# RFSO, BEARING	1.3	x	17100	/	17100	x	650.00	=	845.00
2"-300# RFSO, RETURN L	1.3	x	17100	/	17100	x	650.00	=	845.00
3"-300# RFSO, HEATER (	1.3	x	17100	/	17100	x	650.00	=	845.00
3"-300# RFSO, MIST ELI	1.3	x	17100	/	17100	x	650.00	=	845.00
6"-300# RFSO, INSPECTI	1.3	x	17100	/	17100	x	650.00	=	845.00
DRAIN, 1 1/2"-300# RFS	1.3	x	17100	/	17100	x	650.00	=	845.00
FILL PUMP, 1 1/2"-300#	1.3	x	17100	/	17100	x	650.00	=	845.00
FRONT HEAD, 28" O.D.,	1.3	x	20000	/	20000	x	650.00	=	845.00
LEVEL GAUGE, 3/4"-300#	1.3	x	17100	/	17100	x	650.00	=	845.00
LEVEL GAUGE, 3/4"-300#	1.3	x	17100	/	17100	x	650.00	=	845.00
LEVEL SWITCH, 3/4"-300	1.3	x	17100	/	17100	x	650.00	=	845.00
LEVEL SWITCH, 3/4"-300	1.3	x	17100	/	17100	x	650.00	=	845.00
REAR HEAD, 28" O.D., S	1.3	x	20000	/	20000	x	650.00	=	845.00
SHELL, 28" O.D. x 56"L	1.3	x	20000	/	20000	x	650.00	=	845.00
SRV, 1"-300# RFSO (N5)	1.3	x	17100	/	17100	x	650.00	=	845.00
THERMOWELL, 1 1/2"-600	1.3	x	17100	/	17100	x	650.00	=	845.00

Calculated Test Pressure: 845.00 PSI
Specified Test Pressure: 975.00 PSI

Special Notes:

This calculation assumes one chamber.

This calculation is limited by the lowest component pressure per chamber.

Table of Contents

SHELL, 28" O.D. x 56"L	1
FRONT HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.	2
REAR HEAD, 28" O.D., SEMI-ELLIP., 2" S.F.	4
2"-300# RFSO, PUMP SUCTION (N1A/N1B)	6
2"-300# RFSO, RETURN LINE (N2)	9
3"-300# RFSO, MIST ELIMINATOR (N4)	12
3"-300# RFSO, HEATER (N10)	18
6"-300# RFSO, INSPECTION (N9)	24
2"-300# RFSO, BEARING DRAIN (N11)	30
THERMOWELL, 1 1/2"-600# RFSO (N12)	33
DRAIN, 1 1/2"-300# RFSO (N8)	36
FILL PUMP, 1 1/2"-300# RFSO (N3)	39
SRV, 1"-300# RFSO (N5)	42
LEVEL SWITCH, 3/4"-300# RFSO (N7A)	45
LEVEL SWITCH, 3/4"-300# RFSO (N7B)	48
LEVEL GAUGE, 3/4"-300# RFSO (N6A)	51
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South Gate Engineering

JOB NO. 12388

SERIAL NO. 25372

CUSTOMER LA TURBINE

MATERIAL SCHEDULE

HEAD A MATERIAL: SA-516,70 THICKNESS: 3/4" HEAT NO: IWG

HEAD B MATERIAL: SA-516,70 THICKNESS: 3/4" HEAT NO: IWG

SHELL MATERIAL: SA-516,70 COURSES: 1 HEAT NO: 1. WGG570-E19

NOMINAL THICKNESS: 3/4" 2.

ACTUAL THICKNESS: 3.

4.

5.

ITEM: MATERIAL: THICKNESS:

HEAT NO.

ITEM: MATERIAL: THICKNESS:

HEAT NO.

ITEM: MATERIAL: THICKNESS:

HEAT NO.

ITEM: MATERIAL: THICKNESS:

HEAT NO.

Commercial Metal Forming

Commercial Metal Forming - O
341 West Collins Ave
Orange, CA 92867
PHONE: 714.532.6321
FAX:

PACKING LIST

SHIPMENT NO. 271960
PAGE NO. 2

SALES ORDER	CUSTOMER NO.	P.O. NUMBER	P.O. DATE	S.O. DATE	PLANT
973127	17248	0040508-00	10/27/16	10/27/16	OCW

SOLD TO: SOUTH GATE ENGINEERING*
13477 YORBA AVENUE
CHINO, CA 91710

SHIP DATE: 11/09/16
PREPAID&ALLOW-FOB DE
B/L NO. 233810

SHIP TO: SOUTH GATE ENGINEERING*
13477 YORBA AVE
CHINO, CA 91710
USA

MTR'S WITH SHIPMENT

ITEM	PART NO.	DESCRIPTION	REL	REQ DATE	DUE QTY	SHIP QTY
1	4790000170	4X6X1/4X1-5/8 H H SET NEO GKT HEAT: 1414704 SLAB: HEAT: 11H506 SLAB: 12386	1	11/04/16	1	1
1	4793251301	4X6X1/4 COVER WITH STUD 304 SS SA240-304L	1	11/04/16	0	1
1	479457304L	4 X 6 X 1/4 X 1-5/8 RING 304L	1	11/04/16	0	1
1	4793253000	3X4&4X6 X 3/16 STAINLESS YOKE	1	11/04/16	0	1
1	4793090000	4 X 6 X 3/16 NEOPRENE GASKET	1	11/04/16	0	1
~~1~~	~~4792890000~~	~~3/4 STAINLESS 18-8 HEX NUT~~	~~1~~	~~11/04/16~~	~~0~~	~~1~~
4	8392702800750	28"OD X .75"NOM SE 2:1 SA516-70 NORM 2 SF OSB 30 DEG 1/16"LAND SA516-70 NORM MTRS 222# (.6563"MIN) 12388 HEAT: IWG=B6H530 SLAB: B37	1	11/11/16	2	2

25372

8 5/8"

HOT FORMED

COMMERCIAL METAL FORMING
341 W. COLLINS AVENUE
ORANGE, CA 92867
PHONE (714) 532-6321 FAX (714) 532-4126

Date: 11/9/16

SOLD TO
SOUTH GATE ENGINEERING 13477 YORBA AVE CHINO CA 91710
DESCRIPTION
28"OD X .75"NOM SE 2:1 2"SF OSB 30 DEG 1/16"LAND (.6563"MIN)
MATERIAL GRADE
SA516-70

SHIP TO
P.O. NO.
0040508-00
CMF JOB #
973127

ITEM	CODE NO.	QTY.	NOM THK	PRODUCING MILL	HEAT NO.	SLAB/PIECE	MATERIAL GRADE
	IWG		.75"		B6H530	B37	SA516-70

MILL TEST REPORTS ATTACHED

The chemical and physical properties as indicated on the attached report(s) are the results of the Mill Tests of the raw material used in the manufacture of these products and are certified to meet the minimum requirements of the ASME and/or ASTM specifications for this material.

☐ Heads were heat treated. ☒ Heads were not heat treated

☒ Heated to temperature between 1650°F & 1700°F and formed above 1200°F. Cooled in still air.

☒ Heads were hot formed at the required normalizing temperature and cooled in still air.

☐ Heads were cold formed in compliance with the ASME Boiler and Pressure Vessel Code, Section VIII, Div.1, paragraph UG-79.

☐ Heads were heat-treated in accordance with the applicable requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Div. 1.

☐ Heads comply with requirements of ASME Section VIII, Div. 1, paragraph UCS-79 (d) for carbon steel materials.

☐ Heads comply with requirements of ASME Section VIII, Div. 1, paragraph UHA-44 for stainless steel materials.

☐ Heads comply with requirements of ASME Section VIII, Div. 1, paragraph UNF-79 (a) for non-ferrous materials.

☐ Heads comply with requirements of ASME Section VIII, Div. 1, paragraph UHT-79 (a)(1) for ferritic steels with tensile properties enhanced by heat treatment.

☒ Heads comply with tolerances of UG-81 of ASME Section VIII, Div. 1.

☐ Other _____

WE HEREBY CERTIFY THAT THIS REPORT COVERING THE ABOVE AND ATTACHED INFORMATION IS TRUE AND CORRECT AS SHOWN AND CONTAINED IN OUR RECORDS.

Miguel Ramos
QUALITY CONTROL

11/9/16
DATE

SA516-70

3/4"

B6H530-B37

L634697

SSAB

Test Certificate

Form TC1: Revision 2: Date 23 Apr 2014

1770 Bill Sharp Boulevard, Muscatine, IA 52761-9412, US

Customer:
SAMUEL, SON & CO INC
6415 E CORVETTE STREET

LOS ANGELES
CA 90040

Customer P.O.No.:042S-7232863 | Mill Order No. 41-475248-10 | Shipping Manifest: MR293736

Product Description: ASTM A516-70(10/15)/ASME SA516-70(15) ✓✓
AS-ROLLED, TENSILE COUPON NORMALIZED
1650F+/-25F/1HR/"

Ship Date: 09 Aug 16
Cert Date: 09 Aug 16

Cert No: 061595429
(Page 1 of 1)

Size: 0.750 X 120.0 X 480.0 (IN)

Tested Pieces:				Tensiles:					Hardness	Charpy Impact Tests							
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir		Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
B6H530 ✓	B37 ✓	0.749 (DISCRT)	L	58 ✓	83 ✓		32 ✓	T							
B6H530 ✓	B37* ✓	0.749 (DISCRT)	L	53 ✓	81 ✓		34 ✓	T							

Chemical Analysis

Heat Id	C ✓	Mn ✓	P ✓	S ✓	Si ✓	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	ORGN
B6H530 ✓	.22	1.15	.013	.001	.22	.023	.022	.31	.20	.11	.04	.002	.006	.006	.0003	USA

KILLED STEEL
MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT.
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
RESULTS OF TESTS PERFORMED ON NORMALIZED TEST COUPONS ARE LABELED ABOVE WITH *
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
✓ 100% MELTED AND MANUFACTURED IN THE USA.
WELD REPAIRING HAS NOT BEEN PERFORMED ✓
PRODUCTS SHIPPED:
IWG B6H530 B37 ✓ PCES: 1, LBS: 12252

REVIEWED AND MEETS
MATERIAL REQUIREMENTS
PER 2015 ASME CODE
LATEST ADDENDA
gs. 11.11.16

APPROVED
ASME SEC. II
2015 Ed. ____ Ad.
CMF

P062849 08/26/16 KAW

(P) Cust Part #: 1344089

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION

Brian Wales
SENIOR METALLURGIST - PRODUCT

PO. 39940 · 3/4". THK 96"X480". SA · 516 · 70 HN · W6G570 E19

SSAB

Test Certificate

Form TC1: Revision 2: Date 23 Apr 2014

12400 Highway 43 North, Axis, Alabama 36505, US

Customer:
KLOECKNER METALS CORPORATION
500 COLONIAL CENTER PARKWAY
SUITE 500
ROSWELL
GA 30076

Customer P.O.No.: 7064174 | **Mill Order No.** 41-473520-02 | **Shipping Manifest:** AR228813

Product Description: ASTM A516-70(10/15)/ASME SA516-70(15) ✓
A573-70(13), 0.20% MAX CARBON

Ship Date: 18 Jul 16 | **Cert No:** 081568758
Cert Date: 18 Jul 16 | (Page 1 of 1)

Size: 0.750 X 96.00 X 480.0 (IN)

Tested Pieces:				Tensiles:					Hardness	Charpy Impact Tests								
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir		Abs. Energy(FTLB) 1 2 3 Avg				% Shear 1 2 3 Avg				Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
W6G570 ✓	E19 ✓	0.748 (DISCRT)	L	51 ✓	74 ✓		25	T													

Chemical Analysis																	
Heat Id	C ✓	Mn ✓	P ✓	S ✓	Si ✓	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B		ORGN
W6G570	.18	.97	.014	.002	.22	.024	.023	.28	.18	.13	.06	.000	.006	.009	.0001		USA

KILLED STEEL
MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT.
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA. ✓
PRODUCTS SHIPPED:
W6G570 E19 PCES: 1, LBS: 9801

REVIEWED AND MEETS MATERIAL REQUIREMENTS PER 2015 ASME CODE LATEST ADDENDA
gs. 11-8-16

(P) Cust Part #: SLT

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION

Justin Ward
SENIOR METALLURGIST - PRODUCT

10-21-2016 13:56 South Gate Engr Inc. Load - 2651757 BL - 20308905
Cust. PO - 0039940-00 Heat - W6G570 blr466
Order-Line - 14249079 / 2

P.O. 38605 3/8" x 96" x 380" SA-516-70 HN-A5L248-0343 (2pc)

SSAB

Test Certificate

Form TC1: Revision 2: Date 23 Apr 2014

1770 Bill Sharp Boulevard, Muscatine, IA 52761-9412, US

Customer:	Customer P.O.No.: 6993201	Mill Order No. 41-450487-02	Shipping Manifest: MR275105
KLOECKNER METALS CORPORATION 500 COLONIAL CENTER PARKWAY SUITE 500 ROSWELL GA 30076	Product Description: ASTM A516-70(10/15)/ASME SA516-70(15) ✓ A573-70(13), 0.20% MAX CARBON 60 KSI MAX YS; COIL FOR CONV'N TO PLATE	Ship Date: 30 Dec 15 Cert Date: 30 Dec 15	Cert No: 061553167 (Page 1 of 1)
	Size: 0.375(NOM) X 96.00 X COIL (IN)		

Tested Pieces:				Tensiles:						Charpy Impact Tests							
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir	Hardness	Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
A5L248	0343	0.374		51	76		32	T							

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	ORGN
A5L248	.19	1.05	.010	.002	.24	.030	.027	.31	.11	.07	.03	.002	.006	.006	.0006	USA

KILLED STEEL
MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT.
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
HOT-ROLLED COIL INTENDED FOR CONVERSION TO GRADE. CERTIFIED TO CHEMISTRY ONLY.
COIL END PHYSICAL TEST RESULTS, IF REPORTED, ARE FOR INFORMATION ONLY.
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA.
PRODUCTS SHIPPED:
A5L248 0343 PCES: 1, LBS: 45120
ALSO MEETS ASTM A516-60(10/15)/ASME SA516-60(15). REV 5/3/2016CSV

REVIEWED AND MEETS MATERIAL REQUIREMENTS PER 2015 ASME CODE LATEST ADDENDA
GS 6-2-16

(P) Cust Part #:

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION

Brian Wales
SENIOR METALLURGIST - PRODUCT

06-02-2016 03:50 Load - 2550900 BL - 20301465
South Gate Engr Inc. Heat - A5L248 blr466
Cust. PO - 0038605-00 Order-Line - 13770543 / 1

kloeckner metals

Kloeckner Metals Corporation

Material Certification

imr060

Printed: June 02, 2016

Certification Date: January 14, 2016

Heat Number: A5L248

Mill Coil/Slab ID: A5L2480343

Mill: 4578 - SSAB - MONTPELIER

Grade: %

Sample Size Thick .375 Width Length

	Value	Test 1 (Head)	Test 2 (Middle)	Test 3 (Tail)
YIELD	51 KSI	57370	49650	61700
TENSILE	76 KSI	72350	74000	82150
ELONG	32	33.5	37.9	31.9
ELONG-IN		2	2	2

Charpy

Sample Size			
Ft Lbs 1			
Ft Lbs 2			
Ft Lbs 3			
Ft Lbs Avg			

Chemical Properties

C	Mn	P	S	Si	Al	B	Cb	Cr
0.19000	1.05000	0.01000	0.00200	0.24000	0.03000	0.00060	0.00200	0.07000

Cu	Mo	Ni	Ti	V
0.31000	0.03000	0.11000	0.00600	0.00600

Cert Comment

GR70 - ASTM - A516 - 70 / ASME SA516 - 70

PO. 37579 3/16 THK @ 96"x227" SA-516.70/1455
HN · E6A136 · E10

SSAB

Preliminary Test Certificate

12400 Highway 43 North, Axis, Alabama 36505, US

Official copy to follow

Form TC1: Revision 2: Date 23 Apr 2014

Customer:
SAMUEL, SON & CO INC
6415 E CORVETTE STREET

LOS ANGELES
CA 90040

Customer P.O.No.:042S-7200982 | Mill Order No. 41-453385-01 | Shipping Manifest: AR218912

Product Description: ASTM A516-70(10/15)/A455(12); ASME(15) ✓
SA516-70/SA455; AS-ROLLED, TENSILE
COUPON NORMALIZED 1650 F+/-25F/1HR/*
✓

Ship Date: 31 Jan 16
Cert Date: 31 Jan 16

Cert No: 081540832
(Page 1 of 1)

Size: 0.188 X 96.00 X 227.0 (IN)

Tested Pieces:				Tensiles:					Hardness	Charpy Impact Tests						
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2In 8in	Tst Dir		Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
E6A023	B44	0.184 (DISCRT)	L	65	86		21	T							
E6A023	B44*	0.184 (DISCRT)	L	60	84		21	T							
E6A136 ✓	E10 ✓	0.184 (DISCRT)	L	65 ✓	84 ✓		21 ✓	T							
E6A136	E10*	0.184 (DISCRT)	L	63	81		23	T							

Heat Id	Chemical Analysis C ✓	Mn ✓	P ✓	S ✓	Si ✓	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	
E6A023	.16	1.34	.006	<.001	.22	.028	.027	.19	.10	.07	.05	.017	.004	.007	.0001	ORGN
E6A136 ✓	.15	1.28	.008	.001	.22	.029	.027	.17	.08	.09	.06	.018	.004	.008	.0001	USA
																USA

KILLED STEEL
MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT.
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
RESULTS OF TESTS PERFORMED ON NORMALIZED TEST COUPONS ARE LABELED ABOVE WITH *
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA. ✓
PRODUCTS SHIPPED:
E6A136 E10 PCES: 17, LBS: 19754 E6A023 B44 PCES: 1, LBS: 1162

REVIEWED AND MEETS
MATERIAL REQUIREMENTS
PER 2015 ASME CODE
LATEST ADDENDA
98 - 2-26-16

(P) Cust Part #: 1344005

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION

SENIOR METALLURGIST - PRODUCT

PO·349773 6"- SCH·80 SMLS PIPE SA·106,B
HT·8835

Tenaris

INSPECTION CERTIFICATE 3.1.B
CERTIFICADO DE INSPECCIÓN 3.1.B
API 5L 8.13.2-EN 10204 3.1: 2004-DIN 50049 3.1B

Number / Número:	Page / Página:
14057953	1 / 8

Date / Día: October 28, 2014

Tubos de Acero de México, S.A.
Carret. México Veracruz KM 433.7 SN
Delfino Valenzuela Tejería, Veracruz, Veracruz
C.P. 91697 MEXICO
(52) 229 989 1100 tel
(52) 229 989 1600 fax

Customer / Cliente: DNOW L.P	Customer's Order Item / Orden Cliente - Item: 25301140 ITEM 3	Customer's Reference / Ref. del Cliente: N/A	Manufacturer's Works Order N° / Confirmación de Venta: 221830/03
Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED / LAMINADO EN CALIENTE SIN COSTURA	Product Type / Tipo de Producto: LINE PIPE SEAMLESS / CONDUCCION SIN COSTURA		Surface / Superficie: VARNISHED / BARNIZADO
Standard or Specification / Normas o Especificaciones: API 5L ED45/DECEMBER 2012, ASTM A106/14, ASTM A53/12, ASME SA106/2013, ASME SA53/2013		Steel Grade / Grado de acero: BR-L245R/X42R-L290R/C PSL2	Ends / Extremos: NORMAL BEVEL / BISELADO NORMAL

Dimensions / Dimensiones:	Schedule / Cédula:	Length / Longitud:	Quantity / Cantidad: 183 Pcs/Pz		Nominal Weight / Peso Nominal:
6.625 X 0.432 INCH	SCH 080 / W.C XS	35.01 / 38.98 FT	7020.538 FT	201738.567 LB	28.60 LB/FT
168.3 X 11 MM		10.67 / 11.88 MTS	2139.860 MTS	91507.000 KG	42.56 KG/M

TENSILE TEST / ENSAYO DE TENSION

Heat N° / Colada N°	Sample N° / Muestra N°	Zone / Zona	Specimen condition / Condición de la probeta: Ls	Sc	Type / Tipo	Ori	Specimen dimensions / Dimensiones de la probeta: Size / Tamaño (mm)	Area / Sección (mm2)	Test temp / Temp. ensayo (°C)	Y.S. Eul 0.50 %. Min: 42 100 Max: 65 300 (psi)	U.T.S. Req. Min: 70 000 Max: 95 000 (psi)	Y.S./U.T.S Req. Max. 0.93	Elongation / Alargamiento: Lo (in)	Min. (%)	Obt. (%)
8835	81789	E2	B	AM	Ss	L	25.72 X 11.07	284,72	RT	45 741	73 391	0.62	2	23.1	39.0
8925	95578	E2	B	AM	Ss	L	25.43 X 11.29	287,10	RT	46 225	74 386	0.62	2	23.1	44.0
8925	95579	E2	B	AM	Ss	L	25.64 X 11.06	283,58	RT	46 154	74 728	0.62	2	23.1	43.0

AM: As manufactured / Según proceso de fabricación
B: Body / Cuerpo
E1 / E2: Ends of Sampling / Extremos de Muestra
L: Longitudinal / Longitudinal
Lo: Initial length / Longitud inicial
Ls: Location of sample / Ubicación de la muestra
Max: Maximum / Máximo
Min: Minimum / Mínimo
Obt: Obtained / Obtenido
Ori: Orientation / Orientación
Req. Max: Required maximum / Máximo requerido
Req: Required / Requerido
RT: Room temperature / Temperatura ambiente
Sc: Specimen condition / Condición de la probeta
Ss: Strip specimen / Muestra rectangular
U.T.S: Ultimate tensile strength / Resistencia
Y.S: Yield strength / Fluencia

REVIEWED AND MEETS
MATERIAL REQUIREMENTS
PER 2013 ASME CODE
LATEST ADDENDA
98 · 4·25-15

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trade-mark green colored "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use. Any alteration and/or falsification will be subjected to the law.

Este certificado se emite mediante sistema computarizado y es validado con firma electrónica. El certificado original posee impreso el logo Tenaris color verde. En caso de que el poseedor del certificado entregue una copia, deberá garantizar la conformidad con el original haciéndose responsable por cualquier uso ilegal o indebido. Cualquier alteración y/o falsificación estará sujeta a la ley.

Tenaris

INSPECTION CERTIFICATE 3.1.B
CERTIFICADO DE INSPECCIÓN 3.1.B
API 5L 8.13.2-EN 10204 3.1: 2004-DIN 50049 3.1B

Number / Número: **14057953** | Page / Página: **2 / 8**

Date / Día: **October 28, 2014**

Tubos de Acero de México, S.A.
Carret. México Veracruz KM 433.7 SN
Delfino Valenzuela Tejería, Veracruz, Veracruz
C.P. 91697 MEXICO
(52) 229 989 1100 tel
(52) 229 989 1600 fax

Customer / Cliente:	Customer's Order Item / Orden Cliente - Item:	Customer's Reference / Ref. del Cliente:	Manufacturer's Works Order N° / Confirmación de Venta:
DNOW L.P	25301140 ITEM 3	N/A	221830/03

Manufacturing Process / Proceso de Manufactura:	Product Type / Tipo de Producto:	Surface / Superficie:
SEAMLESS HOT ROLLED LAMINADO EN CALIENTE SIN COSTURA	LINE PIPE SEAMLESS CONDUCCION SIN COSTURA	VARNISHED BARNIZADO

Standard or Specification / Normas o Especificaciones:	Steel Grade / Grado de acero:	Ends / Extremos:
API 5L ED45/DECEMBER 2012, ASTM A106/14, ASTM A53/12, ASME SA106/2013, ASME SA53/2013	BR-L245R/X42R-L290R/C PSL2	NORMAL BEVEL BISELADO NORMAL

Dimensions / Dimensiones:	Schedule / Cédula:	Length / Longitud:	Quantity / Cantidad: 183 Pcs/Pz		Nominal Weight / Peso Nominal:
6.625 X 0.432 INCH 168.3 X 11 MM	SCH 080 / W.C XS	35.01 / 38.98 FT 10.67 / 11.88 MTS	7020.538 FT 2139.860 MTS	201738.567 LB 91507.000 KG	28.60 LB/FT 42.56 KG/M

CHEMICAL COMPOSITION / COMPOSICION QUIMICA

			Composition % / Composición %																				
			X 100					X 1000									X 10000			X 100		
			C	Mn	Si	Mo	Cr	P	S	V	Nb	Ni	Cu	Sn	Al	Ti	As	B	Ca	N	Ce. 1	Col. 1	Col. 2
		H Max	24	106	40	15	30	25	15	70	20	300	400	–	–	40	–	–	–	–	43	100	10
		Min	–	29	10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Heat N°	Sample N°	P Max	24	106	40	15	30	25	15	70	20	300	400	–	–	40	–	–	–	–	43	100	10
Colada N°	Muestra N°	Min	–	29	10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8835	00001	H	21	94	21	0.4	2	6	2	2	1	20	65	5	20	2	2	2	12	52	38	11.1	0.3
8835	81789	P	21	88	18	0.8	2	6	2.4	0	0	20	54	4	20	0	1	0	6	49	37	10.2	0
8835	81790	P	21	88	18	0.8	2	6	2.3	0	0	20	55	4	21	0	1	0	7	48	37	10.3	0
8925	00001	H	21	92	21	0.3	2	6	2	1	1	10	38	3	20	1	1	1	13	67	37	7.2	0.2
8925	95578	P	20	88	19	0.7	2	6	2.3	0	0	20	33	3	23	1	1	0	8	70	36	8	0
8925	95579	P	20	87	19	0.7	2	6	2.2	0	0	20	33	3	22	0	1	0	7	67	35	8	0

Ce. 1: Carbon equivalent/Carbono equivalente
Col. 1: SUMA Mo+Cr+Ni+Cu+V
Col. 2: SUMA Nb+V
H: Heat / Colada
Max: Maximum / Máximo
Min: Minimum / Mínimo
P: Product / Producto

THROUGH WALL HARDNESS / DUREZA EN EL ESPESOR

Required values / Valores requeridos	Individuals / Individuales			Average / Promedio			Hardness type/Tipo de dureza:HRC																
	Min: –	Max: 22.0	Var: –	Min: –	Max: –	Var: –																	
Heat N° / Colada N°	Sample N° / Muestra N°	Zone / Zona	Specimen condition			Quad.	Scale / Escala	OD				MW				ID				Var.
			Ls		Sc			1	2	3	Avg.	1	2	3	Avg.	1	2	3	Avg.	
8835	81789	E2	B		AM	1	HRBW	76.4	77.2	76.6	76.7	76.7	77.6	77.1	77.1	76.9	76.6	77.2	76.9	0.4

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INSPECTION CERTIFICATE 3.1.B
CERTIFICADO DE INSPECCIÓN 3.1.B
API 5L 8.13.2-EN 10204 3.1: 2004-DIN 50049 3.1B

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Date / Día: October 28, 2014

Tubos de Acero de México, S.A.
Carret. México Veracruz KM 433.7 SN
Delfino Valenzuela Tejería, Veracruz, Veracruz
C.P. 91897 MEXICO
(52) 229 989 1100 tel
(52) 229 989 1600 fax

Customer / Cliente: DNOW L.P	Customer's Order Item / Orden Cliente - Item: 25301140 ITEM 3	Customer's Reference / Ref. del Cliente: N/A	Manufacturer's Works Order N° / Confirmación de Venta: 221830/03
Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED / LAMINADO EN CALIENTE SIN COSTURA	Product Type / Tipo de Producto: LINE PIPE SEAMLESS / CONDUCCION SIN COSTURA		Surface / Superficie: VARNISHED / BARNIZADO
Standard or Specification / Normas o Especificaciones: API 5L ED45/DECEMBER 2012, ASTM A106/14, ASTM A53/12, ASME SA106/2013, ASME SA53/2013	Steel Grade / Grado de acero: BR-L245R/X42R-L290R/C PSL2		Ends / Extremos: NORMAL BEVEL / BISELADO NORMAL

Dimensions / Dimensiones:	Schedule / Cédula:	Length / Longitud:	Quantity / Cantidad: 183 Pcs/Pz		Nominal Weight / Peso Nominal:
6.625 X 0.432 INCH	SCH 080 / W.C XS	35.01 / 38.98 FT	7020.538 FT	201738.567 LB	28.60 LB/FT
168.3 X 11 MM		10.67 / 11.88 MTS	2139.860 MTS	91507.000 KG	42.56 KG/M

THROUGH WALL HARDNESS / DUREZA EN EL ESPESOR

Required values / Valores requeridos	Individuals / Individuales			Average / Promedio			Hardness type/Tipo de dureza:HRC													
	Min: –	Max: 22.0	Var: –	Min: –	Max: –	Var: –														
Heat N° / Colada N°	Sample N° / Muestra N°	Zone / Zona	Specimen condition Ls	Sc	Quad.	Scale / Escala	OD 1	OD 2	OD 3	OD Avg.	MW 1	MW 2	MW 3	MW Avg.	ID 1	ID 2	ID 3	ID Avg.	Var.
8835	81790	E2	B	AM	1	HRBW	77.3	77.1	77.3	77.2	77.3	77.2	77.5	77.3	77.5	77.1	77.5	77.4	0.2
8925	95578	E2	B	AM	1	HRBW	75.5	76.7	76.9	76.4	78.5	79.2	78.1	78.6	78.1	79.8	80.4	79.4	3.0
8925	95579	E2	B	AM	1	HRBW	73.9	75.5	75.3	74.9	78.2	78.5	78.5	78.4	78.8	80.7	79.3	79.6	4.7

AM: As manufactured / Según proceso de fabricación
Avg: Average / Promedio
B: Body / Cuerpo
E1 / E2: Ends of Sampling / Extremos de Muestra
ID: Internal diameter / Diámetro interno
Ls: Location of sample / Ubicación de la muestra
Max: Maximum / Máximo
Min: Minimum / Mínimo
MW: Middle wall / Centro
OD: Outside diameter / Diámetro externo
Quad: Quadrant / Cuadrante
Sc: Specimen condition / Condición de la probeta
Var: Variation / Variación

IMPACT TEST / ENSAYO DE IMPACTO

Type/Tipo: CHARPY V	Orientation/Orientación: T			Unit / Unidad: ft.lb				Shear area / Área dúctil %			
Position/Posición: N/A	Temp: 0		Unit/Unidad: °C	Ind.Min.Req: 11		Req.Min.Avg: 15		Ind.Min.Req: –		Req.Min.Avg: –	
Heat N° / Colada N°	Sample N° / Muestra N°	Zone / Zona	Ls	Sc	T.T °C	Size / Tamaño mm	Results / Resultados 1	2	3	Avg.	Results / Resultados 1	2	3	Avg.
8835	81789	E2	B	AM	0	10 x 7.5	65	70	71	69	60	60	60	60
8925	95578	E2	B	AM	0	10 x 7.5	46	67	54	56	40	60	40	46.7
8925	95579	E2	B	AM	0	10 x 7.5	53	68	46	56	40	50	40	43.3

AM: As manufactured / Según proceso de fabricación
Ind. Min. Req: Individual Minimum Required /
Ls: Location of sample / Ubicación de la muestra
T.T: Test temperature / Temperatura de ensayo

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Manufacturing Process / Proceso de Manufactura:	Product Type / Tipo de Producto:	Surface / Superficie:
SEAMLESS HOT ROLLED LAMINADO EN CALIENTE SIN COSTURA	LINE PIPE SEAMLESS CONDUCCION SIN COSTURA	VARNISHED BARNIZADO

Standard or Specification / Normas o Especificaciones:	Steel Grade / Grado de acero:	Ends / Extremos:
API 5L ED45/DECEMBER 2012, ASTM A106/14, ASTM A53/12, ASME SA106/2013, ASME SA53/2013	BR-L245R/X42R-L290R/C PSL2	NORMAL BEVEL BISELADO NORMAL

Dimensions / Dimensiones:	Schedule / Cédula:	Length / Longitud:	Quantity / Cantidad: 183 Pcs/Pz		Nominal Weight / Peso Nominal:
6.625 X 0.432 INCH 168.3 X 11 MM	SCH 080 / W.C XS	35.01 / 38.98 FT 10.67 / 11.88 MTS	7020.538 FT 2139.860 MTS	201738.567 LB 91507.000 KG	28.60 LB/FT 42.56 KG/M

IMPACT TEST / ENSAYO DE IMPACTO

Avg: Average / Promedio	Requerido Mínimo Individual	Req. Min. Avg: Required minimum average / Promedio	T: Transversal / Transversal
B: Body / Cuerpo	Ind. Min. Req: Individual Minimum Required /	mínimo requerido	Temp: Temperature / Temperatura
E1 / E2: Ends of Sampling / Extremos de Muestra	Requerido Mínimo Individual	Sc: Specimen condition / Condición de la probeta	

FLATTENING TEST / ENSAYO DE APLASTAMIENTO

Standard / Norma:

Heat N° / Colada N°	Sample N° / Muestra N°	Zone / Zona	Result / Resultado
8835	81789	E2	Good / Bueno

Standard / Norma:

Heat N° / Colada N°	Sample N° / Muestra N°	Zone / Zona	Result / Resultado
8835	81790	E2	Good / Bueno

Standard / Norma:

Heat N° / Colada N°	Sample N° / Muestra N°	Zone / Zona	Result / Resultado
8925	95578	E2	Good / Bueno

Standard / Norma:

Heat N° / Colada N°	Sample N° / Muestra N°	Zone / Zona	Result / Resultado
8925	95579	E2	Good / Bueno

E1 / E2: Ends of Sampling / Extremos de Muestra

HYDROSTATIC TEST / PRUEBA HIDRAULICA

Pressure / Presión		Time / Tiempo	Results / Resultado
Unit / Unidad	Value / Valor	Seconds / Segundos	
psi	2,970	5	Satisfactory / Satisfactorio

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Customer / Cliente:	Customer's Order Item / Orden Cliente - Item:	Customer's Reference / Ref. del Cliente:	Manufacturer's Works Order N° / Confirmación de Venta:
ONOW L.P	25301140 ITEM 3	N/A	221830/03

Manufacturing Process / Proceso de Manufactura:	Product Type / Tipo de Producto:	Surface / Superficie:
SEAMLESS HOT ROLLED LAMINADO EN CALIENTE SIN COSTURA	LINE PIPE SEAMLESS CONDUCCION SIN COSTURA	VARNISHED BARNIZADO

Standard or Specification / Normas o Especificaciones:	Steel Grade / Grado de acero:	Ends / Extremos:
API 5L ED45/DECEMBER 2012, ASTM A106/14, ASTM A53/12, ASME SA106/2013, ASME SA53/2013	BR-L245R/X42R-L290R/C PSL2	NORMAL BEVEL BISELADO NORMAL

Dimensions / Dimensiones:	Schedule / Cédula:	Length / Longitud:	Quantity / Cantidad: 183 Pcs/Pz		Nominal Weight / Peso Nominal:
6.625 X 0.432 INCH 168.3 X 11 MM	SCH 080 / W.C XS	35.01 / 38.98 FT 10.67 / 11.88 MTS	7020.538 FT 2139.860 MTS	201738.567 LB 91507.000 KG	28.60 LB/FT 42.56 KG/M

HEAT TREATMENT / TRATAMIENTO TERMICO

Heat treatment / Tratamiento térmico: Pipe / Tubo
Quench media of heat treatment process / Medio de enfriamiento del tratamiento térmico: n/a
Temperature Scale / Escala de Temperatura: n/a

Type Tipo
asrolled

SUPPLEMENTARY INFORMATION / INFORMACIÓN SUPLEMENTARIA

Supplementary Information Información Suplementaria	
Manufactured by TenarisTamsa	Fabricado por TenarisTamsa
Steel making process:	Fabricación del acero:
Electric Arc Furnace-Ladle Furnace-Continuous Casting Machine.	Horno de Arco Eléctrico-Horno de Afinación-Máquina de Colada Continua.
Fully Killed Steel	Acero calmado con aluminio
Material free from Mercury contamination	Material libre de contaminación de Mercurio
Not repaired by welding	No reparado por soldadura
Non destructive test. Satisfactory	Control no destructivo. Satisfactorio
Inspection method	Método de inspección
. - EMI - FLVI - MPI -	. - EMI - FLVI - MPI -
ASTM A106/14, ASTM A53/12, ASME SA106/2013, ASME SA53/2013	ASTM A106/14, ASTM A53/12, ASME SA106/2013, ASME SA53/2013
MATERIAL ACCORDING TO NACE MR0175 / ISO 15156-2, 2009 AND NACE MR0103, 2010 ONLY FOR HARDNESS 22 HRC MAX.	MATERIAL DE ACUERDO A NACE MR0175 / ISO 15156-2, 2009 Y NACE MR0103, 2010 SOLO DUREZA MAX. 22 HRC
SUM Mo+Cr+Ni+Cu+V MAX 1	SUM Mo+Cr+Ni+Cu+V MAX 1

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Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED LAMINADO EN CALIENTE SIN COSTURA	Product Type / Tipo de Producto: LINE PIPE SEAMLESS CONDUCCION SIN COSTURA		Surface / Superficie: VARNISHED BARNIZADO
Standard or Specification / Normas o Especificaciones: API 5L ED45/DECEMBER 2012, ASTM A106/14, ASTM A53/12, ASME SA106/2013, ASME SA53/2013	Steel Grade / Grado de acero: BR-L245R/X42R-L290R/C PSL2		Ends / Extremos: NORMAL BEVEL BISELADO NORMAL

Dimensions / Dimensiones:	Schedule / Cédula:	Length / Longitud:	Quantity / Cantidad: 183 Pcs/Pz		Nominal Weight / Peso Nominal:
6.625 X 0.432 INCH	SCH 080 / W.C XS	35.01 / 38.98 FT	7020.538 FT	201738.567 LB	28.60 LB/FT
168.3 X 11 MM		10.67 / 11.88 MTS	2139.860 MTS	91507.000 KG	42.56 KG/M

SUPPLEMENTARY INFORMATION / INFORMACION SUPLEMENTARIA

Supplementary Information Información Suplementaria	
SUM Nb+V MAX 0.1	SUM Nb+V MAX 0.1
NO WELD REPAIR & MERCURY FREE	NO WELD REPAIR & MERCURY FREE
CERTIFICATE ACCORDING TO API 5L 8.13.2	CERTIFICADO DE ACUERDO A API 5L 8.13.2
CERTIFICATE ACCORDING TO EN 10204 3.1: 2004	CERTIFICADO DE ACUERDO A EN 10204 3.1: 2004
CERTIFICATE ACCORDING TO DIN 50049 3.1B/1992	CERTIFICADO DE ACUERDO A DIN 50049 3.1B/1992
COUNTRY OF MELT: Mexico	ORIGEN DE LAS COLADAS: México

MARKING / MARCACION

Marking Marcación	
PIPE STENCIL:	MASCARILLA DE TUBO ESTARCIDO:
#T***** TENARIS TM SPEC 5L-0103 ? #FE1 ASTM A53/A106 ASME SA53/SA106 6.625 0.432 XS SCH 080	#T***** TENARIS TM SPEC 5L-0103 ? #FE1 ASTM A53/A106 ASME SA53/SA106 6.625 0.432 XS SCH 080
BR-L245R/X42R-L290R/C PSL2 S SMLS CE TEST PRESSURE/NDE #P*** FT #L**** LBS HEAT #C***** O.P	BR-L245R/X42R-L290R/C PSL2 S SMLS CE TEST PRESSURE/NDE #P*** FT #L**** LBS HEAT #C***** O.P
248547 / #T***** HABILITADA MADE IN MEXICO	248547 / #T***** HABILITADA MADE IN MEXICO
WHERE :	DONDE :
Heat number #C*****:	Numero de colada #C*****:
Manufacturing Date #FE1:	Fecha de Fabricación #FE1:
Net weight of pipe in Lbs #L*****:	Net weight of pipe in Lbs #L*****:
Pipe length in Fts #P****:	Longitud de tubo en Fts #P****:
Total Traceability Number #T******:	Num. de Rastreab. Total #T******:

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API 5L 8.13.2-EN 10204 3.1: 2004-DIN 50049 3.1B

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Manufacturing Process / Proceso de Manufactura: SEAMLESS HOT ROLLED / LAMINADO EN CALIENTE SIN COSTURA	Product Type / Tipo de Producto: LINE PIPE SEAMLESS / CONDUCCION SIN COSTURA		Surface / Superficie: VARNISHED / BARNIZADO
Standard or Specification / Normas o Especificaciones: API 5L ED45/DECEMBER 2012, ASTM A106/14, ASTM A53/12, ASME SA106/2013, ASME SA53/2013		Steel Grade / Grado de acero: BR-L245R/X42R-L290R/C PSL2	Ends / Extremos: NORMAL BEVEL / BISELADO NORMAL

Dimensions / Dimensiones:	Schedule / Cédula:	Length / Longitud:	Quantity / Cantidad: 183 Pcs/Pz		Nominal Weight / Peso Nominal:
6.625 X 0.432 INCH	SCH 080 / W.C XS	35.01 / 38.98 FT	7020.538 FT	201738.567 LB	28.60 LB/FT
168.3 X 11 MM		10.67 / 11.88 MTS	2139.860 MTS	91507.000 KG	42.56 KG/M

MARKING / MARCACIÓN

Marking / Marcación	
API; Monogram ?: HABILITADA DNOW L.P. PO 25301140	Monograma; API ?: HABILITADA DNOW L.P. PO 25301140

SUMMARY REPORT / REPORTE RESUMEN

Heat N° / Colada N°	Quantity / Cantidad (Pieces)	Length / Longitud (ft)	Length / Longitud (m)	Weight / Peso (Tons)
8835	10	381.1	116.16	4,966

Heat N° / Colada N°	Quantity / Cantidad (Pieces)	Length / Longitud (ft)	Length / Longitud (m)	Weight / Peso (Tons)
8925	173	6,639.44	2,023.7	86.541

Average length per pipe / Longitud promedio por tubo (ft)	Average length per pipe / Longitud promedio por tubo (m)	Nominal weight per pipe / Peso nominal por tubo (lb/ft)	Nominal weight per pipe / Peso nominal por tubo (kg/m)
38.364	11.693	28.735	42.763

TRACKING / RASTREABILIDAD

Type / Tipo: API 5L 8.13.2

Heat N° / Colada N°	Sample N° / Muestra N°	Tracking Pipe Number / Número de Rastreabilidad de Tubo
8835	81789	FULL HEAT
8835	81790	FULL HEAT

Type / Tipo: API 5L 8.13.2

Heat N° / Colada N°	Sample N° / Muestra N°	Tracking Pipe Number / Número de Rastreabilidad de Tubo
8925	95578	FULL HEAT
8925	95579	FULL HEAT

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Standard or Specification / Normas o Especificaciones: API 5L ED45/DECEMBER 2012, ASTM A106/14, ASTM A53/12, ASME SA106/2013, ASME SA53/2013		Steel Grade / Grado de acero: BR-L245R/X42R-L290R/C PSL2	Ends / Extremos: NORMAL BEVEL / BISELADO NORMAL

Dimensions / Dimensiones:	Schedule / Cédula:	Length / Longitud:	Quantity / Cantidad: 183 Pcs/Pz		Nominal Weight / Peso Nominal:
6.625 X 0.432 INCH / 168.3 X 11 MM	SCH 080 / W.C XS	35.01 / 38.98 FT / 10.67 / 11.88 MTS	7020.538 FT / 2139.860 MTS	201738.567 LB / 91507.000 KG	28.60 LB/FT / 42.56 KG/M

This is to certify that the product described here has been manufactured, sampled, tested, and inspected in accordance with purchaser order requirements. This certificate is not a declaration of origin nor may it be used as a declaration of origin.

Por el presente certificamos que el material aquí descrito ha sido fabricado, muestreado, ensayado e inspeccionado de acuerdo a los requisitos de su orden de compra. Este certificado no es, ni puede ser usado, como una declaración de origen.

	CUSTOMER . THIRD PARTY	TENARIS QUALITY DEPARTMENT SIGNATURE	
	INSPECTION COMPANY COMPAÑÍA DE INSPECCIÓN NO APLICA Employee Name: N/A	QUALITY CERTIFICATION DEPT. DEPTO. DE CERTIFICACIÓN DE CALIDAD Néstor T. Rodríguez Castañeda	CHIEF OF QUALITY CERTIFICATION DEPT. RESPONSABLE DEL DEPTO. DE CERTIFICACIÓN DE CALIDAD Rafael Gutiérrez de Velasco Magallanes

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trade-mark green colored "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use. Any alteration and/or falsification will be subjected to the law.

Este certificado se emite mediante sistema computarizado y es validado con firma electrónica. El certificado original posee impreso el logo Tenaris color verde. En caso de que el poseedor del certificado entregue una copia, deberá garantizar la conformidad con el original haciéndose responsable por cualquier uso ilegal o indebido. Cualquier alteración y/o falsificación estará sujeta a la ley.

PO. 38727. 1" (S.160) SMLS. SA-106.B HN. RA0311

PO # :36575SW
Item #:
Desc :1 BPE S160 0.250W SRL IMP 1.315 OD 2.8
Heat #:RA0311

DOC. No: LBST/QAR/16

MILL TEST CERTIFICATE

NACE MR-01-75 SEC 3.1 - 3.2.2.1 (2004)

MANUFACTURER NAME: LAL BABA SEAMLESS TUBES PVT. LTD.
Address:- KASHBERIA, BARDHANYAGHATA, DEBHOG, HPL LINK ROAD, HALDIA - 721 657,
Website : www.lbstubes.com, Rev 0 Dt.01.01.2010

PURCHASER NAME :
P.O.NO. : NBR 710572
DATE:10.03.2014
SALES CONTRACT NO.: 930
DATE:11.03.2014

PRODUCT: SEAMLESS STEEL PIPES
PRODUCT STANDARD: ASTM A106/A53 ASME SA106/SA 53 GR.B (2010)
STEEL GRADE: Carbon Steel
MAKING METHOD: COLD DRAWN
STEEL MAKING PROCESS: ELECTRIC FURNACE METHOD, Fully Killed

TEST CERTIFICATE No.: 020/2014 REV.
DATE: 29.04.2014
INVOICE NO: LBST/EXP/14-15/00067,0008 & 0009
DATE: 30.04.2014

Sr. No.	HEAT NO.	SIZES(MM) DIAMETER X THICKNESS X LENGTH	PIECES	QUANTITY (MTRS)	WEIGHT (MT)	SUPPLIER HEAT NO.	CHEMICAL COMPOSITION										
							REQUIRED	%C	%MN	%SI	%S	%P	%Cr	%NI	%Cu	%Mo	%V	%C.E
							Max	0.30	1.06		0.035	0.035	0.40	0.40	0.40	0.15	0.08	0.400
							MIN		0.29	0.10								
7	RA0313	1" x Sch 160 x 21 FEET	222	1422.58	6.021	314779	L /A	0.17	0.63	0.17	0.022	0.027	0.000	0.000	0.000	0.000	0.000	0.275
							P1 /A	0.18	0.66	0.15	0.022	0.025	0.004	0.001	0.004	0.003	0.002	0.292
							P2 /A	0.17	0.65	0.18	0.023	0.030	0.006	0.001	0.006	0.002	0.002	0.281

Sr. No.	HEAT NO.	MECHANICAL PROPERTIES					TECHNOLOGICAL		NON-DESTRUCTIVE TEST			SURFACE QUALITY		DIMENSION TOLERANCE	
		TENSILE STRENGTH (Psi)	YIELD STRENGTH (Psi)	ELONGATION (%)	FLARING TEST	HARD-NESS	IMPACT	FLATTENING TEST / BEND TEST	HYDRO-STATIC TEST (psi)	E.T. as Per ASTM E-309	U.T. AS PER ASTM E-213	IN -	OUT	O.D.	W.T.
		G.L. = 50mm, G.W. = 19.05mm													
Required (Max)															
Required (Min)		60000	35000	30											
7	RA0311	71206.26	45018.70	42.50	NA	NA	NA	OK	2500	OK	NA	Satisfactory	Satisfactory	Satisfactory	Satisfactory

Coating : All Pipes are coated with rust preventive varnish from outside surface only.
Heat Treatment : Heat Treated Above 650°C (1200°F)

REMARKS: 1. We hereby certify that the material herein described has been Manufactured, Sample, Tested & Inspected in accordance with above standard & specification & satisfy the requirement.
2. Legends: L/A= Ladle Analysis, P1/A= Product Analysis One, P2/A=Product Analysis Two
3. All materials are Lead (Pb) & Mercury (Hg) Free.

MARKING: LBST CDS / ASTM A 106 / A53 / ASME SA 106 / SA53 GR.B-S Size (INCH): ....., LENGTH ..... FEET , H.No. ..... HYD------ PSI / NDE
MADE IN INDIA / PO. NO.- NBR 710572

LAL BABA SEAMLESS TUBES PVT. LTD. * HALDIA

ISSUED:

QC MANAGER :

REVIEWED AND MEETS MATERIAL REQUIREMENTS PER 2015 ASME CODE LATEST ADDENDA

gs. 4.20.16

P.O. 35310 3/4" (5.160) pipe SA-106.B HN: RA0396

10P15164

MILL TEST CERTIFICATE

EN:10204:3.1, 2004

DOC. No: LBST/QAR/15

Page: 2 of 2

MANUFACTURER NAME: LAL BABA SEAMLESS TUBES PVT. LTD.

Address:- KASHBERIA, BARDHANYAGHATA, DEBHOG, HPL LINK ROAD, HALDIA - 721 657.

Website : www.lbstubes.com, Rev.0 DL01.01.2010

PURCHASER NAME :
PURCHASE ORDER NO. : 26925
DATE: 24.10.2014
WORK OREDER NO.: LBST/WO/EXP/2028/14/10 Amndt.1
DATE: 31.10.2014

PRODUCT: SEAMLESS STEEL PIPES
PRODUCT STANDARD: ASTM A53 GR.B/106 GR.B/C ,ASME SA 53 GR.B/106 GR.B/C, (EDT-2012), NACE MR 0175 / MR0103
STEEL GRADE: Carbon Steel
MAKING METHOD: COLD DRAWN
STEEL MAKING PROCESS: ELECTRIC FURNACE METHOD, Fully Killed

TEST CERTIFICATE No.: 389/2014
DATE: 29.11.2014
INVOICE No: LBST/EXP/14-15/0111
DATE: 29.11.2014

Sr. No.	HEAT NO.	SIZES(INCH.) DIAMETER X THICKNESS X LENGTH	PIECES	QUANTITY (MTRS)	WEIGHT (MT)	SUPPLIER HEAT NO.	CHEMICAL COMPOSITION	%C	%MN	%SI	%S	%P	%Cr	%Ni	%Cu	%Mo	%V	%C.E
							REQUIRED Max	0.30	1.06		0.035	0.035	0.40	0.40	0.40	0.15	0.08	
							REQUIRED Min		0.29	0.10								
5	RA0398 ✓	3/4" X 0.219" X 20 FEET. ✓	188	1024.13	-	409925	L/A	0.200	0.650	0.220	0.024	0.026	0.005	0.000	0.000	0.000	0.000	0.309
							P1/A	0.196	0.648	0.212	0.023	0.025	0.006	0.007	0.005	0.002	0.001	0.307
							P2/A	0.199	0.653	0.215	0.023	0.026	0.007	0.008	0.006	0.002	0.002	0.311
6	RA0348	1/2" X 0.188" X 20 FEET.	120	731.52	-	404377	L/A	0.150	0.430	0.130	0.030	0.019	0.009	0.000	0.000	0.000	0.000	0.223
							P1/A	0.156	0.424	0.129	0.028	0.018	0.009	0.004	0.005	0.001	0.001	0.229
							P2/A	0.152	0.428	0.126	0.029	0.017	0.010	0.005	0.007	0.001	0.001	0.227
7	RA0348	3/8" X 0.125" X 20 FEET.	180	1097.28	-	404418	L/A	0.160	0.380	0.140	0.033	0.020	0.016	0.000	0.000	0.000	0.000	0.227
							P1/A	0.155	0.392	0.138	0.032	0.018	0.015	0.002	0.003	0.001	0.002	0.224
							P2/A	0.162	0.390	0.139	0.03	0.019	0.014	0.002	0.002	0.001	0.002	0.231

Sr. No.	HEAT NO.	MECHANICAL PROPERTIES: TENSILE STRENGTH (Psi) G.L. = 50mm, G.W. = 19.05mm	YIELD STRENGTH (Psi)	ELONGATION (%)	FLARING TEST	HARDNESS (BHN)	TECHNOLOGICAL: IMPACT	FLATTERING TEST / BEND TEST	NON-DESTRUCTIVE TEST: HYDRO-STATIC TEST (2500 psi)	E.T. as Per ASTM E-309 (100%)	U.T. AS PER ASTM E-213	SURFACE QUALITY: IN	OUT	DIMENSION TOLERANCE: O.D.	W.T.
Required (Max)						237									
Required (Min)		70000	40000	30											
5	RA0398	73753 ✓	44721 ✓	41	NA	151-153	NA	OK	OK	OK	NA	Satisfactory	Satisfactory	Satisfactory	Satisfactory
6	RA0348	74042	44286	40	NA	153-154	NA	OK	OK	OK	NA	Satisfactory	Satisfactory	Satisfactory	Satisfactory
7	RA0348	74477	44617	40	NA	153-155	NA	OK	OK	OK	NA	Satisfactory	Satisfactory	Satisfactory	Satisfactory

Coating : All Pipes are coated with rust preventive black varnish from outside surface only.
Heat Treatment : Normalised

REMARKS: 1. We hereby certify that the material herein described has been Manufactured, Sample, Tested & Inspected in accordance with above standard & specification & satisfy the requirement.
Legends: L/A= Ladle Analysis, P1/A= Product Analysis One, P2/A=Product Analysis Two
3. All materials are Lead (Pb) & Mercury (Hg) Free.

MARKING: LBST CDS / ASTM A53 B/ 106 B/C / ASME SA 53 B / 106 B/C / Size (INCH): ....., LENGTH ..... FEET , H.No. ..... HYD.....PSI / NDE
P.O. NO.-10P15164/NACE MR 0175

COMPANY:

ISSUED:

QC MANAGER :

REVIEWED AND MEETS MATERIAL REQUIREMENTS 2015 ASME CODE LATEST ADDENDA

5-12-15

P.O. 10P2243 3" S-80 SMLS PIPE SA-106-B
HT. FA1742.

UNITED STATES STEEL

TUBULAR PRODUCTS
CERTIFIED TEST REPORT
(IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 "type 3.1")

DATE: 04/04/12
TIME: 05:13:02
SERIAL NO: L0040551

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	VEHICLE ID
DR03782 04	R88590	10P2243	CSXT708683

SOLD TO ADDRESS
KELLY PIPE CO LLC
11680 BLOOMFIELD AVE
SANTA FE SPRINGS CA 90670-4608

MAIL TO ADDRESS
KELLY PIPE CO LLC
11680 BLOOMFIELD AVE
SANTA FE SPRINGS CA 90670-4608

VENDOR
USS TUBULAR PRODUCTS
2199 EAST 28TH ST.
LORAIN, OH 44055

SPECIFICATION AND GRADE

PIPE CARBON SMLS STD PIPE API 5L-*44TH ED DTD OCT 2007 AND ISO 3183:2007 MOD PSL-1 GRADE B AND GRADE X42 R N OR Q ASTM A53-*07 ASTM A106-*08 GRADE B QUAD STENCIL ASME SA53-*2010 EDITION ASME SA106-*2010 EDITION GRADE B BLK REG MILL COAT PE BEV 30 DEG MEETING ALL THE APPLICABLE REQUIREMENTS OF NACE STANDARD MR-01-75 *:ISO 15156-2 2009 ED AND MR-0103-2009_ED

MATERIAL COND: AS ROLLED

O.D.: 3.500 (88.900) In (mm)

WALL: 0.300 (7.620) In (mm)

PRODUCT IDENTIFICATION	TENSILE TEST TYPE/ ORIENTATION	TEST COND.	GAUGE WIDTH IN	YIELD PSI	EXT % .50	TENSILE PSI	Y/T	ELONG % (IN 2")	HARDNESS SCALE: HRB	MIN HYDRO PSI	DWELL(SEC)
				MIN: 42100		MIN: 70000	MAX:	MIN: 23.0	MIN: 66.0	2970	5
				MAX:		MAX:			MAX: 99.5		
FA1742	STRIP/L/B	AR	0.750	50000	.50	76500	0.66	33.4	B 76.2	2970	5
		**	END OF DATA THIS SHEET			**					

LEGEND: L - LONGITUDINAL, U - UPSET; T - TRANSVERSE, NM - NORMALIZED; QT - QUENCH & TEMPERED, SR - STRESS RELIEVED; AR - AS ROLLED, TR - THERMOMECHANICAL ROLLED; B - BODY; W - WELD

PRODUCT IDENTIFICATION	TYPE	C	MN	P	S	SI	CU	NI	CR	MO	AL	N	V	B	TI	CB	CO	C.E.* MAX .50
FA1742	HEAT	18	102	009	002	20	14	11	07	01	030		00	0001	002	002		.38
FA1742	PROD	18	104	005	002	24	14	12	06	01	026		00	0003	003	002		.39
FA1742	PROD	18	104	005	002	24	15	12	06	01	027		00	0003	002	001		.39
		** END OF DATA THIS SHEET **																

*C.E. IS BASED ON THE FOLLOWING EQUATION(S): CE=C+ (MN/6) + (CR+MO+V) /5+ (NI+CU) /15

DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT. ELEMENTS REPORTED IN MASS FRACTION (%)

UNITED STATES STEEL

TUBULAR PRODUCTS
CERTIFIED TEST REPORT
(IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 "type 3.1")

DATE: 04/04/12
TIME: 05:13:02
SERIAL NO: L0040551

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	
DR03782 04	R88590	10P2243	0014644

MATERIAL COND: AS ROLLED

O.D.: 3.500(88.900) in (mm)

WALL: 0.300 (7.620) in (mm)

PRODUCT IDENTIFICATION	FLAT	BEND	GRAIN SIZE	MIN COLLAPSE	CHARPY V-NOTCH IMPACT TESTING: DIR	TEST LOC.	TEMP	SIZE	TEST COND.	FT-LBS 1	FT-LBS 2	FT-LBS 3	FT-LBS AVG	% SHEAR 1	% SHEAR 2	% SHEAR 3	% SHEAR AVG
							DEG										
FA1742	OK		**	END OF DATA THIS SHEET **													

LEGEND L - LONGITUDINAL T - TRANSVERSE B - BODY W - WELD HAZ - HEAT AFFECTED ZONE

TESTING / INSPECTION INFORMATION

TEST / INSPECTION	YES	RESULTS / COMMENTS
FULL LENGTH VISUAL	X	
FULL LENGTH EMI		OD _____ OD/ID _____ L _____ L/T _____
FULL LENGTH MPI		
FULL LENGTH UT		ID _____ OD/ID _____ L _____ L/T _____
END AREA INSPECTION (PLAIN END)		MPI _____ UT _____
SPECIAL END AREA (SEA) INSP		MPI _____ UT _____
FULL LENGTH DRIFT		DRIFT MANDREL SIZE:

ADDITIONAL NOTES/COMMENTS

MELTED AND MANUFACTURED IN THE USA. NO REPAIRS BY WELDING. NO MERCURY OR MERCURY COMPOUNDS ARE ADDED TO THE STEEL AND ALL MERCURY BEARING EQUIPMENT IS PROTECTED BY A DOUBLE BOUNDARY OF CONTAINMENT.
PRODUCT WAS HOT ROLLED AND HOT FINISHED
PIPE ALSO MEET THE REQUIREMENTS OF ASTM A106 GRADE C & ASME SA106 GRADE C

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, SAMPLED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS THE REQUIREMENTS IN SUCH RESPECTS.

PREPARED BY THE OFFICE OF: R. HARRIS - MANAGER, Q.A.

DATE 04/04/12

**

PO. 35310 1½" (S.160) pipe SA.106.B HN·RA0400.

DOC. No: LBST/QAR/15

MILL TEST CERTIFICATE

EN:10204:3.1, 2004

MANUFACTURER NAME: LAL BABA SEAMLESS TUBES PVT. LTD.

Address:- KASHBERIA, BARCHANYAGHATA, DEBHOG, HPL LINK ROAD. HALDIA - 721 657.

Website : www.lbstubes.com, Rev.0 Dt.01.01.2010

PURCHASER NAME :
PURCHASE ORDER NO. : 26928
DATE: 24.10.2014
WORK OREDER NO.: LBST/WO/EXP/2028/14/10 Amndt.1
DATE: 31.10.2014

PRODUCT: SEAMLESS STEEL PIPES
PRODUCT STANDARD: ASTM A53 GR.B/106 GR.B/C ,ASME SA 53 GR.B/106 GR.B/C, (EDT-2012), NACE MR 0175 / MR0103
STEEL GRADE: Carbon Steel
MAKING METHOD: COLD DRAWN
STEEL MAKING PROCESS: ELECTRIC FURNACE METHOD, Fully Killed

TEST CERTIFICATE No.: 369/2014
DATE: 29.11.2014
INVOICE NO: LBST/EXP/14-15/0111
DATE: 29.11.2014

Sr. No.	HEAT NO.	SIZES(INCH.) DIAMETER X THICKNESS X LENGTH	PIECES	QUANTITY (MTRS)	WEIGHT (MT)	SUPPLIER HEAT NO.	CHEMICAL COMPOSITION REQUIRED	%C	%MN	%SI	%S	%P	%Cr	%Ni	%Cu	%Mo	%V	%C.E
							Max	0.30	1.06		0.035	0.035	0.40	0.40	0.40	0.15	0.08	
							MIN		0.29	0.10								
1	RA0343	1-1/2" X 0.400" X 20 FEET.	108	658.368	-	400424	L/A	0.180	1.030	0.190	0.017	0.029	0.019	0.009	0.000	0.000	0.000	0.356
							P1/A	0.182	0.980	0.185	0.018	0.027	0.017	0.004	0.004	0.002	0.001	0.352
							P2/A	0.184	1.010	0.189	0.017	0.028	0.018	0.005	0.005	0.001	0.002	0.357
2	RA0400	1-1/2" X 0.281" X 20 FEET.	72	438.912	-	410036	L/A	0.160	0.680	0.230	0.017	0.027	0.011	0.000	0.000	0.000	0.000	0.277
							P1/A	0.162	0.685	0.224	0.016	0.027	0.009	0.005	0.004	0.002	0.001	0.279
							P2/A	0.167	0.693	0.232	0.017	0.028	0.010	0.006	0.005	0.002	0.001	0.286
3	RA0399	1-1/4" X 0.381" X 20 FEET.	42	256.032	-	314852	L/A	0.150	0.440	0.170	0.015	0.022	0.010	0.000	0.000	0.000	0.000	0.226
							P1/A	0.153	0.435	0.165	0.015	0.021	0.008	0.001	0.002	0.002	0.001	0.228
							P2/A	0.161	0.442	0.120	0.014	0.022	0.009	0.002	0.002	0.002	0.001	0.237
4	RA0335	1" X 0.133" X 20 FEET	420	2560.320	-	402816	L/A	0.200	0.630	0.220	0.023	0.032	0.021	0.000	0.000	0.000	0.000	0.309
							P1/A	0.185	0.625	0.202	0.025	0.027	0.016	0.006	0.004	0.001	0.001	0.293
							P2/A	0.186	0.630	0.205	0.025	0.028	0.018	0.005	0.005	0.001	0.002	0.298

Sr. No.	HEAT NO.	MECHANICAL PROPERTIES TENSILE STRENGTH (Psi)	YIELD STRENGTH (Psi)	ELONGATION (%)	FLARING TEST	HARDNESS (BHN)	TECHNOLOGICAL IMPACT	FLATTENING TEST / BEND TEST	NON-DESTRUCTIVE TEST HYDRO-STATIC TEST (2500 psi)	E.T. as Per ASTM E-309 (100%)	U.T. AS PER ASTM E-213	SURFACE QUALITY IN	OUT	DIMENSION TOLERANCE O.D.	W.T.
		G.L. = 50mm, G.W. = 19.05mm													
Required (Max)						237									
Required (Min)		70000	40000	30											
1	RA0343	74761	44983	44	NA	151-153	NA	OK	OK	OK	NA	Satisfactory	Satisfactory	Satisfactory	Satisfactory
2	RA0400	74346	44382	42	NA	152-154	NA	OK	OK	OK	NA	Satisfactory	Satisfactory	Satisfactory	Satisfactory
3	RA0399	74042	44286	46	NA	153-154	NA	OK	OK	OK	NA	Satisfactory	Satisfactory	Satisfactory	Satisfactory
4	RA0335	73752	44721	41	NA	153-155	NA	OK	OK	OK	NA	Satisfactory	Satisfactory	Satisfactory	Satisfactory

Coating : All Pipes are coated with rust preventive black varnish from outside surface only.
Heat Treatment : Normalised

REMARKS: 1. We hereby certify that the material herein described has been Manufactured, Sample, Tested & Inspected in accordance with above standard & specification & satisfy the requirement.
2. Legends: L/A= Ladle Analysis, P1/A= Product Analysis One, P2/A=Product Analysis Two
3. All materials are Lead (Pb) & Mercury (Hg) Free.

MARKING: LBST CDS / ASTM A53 B/ 106 B/C / ASME SA 53 B / 106 B/C / Size (INCH): ....., LENGTH ..... FEET , H.No. ..... HYD.....PSI / NDE
P.O. NO.-10P15164/NACE MR 0175

COMPANY: LAL BABA SEAMLESS TUBES PVT. LTD. HALDIA

ISSUED:

QC MANAGER:

REVIEWED AND MEETS MATERIAL REQUIREMENTS PER 2013 ASME CODE LATEST ADDENDA

98 - 5 - 12 - 15

WEST COAST METALS

2455 NW Nicolai St. Suite B, Portland, OR 97210

SOUTH GATE ENGINEERING* **PO/Rel:** 0040304-00 **Contact:** LUIS **Inv:** I401880 **Date:** 10/05/2016

CARBON SEAMLESS PIPE CSP SMLS PIPE 2" S160 21'R/L A-106 B **Heat:** LA1316

Certificate of Mill Test Results

Po. 40304. 2" (S.160) Smls. SA-106.B HN. LA1316

UNITED STATES STEEL CORPORATION

TUBULAR PRODUCTS
CERTIFIED TEST REPORT
(IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 "type 3.1")

DATE: 01/17/15
TIME: 04:05:52
SERIAL NO: L0054995
EBS NO: 2000924687 1

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	VEHICLE I.D
DR91903 01	R03917	10P15196-PIT 2014-10-23	GRW87850

VENDOR
UNITED STATES STEEL CORP
LORAIN TUBULAR OPERATIONS
2199 EAST 28TH ST.
LORAIN, OH 44055

SPECIFICATION AND GRADE

SMLS STANDARD AND LINE PIPE API 5L 45TH EDITION DATED 12/1/12 GRADE B/X42 R N OR Q PSL-1, ASTM A106-14 GRADE B/C, ASTM A53-12 GRADE B, ASME SA106-2013 GRADE B/C, ASME SA53-2013 GRADE B REG MILL COAT PE BEV 30 DEGREE APPLICABLE REQUIREMENTS OF NACE MR0103-2012 ED AND NACE MR0175/ISO 15156-2 2009 ED

MATERIAL COND: AS ROLLED

O.D.: 2.375 (60.325) in (mm) WALL: 0.344 (8.737) in (mm)

PRODUCT IDENTIFICATION	TENSILE TEST TYPE/ ORIENTATION	TEST COND.	GAUGE WIDTH	YIELD PSI	EXT %	TENSILE PSI	Y/T	ELONG % (IN 2 ")	HARDNESS SCALE:	MIN HYDRO PSI	DWELL(SEC)
			IN	MIN: 42100	.50	MIN: 70000	MAX:	MIN: 24.0	MIN:	2970	5
				MAX:		MAX:			MAX:		
LA1316	STRIP/L/B	AR	0.750	59500	.50	83500	0.71	33.1		2970	5
		**	END OF DATA	THIS	SHEET	**					

LEGEND: L - LONGITUDINAL, U - UPSET; T - TRANSVERSE, NM - NORMALIZED; QT - QUENCH & TEMPERED, SR - STRESS RELIEVED; AR - AS ROLLED, TR - THERMOMECHANICAL ROLLED; B - BODY; W - WELD

PRODUCT IDENTIFICATION	TYPE	C	MN	P	S	SI	CU	NI	CR	MO	AL	N	V	B	TI	CB	CO	C.E.1	C.E.2
LA1316	HEAT	20	106	006	003	23	06	03	06	02	040		03	0001	002	001			
LA1316	PROD	20	104	001	002	24	05	02	06	02	034		03	0001	002	001			
LA1316	PROD	21	104	001	003	23	05	02	06	02	031		03	0002	001	002			
		** END OF DATA THIS SHEET **																	

*C.E. IS BASED ON THE FOLLOWING EQUATION(S):

DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT. ELEMENTS REPORTED IN MASS FRACTION (%).

REVIEWED AND MEETS MATERIAL REQUIREMENTS PER ASME CODE LATEST ADDENDA S. C.F. LLC

21002

WEST COAST METALS

2455 NW Nicolai St. Suite B, Portland, OR 97210

Certificate of Mill Test Results

SOUTH GATE ENGINEERING* **PO/Rel:** 0040304-00 **Contact:** LUIS **Inv:** I401880 **Date:** 10/05/2016

CARBON SEAMLESS PIPE CSP SMLS PIPE 2" S160 21'R/L A-106 B **Heat:** LA1316

DATE: 01/17/15
TIME: 04:05:52
SERIAL NO: L0054995
EBS NO: 2000924687 1

UNITED STATES STEEL CORPORATION — TUBULAR PRODUCTS
CERTIFIED TEST REPORT
(IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 "type 3.1")

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER
DR91903 01	R03917	10P15196-PIT 2014-10-23

MATERIAL COND: AS ROLLED

O.D.: 2.375 (60.325) in (mm) WALL: 0.344 (8.737) in (mm)

PRODUCT IDENTIFICATION	FLAT	BEND	GRAIN SIZE	MIN COLLAPSE	CHARPY V-NOTCH IMPACT TESTING DIR	TEST LOC.	TEMP	SIZE	TEST COND.	FT-LBS 1	FT-LBS 2	FT-LBS 3	FT-LBS AVG	% SHEAR 1	% SHEAR 2	% SHEAR 3	% SHEAR AVG
							DEG										
LA1316		OK		** END OF DATA THIS SHEET **													

LEGEND L - LONGITUDINAL T - TRANSVERSE B - BODY W - WELD HAZ - HEAT AFFECTED ZONE

TESTING / INSPECTION INFORMATION

TEST / INSPECTION	YES	RESULTS / COMMENTS
FULL LENGTH VISUAL	X	
FULL LENGTH EMI		OD ____ OD/ID ____ L ____ L/T ____
FULL LENGTH MPI		
FULL LENGTH UT		ID ____ OD/ID ____ L ____ L/T ____
END AREA INSPECTION (PLAIN END)		MPI ____ UT ____
SPECIAL END AREA (SEA) INSP		MPI ____ UT ____
FULL LENGTH DRIFT		DRIFT MANDREL SIZE:

ADDITIONAL NOTES/COMMENTS

MELTED AND MANUFACTURED IN THE USA, NO REPAIRS BY WELDING, NO MERCURY COMPOUNDS ARE ADDED TO THE STEEL AND ALL MERCURY BEARING EQUIPMENT IS PROTECTED BY A DOUBLE BOUNDARY OF CONTAINMENT. MANUFACTURED IN AN ISO 9001 CERTIFIED FACILITY - CERTIFICATE #32022.

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, SAMPLED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS THE REQUIREMENTS IN SUCH RESPECTS.

PREPARED BY THE OFFICE OF: BRAD KOURY - MANAGER, Q.A.

DATE 01/17/15

**

P.O.40572 · 2"·300 # · RFSO · SA·105 · 12388 · HN · 213

JAI AUTO PVT. LIMITED

B-44/52, Site IV industrial Area, Sahibabad , Ghaziabad, (U.P)
Tel: +91-120-4380042, 4111732, Fax No. +91-120-4111731, E-Mail:info@jaiauto.in

Works Test Certificate

JAPL/LAB NO: 14-15/1038		INVOICE NO.: J1415-035		DATE: 10-09-2014	
Purchase Order No	65632	Customer		Forging specification	ASME SA 105- 13 ✓ ASTM A105- 13
Component	2"-300 # SORF FLG. ✓			Steel Supplier	BHUSAN STEEL
Drawing No.					
Machining STD	ANSI B16.5- 2013 ASME B16.5- 2013	Quantity	04 Nos	Mill Heat No.	14F-093
				JAPL. HEAT NO:	213 ✓

TEST RESULTS

CHEMICAL COMPOSTION

Element %	Specified Composition	Actual JAPL LAB	Actual MILL T.C.
Carbon	0.35max	0.21	0.21
Manganese	0.60-1.05	0.95	0.89
Silicon	0.10-0.35	0.25	0.24
Sulphur	0.040max	0.012	0.010
Phosphorous	0.035max	0.024	0.024
Chromium	0.30max	0.037	0.053
Nickel	0.40max	0.011	0.009
Copper	0.40max	0.013	0.014
Molybdenum	0.12max	0.0001	0.005
Vanadium	0.08max	0.004	0.003
Carbon Equivalent (CE)	0.47max	0.378	0.372

MECHANICAL PROPERTIES

PROPERTIES	SPECIFIED	OBTAINED
Yield Strength (mpa)	250.00min.	323.52
Tensile Strength (mpa)	485.00min.	585.28
%Elongation in 50mm / 4D	22.00min.	34.2
Hardness HBW	187max.	153-156
% Reduction of Area	30.00min.	58.31

Remarks:- We hereby certify that the product Satisfies the requirement of ASTM A 105 and Material described here in has been tested in accordance with the applicable specifications referred above and meets the requirements as per EN10204/3.1B & NACE MRO-175 & ISO 15156.

Specified carbon as per Purchase Order 0.25%max.

Serrated face as per MSS-SP-6 With in limits of 125-250AARH

CARBON EQUIVALENT (CE)

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

MARKING AS PER MSS-SP-25-2013

2"- 300 SA105 213 B16.5 JAPL INDIA

Checked by: Rahul Metallurgist

Certified by: Quality Control Manager

Stock 6327 11/19/

2 300 RF SLIP ON FLANGE **
A105

Stock 6327

P.O. 40572 · 2" · 300# · RFSO · SA-105 · 12388 · HN. A37T3

2 300 RF SLIP ON FLANGE **
A105

PO#: P1482174 Pack#: 161112 Order#: 873250 Lot# : ULM.A37T3 Desc: 2 300 RF SO FLG A/SA 105 NORM ULM

CLIENTE / Customer / Client

CERTIFICADO DE INSPECCION

Inspection Certificate - Certificat de Réception

DIN EN 10204 / 3.1
ISO 10474 / 3.1

FECHA: Date: 05/11/2013 | N.º No. 160891 | HOJA: Page: 1

ULMA FORJA, S.COOP.
Bª Zubillaga, 3 - Apdo. 14
20560 OÑATI (Gipuzkoa) SPAIN
Tel.: 34 - 943 780552
Fax: 34 - 943 781808
E-mail: ulma@ulmapiping.com

SGI 1922164 SGI 6000236 SGI 6009857

Management Systems certified by LRQAE

Certified acc. PED 97/23/EC+AD2000-W0 by TÜV Rheinland N.º 01 202 E/Q 02 7443

Packing List: 105822

PRODUCTO / Article - Produit: FLANGES

SU PEDIDO N.º / Your Order No. / Votre Cde. N.º: 174838-HOUSTON

59122

DE ot. - de: 14/10/2013

NORMAS APLICABLES / Requirements - Normes Applicables: ASME B16.5-13

MATERIAL CORRESPONDIENTE / Material Correspondent - Qualité: ASME SA105M-13, ASTM A105M-12 ✓

MODO DE FUSION (*) / Steel Making - Elaboration de l'acier: NACE MR0175/ISO15156-2-09 & MR0103-12

E = Elec. Y = Oxigeno básico

MARCA DEL FABRICANTE / Mark of factory / Marque du fabricant

DEPARTAMENTO / Section / Département: QUALITY ASSURANCE

PARTIDA Item Poste	CANTIDAD Quantity Quantité	DESCRIPCION Description Description	OBSERVACIONES Remarks Observations (*)	COLADA N.º Heat No N.ºCoulée	RESISTENCIA T.Strength Resist Rupt N/mm2	LIMITE ELAST. Y.Strength 0.2 % N/mm2	ALARGAM. Elongation Allongement Lo: 4 d %	ESTRICCION Red. Area Striction %	RESILIENCIA Impact test Résilience Joules	CHARPY V 10x10mm MEDIA Average Moyenne	ºC	DUREZA Hardness Dureté HBW
40 F1SA060	132	SO 6 150LB RF A105N	NE	B46T3	513	316	31,90	52,60				155 161
40 F1SA060	528	SO 6 150LB RF A105N	NE	B63T3	502	310	31,60	53,60				148 153
46 F1SA100	120	SO 10 150LB RF A105N	NE	A91A3	511	316	30,30	59,80				154 158
97 F14WA080	60	WN 8 150LB STD/40 RF A105N	NE	B15T3	519	324	30,60	54,70				150 158
97 F14WA080	240	WN 8 150LB STD/40 RF A105N	NE	B16T3	512	319	31,80	53,40				153 160
126 F3SA020	490	SO 2 300LB RF A105N ✓	NE	A37T3 ✓	508	312	28,50	59,20				148 152
182 F3T6WA120	16	WN 12 300LB S80 RF A105N	NE	C03T3	516	315	32,60	54,20				153 160
217 F3BA180	8	BLIND 18 300LB RF A105N	NE	489A2	509	308	28,60	58,50				150 156
326 F6UWA200	1	WN 20 600LB S80 RF A105N V01 S/CHAF	NE	B30A3	509	316	30,90	54,30				150 155

COMPOSICION QUIMICA - STEEL MAKER'S LADLE ANALYSIS - ANALYSE CHIMIQUE

COLADA N.º Heat No N.ºCoulée	C %	Si %	Mn %	P %	S %	Cr %	Ni %	Mo %	Nb %	V %	Cu %	Al %	Ti %	CEq %	Origin of Steel
489A2	0,210	0,189	0,880	0,017	0,004	0,074	0,059	0,011	0,006	0,005	0,187	0,026	0,009	0,391	Spain
A37T3	0,188	0,173	0,839	0,016	0,021	0,110	0,115	0,027	0,002	0,003	0,389	0,000	0,000	0,389	Spain
A91A3	0,205	0,187	0,925	0,007	0,006	0,044	0,077	0,029	0,008	0,006	0,148	0,030	0,000	0,390	Spain
B15T3	0,180	0,200	0,930	0,014	0,015	0,080	0,180	0,031	0,003	0,001	0,320	0,000	0,000	0,391	France
B16T3	0,190	0,190	0,870	0,013	0,011	0,070	0,150	0,029	0,003	0,001	0,310	0,000	0,000	0,386	France
B30A3	0,190	0,190	0,920	0,016	0,008	0,130	0,130	0,030	0,003	0,003	0,290	0,028	0,000	0,404	Croatia
B46T3	0,210	0,150	0,840	0,026	0,010	0,090	0,120	0,025	0,007	0,004	0,340	0,000	0,000	0,404	France
B63T3	0,210	0,180	0,890	0,021	0,008	0,080	0,120	0,017	0,005	0,001	0,250	0,000	0,000	0,403	France
C03T3	0,200	0,170	1,010	0,020	0,014	0,080	0,090	0,017	0,002	0,003	0,270	0,000	0,000	0,412	France

(*) OBSERVACIONES: Remarks Observations: N_NORMALIZED AT 900 C AND ALLOWED TO COOL IN STILL AIR

- Las dimensiones y la condición superficial se hallaron satisfactorias.
- Dimension and surface condition were found acceptable.
- Les dimensions et états de surface sont satisfaisants.

- Los materiales citados cumplen las normas aplicables.
- Manufacturing requirements are satisfied.
- Les normes applicables sont respectées.

EL INSPECTOR
Works Inspector - L'inspecteur

ULMA FORJA S. COOP.
Dpto. de Garantía de calidad
Quality Assurance Dept.

P.O. 40572 · 1½" · 300# · RFSO · SA-105 · 12588 · HN · H5394

P.O. 8154 6807

R.N. GUPTA & COMPANY LTD., C-55, FOCAL POINT, LUDHIANA -141 010 (INDIA)

F-MTR-01-01

MATERIAL / MILL TEST CERTIFICATE EN 10204 : 2004 - 3.1

CERTIFICATE NO. 9955 DATE 21/05/2016

NAME OF BUYER

RAW MATERIAL SPECIFICATION : ASTM A105-14/ASME SA105-13 ✓

SPECIFICATION FOR INSPECTION : ANSI/ASME B16.5-2013

P.O NO. 67460 DT. 23/02/2016

INVOICE NO. RNG/EXP/16-2032 DT. 14/05/2016

MECHANICAL REQUIREMENTS

Sr. No.	Description	Qty (PCS)	Heat No.	Supp. Code	Y.S(PSI) Min 36,000	T.S(PSI) Min 70,000	E% Min 22%	R.A% Min 30%	Heat Treatment	Soaking Time (Min.)	Hardness BHN 137-187
1	1 1/2 300# SORF FLGS ✓	10	H 5394 ✓	6	45966	77283	29.90	66.30	AS FORGED		158 - 160
2	3X2 150# RED THR RF FLG	8	H 5428	6	51361	80762	28.50	64.89	AS FORGED		164 - 166
3	4X2 150# RED THR RF FLG	5	H 5375	6	45646	74780	33.00	65.90	AS FORGED		154 - 156
4	6X4 150# RED THR RF FLG	4	H 5399	1	46861	75832	30.96	66.55	AS FORGED		154 - 156
5	2 300# SORF FLGS	13	H 5427	6	50485	80441	30.04	66.49	AS FORGED		164 - 166
6	10 300# BLRF FLG	3	H 5396	19	48572	81062	33.40	66.26	AS FORGED		164 - 166
7	2 300# WNRF STD FLGS	20	H 5418	1	48199	78616	30.60	67.00	AS FORGED		162 - 164
8	2 300# WNRF XH FLGS	100	H 5427	6	50485	80441	30.04	66.49	AS FORGED		164 - 166

CHEMICAL REQUIREMENTS

Sr. No.	Heat No.	SPECIFIED ELEMENTS						UNSPECIFIED ELEMENTS				
		C.E. 0.47% Max	C 0.35 Max	Mn 0.60-1.25	P 0.035 Max.	S 0.04 Max.	Si .10 -0.35	Cu 0.40 Max.	Ni 0.40 Max	Cr 0.30 Max.	Mo 0.12 Max.	V 0.05 Max.
1	H 5394	0.39	0.21	1.05	0.018	0.020	0.28	0.005	0.014	0.011	0.010	0.003
2	H 5428	0.40	0.21	1.08	0.020	0.012	0.27	0.004	0.019	0.008	0.009	0.003
3	H 5375	0.39	0.21	1.08	0.024	0.017	0.24	0.004	0.008	0.006	0.006	0.003
4	H 5399	0.38	0.21	0.93	0.023	0.017	0.20	0.013	0.025	0.036	0.006	0.003
5	H 5427	0.39	0.21	1.06	0.019	0.020	0.28	0.004	0.013	0.007	0.005	0.003
6	H 5396	0.41	0.20	1.24	0.017	0.009	0.26	0.006	0.008	0.012	0.004	0.003
7	H 5418	0.36	0.20	0.89	0.018	0.010	0.23	0.037	0.038	0.036	0.009	0.003
8	H 5427	0.39	0.21	1.06	0.019	0.020	0.28	0.004	0.013	0.007	0.005	0.003

Material in accordance with NACE MRO 175-2003 and NACE MRO 103

All Products were manufactured, Sampled, Tested and Inspected Solely by the manufacturer shown on this Test Report in accordance with Indicated specification and were found to meet the requirements.

No Weld Repair was performed and all products are free of Weld Repair.All Products are free of Mercury Contamination and Radioactivity.

Note: We hereby confirm that our QA system comply with the requirements of Annex I,section 4.3 of PED 97/23/EC and it is certified by M/s DNV BUSINESS ASSURANCE vide Certificate No.4487-2014-CE-IND-DNV valid upto 31-03-2017 ISO 9001-2008 Certificate No. is 39752-2008-QA-INDIA-RvA.02 Dated 22/07/2014. Products also conform to requirements of ASTM A105-05/ASME SA105

For R.N. GUPTA & COMPANY LTD.

METALLURGIST

Stock 6321

1 1/2 300 RF SLIP ON FLANG

A105

Stock 6334

6 300 RF SLIP ON FLANGE ** A105

P.O. 40572 · 6" · 300# · RFSO · SA 105 · 12388
HN · H5397

R.N. GUPTA & COMPANY LTD., C-55, FOCAL POINT, LUDHIANA -141 010 (INDIA)

F-MTR-01-01

RNG

MATERIAL / MILL TEST CERTIFICATE EN 10204 : 2004 - 3.1

CERTIFICATE NO. 9813 DATE 14/03/2016

RAW MATERIAL SPECIFICATION : ASTM A105-14/ASME SA105-13 ✓

SPECIFICATION FOR INSPECTION : ANSI/ASME B16.5-2013

NAME OF BUYER
ALLIED FITTING L.P.

P.O NO. 12016RG DT. 20/01/2016
INVOICE NO. RNG/EXP/15-3576 DT. 08/03/2016

MECHANICAL REQUIREMENTS

Sr. No.	Description	Qty (PCS)	Heat No.	Supp. Code	Y.S(PSI) Min 36,000	T.S(PSI) Min 70,000	E% Min 22%	R.A% Min 30%	Heat Treatment	Soaking Time (Min.)	Hardness BHN 137-187
1	8 300# SOFF FLG L3SF8-RG	5	H 5263	19	50852	79894	30.84	65.93	AS FORGED		162 - 164
2	8 300# SOFF FLG L3SF8-RG	8	H 5156	19	47542	78380	32.00	65.45	AS FORGED		158 - 160
3	8 300# SOFF FLG L3SF8-RG	13	H 5249	19	50260	78534	29.94	66.09	AS FORGED		160 - 162
4	8 300# SOFF FLG L3SF8-RG	2	H 5317	1	50388	83439	33.88	67.55	AS FORGED		170 - 172
5	8 300# SOFF FLG L3SF8-RG	27	H 5334	19	49443	80761	32.60	65.28	AS FORGED		164 - 166
6	6 300# SORF FLGS L3SR6-RG ✓	642	H 5400 ✓	34	48914	76005	30.70	65.12	AS FORGED		156 - 158
7	6 300# SORF FLGS L3SR6-RG ✓	6	H 5397 ✓	34	49499	78807	30.84	67.45	AS FORGED		160 - 162
8	6 300# LJ FLGS L3L6-RG	10	H 5392	27	49667	80346	34.44	69.24	AS FORGED		164 - 166

CHEMICAL REQUIREMENTS

Sr. No.	Heat No.	SPECIFIED ELEMENTS						UNSPECIFIED ELEMENTS				
		C.E. 0.47% Max	C 0.35 Max	Mn 0.60-1.25	P 0.035 Max.	S 0.04 Max.	Si .10 -0.35 Max.	Cu 0.40 Max.	Ni 0.40 Max	Cr 0.30 Max.	Mo 0.12 Max.	V 0.08 Max.
1	H 5263	0.41	0.20	1.24	0.015	0.009	0.23	0.006	0.008	0.010	0.003	0.003
2	H 5156	0.41	0.20	1.25	0.018	0.011	0.22	0.002	0.011	0.007	0.003	0.002
3	H 5249	0.41	0.20	1.24	0.011	0.007	0.23	0.006	0.008	0.007	0.003	0.003
4	H 5317	0.38	0.21	0.91	0.016	0.008	0.20	0.045	0.068	0.057	0.003	0.002
5	H 5334	0.42	0.21	1.24	0.023	0.009	0.25	0.007	0.008	0.013	0.003	0.004
6	H 5400	0.40	0.21	1.07	0.014	0.013	0.20	0.006	0.008	0.026	0.005	0.003
7	H 5397	0.39	0.20	1.07	0.014	0.016	0.20	0.007	0.008	0.022	0.005	0.003
8	H 5392	0.42	0.19	1.17	0.030	0.019	0.26	0.150	0.057	0.100	0.019	0.003

Certificate that the materials described above are in accordance with the order and specifications.
Material in accordance with NACE MRO 175-2003 and NACE MRO 103

For R.N. GUPTA & COMPANY LTD. Page No : 1

Note:- We hereby confirm that our QA system comply with requirements of Annex I, Clause4.3 of PED 97/23/EC and it is certified by M/s DNV BUSINESS ASSURANCE vide certificate No. 4487-2014-CE-IND-DNV Valid upto 31-03-2017. ISO 9001:2008 certificate No. is 39752-2008-AQ-IND-RvA.03 Dated 22/07/2017. Products also conform to requirements of ASTM A105-05/ASME SA105

METALLURGIST

P.O. 40572. 6" 300# - RFBLND. SA-105. 12388. HN. H5421

Stock 6317

6 300 RF BLIND FLANGE **
A105

R.N. GUPTA & COMPANY LTD., C-55, FOCAL POINT, LUDHIANA -141 010 (INDIA)

MATERIAL / MILL TEST CERTIFICATE EN 10204 : 2004 - 3.1

CERTIFICATE NO. 10021 DATE 16/05/2016

RAW MATERIAL SPECIFICATION : ASTM A105-14/ASME SA105-13 ✓

SPECIFICATION FOR INSPECTION :ANSI/ASME B16.5-2013

NAME OF BUYER

P.O NO. 67461 DT. 23/02/2016

INVOICE NO. RNG/EXP/16-3068 DT. 11/05/2016

MECHANICAL REQUIREMENTS

Sr. No.	Description	Qty (PCS)	Heat No.	Supp. Code	Y.S(PSI) Min 36,000	T.S(PSI) Min 70,000	E% Min 22%	R.A% Min 30%	Heat Treatment	Soaking Time (Min.)	Hardness BHN 137-187
17	12 150# BLRF FLGS	15	H 5438	19	50357	81250	30.64	65.02	AS FORGED		164 - 166
18	10 150# WNRF STD FLGS	57	H 5451	19	50965	77667	34.20	67.23	AS FORGED		158 - 160
19	12 150# WNFF STD FLG	2	H 5406	19	47121	78600	30.38	64.95	AS FORGED		160 - 162
20	10 150# WNFF STD FLGS	5	H 5451	19	50965	77667	34.20	67.23	AS FORGED		158 - 160
21	6 300# BLRF FLG ✓	10	H 5421 ✓	19	54407	80655	33.08	67.40	AS FORGED		162 - 164
22	5 150# SORF FLGS	25	H 5388	29	48228	78038	33.56	66.36	AS FORGED		158 - 160
23	6 150# SORF FLGS	16	H 5383	19	50607	81170	32.80	68.98	AS FORGED		164 - 166
24	6 150# SORF FLGS	107	H 5303	19	50145	79226	33.20	69.71	AS FORGED		162 - 164

CHEMICAL REQUIREMENTS

Sr. No.	Heat No.	SPECIFIED ELEMENTS						UNSPECIFIED ELEMENTS				
		C.E. 0.47% Max	C 0.35 Max	Mn 0.60-1.25	P 0.035 Max.	S 0.04 Max.	Si .10 -0.35	Cu 0.40 Max.	Ni 0.40 Max	Cr 0.30 Max.	Mo 0.12 Max.	V 0.05 Max.
17	H 5438	0.41	0.20	1.25	0.018	0.008	0.23	0.005	0.008	0.015	0.004	0.003
18	H 5451	0.41	0.20	1.24	0.024	0.002	0.21	0.004	0.008	0.006	0.003	0.003
19	H 5406	0.41	0.20	1.24	0.016	0.009	0.31	0.004	0.009	0.013	0.006	0.003
20	H 5451	0.41	0.20	1.24	0.024	0.002	0.21	0.004	0.008	0.006	0.003	0.003
21	H 5421	0.41	0.20	1.24	0.020	0.007	0.24	0.005	0.008	0.016	0.010	0.003
22	H 5388	0.38	0.21	0.95	0.016	0.011	0.22	0.009	0.015	0.015	0.013	0.003
23	H 5383	0.41	0.20	1.23	0.015	0.013	0.23	0.005	0.010	0.016	0.007	0.003
24	H 5303	0.40	0.19	1.24	0.018	0.011	0.25	0.007	0.010	0.009	0.003	0.003

Material in accordance with NACE MRO 175-2003 and NACE MRO 103

All Products were manufactured, Sampled, Tested and Inspected Solely by the manufacturer shown on this Test Report in accordance with indicated specification and were found to meet the requirements.

No Weld Repair was performed and all products are free of Weld Repair.All Products are free of Mercury Contamination and Radioactivity.

Note: We hereby confirm that our QA system comply with the requirements of Annex I,section 4.3 of PED 97/23/EC and it is certified by M/s DNV BUSINESS ASSURANCE vide Certificate No.4487-2014-CE-IND-DNV valid upto 31-03-2017 ISO 9001-2008 Certificate No. is 39752-2008-QA-INDIA-RvA.02 Dated 22/07/2014. Products also conform to requirements of ASTM A105-05/ASME SA105

For R.N. GUPTA & COMPANY LTD.

METALLURGIST

P.O. 40572 · 1" 300# RFSO · SA-105 · 12388 · HN · H5445

R.N. GUPTA & COMPANY LTD., C-55, FOCAL POINT, LUDHIANA -141 010 (INDIA)

MATERIAL / MILL TEST CERTIFICATE EN 10204 : 2004 - 3.1

Stock 6319

1 300 RF SLIP ON FLANGE **
A105

CERTIFICATE NO. 10076 DATE 30/06/2016

RAW MATERIAL SPECIFICATION : ASTM A105-14/ASME SA105-13 ✓

SPECIFICATION FOR INSPECTION : ANSI/ASME B16.5-2013

P.O NO. 67461 DT. 23/02/2016

INVOICE NO. RNG/EXP/16-2054 DT. 21/06/2016

MECHANICAL REQUIREMENTS

Sr. No.	Description	Qty (PCS)	Heat No.	Supp. Code	Y.S(PSI) Min 36,000	T.S(PSI) Min 70,000	E% Min 22%	R.A% Min 30%	Heat Treatment	Soaking Time (Min.)	Hardness BHN 137-187
33	3 150# SWRF STD FLGS	6	H 5442	19	48995	73865	30.04	66.36	AS FORGED		152 - 154
34	3 150# THRD FF FLGS	10	H 5461	1	47185	75544	30.96	66.55	AS FORGED		158 - 160
35	4 150# SWRF STD FLGS	6	H 5406	19	47121	78600	30.38	64.95	AS FORGED		160 - 162
36	4 150# THRD RF FLGS	25	H 5433	1	47119	77546	32.16	66.74	AS FORGED		158 - 160
37	1 300# SORF FLGS ✓	15	H 5445 ✓	6	51314	79913	28.24	64.89	AS FORGED		162 - 164
38	6 300# SORF FLGS	7	H 5442	19	48995	73865	30.04	66.36	AS FORGED		152 - 154
39	12 150# WNRF XH FLG	1	H 5443	19	45990	80441	32.02	63.81	AS FORGED		164 - 166
40	12 150# WNRF XH FLG	1	H 4990	19	51967	76457	30.90	65.26	AS FORGED		156 - 158

CHEMICAL REQUIREMENTS

Sr. No.	Heat No.	SPECIFIED ELEMENTS C.E. 0.47% Max	C 0.35 Max	Mn 0.60-1.25	P 0.035 Max.	S 0.04 Max.	Si .10 -0.35	UNSPECIFIED ELEMENTS Cu 0.40 Max.	Ni 0.40 Max	Cr 0.30 Max.	Mo 0.12 Max.	V 0.05 Max.
33	H 5442	0.42	0.21	1.24	0.025	0.002	0.21	0.005	0.008	0.008	0.004	0.003
34	H 5461	0.36	0.20	0.90	0.020	0.015	0.21	0.018	0.026	0.023	0.008	0.003
35	H 5406	0.41	0.20	1.24	0.016	0.009	0.31	0.004	0.009	0.013	0.006	0.003
36	H 5433	0.38	0.21	0.90	0.019	0.010	0.26	0.058	0.041	0.039	0.011	0.003
37	H 5445	0.39	0.22	0.98	0.024	0.010	0.26	0.004	0.020	0.008	0.005	0.003
38	H 5442	0.42	0.21	1.24	0.025	0.002	0.21	0.005	0.008	0.008	0.004	0.003
39	H 5443	0.41	0.20	1.25	0.025	0.003	0.21	0.004	0.008	0.007	0.004	0.003
40	H 4990	0.41	0.20	1.20	0.023	0.010	0.26	0.002	0.014	0.010	0.010	0.003

Material in accordance with NACE MRO 175-2003 and NACE MRO 103

All Products were manufactured, Sampled, Tested and Inspected Solely by the manufacturer shown on this Test Report in accordance with indicated specification and were found to meet the requirements.

No Weld Repair was performed and all products are free of Weld Repair.All Products are free of Mercury Contamination and Radioactivity.

ote: We hereby confirm that our QA system comply with the requirements of Annex I,section 4.3 of PED 97/23/EC and it is certified by M/s DNV BUSINESS ASSURANCE vide Certificate No.4487-2014-CE-IND-DNV valid upto 31-03-017 ISO 9001-2008 Certificate No. is 39752-2008-QA-INDIA-RvA.02 Dated 22/07/2014. Products also conform to requirements of ASTM A105-05/ASME SA105

For R.N. GUPTA & COMPANY LTD.

METALLURGIST

P.O. 40572 · 3/4". 300# · RFSO · SA-105 · 12388 · HN · 903256

AN ISO 9001: 2008 COMPANY

BALKRISHNA STEEL FORGE PVT. LTD.

Works:
Sitlamata Temple Road, Beyond G.E.B. Substation, Village : Shapar (Veraval), Dist.: RAJKOT-360 002. GUJARAT INDIA
Ph.: + +91 02827 252777, Fax : + + 91 2827-252507, E-mail : info@balkrishnaforge.com Web.: www.balkrishnaforge.com

MANUFACTURING TEST CERTIFICATE

CERTIFICATION AS PER EN 10204 3.1

F:QC:08

CERTIFICATE No.:-BF/1552
DATE:- 21.09.2010

P.O. No. :- 1008917LA, Dt.-08.07.2010
OUR REF No.:- EC- 474

P.O. Item. No.	Inv. Item No.	Sr. No.	Description	H.L No.	Qty.	Heat No.
13	1	1	3/4" NB x 300# SO RF	-	250	903256
14	2	2	1" NB x 300# SO RF	-	200	004939
15	3	3	8" NB x 300# SO RF	-	250	08/12/13
16	4	4	2" NB x 300# SW RF XH	-	02	C-449
16	4	5	2" NB x 300# SW RF XH	-	123	923268
17	5	6	1-1/4" NB x 300# THRD RF	-	100	004939
18	6	7	2" NB x 300# THRD RF	-	200	923268
19	7	8	6" NB x 300# THRD RF	-	25	08/21/05
20	8	9	8" NB x 300# WN FF STD	-	100	08/12/23

Supplied to :- M/s VAL-FIT, INC. USA.

GRADE : ASTM -A 105 (2006)

CHEMICAL COMPOSITION		C.%	Mn.%	P%	S%	Si.%	Cu.%	Ni.%	Cr.%	Mo.%	V.%	CE%
Std. Reqmnt.		0.25% Max	0.60/1.05 Max	0.035 Max	0.040 Max	0.10/0.35 Max	0.40 Max	0.40 Max	0.30 Max	0.12 Max	0.08 Max	0.47 Max
Check Analysis	903256	0.233	0.925	0.022	0.016	0.214	0.001	0.001	0.001	0.001	0.001	0.39
	004939	0.21	0.88	0.025	0.017	0.21	0.001	0.001	0.001	0.001	0.001	0.37
	08/12/13	0.20	0.84	0.035	0.017	0.26	0.17	0.031	0.039	0.001	0.001	0.36
	C-449	0.215	0.905	0.0284	0.020	0.26	0.007	0.005	0.022	0.001	0.001	0.37
	923268	0.183	0.755	0.023	0.016	0.175	0.001	0.001	0.001	0.001	0.001	0.31
	08/21/05	0.191	0.86	0.018	0.009	0.298	0.23	0.056	0.06	0.014	0.006	0.34
	08/12/23	0.19	0.88	0.021	0.017	0.33	0.112	0.020	0.007	0.001	0.001	0.35

Note :- Photo-copies of Original Mill Test Certificate for Heat No. 903256, 004939, 08/12/13, C-449, 923268, 08/21/05 & 08/12/23 are enclosed.

MECHANICAL PROPERTIES		U.T.S. N/mm2	Y.S. N/mm2	ELONGATION %	REDUCTION IN AREA %	HARDNESS (BHN)	GRAIN SIZE	HEAT TREATMENT
Std. Reqmnt.		485 Min	250 Min.	22% Min.	30% Min	137 to 187 BHN	ASTM 7-8	--NIL--
Results	903256	538.07	326.10	30.00	64.96	152		
	004939	517.69	328.14	34.20	64.96	149		
	08/12/13	520.49	328.09	30.20	66.11	156		
	C-449	526.63	336.26	25.34	65.43	152		
	923268	529.92	322.02	30.00	62.05	149		
	08/21/05	521.76	317.95	32.00	63.03	146		
	08/12/23	536.41	333.22	34.00	59.16	152		

Identification: "Nominal Bore, Pressure, Ratings Type B-16.5 A/ SA-105 903256, 004939, 08/12/13, C-449, 923268, 08/21/05 & 08/12/23 INDIA"
(Stamped on Periphery of Flanges)

Remark:- We hereby certify that the above mentioned item conforms to specification ASTM A- 105 & NACE MR0175

Chemist

Metallurgist

P.O. 40572 · 1½" 600# RFSO · SA · 105 · 12388 · HN · 95

UMA SHANKAR KHANDELWAL FORGING LTD.

Village Gholu Majra, Block Dera Bassi, Disst. Mohali (Punjab)
Tel: (01762) 281065 ,281402, E-MAIL:-info@uskfl.com

Works Test Certificate

USKFL/LAB NO: 12-13/13/SI-058 | INVOICE NO.: E-058 | DATE: 21.12.2013

Purchase Order No	63879	Customer	Silbo Industries INC. U.S.A.	Forging specification	ASME SA105-11 ASTM A105- 11a
Component	1 ½" -600 # SORF FLG.			Steel Supplier	BSL.
Drawing No.				Mill Heat No.	13H-089
Machining STD	ANSI B16.5- 2009 ASME B16.5- 2009	Quantity	100Nos.	USKFL HEAT NO:	95

TEST RESULTS

CHEMICAL COMPOSTION

Element %	Specified Composition	Actual	
		USKFL LAB	MILL T.C.
Carbon	0.35max	0.21	0.20
Manganese	0.60-1.05	0.91	0.88
Silicon	0.10-0.35	0.24	0.26
Sulphur	0.040max	0.020	0.016
Phosphorous	0.035max	0.029	0.032
Chromium	0.30max	0.038	0.042
Nickel	0.40max	0.018	0.015
Copper	0.40max	0.030	0.033
Molybdenum	0.12max	0.002	0.004
Vanadium	0.08max	0.003	0.004
Carbon Equivalent (CE)	0.47max	0.373	0.359

MECHANICAL PROPERTIES

PROPERTIES	SPECIFIED	OBTAINED
Yield Strength (mpa)	250.00min.	324.10
Tensile Strength (mpa)	485.00min.	545.20
%Elongation in 50mm / 4D	22.00min.	31.22
Hardness HBW	187max.	156-158
% Reduction of Area	30.00min.	64.29

Remarks:- We hereby certify that the product satisfies the requirement of ASTM A105 and material described here in has been tested in accordance with the applicable specifications referred above and meets the requirements as per EN10204/3.1&NACE-MR0-175/ISO15156Standard

Specified carbon as per Purchase Order 0.25%max.

Serrated face as per MSS-SP-6 With in limits of 125-250AARH

H.T:-Normalized at tem900c for 2 ½ hrs

CARBON EQUIVALENT (CE)

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

MARKING AS PER MSS-SP-25-2008

1 ½ -600 SA105 N 95 B16.5 USKFL INDIA

Checked by: Metallurgist

Certified by: Quality Control Manager

20

FLANGE / 600 SO RF / 1.5 - HEAT : 95

P.O.40572 · 3" · 300# · RFSO · SA 105 · 12388 · HN. 088

NORMA (INDIA) LIMITED

48,Site IV industrial Area, Sahibabad, Ghaziabad-201010 (U.P) INDIA.
Tel: 91-120-2896091, 2895404 Fax: 91-120-2895930 E-mail: normaindia@gmail. com

Works Test Certificate

NORMA/LAB NO-2606/14-15		INVOICE NO. E-205		DATE:-25-07-14	
P. Order. No:	202003	Customer:-		Forging specification	ASME SA105 -09 ASTM A105 -12
Component	3"-300# SORF FLG.			Steel Supplier	Bhushan Steels Ltd.
Drawing No.					
Machining STD	ANSI B16.5- 2009 ASME B16.5- 2009	Quantity:-	1500Nos.	Mill Heat No.	14E 162

TEST RESULTS — NORMA HEAT NO-088

CHEMICAL COMPOSTION

Elements %	Specified Composition	Actual	
		NORMA LAB	MILL T.C.
Carbon	0.35max.	0.22	0.21
Manganese	0.60-1.05	0.96	0.89
Silicon	0.10-0.35	0.24	0.24
Sulphur	0.040max.	0.014	0.012
Phosphorous	0.035max.	0.019	0.021
Chromium	0.30max.	0.10	0.010
Nickel	0.40max.	0.024	0.035
Copper	0.40max.	0.026	0.026
Molybdenum	0.12max.	0.007	0.005
Vanadium	0.080max.	0.004	0.007
Carbon Equivalent (CE)	0.47max.	0.388	0.367

MECHANICAL PROPERTIES.

PROPERTIES	SPECIFIED	OBTAINED
Yield Strength (mpa)	250.00 min.	348.53
Tensile Strength (mpa)	485.00 min.	541.96
%Elongation in 50mm / 4D	22.00 min	31.60
Hardness HB.	187. max.	149-163
% Reduction of Area	30.00 min.	60.25

Specified carbon as per Purchase Order 0.25max.

Serrated face as per MSS-SP-6 With in limits of 125-250AARH

CARBON EQUIVALENT (CE)

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

MARKING AS PER MSS-SP-25-2008
3"-300 SA/A105 088 B16.5 NORMA INDIA.

Remarks:- We here by certify that the material described here in has been tested in accordance with the applicable specifications referred above and meets the requirements as per EN10204/3.1B & NACE Standard-MR0175-2003.
"As per ASTM A105 Table 1 Note:-For each reduction of 0.01% below the specified carbon maximum(0.35%).an increase of 0.06% manganese above the specified maximum (1.05%)will be permitted up to maximum 1.35%.
Country of Origin-India.

Checked by: Metallurgist

Certified by: Quality Control Manager

Stock 6331

3 300 RF SLIP ON FLANGE **
A105

10140572 · 3" · 300# · RFSO · SA 105 · R388 1
HN · H5166

R.N. GUPTA & COMPANY LTD., C-55, FOCAL POINT, LUDHIANA -141 010 (INDIA)

RNG

MATERIAL / MILL TEST CERTIFICATE EN 10204 : 2004 - 3.1

CERTIFICATE NO. 8727 DATE 08/05/2015

RAW MATERIAL SPECIFICATION : ASTM A105-14/ASME SA105-14

SPECIFICATION FOR INSPECTION :ANSI/ASME B16.5-2013

NAME OF BUYER

P.O NO. 66414 DT. 18/12/2014

INVOICE NO. RNG/EXP/15-2046 DT. 02/05/2015

MECHANICAL REQUIREMENTS

Sr. No.	Description	Qty (PCS)	Heat No.	Supp. Code	Y.S(PSI) Min 36,000	T.S(PSI) Min 70,000	E% Min 22%	R.A% Min 30%	Heat Treatment	Soaking Time (Min.)	Hardness BHN 137-187
9	3 300# SORF FLGS	20	H 5166	19	50143	79905	33.14	68.45	AS FORGED		164 - 166
10	3 300# WNRF STD FLGS	53	H 5166	19	50143	79905	33.14	68.45	AS FORGED		164 - 166
11	3 300# WNRF STD FLGS	37	H 5105	1	47485	75352	30.64	67.17	AS FORGED		154 - 156
12	3 300# WNRF XH FLGS	130	H 5160	6	48588	78925	33.74	67.75	AS FORGED		161 - 163
13	3 300# BLRF FLGS	30	H 5171	20	49794	80249	31.20	65.43	AS FORGED		162 - 164
14	4 300# SORF FLGS	11	H 5170	19	52397	80063	32.80	65.32	AS FORGED		162 - 164
15	4 300# SORF FLGS	3	H 5026	2	49770	80273	33.86	66.28	AS FORGED		164 - 166
16	4 300# SORF FLGS	6	H 5153	19	53511	80368	32.84	69.30	AS FORGED		164 - 166

CHEMICAL REQUIREMENTS

Sr. No.	Heat No.	SPECIFIED ELEMENTS						UNSPECIFIED ELEMENTS				
		C.E. 0.47% Max	C 0.35 Max	Mn 0.60-1.25	P 0.035 Max.	S 0.04 Max.	Si .10 -0.35	Cu 0.40 Max.	Ni 0.40 Max	Cr 0.30 Max.	Mo 0.12 Max.	V 0.05 Max.
9	H 5166	0.41	0.19	1.25	0.018	0.022	0.25	0.002	0.028	0.018	0.014	0.003
10	H 5166	0.41	0.19	1.25	0.018	0.022	0.25	0.002	0.028	0.018	0.014	0.003
11	H 5105	0.38	0.21	0.91	0.015	0.019	0.19	0.016	0.018	0.046	0.013	0.002
12	H 5160	0.40	0.22	1.03	0.023	0.019	0.25	0.002	0.008	0.019	0.004	0.002
13	H 5171	0.38	0.20	0.93	0.030	0.018	0.23	0.074	0.043	0.081	0.012	0.003
14	H 5170	0.42	0.20	1.25	0.018	0.021	0.24	0.002	0.036	0.022	0.018	0.003
15	H 5026	0.37	0.20	0.93	0.020	0.015	0.22	0.019	0.023	0.051	0.016	0.002
16	H 5153	0.40	0.19	1.24	0.014	0.010	0.22	0.002	0.028	0.012	0.016	0.003

Material in accordance with NACE MRO 175-2003 and NACE MRO 103

All Products were manufactured, Sampled, Tested and Inspected Solely by the manufacturer shown on this Test Report in accordance with indicated specification and were found to meet the requirements.

No Weld Repair was performed and all products are free of Weld Repair.All Products are free of Mercury Contamination and Radioactivity.

Note: We hereby confirm that our QA system comply with the requirements of Annex I,section 4.3 of PED 97/23/EC and it is certified by M/s DNV BUSINESS ASSURANCE vide Certificate No.4487-2014-CE-IND-DNV valid upto 31-03-2017 ISO 9001-2008 Certificate No. is 39752-2008-QA-INDIA-RvA.02 Dated 22/07/2014. Products also conform to requirements of ASTM A105-05/ASME SA105

For R.N. GUPTA & COMPANY LTD.

METALLURGIST

P0.40572 · 3/4". (S.160) 90° elbow SA·234· WPB · 12388 · HN · 563

성적서번호 CERTIFICATE No. YKB045 페이지 Page : 1 of 6
발행일자 DATE OF ISSUE :2012.9.4
계약번호 CONTRACT(P/O)No. : YKTT1045
소 재 MATERIAL : ASTM A234/ASME SA234 WPB NACE MR0175-2003
적용규격 CRITERIA : ANSI B16.9-2007
수요가 CUSTOMER NORCA INDUSTRIAL COMPANY , LLC

검 사 증 명 서
MILL INSPECTION CERTIFICATE

MATERIAL MEET THE EN10204: 2004 type 3.1

주식회사 영광벤드
YOUNG KWANG BEND CO.,LTD
경기도 파주시 검산동 449
#449, GEOMSAN-DONG, PAJU-SI, GYEONGGI-DO, KOREA
TEL : 031-943-9885
FAX : 031-601-6210

순서 NO	제품규격 DESCRIPTION 각도×호칭×두께 (ANGLE×OUTDIA×THICK)			수량 QUANTITY (PCS)	제강번호 HEAT No.	화학성분(%) CHEMICAL COMPOSITION C	Si	Mn	P	S	Cr	Mo	Ni	Cu	V	CE	인장시험 TENSILE TEST 항복강도 YIELD STRENGTH	인장강도 TENSILE STRENGTH	연신율 (EL)	경도 HARDNESS	Delivery Condition	충격시험(℃) IMPACT TEST 흡수에너지 ENERGY	FLATTENING TEST	수압시험 HYDROSTATIC TEST
						×100			×1000								kgf/㎟		%	HB		J		kgf/㎠
	SPEC								0.040↓	0.040↓							240↑	415↑	25.5↑	197↓				N/A
1	90 LR	2.1/2	XH	15	262	0.22	0.26	0.52	0.019	0.019	0.01	0.01	0.004	0.01	0.001	0.31	335	485	29	158	A			
2	90 LR	3.1/2	XH	5	701	0.20	0.23	0.51	0.010	0.012	0.06	0.02	0.04	0.11	0.001	0.31	265	440	27	142	A			
3	90 LR	1/2	S160	15	310	0.17	0.22	0.45	0.027	0.022	0.05	0.01	0.02	0.02	0.001	0.26	305	455	26	146	A			
4	90 LR	3/4	S160	15	563	0.21	0.25	0.53	0.012	0.018	0.01	0.01	0.006	0.01	0.001	0.30	310	415	28	151	A			
5	90 LR	1.1/4	S160	15	611	0.21	0.29	0.52	0.020	0.011	0.01	0.01	0.006	0.02	0.001	0.30	315	470	28	159	A			
6	90 LR	1.1/2	S160	20	629	0.19	0.23	0.51	0.021	0.012	0.01	0.01	0.02	0.04	0.001	0.28	290	475	28.5	154	A			
7	90 LR	2	S160	17	492	0.18	0.24	0.55	0.005	0.004	0.03	0.01	0.01	0.02	0.001	0.28	300	505	32	158	A			
7	90 LR	2	S160	8	713	0.20	0.26	0.54	0.010	0.010	0.05	0.02	0.01	0.01	0.001	0.31	270	455	28.5	149	A			
8	90 LR	3	S160	15	171	0.21	0.26	0.48	0.018	0.016	0.02	0.01	0.02	0.02	0.001	0.30	295	500	32	156	A			
9	90 LR	3/4	XXH	15	116	0.18	0.26	0.44	0.014	0.017	0.03	0.01	0.02	0.05	0.001	0.27	290	435	26.5	143	A			
10	90 LR	1.1/4	XXH	5	355	0.21	0.26	0.43	0.025	0.028	0.04	0.01	0.01	0.01	0.001	0.29	245	410	26	157	A			
11	90 LR	1.1/2	XXH	20	411	0.20	0.23	0.51	0.006	0.008	0.03	0.01	0.02	0.05	0.001	0.30	330	480	29.5	154	A			

NOTE:
1. VISUAL & DIMENSION TEST:GOOD
2. Made from Seamless pipe,Cap is made from plate.
3. A:HOT FORMED WITH FINAL TEMPERATURE BETWEEN 620℃-980℃,AIR COOLING
   N:NORMALIZING AT TEMPERATURE 880℃×0.5 HR,AIR COOLING
4. C.E=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15

NONDESTRUCTIVE TEST

Inspection mode	NO.	Conclusion
UT		
MT		
PT		

SURVEYOR	본 제품은 관련규격에 합격 되었음을 보증합니다. WE HEREBY CERTIFY THAT MATERIAL DESCRIBED SPECIFICATION HEREIN HAS BEEN ACCEPTED IN ACCORDANCE WITH THE PRESCRIBED SPECIFICATION AND ORDER	S . H . KANG INSPECTION MANAGER

YOUNG KWANG BEND CO., LTD. S. H. Kang MANAGER QUALITY ASSURANCE DEPARTMENT

P0.40572. 3/4". 90° elbow. SA. 234. WPB. 12388. HN. 181581

PO#: p1578669 Pack# :417129 Order#: 1032076 Lot# : SKB.181581 Desc: 3/4 SCH 160 SMLS LR 45 A/SA234 WPB,SKB 54414

MATERIAL TEST & INSPECTION CERTIFICATE

SUNGKWANG BEND CO., LTD.(SKB)
26, Noksansandan 262-ro, Gangseo-Gu, Busan, Korea
TEL : 82-051-3300-450
FAX : 82-051-3300-335
http://www.skbend.com

CUSTOMER: FORGINGS FLANGES & FITTINGS INC.
PROJECT NAME: N/A

According to
DIN 50049 3.1 / EN 10204 3.1 / ISO 10474 3.1

PURCHASE ORDER NO.	173504	SPEC. FOR MATERIAL	ASTM/ASME A/SA234WPB-S 07/07ED ✓	CERTIFICATE NO.	QCLH2013052341
PJT NO.	N/A	SPEC. FOR INSPECTION	ASME B16.9	DATE OF ISSUE	2013.05.28
STARTING MATERIAL	SEAMLESS PIPE	SKB NO.	2012082502	VISUAL & DIMENSION	SATISFACTORY

NO.	SEQ/LINE/ITEM NO	DESCRIPTION	QTY	HEAT NO.	MFG ID NO.	POR/CODE/TAG NO
236		45D ELBOW(L) S20 12" B.W SMLS Black	100	026008	026008	
241		45D ELBOW(L) ✓ S160 ✓ 3/4" ✓ B.W SMLS Black	125	181581	181581 ✓	

CHEMICAL COMPOSITION(%) (L : LADLE, P : PRODUCT)

STD. / HEAT NO.	SPEC.	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	V	Nb	N	Al	B	Zr	Fe	Ti	C.E
	MIN		0.10	0.29															
	MAX	0.30		1.06	0.050	0.058	0.40	0.40	0.15	0.40	0.08								
026008	L	0.21	0.23	0.58	0.013	0.010	0.03	0.05	0.02	0.03	<0.01								
	P																		
181581	L	0.15	0.20	0.80	0.009	0.004	0.09	0.11	0.04	0.16	0.002								
	P																		

TENSILE TEST(Gauge Length :5D)

SPEC.	Y.S 0.2% offset	T.S	EL.	R.A
	KSI	KSI	%	%
MIN	35.0	60.0	1*	
MAX		85.0		
	45.6	68.9	41.0	
	45.9	74.5	39.0	

IMPACT TEST / HEAT NO.	TEST TEMP.	SIZE OF SPECIMEN(mm)		ABSORBED ENERGY STD. / VALUE			AVE.	LATERAL EXPANSION STD. / VALUE			AVE.	PERCENT SHEAR STD. / VALUE			AVE.
026008			B/M												
			H.A.Z												
			W/M												
181581			B/M												
			H.A.Z												
			W/M												

HARDNESS HB		HEAT TREATMENT	HOT FORMED. 870℃, N/A., *Air*		
MIN					
MAX	197	PMI	N/A	N.D.E	N/A
HB	142	FLATTENING TEST	N/A	**MEMO	
		BENDING TEST	N/A	1* THE MINIMUM ELONGATION OF THE FITTING MATERIAL REFER TO TABLE 2 OF A /SA234 SPEC.	
		HYDROSTATIC TEST	N/A		
HB	146	CORROSION TEST	N/A		
		GRAIN SIZE TEST	N/A		
		HIC TEST	N/A		

MATERIAL MEETS THE REQUIREMENTS OF NACE MR0175 & 0103
PED 97/23/EC
MATERIAL ALL MANUFACTURED IN KOREA.

□ REVIEWED BY
□ WITNESSED BY : _____

WE CERTIFY THIS MATERIAL HAS BEEN MANUFACTURED AND EXAMINED IN ACCORDANCE WITH ALL REQUIREMENTS OF THE SPECIFICATION AND THE RESULTS OF ALL EXAMINATION ARE ACCEPTABLE.

QM DIV. SENIOR MANAGING DIRECTOR

0.40572 2"(S.160) 45° elbow · SA-234 WPB · 12388
HN · PF-40

INSPECTION CERTIFICATE

PANTECH STEEL INDUSTRIES SDN. BHD. (809731-A)
LOT 13258 & 13259, Jalan Haji Abd. Manan,
Off Jalan Meru, 42200 Klang, Selangor, Malaysia.
Tel: 603-3393 1633 Fax: 603-3393 1733 E-mail: info@pantechsteel.com

ISO 9001
Cert. No.: QUR 0403926
PED 97/23/EC Annex 1 Clause 4.3
Cert. No.: 0038/PED/MUM/0810070/1

WROUGHT CARBON STEEL BUTTWELDING FITTINGS

INSPECTION DOCUMENT: EN10204:2004 Type 3.1

Certificate No : PSI 97915
Date : 26-Feb-15

Order No.	Invoice No.	Starting Material	Specification for Fittings- Seamless	Specification for Inspection
12515DPS-2	E 000011563	Seamless Pipe	ASTM A234-13 WPB/ASME SA234-13 WPB ✓ NACE MR0175/NACE MR0103/ISO15156* ✓	ASME B16.9-12 / ASTM A960-10

Heat No.	Product & Size	Quantity (pcs)	Visual Examination	Dimensional Inspection	Heat Treatment	Magnetic Particle Testing
PF 403 ✓	2" 45 DEG LR S160 ELBOW ✓	100	GOOD	GOOD	H	N-A

Specification	Chemical Composition (%)												Tensile Test *1			Hardness	
	C x100	Si x100	Mn x100	P x1000	S x1000	Ni x100	Cr x100	Mo x100	Cu x100	V x1000	Pb	CE x100	YS (KSI / MPa)	TS	E (%)	(HB) 1	(HB) 2
Min																	
Max	-	10	29	-	-	-	-	-	-	-	-	-	240	415	22	-	
Heat No.	30	-	106	50	58	40	40	15	40	80	-	50	-	-	-	197	
PF 403	11	18	80	11	0	3	3	1	5	0	<0.10	26	333	479	42.4	132	124

WE CERTIFY THAT ALL PRODUCTS WERE MANUFACTURED,SAMPLED,TESTED, AND INSPECTED SOLELY BY THE MANUFACTURER LISTED AT THE ADDRESS ABOVE IN ACCORDANCE WITH INDICATED SPECIFICATION AND FOUND TO MEET REQUIREMENTS. MATERIAL IS FREE FROM MERCURY AND RADIOACTIVE CONTAMINATION.
TENSILE REQUIREMENT: CONFORMS TO ASTM A370 STANDARD, LONGITUDINAL DIRECTION, GAUGE LENGTH 2" (50mm)
* HARDNESS ACCORDING TO NACE MR0175/ NACE MR 0103/ISO15156

NOTE:
C: Cold formed at temperature below 620°C
S: Stress relieved in temperature between 595°C - 690°C and cooled in still air
H : Hot formed in tamperature between 845°C - 945°C and cooled in still air.
N: Normalised at 910°C
Q: Heated to 910°C and quench in water.
T: Temper between 590°C - 690°C.

*1: YS = Yield strength TS=Tensile strength E = Elongation

Made in Malaysia

Stock 5271
2 S160 LR 45 WELD ELL **
A234WPB .344W

PANTECH STEEL INDUSTRIES SDN. BHD. 809731-A QA / QC MANAGER HOI YS

Quality Assurance Manager

P0.40572 · 1½" (S.160) 90° elbow · SA·234 WPB · 12388 ·
HN · 27082
PL 005403

PO#: p1578669 Pack# :417129 Order#: 1032076 Lot# : AWA.27082 Desc: 1-1/2 SCH 160 SMLS LR 90 A/SA234 WPB AWA

Awaji ASK

INSPECTION CERTIFICATE

EN 10204 3.1 : 2004

AWAJI MATERIA (THAILAND) CO.,LTD.

81,MOO4, PRAKASA ROAD, TAMBOL BANGMUANG, AMPHUR MUANG
SAMUTPRAKARN THAILAND 10270, Tel : (662)701-5226

ISO 9001 :2008 Manufacturing Company
Certified by BV. Certificate No. A-TH10000101

Material manufacturer QMS acc.
PED 97/23/EC. Annex1. Par4.3/AD2000W0
Certified by Lloyd's Register
Certificate No. 50207/1A1

MADE FROM SEAMLESS STEEL PIPE

Purchaser : FORGINGS FLANGES & FITTINGS, INC.

Date : JULY 23, 2012

Certificate No. : T12-71135

Order No.	Job No.	Product	Raw Material Pipe Maker
172508/27	-	CARBON STEEL BUTT WELDING FITTINGS	SUMITOMO METAL INDUSTRIES, LTD. (JAPAN)
Inspection Standard	Material Standard		Pipe Heat No. : J1KC776
ASME B16.9-07, ASME B16.25-07 ASTM A960-10 NACE MR-0175/ISO 15156-09 MR-0103-10	ASTM A234-11a, WPB ASME SA234-10, WPB except nuclear usage	Visual: GOOD / Dimension: GOOD	*4 UT Inspection: W.T. INSPECTED / Magnetic Particle Test: -

Manufacturing No. (Heat code.)	Product Code	Material	Article & Size	Quantity	Note.
27082 ✓	-	WPB ✓	S160 90 LONG RADIUS ELBOW ✓ 1~1/2"	100 Pcs.	

Specification		*1 Chemical Composition (%)																*2 Mechanical Test			
		C	Si	*3 Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	Ca	N	Al	C.E.	Y.S.	T.S.	E	Hardness
Min.		X100	X100	X100	X1000	X1000	X100	X100	X100	X100	X100	X100	X100	X10000	X10000	x1000	X1000	X100	MPa		%	HB
Max.		-	10	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	240	415	-	-
Heat No.		30	-	108	50	58	40	40	40	15	8	2	-	-	-	-	-	50	-	-	-	197
J1KC776	L	19	21	65	14	7	2	3	5	1	0	0	0	1	10	4	19	31	324	469	59	134
	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				

$$C.E. = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

*1 Equivalent for A234 WPB
*2 Y.S.= Yield Strength (0.2% offset), T.S. = Tensile Strength, E = Elongation (in 50mm)
*3 As per foot note D of ASTM A234 Table 1.
*4 UT = Ultrasonic thickness inspection

L = Ladle Analysis, P = Product Analysis
Weld repair is not applied to our products.
Steel Making by Vacuum degassed, killed steel.

ELBOW / Forming temperature 850°C—945°C and cooled in still air
TEE, REDUCER & CAP / Normalizing : 910°C

"We hereby certify that the material described herein has been duly inspected and conforms to the standard as specified above.

AT-24(2)17

Surveyor to

QA GM. /Work Inspector S. MAEKAWA

Stock 77804

2 S160 LR 90 WELD ELL **
A234WPB .344W

INSPECTION CERTIFICATE
(MILL TEST CERTIFICATE)
EN 10204 3.1

CHARM MING VIETNAM CO., LTD
SAIGON - LINH TRUNG EXPORT PROCESSING ZONE
THU DUC DISTRICT, HO CHI MINH CITY, VIET NAM.
TEL : 84-8-3897 4885
FAX : 84-8-3897 4894

PURCHASER : ALLIED FITTING L.P.
ORDER NO. : 12415CCV
SPEC. FOR RAW MATERIAL : ASTM A106 Gr. B, ASTM A234 Gr. WPB
SPEC. FOR INSPECTION : ASTM A234 - 13e1 WPB
ASME SA234 - 2013 WPB ✓
ASME B16.9-2012 / ASME B16.25-2012
BS EN 10204 3.1-2004

JOB NO. : AF1501005A
CERTIFICATE NO. : Q150512005A-03
DATE : MAY. 12, 2015

	PO. Item No.	Product & Size(Inch)			Heat Code	Quantity	Heat No.	Certificate No.
11	4	45 ELBOW LR	3	STD	73V	204	1414673V	C201440177-1
12	27	90 ELBOW LR	12	S40	476	27	WB530476	32120000853011-1
13	29	90 ELBOW LR	10	S80	357	10	W11405357	32120000571003-1
14	30	90 ELBOW LR	4	S120	2VS	34	1212882VS	C201228977-1
15	31	90 ELBOW LR ✓	2 ✓	S160 ✓	207 ✓	140	320207	BGSAG1205230001900

Spe.	Chemical Composition %													Tension Test			Hardness Test	Magnetic Particle Exam.
	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Pb	CE	Yield Strength	Tensile Strength	Elongation		
	X100	X100	X100	X1000	X1000	X100	X100	X100	X100	X1000	X1000	X1000	X100	P.S.I	P.S.I	%	HBW	
MIN		10	29											35000	60000	30		
MAX	25		106	50	58	40	40	40	15	80	20		42		95000		197	
11	15	22	86	12	6	7	2	5	1	5	1	4	31	43645	65540	38	120 - 128	N/A
12	12	21	125	14	5	1	2	3	0	5	2	4	34	39875	65395	38	133 - 138	N/A
13	15	27	100	13	7	2	1	1	0	3	3	1	32	44225	70905	38	137 - 142	N/A
14	16	23	82	11	9	7	2	3	1	4	1	*<3	31	41470	69310	36	127 - 131	N/A
15	17	24	53	7	3	6	3	6	2	*1	<1	*<3	28	44080	74965	34	129 - 136	N/A

Visual Examination	Dimensional Inspection	Heat Treatment	(*) Product Analysis by CHARM MING
Acceptable	Acceptable	N/A	

$CE = C + Mn/6 + (Cr + Mo + V) / 5 + (Ni + Cu) /15$

MATERIAL CONFORMS TO NACE MR0103-2012/ NACE MR0175-2009 and ISO 15156-2009

We hereby certify that the products described here in have been manufactured and tested in accordance with specifications and also the purchaser's requirements concerned.

NOTE:

1. ABOVE - LISTED ELBOWS HAVE BEEN HOT - FORMED AT A TEMPERATURE ABOVE 1150° F (621°C) AND BELOW 1800°F (982° C) AND SUBSEQUENTLY COOLED IN STILL AIR.
2. THE QUALITY MANAGEMENT SYSTEM OF ISO 9001-2008 AND PED 97/23/EC, ANNEX I SEC. 4.3 HAVE BEEN APPROVED BY LRQA
3. ANOTHER PED 97/23/EC, ANNEX I SEC. 4.3 TUV-NORD 0045
4. ITEM NUMBER 12 USES RAW MATERIAL A106 GR.B/ A333 GR.6. THE MANGANESE ABOVE THE SPECIFIED MAXIMUM WILL BE PERMITTED UP TO A MAXIMUM OF 1.65%. (FOOTNOTE D IN TABLE 1 OF ASTM A234 -13e1 WPB).

Quality Assurance Section/Manager

P.O. 40572. 2" (S160) 90° elbow. SA-234 WPB. 123388. HN. 207

P.O.40572 · 2" (S.160) 90° elbow · SA 234 WPB · 12388 · HN · RL801

INSPECTION CERTIFICATE

PANTECH STEEL INDUSTRIES SDN. BHD. (509731-A)
LOT 13256 & 13259, Jalan Haji Abd. Manan,
Off Jalan Meru, 42200 Klang, Selangor, Malaysia.
Tel: 603-3393 1633 Fax: 603-3393 1733 E-mail: info@pantechsteel.com

LLOYD'S REGISTER · LRQA
ISO 9001
Cert. No.: KLR 0403926
PED 97/23/EC Annex 1 Clause 4.3
Cert. No.: 0038/PED/MUM/0810070/1

WROUGHT CARBON STEEL BUTTWELDING FITTINGS

INSPECTION DOCUMENT: EN10204:2004 Type 3.1

Purchaser: ALLIED FITTING CORP

Certificate No: PSI 102152
Date: 7-Jul-15

Order No.	Invoice No.	Starting Material	Specification for Fittings- Seamless	Specification for Inspection
12815VPS-1	E 000011901	Seamless Pipe	ASTM A234-13 WPB/ASME SA234-13 WPB ✓ NACE MR0175/NACE MR0103/ISO15156*	ASME B16.9-12 / ASTM A960-10

Heat No.	Product & Size	Quantity (pcs)	Visual Examination	Dimensional Inspection	Heat Treatment	Magnetic Particle Testing
RL 801 ✓	2" 90 DEG LR S160 ELBOW ✓	3	GOOD	GOOD	H	N.A

Specification / Heat No.	Chemical Composition (%)												Tensile Test *1			Hardness	
	C x100	Si x100	Mn x100	P x1000	S x1000	Ni x100	Cr x100	Mo x100	Cu x100	V x1000	Pb	CE x100	YS (KSI / MPa)	TS	E (%)	(HB) 1	(HB) 2
Min	-	10	29	-	-	-	-	-	-	-	-	-	240	415	22	-	
Max	30	-	106	50	58	40	40	15	40	80	-	50	-	-	-	197	
RL 801	12	17	76	13	4	1	5	1	3	8	<0.10	28	300	454	41.0	131	133

WE CERTIFY THAT ALL PRODUCTS WERE MANUFACTURED,SAMPLED,TESTED, AND INSPECTED SOLELY BY THE MANUFACTURER LISTED AT THE ADDRESS ABOVE IN ACCORDANCE WITH INDICATED SPECIFICATION AND FOUND TO MEET REQUIREMENTS. MATERIAL IS FREE FROM MERCURY AND RADIOACTIVE CONTAMINATION.
TENSILE REQUIREMENT: CONFORMS TO ASTM A370 STANDARD, LONGITUDINAL DIRECTION, GAUGE LENGTH 2" (50mm)
* HARDNESS ACCORDING TO NACE MR0175/ NACE MR 0103/ ISO15156

NOTE:
C: Cold formed at temperature below 620°C
S: Stress relieved in temperature between 595°C - 690°C and cooled in still air.
H : Hot formed in temperature between 845°C - 945°C and cooled in still air.
N: Normalised at 910°C
Q: Heated to 910°C and quench in water.
T: Temper between 590°C - 690°C.

*1: YS = Yield strength TS=Tensile strength E = Elongation

Made in Malaysia

Stock 77804
2 S160 LR 90 WELD ELL **
A234WPB .344W

Quality Assurance Manager

Radiographic Inspection Report – ASME
CP120216

QMS Management System	Issued by: TechCorr USA Management, LLC	Date: 10/31/16	TC-4300 Rev B

Client SOUTH GATE ENG. **Date:** 12/2/16 **Page** 1 of 1

Location CHINO,CA **P.O. Number:** 40769 BT#8459

Unit / System S/N 25372 **Job Number:** 12388

	C/S	A	B	C	D	E
Material		A	B	C	D	E
Thickness	.75"	A	B	C	D	E
Diameter	28"	A	B	C	D	E
Reinf. Thickness	.187"	A	B	C	D	E
SFD / SOD	A 14"/13.06"		B	C	D	E
Exposure Time	55SECA		B	C	D	E
IQI Size/Material	.016/SSA		B	C	D	E
IQI Location (S/F)	F	A	B	C	D	E
Shim Thk & Mat'l	WIRE	A	B	C	D	E
# of Exposures	1	A	B	C	D	E
Markers: NBR or Spacing	12.56"	A	B	C	D	E

☒ A — SWE/SWV

☐ SWE/SWV

☐ SWE/SWV

☐ DWE/SWV

☐ DWE/SWV

☐ DWE/DWV

☐ DWE/DWV

Source	Ci	kV	Ma	Focal Spot	Screens	Film Loading	Film Process:
☒ Ir ☐ Co ☐ X-ray	90.2	N/A	N/A	.124"	PB Front .010 Rear .010	☒ Single ☐ Double	Time 5MIN

NDE Procedure: RT001 REV.2.5

Acceptance Standard: ASME SECVIII DIV.1(UW51)

Surface Condition: AS WELDED

Temp 68 DEG. ☐ Auto ☒ Manual

Stage of Manufacture: ☐ Intermediate ☒ Final ☐ Repair ☐ Before PWHT ☐ After PWHT

C – Crack; SL – Slag; T – Tungsten; CP – Cluster Porosity; P – Porosity / Gas Pocket; HB – Hollow Bead; IP – Insufficient Penetration; IF – Insufficient Fusion; EP – Excessive Penetration; EU – External Undercut; IU – Internal Undercut; IC – Internal Concavity; SU – Surface; HL – IP Due to High / Low; BT – Burn Through

Weld	View	Density Pen.	Density Weld	ACC	REJ	List Indications	Welder ID – Other ID – Remarks
GS-2 28"	0-14	3.18	3.13	ACC			
	14-26		2.95	ACC			
	26-38	2.56	2.48	ACC			
	38-50		2.91	ACC			
	50-62		3.01	ACC			JK 12.5.16
	62-76	3.24	3.28	ACC			
	76-0		3.30	ACC			

Number of Film and Size: (7)4.5"X17" | Film Brand/Type: AGFA D5 | Total Number of Welds: 1

Time Start (am/pm) _____ Time End (am/pm) _____ Travel Time (hrs.) _____ Work Time (hrs.) _____ Vehicle/ Mileage _____ Materials Used _____

By signing below I attest to the fact that all activities involved during this inspection were performed in accordance with the procedure and/or specification referenced above. Customer's signature certifies hours, equipment and materials shown here are correct for the period covered by this time sheet and are accepted this date for payment.

	Print Name		*Signature*
TCE Inspector	CRIS PEREZ LEVELII	TCE Inspector	[signature]
TCE Assistant(s)	C. RUBIO	TCE Assistant(s)	
Client Rep.		Client Rep.	

Our letters and reports are for the exclusive use of the CLIENT. The use of our name must receive our prior written approval. Our letters and reports apply only to the material(s) tested and/or inspected and are not necessarily indicative of the qualities of apparently identical or similar material(s). We assume no responsibility for losses of any kind due to our interpretation of the quality of the materials submitted. (all data and information will be held strictly confidential.)

Magnetic Particle Inspection Report

QMS Management System	Issued by: TechCorr USA Management, LLC	Date: 09/16/14	TC-4200 Rev B

Client SOUTHGATE ENGINEERING REPORT:AG111516MT4 BT:07324

Project Description MT INSPECTION ON ELEVEN [11] CAT C NOZZLE WELDS.

Inspection Date 11/15/16
Purchase Order 0040659-00
Procedure MT-001 REV 2.0
Specification ASME SEC VIII DIV 1
Scope of Exam PERFORM MT FINAL ON [11] NOZZLES. SEE BELOW

Work Order 012388 01 002000
Part Number 9927
S/N: 25372 JOB: 12388
Description PERFORM MT ON [11] NOZZLES SEE BELOW FOR NOZZLES NUMBERS.
Material C/S
Material Temperature 75* F
Quantity 11

TEST PARAMETERS

☒ A/C ☐ D/C ☒ Dry ☐ Wet

Magnetizing Source:
Mfg. & Model PARKER B-100 CONTOUR S/N 9456 Calibration Date 10/20/16

Magnetic Particle:
Manufacturer MAGNAVIS Type #8A RED Batch No. 14M023
Color RED POWDER Concentration DRY

LIGHT SOURCE

☒ Natural Light ☐ U.V. Light

U.V. Light Manufacturer - Model - Intensity @ surface - $\mu W/cm^2$
U.V. Light Meter Manufacturer - Model - S/N - Date of Calibration -

RESULTS

JK 11.16.16

☒ Acceptable / Quantity: 11 ☐ Unacceptable / Quantity:

Remarks: PERFORMED MT FINAL ON ELEVEN [11] CAT C NOZZLES.
NO RELEVANT INDICATIONS WERE FOUND AT THE TIME OF INSPECTION.
NOZZLE: N1A, N1B, N2, N3, N4, N5, N8, N9, N10, N11, N12.

Time Start (am/pm)	Time End (am/pm)	Travel Time (hrs.)	Work Time (hrs.)	Vehicle/ Mileage	Materials Used

By signing below I attest to the fact that all activities involved during this inspection were performed in accordance with the procedure and/or specification referenced above. Customer's signature certifies hours, equipment and materials shown here are correct for the period covered by this time sheet and are accepted this date for payment.

	Print Name		Signature
TCE Inspector	ALAN GATZ LV II	TCE Inspector	
TCE Assistant(s)		TCE Assistant(s)	
Client Rep.	JOHN KING	Client Rep.	

Our letters and reports are for the exclusive use of the CLIENT. The use of our name must receive our prior written approval. Our letters and reports apply only to the material(s) tested and/or inspected and are not necessarily indicative of the qualities of apparently identical or similar material(s). We assume no responsibility for losses of any kind due to our interpretation of the quality of the materials submitted. (all data and information will be held strictly confidential.)

Radiographic Inspection Report – ASME CP111616-7

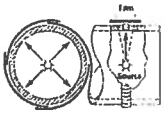
QMS Management System	Issued by: TechCorr USA Management, LLC	Date: 12/23/09	TC-4300 Rev A

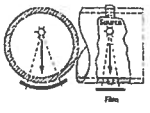
Client SOUTH GATE ENG. **Date:** 11/16/16 **Page** 1 of 1

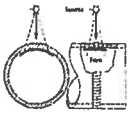
Location CHINO,CA **P.O. Number:** 40676 BT#8093

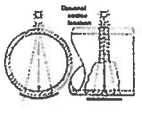
Unit / System S/N 25372 **Job Number:** 12388

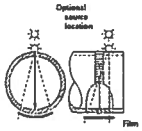
Material	C/S A	B	C	D	E
Thickness	.75" A	B	C	D	E
Diameter	28" A	B	C	D	E
Reinf. Thickness	.187" A	B	C	D	E
SFD	18" A	B	C	D	E
Exposure Time	1:50 A	B	C	D	E
IQI Size/Material	.020/SS A	B	C	D	E
IQI Location (S/F)	S A	B	C	D	E
Shim Thk & Mat'l	WIRE A	B	C	D	E
# of Exposures	5 A	B	C	D	E
Markers: NBR or Spacing	11" A	B	C	D	E

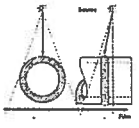
☐  SWE/SWV

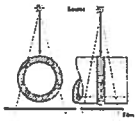
☐  SWE/SWV

☒ A  SWE/SWV

☐  DWE/SWV

☐  DWE/SWV

☐  DWE/DWV

☐  DWE/DWV

☐

Source	Ci	kV	Ma	Focal Spot	Screens	Front .010 / Rear .010	Film Loading	Film Process:
☒ Ir ☐ Co ☐ X-ray	71.5	N/A	N/A	.154	Pb		☒ Single ☐ Double	Time 5MIN

NDE Procedure: RT001REV.2.5

Acceptance Standard: ASME SECVIII DIV.1(UW51)

Surface Condition: AS WELDED

Temp 68 ☐ Auto ☒ Manual

Stage of Manufacture: ☐ Intermediate ☒ Final ☐ Repair ☐ Before PWHT ☐ After PWHT

C – Crack; CP – Cluster Porosity; IP – Insufficient Penetration; EU – External Undercut; SU – Surface
SL – Slag; P – Porosity / Gas Pocket; IF – Insufficient Fusion; IU – Internal Undercut; HL – IP Due to High / Low
T – Tungsten; HB – Hollow Bead; EP – Excessive Penetration; IC – Internal Concavity; BT – Burn Through

Weld	View	Density Pen.	Density Weld	ACC	REJ	List Indications	Welder ID – Other ID – Remarks
LS 28"	0-1	2.86	2.87	ACC			
	1-2	2.56	2.53	ACC			
	2-3	2.75	2.67	ACC			
	3-4	3.06	3.17	ACC			
	4-5	3.14	3.02	ACC			

JK 11.17.16

Number of Film and Size: (5) 4.5"X17" | Film Brand/Type: AGFA D5 | Total Number of Welds: 1

Time Start (am/pm) _____ Time End (am/pm) _____ Travel Time (hrs.) _____ Work Time (hrs.) _____ Vehicle/ Mileage _____ Materials Used _____

By signing below I attest to the fact that all activities involved during this inspection were performed in accordance with the procedure and/or specification referenced above. Customer's signature certifies hours, equipment and materials shown here are correct for the period covered by this time sheet and are accepted this date for payment.

	Print Name		*Signature*
TCE Inspector	CRIS PEREZ LEVELII	TCE Inspector	
TCE Assistant(s)	D. PRESLEY	TCE Assistant(s)	
Client Rep.		Client Rep.	

Our letters and reports are for the exclusive use of the CLIENT. The use of our name must receive our prior written approval. Our letters and reports apply only to the material(s) tested and/or inspected and are not necessarily indicative of the qualities of apparently identical or similar material(s). We assume no responsibility for losses of any kind due to our interpretation of the quality of the materials submitted. (all data and information will be held strictly confidential.)

TechCorr	Ultrasonic Inspection Report - ASME		
QMS Management System	Issued by: TechCorr USA Management, LLC	Date: 12/15/09	TC-4001 Rev A

Client South Gate Engineering

Project Description UTSW Job 12388

Inspection Date 12-02-2016
Purchase Order 0040764-00
Procedure UT-002 Rev 1.5
Specification ASME SEC VIII DIV 1
Scope of Exam UTSW

Work Order 012388 01 002000
Part Number s/n 25372
Description UTSW in lieu of RT per UW 51
Girth Seam 1
Material 28" O.D. / 3/4" THK / C.S.
Heat Code/Number N/A
Quantity 1

TEST PARAMETERS

Instrument Epoch 600 S/N 120446811 Date of Calibration 1-8-2016

Longitudinal Frequency	5 mHZ	Size	.375"	Type	D790	S/N	689796
Shear Wave Frequency	2.25" mHZ	Size	.5"	Type	V540-SM	S/N	935980
Shear Wave Frequency	mHZ	Size		Type		S/N	
Shear Wave Frequency	mHZ	Size		Type		S/N	

Couplant sonotech Surface Condition as welded
Calibration Standard DSC S/N 087114 .25"-1.0" S/N 069014

Calibration Reference Level (db)	0 80	45	N/A	60	80	70	80
Others N/A	0 N/A	45	N/A	60	N/A	70	N/A

RESULTS

Acceptable 1 Unacceptable 0

Remarks TechCorr performed ultrasonic shear wave inspection on girth seam 1 (final weld) in lieu of RT.
No relevant indications were noted at the time of inspection.

Time Start (am/pm)	Time End (am/pm)	Travel Time (hrs.)	Work Time (hrs.)	Vehicle/ Mileage	Materials Used

By signing below I attest to the fact that all activities involved during this inspection were performed in accordance with the procedure and/or specification referenced above.

	Print Name		*Signature*
TCE Inspector	Christopher Perkins LV II	TCE Inspector	
TCE Assistant(s)		TCE Assistant(s)	
Client Rep.	JOHN KING	Client Rep.	

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Magnetic Particle Inspection Report

QMS Management System	Issued by: TechCorr USA Management, LLC	Date: 09/16/14	TC-4200 Rev B

Client South Gate Engineering

Project Description Magnetic Particle Inspection on Cat C Welds

Inspection Date: 12-02-2016
Purchase Order: 0040764-00
Procedure: MT-001 Rev 2.0
Specification: ASME Sec VIII Div 1
Scope of Exam: Dry Magnetic Particle Inspection

Work Order: 012388 01 002000
Part Number: s/n 25372
Description: Cat C Final Welds
Material: c/s
Material Temperature: 65F
Quantity: 4

TEST PARAMETERS

■ A/C ☐ D/C ■ Dry ☐ Wet

Magnetizing Source:
Mfg. & Model: Parker B-100 S/N: 9372 Calibration Date: 5-16-2017

Magnetic Particle:
Manufacturer: Magnaflux Type: #8A Red Powder Batch No.: 13B063
Color: Red Concentration: n/a

LIGHT SOURCE

■ Natural Light ☐ U.V. Light

U.V. Light Manufacturer: N/A Model: N/A Intensity @ surface: N/A $\mu W/cm^2$
U.V. Light Meter Manufacturer: N/A Model: N/A S/N: N/A Date of Calibration: N/A

RESULTS

■ **Acceptable / Quantity:** 4 ☐ **Unacceptable / Quantity:**

Remarks: Techcorr performed dry powder magnetic particle testing on the final weld of nozzles: N6A, N6B N7A, N7B. No relevant indications were noted at the time of inspection.

Time Start (am/pm)	Time End (am/pm)	Travel Time (hrs.)	Work Time (hrs.)	Vehicle/ Mileage	Materials Used

By signing below I attest to the fact that all activities involved during this inspection were performed in accordance with the procedure and/or specification referenced above.

	Print Name	Signature
TCE Inspector	Christopher Perkins LV II	TCE Inspector
TCE Assistant(s)		TCE Assistant(s)
Client Rep.	JOHN KING	Client Rep.

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Magnetic Particle Inspection Report

QMS Management System	Issued by: TechCorr USA Management, LLC	Date: 09/16/14	TC-4200 Rev B

Client South Gate Engineering

Project Description Magnetic Particle Inspection on Cat D Welds

Inspection Date: 12-02-2016
Purchase Order: 0040764-00
Procedure: MT-001 Rev 2.0
Specification: ASME Sec VIII Div 1
Scope of Exam: Dry Magnetic Particle Inspection

Work Order: 012388 01 002000
Part Number: s/n 25372
Description: Cat D Final Welds
Material: c/s
Material Temperature: 65F
Quantity: 15

TEST PARAMETERS

■ A/C ☐ D/C ■ Dry ☐ Wet

Magnetizing Source:
Mfg. & Model: Parker B-100 S/N: 9372 Calibration Date: 5-16-2017

Magnetic Particle:
Manufacturer: Magnaflux Type: #8A Red Powder Batch No.: 13B063
Color: Red Concentration: n/a

LIGHT SOURCE

■ Natural Light ☐ U.V. Light

U.V. Light Manufacturer: N/A Model: N/A Intensity @ surface: N/A $\mu W/cm^2$
U.V. Light Meter Manufacturer: N/A Model: N/A S/N: N/A Date of Calibration: N/A

RESULTS

■ **Acceptable / Quantity:** 15 ☐ **Unacceptable / Quantity:**

Remarks: Techcorr performed dry powder magnetic particle testing on the final weld of nozzles: N1A N1B, N2, N3, N4, N5, N6A, N6B, N7A, N7B, N8, N9, N10, N11, N12.

No relevant indications were noted at the time of inspection.

Time Start (am/pm)	Time End (am/pm)	Travel Time (hrs.)	Work Time (hrs.)	Vehicle/ Mileage	Materials Used

By signing below I attest to the fact that all activities involved during this inspection were performed in accordance with the procedure and/or specification referenced above.

	Print Name		Signature
TCE Inspector	Christopher Perkins LV II	TCE Inspector	
TCE Assistant(s)		TCE Assistant(s)	
Client Rep.	JOHN KING	Client Rep.	

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SOUTH GATE ENGINEERING

RECORD OF HYDROSTATIC TEST

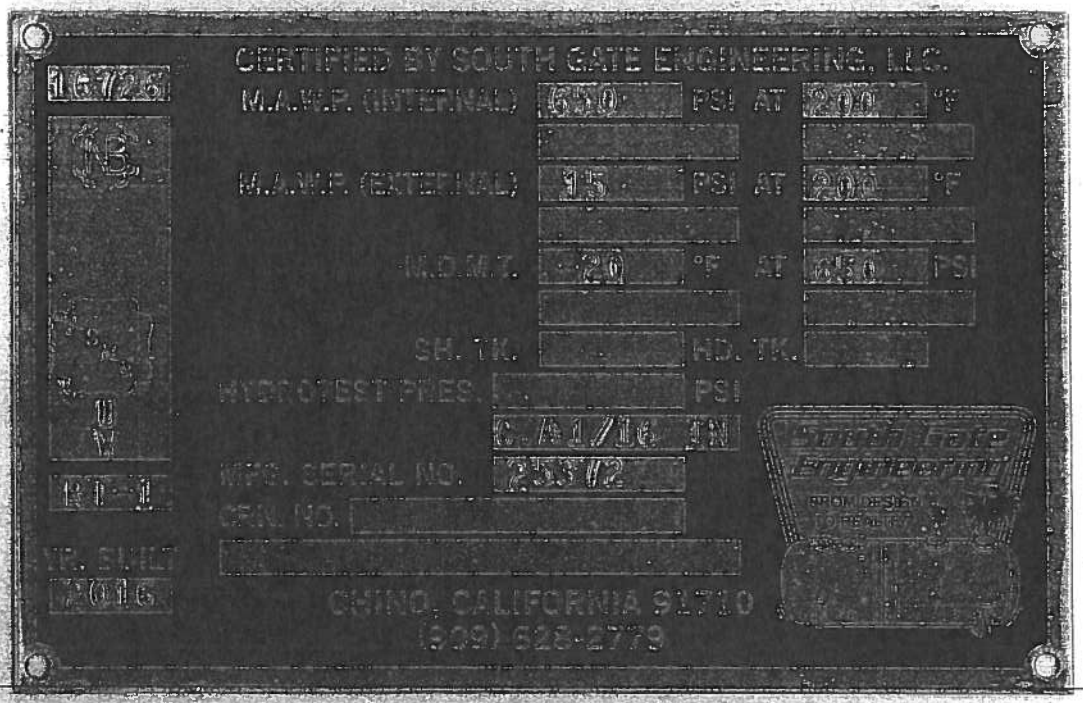
SGE job No.:	12388	**Customer:**	LA Turbine Corp
Serial No.:	25372	**Customer PO:**	23748
Model No.:	HOT28-56U	**Tag #:**	
Date of Test:	12/6/2016		
Gauge No.:	10	**Chart Recorder No.:**	
Gauge Range:	3,000	**Chart Recorder Range:**	
Calib. Valid thru:	9/1/17	**Calibration Date Due:**	
Test Medium:	Water		
Test Pressure:	975 PSI	**Hold Time:**	1 Hrs.

Remarks: No leaks detected during test 74 deg. F

SGE Representative: Greg Allen **Date:** 12/6/2016

***Customer Representative:** _____ **Date:** _____

* If Required


16726
CERTIFIED BY SOUTH GATE ENGINEERING, LLC.
M.A.W.P. (INTERNAL) 650 PSI AT 200 °F
M.A.W.P. (EXTERNAL) 15 PSI AT 200 °F
M.D.M.T. -20 °F AT 650 PSI
SH. TK. HD. TK.
HYDROTEST PRES. PSI
C.A 1/16 IN
MFG. SERIAL NO. 25362
DRN. NO.
YR. BUILT 2016
CHINO, CALIFORNIA 91710
(909) 628-2779
PT-1

10/31/2016 10:13:46AM

SHOP TRAVELER

Work Order
012388 - 01L

Description	Order	Quantity	UO	Due	Sales Order
vessel coating	10/31/16	1.00	EA	12/20/16	0012388-002

Part Number/Rev/Loc 12388-PAINT
Customer Name
Cust P O Number 23748
S/N - 25372
Cust Number LATURB
Prod Line PA
N/B# - _____

Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	LABOR Setup	LABOR Runtime	LABOR Total	MATERIAL Unit/Part	MATERIAL Total
000001			Interior Coating:								
000001			Interior Coating:				.0501	97.0000	97.0501		
			Surface to be sandblasted to SP-6 and treated with rust inhibitor (WD-40).								
			Exterior Coating:								
			Surface is sandblasted to SP-6and coated with 4 to 6 mils of Carboline Carboguard 890.								
			Color TBD.								
			S/N 25372								

000100 L Q.C 25 — Start 12/14/16 Due 12/14/16 — Hrs 0.02

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
		[illegible]	10/31/16		

Q.C/AI REVIEW HOLD

000200 L SNBL 295 — Start 12/15/16 Due 12/15/16 — Hrs 10.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
[signature]	12-9-16	JG	12-9-16		

SANDBLAST

000300 L LNPN 305 — Start 12/15/16 Due 12/15/16 — Hrs 2.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
[signature]	12-5-16	JG	12-5-16		

SPRAY W/WD-40

Work Order	Description	Due	Quantity	Ship	Quantity	Sales Order
012388 - 01L	vessel coating	12/20/16	1.00			0012388-002

S/N - 25372

Seq	LMO	WC-Part-Code	Description	Start	Due	Unit	LABOR Setup	LABOR Runtime	LABOR Total	MATERIAL Unit/Part	MATERIAL Total

000400 L LNPN 310 — Start 12/15/16 Due 12/16/16 — Hrs 6.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
[signature]	12-9-16	JG	12-9-16		

PAINT

000500 L LNPN 320 — Start 12/16/16 Due 12/16/16 — Hrs 1.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
[signature]	12-12-16	JG	12-12-16		

DRY FILM TEST

000600 L Q.C 72 — Start 12/16/16 Due 12/16/16 — Hrs 0.02

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
[signature]	12-12-16	JG	12-12-16		

INSPECT LINE AND PAINT

000700 L LNPN 325 — Start 12/16/16 Due 12/16/16 — Hrs 2.00

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date
[signature]	12-12-16	JG	12-12-16		

TOUCH UP

000800 L ZIND 400 — Start 12/19/16 Due 12/19/16 — Hrs 0.02

Foreman Initial	Date	QC Initial	Date	A-I Initial	Date

SHIPPING

.0501 21.0000 21.0501

South Gate Engineering, LLC
13477 Yorba Ave
Chino, CA 91710

Job # 12388-01L
SN: 25372
Date: 12/9/2016

X Internal
External

☑ Surface Preparation ☐ DFT
☐ Coating Application ☐ Holiday

Ambient Conditions

Time of Day	9:30					
Dry Bulb Tempertaure (°F)	73.9					
Wet Bulb Temperature (°F)	57.9					
Relative Humidity(%)	37					
Dew Point (°F)	46.0					
Surface Temperature (°F)	74.5					

Testing

☐ Chlorides
☐ Sulfates
☐ Nitrates

Surface Preparation

SSPC SP- 6 | Specified mils: N/A | Achieved mils: | Blotter test: ☐ Pass ☐ Fail

Abrasive Type: Garnet # 36 | ☑ New ☐ Recycled | Air Supply: cfm

Abrasive Analysis:

	Test Method	Results
☐ Oil & Grease		
☐ Chlorides		ppm
☐ Sulfates		ppm
☐ Nitrates		ppm

Substrate Analysis:

	Test Method	Results
☐ Oil & Grease		
☐ Chlorides		ppm
☐ Sulfates		ppm
☐ Nitrates		ppm

Replica Tape

Minimum 3 readings for first 100 ft², and 3 readings for each additional 1000 ft²

N/A	N/A
Location:	Location:
N/A	N/A
Location:	Location:
N/A	N/A
Location:	Location:

Notes: COAT W/ WD-40 RUST INHIBITOR

QC Inspector Signature	12/9/2016 Date	☐ See attached page for additional replica tape

South Gate Engineering, LLC
13477 Yorba Ave
Chino, CA 91710

Job # 12388-01L
SN: 25372
Date: 12/9/2016

☐ Internal
☐
☒ External

☑ Surface Preparation ☐ DFT
☐ Coating Application ☐ Holiday

Ambient Conditions

Time of Day	9:30					
Dry Bulb Tempertaure (°F)	73.9					
Wet Bulb Temperature (°F)	57.9					
Relative Humidity(%)	37					
Dew Point (°F)	46.0					
Surface Temperature (°F)	74.5					

Testing

☐ Chlorides
☐ Sulfates
☐ Nitrates

Surface Preparation

SSPC SP- 6 | Specified mils: 1.5-3.0 | Achieved mils: 2.9 | Blotter test: ☐ Pass ☐ Fail

Abrasive Type: Garnet # 36 | ☑ New ☐ Recycled | Air Supply: cfm

Abrasive Analysis:

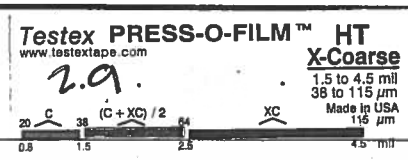
	Test Method	Results
☐ Oil & Grease		
☐ Chlorides		ppm
☐ Sulfates		ppm
☐ Nitrates		ppm

Substrate Analysis:

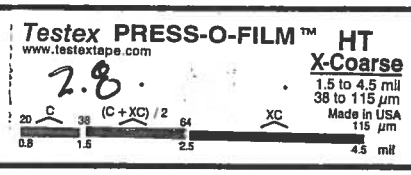
	Test Method	Results
☐ Oil & Grease		
☐ Chlorides		ppm
☐ Sulfates		ppm
☐ Nitrates		ppm

Replica Tape

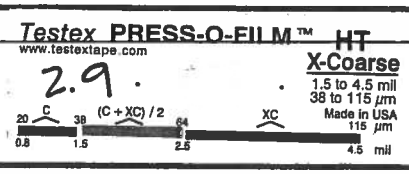
Minimum 3 readings for first 100 ft², and 3 readings for each additional 1000 ft²



Location:



Location:



Location:

Location:

Location:

Location:

Notes:

Gauer | 12/9/2016

QC Inspector Signature | Date

☐ See attached page for additional replica tape

South Gate Engineering, LLC 13477 Yorba Ave Chino, CA 91710	Job #	12388-01L		Internal
	SN:	25372		
	Date:	12/9/2016	X	External
	☐ Surface Preparation ☐ DFT ☑ Coating Application ☐ Holiday			

Ambient Conditions						
Time of Day	9:30					
Dry Bulb Tempertaure (°F)	73.9					
Wet Bulb Temperature (°F)	57.9					
Relative Humidity(%)	37					
Dew Point (°F)	46.0					
Surface Temperature (°F)	74.5					

☑ Stripe Coat ☑ Primer
☐ Intermediate ☑ Finish
☐ Touch Up

Blotter test: ☐ Pass ☐ Fail ☐ N/A

Volume Solids: 75.0 % +- 2.0 %

Required DFT: 4-6 MILS

Product:	CARBOGUARD 890	**Batch Numbers:**	
Manufacturer:	CARBOLINE	Part A	
Color:	LIGHT GRAY	Part B	
Reducer:		Reducer:	

Qty Mixed:	Material Temp (°F):	Pot Life: 3 HOURS @ 75°
Mix Ratio: 4:1 (A to B)	Induction Time:	

Defects Detected: ☐ Overspray ☐ Runs/Sags ☐ Runs/Sags ☐ Cracking ☐ Pinholes ☐ Other:_____

DFT

Test Location:				Average
Spot 1	5.8	6.1	7.5	6.5
Spot 2	6.8	5.7	6.8	6.4
Spot 3	6.9	7.8	7.0	7.2
Spot 4	7.1	6.4	6.3	6.6
Spot 5	6.0	6.6	7.4	6.7
Total Avergae DFT				6.7

Test Location:				Average
Spot 1				
Spot 2				
Spot 3				
Spot 4				
Spot 5				
Total Avergae DFT				

Test Location:				Average
Spot 1				
Spot 2				
Spot 3				
Spot 4				
Spot 5				
Total Avergae DFT				

Gage Type: Type II
MFG: De Felsko
Model: Positector 6000
SN: 273047FS
Value: ☑ Mils ☐ µ

Calibration Standard:
☑ Shims ☐ NIST Tiles

DFT of Tile/Shim:
Gage DFT:
Gage Adjustment:
Calibration:
Notes:

Gauer	12/12/16
QC Inspector Signature	Date

☐ See attached page for additional DFT's

L.A.Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 8: SKID and STRUCTURE

- MATERIAL CERTIFICATION

豐興鋼鐵股份有限公司
FENG HSIN IRON & STEEL CO., LTD.

OFFICE：臺中縣后里鄉甲后路702號
702,CHIA HOU ROAD,HOU LI SHIANG,
TAICHUNG HSIEN,TAIWAN,ROC
TEL ：(04)25565101 FAX ：(04)25566955

MILL TEST CERTIFICATE L29255

CUSTOMER NAME		CERTIFICATE NO.	1011182-A1-1
SPEC.	ASTM A36/A36M-08.	CERTIFICATE DATE	MAR 26 2012

GOODS DESCRIPTION					TENSILE TEST			CHEMICAL ANALYSIS (%)																
SIZE (mm)	LEN. (m)	QTY (bdl.)	WEIGHT (kg)	HEAT NO.	YP ksi / N/mm²	TS ksi / N/mm²	EL (%)	C	Si	Mn	P	S	Ni	Cr	Mo			Al			B		
								× 100			× 1000		× 100					× 1000			ppm		
HOT ROLLED MILD STEEL FLAT BAR																								
B * t					36	58	20																	
					MIN	80	MIN	23	40		40	50												
1 * 1/4	20	1	1,734	195799	53	70	27	MAX	MAX		MAX	MAX												
1 * 1/4	20	1	1,734	199174	40	58	32	12	18	55	34	25												
1 * 1/4	20	2	3,468	199176	42	71	30	10	17	52	16	13												
2 * 1	20	2	3,468	326464H	49	69	29	12	19	58	16	25												
2 * 1	20	3	4,512	327234	54	73	24	16	3	43	12	3												
4 * 3/4	20	5	6,468	327248	54	72	24	12	19	63	27	25												
5 * 1/2	20	5	11,125	195790	54	71	26	11	18	62	20	27												
5 * 3/4	20	4	10,060	100776	53	70	26	11	19	50	13	19												
5/2 * 3/4	20	3	6,844	100772	53	70	26	10	17	51	12	23												
6 * 1/4	20	12	6,252	100172	52	70	26	11	16	54	14	23												
6 * 3/8	20	5	22,042	100763	54	72	26	11	19	52	11	16												
SUB TOTAL		45	87,237	100770	53	71	26	13	18	53	12	22												
								12	16	54	17	29												

Grand Total: 45 BUNDLES 87,237 kgs.

REMARK:

QC-09-04

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MANUFACTURED AND TESTED WITH SATISFACTORY RESULTS IN ACCORDANCE WITH THE REQUIREMENT OF THE ABOVE MATERIAL SPECIFICATION.

MANAGER
METALLURGICAL
R&D DEP.

郭志毅

材 质 书
MILL TEST CERTIFICATE

订货单位：
CONSIGNEE:

发货日期：2007年8月18日
DATE OF ISSUING: 2007.08.18

合同号：
CONTRACT NO. 2007-THS-06

产品名称：热轧角钢
DESC OF GOODS: PRIME HOT ROLLED STEEL ANGLE

标号（级别代号）：ASTM A36/A6-05a
STEEL GRADE: ASTM A36/A6-05a

原产地：中国
ORIGIN: CHINA

制造单位：唐山市宏忠钢铁有限公司
EDITED BY: TANGSHAN HONGZHONG.

编号：
NO.: 2007-HZ-1

规格 SIZE	炉号 HEAT NO.	重量 WEIGHT (MT)	支/捆 PCS/BUN	捆数 NO. OF BUNDLES	化学成分(%) CHEMICAL COMPOSITION (PCT)											机械性能 MECHANICAL PROPERTIES			
					C	Si	Mn	P	S	Ni	Cr	Cu	V	Mo	Nb	屈服强度 YIELD STRENGTH Mpa Test No.1	抗拉强度 TENSILE STRENGTH Mpa Test No.1	延伸率 ELONGATION %	冷弯 CULD BENDING (180o l d=3 a
C10*15.3*20'	b-105	2.085	15	1	0.17	0.22	0.40	0.028	0.028	0.10	0.15	0.22	0.005	0.020	0.005	265	475	26.0	OK
C10*25*20'	b-108	0.902	4	1	0.18	0.28	0.38	0.026	0.026	0.11	0.17	0.25	0.005	0.022	0.006	260	480	25.0	OK
C10*25*40'	b-112	2.256	5	1	0.16	0.25	0.42	0.028	0.028	0.13	0.15	0.20	0.005	0.023	0.005	265	480	26.0	OK

唐山市宏忠钢铁有限公司 质检章

尊敬的客户：用前先验证，如有异议请保留实物并来函说明
For Customers: TEST BEFORE USED ,CLAIM FOR DISCREPANCIES WITH DEFAULT GOODS

检验员 INSPECTOR:

日期： 2007.08.18
DATED:

Customer Name	Customer PO#	Shipper No	Heat Number
METAL SUPPLY INC	2537	49530	T52510

Sales Order No: A71671
Customer: CREST STEEL
: 2070

MILL CERTIFICATE

THIS TUBING WAS MANUFACTURED IN THE U.S.A.

No:
Date:

Specification: A500B/C-13 NO WELD REPAIR

Article: RIV-213277

SEARING INDUSTRIES

Size	Quantity		Chemical Composition (Ladle Analysis)										Tensile Test			(Heat No)
	Number of Pieces	Calculated Weight per ft	C (%) x 100	Mn (%) x 100	P (%) x 1000	S (%) x 1000	Si (%) x 1000	Cr (%) x 100	Cu (%) x 100	Mo (%) x 100	Ni (%) x 100	Va (%) x 1000	Yield Strength (-)	Tensile Strength (-)	Elongation (%)	
2 SQ X .250 X HR 40'	50	5.400	18	82	9	6	21	1	1	0	1	1	74000	77000	23	T52510 08/10/16

We hereby certify that the material described herein conforms fully to the said specification.
Unless noted this tubing does not meet the melted and manufactured specification for MADE IN AMERICA

SEARING INDUSTRIES, INC.

Salvador Rodriguez-Quality Manager

Customer Name	Customer PO#	Shipper No	Heat Number
METAL SUPPLY INC	2537	49530	T52543

26Oct16 3:24 T E S T C E R T I F I C A T E No: 1 541476

Vest Incorporated
6023 Alcoa Avenue
Los Angeles, Ca. 90058
Tel: 323-581-8823 Fax: 323-581-3465

P/O No RIV-213230
Rel
S/O No 1 134368-018
B/L No 1 137637-006 Shp 26Oct16
Inv No Inv

Sold To: (22200)
CREST STEEL
6580 GENERAL ROAD
RIVERSIDE, CA 92509

Ship To: (1)
CREST STEEL
6580 GENERAL DR.
RIVERSIDE, CA 92509

Tel: 714-822-5222 Fax: 714-761-4801

CERTIFICATE of ANALYSIS and TESTS Cert. No: 1 541476
25Oct16

Part No	Qty-FT	Pcs	Wgt
SQUARE TUBE/STRUCTURAL 2.000 X 2.000 X .250 X 40'	1,000	25	5,410

MATERIAL CONFORMS TO ASTM-A-500M-13

Heat Number	Tag No	Shipped Qty-FT	Pcs	Wgt
T52543 A	444076	1,000	25	5,410
	YLD=<72,200>/TEN=<78,300>/ELG=<27.0>/RCK=<84.0>			

Heat Number *** Chemical Analysis ***
T52543 C=<.18> Mn=<.79> P=<.009> S=<.004> Si=<.018>

MANUFACTURED IN THE UNITED STATES OF AMERICA

I CERTIFY THE FOLLOWING TEST INFORMATION TO BE CORRECT AS CONTAINED IN THE RECORD OF:
VEST INC.

LAB TECHNICIAN

10242

Customer Name: METAL SUPPLY INC

Customer PO#: 12599S

Shipper No: 46570

Heat Number: N10670

EVRAZ | EVRAZ INC. NA
Evraz Oregon Steel 14400 N. Rivergate Blvd., Portland, Oregon 97203

REPORT OF CHEMICAL/PHYSICAL TESTS

CERTIFICATE NO.	DATE	PAGE
1510098	Jun 30, 2016	3

ISO 9001 CERTIFIED — U.S. PLATE PRODUCER

SOLD TO:
CREST STEEL CORPORATION
10833 VALLEY VIEW DRIVE
SUITE 100
CYPRESS, CA 90630
USA

CREST STEEL CORP
ATTN:CHRIS BEN
10833 VALLEY VIEW DRIVE SUITE 100
CYPRESS, CA 90630

MILL ORDER NO.	DATE
300611	
CUSTOMER ORDER NO.	
RIV-212490	
JOB/REL NO.	
SHIPPING NO.	DATE
1510098	06/30/2016
CARRIER	
UNION PACIFIC	
CAR/TRUCK NO.	
CN6017	

THIS MATERIAL HAS BEEN MANUFACTURED, TESTED AND FOUND TO MEET THE SPECIFICATIONS AND PURCHASE ORDER REQUIREMENTS
CARBON STRUCTURAL QUALITY PLATE ASTM A36-14/ASME SA36 2013 A709 GR 36. KILLED.

PHYSICAL PROPERTIES

ITEM NO	DESCRIPTION	HEAT NO.	SLAB	YIELD PSI X 100	TENSILE PSI X 100	% ELONG 8"	% ELONG 2"	% RA	HARDNESS BHN	BEND TEST	IMPACTS
4	0.5000 X 96.000MR X 240.000										
	2 PCS 6534 LBS ^	N10158		460	650	28					
				443	640	30					
	2 PCS 6534 LBS ^	N10493		397	615	33					
				475	665	29					
	2 PCS 6534 LBS ^	N10670		443	640	29					
	1 PC 3267 LBS ^	N11048		491	670	33					
5	1.0000 X 96.000MR X 240.000										
	6 PCS 39204 LBS ^	N11221		410	630	26					
				409	630	32					

JEG 2 #213 9/27/16

CHEMICAL ANALYSIS

HEAT NO.	C	Mn	P	S	Si	Cu	Ni	V	Cb	Al	Cr	Mo	Ti	B	N	Ca			CE	
N10158	.14	.89	.014	.005	.23	.01	.05	.006	.000	.043	.02	.00								
N10493	.13	.92	.012	.006	.19	.01	.05	.005	.000	.032	.02	.00								
N10670	.14	.86	.012	.010	.22	.01	.05	.005	.000	.040	.03	.00								
N11048	.14	.87	.012	.006	.22	.01	.06	.005	.000	.037	.02	.00								
N11221	.15	.90	.013	.006	.25	.01	.06	.000	.000	.052	.02	.00							.31	

HEATS INDICATED WITH (+) WERE MELTED & MANUFACTURED IN THE USA. HEATS INDICATED WITH (^) WERE ROLLED IN THE USA.

I certify the above to be correct as contained in the records of EVRAZ INC. NA By _____ Charles Perry Quality Coordinator

07-14-2016 00:45 Load - 2581053 BL - 20303649
Metal Supply, Inc. Heat - A6F114
Cust PO - 125506 Order-Line - 13921472 / 2
blr466

SSAB

Test Certificate

Form TC1: Revision 2: Date 23 Apr 2014

1770 Bill Sharp Boulevard, Muscatine, IA 52761-9412, US

Customer:
KLOECKNER METALS CORPORATION
500 COLONIAL CENTER PARKWAY
SUITE 500
ROSWELL
GA 30076

Customer P.O. No.: 7055523

Mill Order No.: 41-471457-10

Shipping Manifest: MR289333

Product Description: ABS (2016) GR A
ASTM A36(14)/A709(16)36/ASME SA36(15)

Ship Date: 13 Jun 16
Cert Date: 13 Jun 16

Cert No: 061585017
(Page 1 of 1)

CH3166519

Size: 0.750 X 96.00 X 240.0 (IN)

Tested Pieces				Tensiles						Charpy Impact Tests								
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % Gin	Elong % Sin	Tst Dir	Hardness	Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Str (mm)	BDWTT Tmp	BDWTT %Shr
A6F114	C21	0.756 (DISCRT)	L	47	67		36		T								
B6F650	C22	0.759 (DISCRT)	L	47	68		33		T								

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Cu	Ni	Cr	Mo	Cb	V	Ti	CEV	ORGN
A6F114	.19	.54	.009	.001	.05	.030	.31	.15	.11	.04	.002	.005	.006	.28	USA
B6F650	.18	.56	.010	.003	.05	.030	.32	.15	.10	.03	.002	.005	.006	.28	USA

KILLED STEEL
MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT.
WE HEREBY CERTIFY THAT MATERIAL DESCRIBED HEREIN HAS BEEN MADE BY SSAB AMERICAS BY THE ELECTRIC FURNACE / STRAND CAST PROCESS AND TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF THE AMERICAN BUREAU OF SHIPPING RULES WITH SATISFACTORY RESULTS.
CEV = C + MN/6
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA.
PRODUCTS SHIPPED:
A6F114 C21 PCES: 11, LBS: 53911 B6F650 C22 PCES: 8, LBS: 39208

AMERICAN BUREAU OF SHIPPING
MICHAEL S. PRIM
ABS
CHICAGO

(1) Cust Part # :

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION

Brian Wales
SENIOR METALLURGIST - PRODUCT

Agua Mansa-CA
12273 Brown Avenue
Riverside, CA 92509
USA

METALLURGICAL TEST REPORT

6870 Highway 42 East
Ghent, KY 41045-9615
(502) 347-6000

Certificate: 229152 4

Customer: 000053 802

Mail To:
SAMUEL, SON & CO., INC.
CUSTOMER PICKUP
6415 EAST CORVETTE STREET
LOS ANGELES, CA 90040

Ship To:
SAMUEL, SON & CO., INC. 63675
CUSTOMER PICKUP
6415 EAST CORVETTE STREET
LOS ANGELES, CA 90040

Date: 10/18/2016 Page: 1
Steel: 304/304L
Finish: 1
Corrosion: ASTM A262/15 A 180Bend-OK
Red Ratio: 69.4 :1

Your Order: 7230430

NAS Order: PN 0070512 09

PRODUCT DESCRIPTION:

STAINLESS STEEL PLATE, HRAP; UNS 30400/30403
ASTM A240/15b,A480/15,A666/15;ASME SA240/15,SA480/15,SA666/15
CHEM ONLY ON FOLLOWING ASTM: A276/16,A479/16,A484/15,A312/16
CHEM ONLY ON FOLLOWING ASME: SA312/13,SA479/13
AMS 5511H/5513J XMRK; MIL-S-5059D AMD3(X CRN MEAS); MIL-S-4043B
NACE MR0175/ISO 15156-3:2009 A, MR0103/07;QQS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; RoHS 1 & 2 Compliant
Material is Free of Radioactive Contamination
Steel Making Process: EAF, AOD, & Cont. Casting
Product Mfg.by a Quality Mgt.Sys. in Conf. w/ISO 9001
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

Product Id	Plate#	Skid #	Thickness	Width	Weight	-------Length------	Mark	Pieces	Commodity Code
03100R EC	03100R EC	*	1.0000	48.0000	1,375 PLATE	096.00	15	1	5315047

Lab Accreditation Bureau, ISO/IEC 17025, Certificate# L2323

CHEMICAL ANALYSIS

CM(Country of Melt) ES(Spain) US(United States) ZA(South Africa) JP(Japan) Chemical Analysis per ASTM A751/14a

HEAT	CM	C %	CR %	CU %	MN %	MO %	N %	NI %	P %	S %
100R	US	.0110	18.1035	.4275	1.7805	.3535	.0800	8.0925	.0285	.0010

SI %
.1995

MECHANICAL PROPERTIES

Product Id#	Plate#	Loc	Dir	UTS 20C KSI	.2% YS 20C KSI	ELONG % -2"	Hard RB	A 262 Pr A Pr A	R of A %
03100R EC	03100R EC	F	T	84.35	40.64	62.78	83.00	OK	67.10

SAMUEL, SON & CO. INC.
LOS ANGELES
QC Certified True Copy
Of Original Material Test Report
Initials Date 10-18-16

NAS hereby certifies that the analysis on this certification is correct. Based upon the results and the accuracy of the test methods used, the material meets the specifications stated. These results relate only to the items tested and this report cannot be reproduced, except in its entirety, without the written approval of NAS.

Technical Dept. Mgr. KRIS LARK 10/18/2016

NUCOR
PLATE MILL
P.O.Box 279
Winton, NC 27986
(252) 356-3700

Mill Test Report

NUCOR It's in our Nature

Issuing Date : 11/26/2009 B/L No. : 246239 Load No. : 247922 Our Order No. : 77545/23 Cust. Order No. : 6233181

Vehicle No: LW 62462 Sold To : Ship To :

Specification : 1.5000" x 96.000" x 480.000"
ASTM A36-08/ASTM A709 Grade 36-09a/AASHTO M270Grade 36/ASME
SA36-03a 2009 Addenda AASHTO M270 36

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
9106638	0.19	0.83	0.010	0.001	0.19	0.30	0.10	0.08	0.02	0.010	0.004	0.001	0.001		0.0017	0.0001	0.012	0.38	0.26

Tensile Test

Plate Serial No	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"
9106638-02	1	9.80	T	36,000	67,800		23.1
			T	36,000	67,900		24.0

Charpy Impacts

Dir.	1	(ft) shear	2	(ft) shear	3	(ft) shear	Ave.	(ft) shear	Size	Temp	Min Ave.

JEG-QC #213 2/27/14

ID: 1081805

Manufactured to fully killed practice by Electric Arc Furnace. Welding or weld repair was not performed on this material.
Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.
Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/6)+((Cr+Mo+V)/5)+((Cu+Ni)/15)
Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B
Melted and manufactured in the USA. ISO 9001-2000 certified (#006461) by SRI Quality System Registrar (#0965-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.
DIN 50049 3.1.B/EN 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate 08-MMPQA-383

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

T. A. Depretis

11/30/2009 12:33:03 PM

T. A. Depretis, Metallurgist

10242

Customer Name: METAL SUPPLY INC
Customer PO#: 2537
Shipper No: 49530
Heat Number: B124844

CERTIFIED MILL TEST REPORT

Printed: 07 / 21 / 2016
Produced: 07 / 16 / 2016

Steel Dynamics, Inc.
Long Products Group
Structural and Rail Division

(260) 625-8100 (260) 625-8950 FAX
Quality Steel 100% EAF Melted and Manufactured in the USA
Recycled content: PC = 77.0%, PI = 19.4%
ISO 9001:2008 and ABS Certified

Ship to: Customer # 000306
CREST STEEL - RIVERSIDE
6580 General Road
UPRR Spur #23-790-01
Riverside CA, 92509 US
Attn: Gary Hoag

Bill to:
CREST STEEL
10833 Valley View Street
Suite 100
Cypress CA, 90630 US
Attn: Bryan Kretzmer

GENERAL INFORMATION

Product: ~~Wide Flange Beam~~
Size: W8X21
W 200 x 31.3
Heat Number: B124844
Condition(s): As-Rolled
Fine Grained
Fully Killed
No Weld Repair

SPECIFICATIONS

Standards	Grades
ASTM A6/A6M - 16	
ASTM A992/A992M - 11	A992 / A992M
ASTM A709/A709M - 16a	A709 gr50/gr345
ASTM A572/A572M - 15	A572 gr50/gr345
AASHTO M270M/M270 - 12	M270 gr345/gr50
CSA G40.21-13	50W/350W
ASTM A36/A36M - 14	A36 / A36M

SHIPMENT DETAILS

BOL # 0000417962 - 30240.00 lbs

Bundle / ASN #	Length	pcs	Cust PO | Recv PO | Job
060671328	60' 0"	12	RIV-212553
060671327	60' 0"	12	RIV-212553

CHEMICAL ANALYSIS (weight percent)

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	V	Nb/Cb	Al	N	B	*C1	*C2	*C3	*PC	*I	Analysis Type
.08	1.14	.015	.019	.24	.32	.09	.11	.025	.022	.025	.002	.002	.0131	.0004	.33	.37	.31	.17	5.77	Heat

MECHANICAL TESTING

Test	Yield (fy) Strength ksi / MPa	Tensile (fu) Strength ksi / MPa	fy / fu ratio	% Elong. (8" gage)
1	57 / 392	76 / 522	.75	25
2	59 / 405	74 / 513	.79	25
3				
4				

CHARPY IMPACT TESTS (available only when specified at time of order)

Test	Temp F / C	Absorbed Energy ft-lbf / J Specimen 1	Specimen 2	Specimen 3	Average	Minimum
1						
2						
3						
4						
5						
6						
7						

Notes: *Calculated Chemistry Values: Carbon Equivalents (C1, C2, C3, PC), Corrosion Index (I) I (ASTM G101)= 26.01(Cu)+3.88(Ni)+1.20(Cr)-1.49(Si)+17.28(P)-7.29(Cu)(Ni)-9.10(Ni)(P)-33.39(Cu²)
CE1 (IIW)=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE2 (AWS)=C+(Mn+Si)/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE3 (CET) = C + (Mn/6) + (Si/24) + (Cr/5) + (Ni/40) + (Mo/4) + (V/14) Pcm(AWS) = C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+mo/15+V/10+5B

I hereby certify that the material described herein has been made to the applicable specification by the electric arc furnace/continuous cast process and tested in accordance with the requirements of American Bureau of Shipping Rules with satisfactory results.

Signed:

ABS CERTIFICATION

I hereby certify that the content of this report are accurate and correct. All tests and operations performed by this material manufacturer are in compliance with the requirements of the material specifications and applicable purchaser designated requirements.

Signed: **Jeremy Cronkhite**
Quality Manager

State of Indiana, County of Whitley Sworn to and subscribed before me

this _____ day of _____

Signed: _____ My commission expires: _____
Notary Public

Form F-6100-002-054 rev 6

ASTM A5 - 14.6: A signature is not required on the test report; however, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report

10242

Customer Name: METAL SUPPLY INC
Customer PO#: 2537
Shipper No: 49530
Heat Number: B124862

Steel Dynamics, Inc.
Long Products Group
Structural and Rail Division

(260) 625-8100 (260) 625-8950 FAX
Quality Steel 100% EAF Melted and Manufactured in the USA
Recycled content: PC = 77.0%, PI = 19.4%
ISO 9001:2008 and ABS Certified

CERTIFIED MILL TEST REPORT

Printed: 07 / 23 / 2016
Produced: 07 / 16 / 2016

Ship to: Customer # 000306
CREST STEEL - RIVERSIDE
6580 General Road
UPRR Spur #23-790-01
Riverside CA, 92509 US
Attn: Gary Hoag

Bill to:
CREST STEEL
10833 Valley View Street
Suite 100
Cypress CA, 90630 US
Attn: Bryan Kretzmer

GENERAL INFORMATION

Product	Wide Flange Beam
Size	W8X21
	W 200 x 31.3
Heat Number	B124862
Condition(s)	As-Rolled
	Fine Grained
	Fully Killed
	No Weld Repair

SPECIFICATIONS

Standards	Grades
ASTM A6/A6M - 16	
» ASTM A992/A992M - 11	A992 / A992M
ASTM A709/A709M - 16a	A709 gr50/gr345
ASTM A572/A572M - 15	A572 gr50/gr345
AASHTO M270M/M270 - 12	M270 gr345/gr50
CSA G40.21-13	50W/350W
ASTM A36/A36M - 14	A36 / A36M

SHIPMENT DETAILS

BOL # 0000418369 - 41580.00 lbs

Bundle / ASN #	Length	pcs	Cust PO | Recv PO | Job
060671275	55' 0"	12	RIV-212553
060671277	55' 0"	12	RIV-212553
060671265	55' 0"	12	RIV-212553

CHEMICAL ANALYSIS (weight percent)

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	V	Nb/Cb	Al	N	B	*C1	*C2	*C3	*PC	*I	Analysis Type
.07	1.14	.013	.020	.23	.29	.09	.08	.032	.011	.024	.001	.002	.0139	.0003	.31	.35	.30	.16	5.53	Heat

MECHANICAL TESTING

Test	Yield (fy) Strength ksi / MPa	Tensile (fu) Strength ksi / MPa	fy / fu ratio	% Elong. (8" gage)
1	51 / 354	75 / 515	.68	25
2	53 / 364	75 / 515	.71	26
3				
4				

CHARPY IMPACT TESTS (available only when specified at time of order)

Test	Temp F / C	Absorbed Energy ft-lbf / J Specimen 1	Specimen 2	Specimen 3	Average	Minimum
1						
2						
3						
4						
5						
6						
7						

Notes: *Calculated Chemistry Values: Carbon Equivalents (C1, C2, C3, PC), Corrosion Index (I) I (ASTM G101)= 26.01(Cu)+3.88(Ni)+1.20(Cr)+1.49(Si)+17.28(P)-7.29(Cu)(Ni)-9.10(Ni)(P)-33.39(Cu²)
CE1 (IIW)=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE2 (AWS)=C+(Mn+Si)/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE3 (CET) = C + (Mn/6) + (Si/24) + (Cr/5) + (Ni/40) +(Mo/4) + (V/14) Pcm(AWS) = C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+mo/15+V/10+5B

I hereby certify that the material described herein has been made to the applicable specification by the electric arc furnace/continuous cast process and tested in accordance with the requirements of American Bureau of Shipping Rules with satisfactory results.

Signed:

ABS CERTIFICATION

I hereby certify that the content of this report are accurate and correct. All tests and operations performed by this material manufacturer are in compliance with the requirements of the material specifications and applicable purchaser designated requirements.

Signed: **Jeremy Cronkhite**
Quality Manager

State of Indiana, County of Whitley Sworn to and subscribed before me

this _____ day of _____

Signed: _____ My commission expires: _____
Notary Public

Form F-PI-CD-002-054 rev 6

ASTM A6 - 14.6: A signature is not required on the test report; however, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report

10242

Customer Name: METAL SUPPLY INC
Customer PO#: 2320
Shipper No: 46900
Heat Number: 58026271

GERDAU

CERTIFIED MATERIAL TEST REPORT

US-ML-MIDLOTHIAN
300 WARD ROAD
MIDLOTHIAN, TX 76065
USA

CUSTOMER SHIP TO	CUSTOMER BILL TO
CREST STEEL CORP 6580 GENERAL RD RIVERSIDE,CA 92509-0103 USA	CREST STEEL CORPORATION 10833 VALLEY VIEW STREET CYPRESS,CA 90630 USA

GRADE	SHAPE / SIZE	DOCUMENT ID
A992/A572-50	Wide Flange Beam / 8 X 21# / 200 X 31.3	0000000000

LENGTH	WEIGHT	HEAT / BATCH
60'00"	105,800 LB	58026271/02

SALES ORDER	CUSTOMER MATERIAL Nº
3793001/000020	

SPECIFICATION / DATE or REVISION
ASTM A6-14
ASTM A709-15
ASTM A992-11 (2015), A572-15
CSA G40.21-13 345WM

CUSTOMER PURCHASE ORDER NUMBER	BILL OF LADING	DATE
RIV-212445	1327-0000204719	07/12/2016

CHEMICAL COMPOSITION

C %	Mn %	P %	S %	Si %	Cu %	Ni %	Cr %	Mo %	Sn %	V %	Nb %	Al %
0.10	0.85	0.012	0.029	0.23	0.26	0.09	0.19	0.019	0.005	0.001	0.014	0.004

CHEMICAL COMPOSITION

CEqvA6 %
0.30

MECHANICAL PROPERTIES

YS 0.2% PSI	UTS PSI	YS MPa	UTS MPa	Y/T rati %	G/L Inch
55359	72978	382	503	0.758	8.000
55014	72584	379	500	0.758	8.000

MECHANICAL PROPERTIES

G/L mm	Elong. %
200.0	23.90
200.0	23.00

COMMENTS / NOTES

MSI
A
S.J.

The above figures are certified chemical and physical test records as contained in the permanent records of company. We certify that these data are correct and in compliance with specified requirements. This material, including the billets, was melted and manufactured in the USA. CMTR complies with EN 10204 3.1.

BHASKAR YALAMANCHILI
QUALITY DIRECTOR

TOM HARRINGTON
QUALITY ASSURANCE MGR.

NUCOR STEEL - BERKELEY
P.O. Box 2259
Mt. Pleasant, S.C. 29464
Phone: (843) 336-6000

CERTIFIED MILL TEST REPORT

100% MELTED AND MANUFACTURED IN THE USA
All beams produced by Nucor-Berkeley are cast and rolled to a fully killed and fine grain practice.
Mercury has not been used in the direct manufacturing of this material.

Sold To:

Ship To:

Customer #.: 399 - 2

B.o.L. #...: 925239

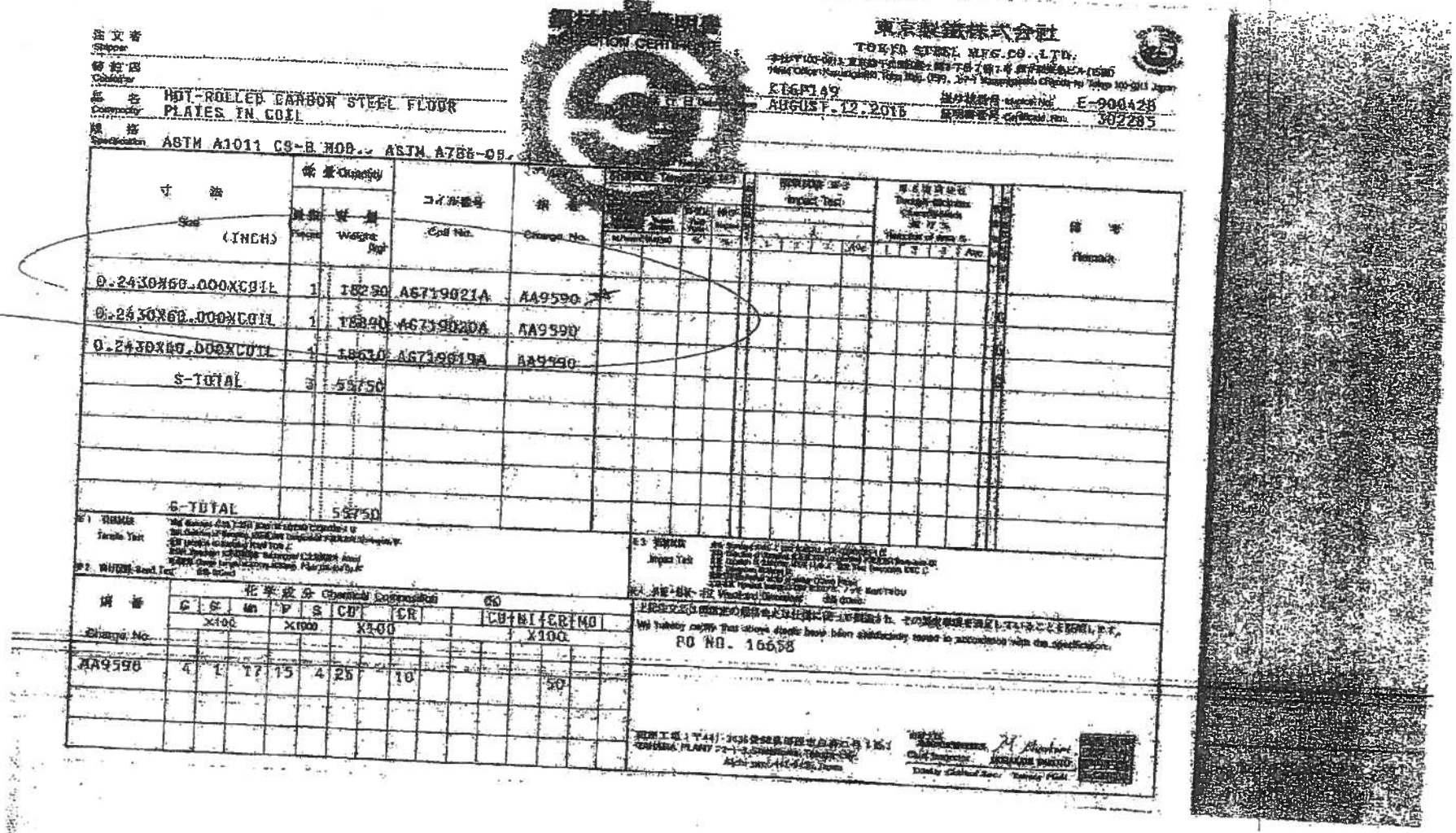
SPECIFICATIONS: Tested in accordance with ASTM specification A6-11/A6M-11 and A370. Quality Manual Rev #25.
AASHTO : M270-50-05
ASME : SA-36 07a
ASTM : A992-11:A36-08/A529-05-50/A572-07-50/A709-345M/A709M11 50S
CSA : G40.21-50W

Description	Heat# Grade(s) Test	Yield/ Tensile Ratio	Yield (PSI) (MPa)	Tensile (PSI) (MPa)	Elong %	C Cr xxxxxx	Mn Mo Ti	P Sn xxxxxx	S B xxxxxx	Si V N	Cu Nb xxxxxx	Ni xxxxxx CI	CE1 CE2 Pcm
W8X15	2200304	.84	60900	72500	26.61	.07	.81	.009	.034	.20	.23	.06	.23
040' 00.00"	A992-11		420	500		.04	.01	.0106	.0001	.004	.025		.2713
W200X22.5		.83	60000	72100	26.49		.002			.0062		4.85	.1308
012.1920m			414	497		20 Piece(s)		Customer PO: B-7515				Inv#:	0
W8X21	1110005	.81	57100	70400	25.21	.07	.81	.010	.037	.24	.21	.06	.24
020' 00.00"	A992-11		394	485		.04	.01	.0084	.0003	.004	.030		.2820
W200X31.3		.82	57200	69700	24.25		.001			.0060		4.77	.1358
006.0960m			394	481		10 Piece(s)		Customer PO: B-7527				Inv#:	0
W8X21	1110007	.81	57100	70100	25.29	.07	.81	.009	.038	.24	.22	.06	.24
020' 00.00"	A992-11		394	483		.04	.02	.0098	.0003	.004	.029		.2866
W200X31.3		.83	58500	70700	27.38		.001			.0067		4.86	.1401
006.0960m			403	487		40 Piece(s)		Customer PO: B-7527				Inv#:	0
W8X24	1115113	.81	56000	68800	25.51	.06	.82	.008	.026	.16	.20	.06	.23
020' 00.00"	A992-11		386	474		.05	.02	.0086	.0003	.004	.028		.2654
W200X35.9		.81	55800	68600	25.96		.001			.0068		4.43	.1274
006.0960m			385	473		6 Piece(s)		Customer PO: B-7527				Inv#:	0

Elongation based on 8" (20.32cm) gauge length. 'No Weld Repair' was performed. Hg free and no contact with Hg during manufacture.
CI = 26.01Cu+3.88Ni+1.20Cr+1.49Si+17.28P-(7.29Cu*Ni)-(9.10Ni*P)-33.39(Cu*Cu)
Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B
CE1= C+(Mn/6)+((Cr+Mo+V)/5)+((Ni+Cu)/15)
CE2 = C+((Mn+Si)/6)+((Cr+Mo+V+Cb)/5)+((Ni+Cu)/15)

I hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with material specifications, and when designated by the Purchaser, meet applicable specifications.

Bruce A. Work
Metallurgist



荷受人 Consignee
品名 Commodity HOT-ROLLED CARBON STEEL FLOOR PLATES IN COIL
規格 Specification ASTM A1011 CS-B MOD., ASTM A786-05,

東京製鐵株式会社
TOKYO STEEL MFG.CO.,LTD.

KIGM149
AUGUST.12.2015

E-900428
302285

寸法 Size (INCH)	数量 Quantity 枚数 Piece	重量 Weight kg	コイル番号 Coil No.	溶番 Charge No.
0.2430X60.000XCOIL	1	18290	A6719021A	AA9590
0.2430X60.000XCOIL	1	18890	A6719020A	AA9590
0.2430X60.000XCOIL	1	18630	A6719019A	AA9590
S-TOTAL	3	55750		
S-TOTAL		55750		

引張試験 Tensile Test
曲げ試験 Bend Test
衝撃試験 Impact Test
備考 Remark

溶番 Charge No.	化学成分 Chemical Composition C	Si	Mn	P	S	Cu	Cr	CU+NI+CR+MO
	X100			X1000		X100		X100
AA9590	4	1	17	15	4	25	10	50

We hereby certify that above steels have satisfactorily tested in accordance with the specification.
SO NO. 16658

TOKYO STEEL MFG.CO.,LTD.
OKAWA PLANT
Chief Inspector

outokumpu
high performance stainless steel

Certificate of Test

PRODEC QUALITY Page: 1

HEAT E160259 ORDER 665500/ 03 BOL 0235365 * RE-CERTIFICATION * 11/01/16

SHIP TO:
FRY STEEL C/O CMI
4201 WEST 36TH STREET

CHICAGO 606320000

---------- YOUR ORDER & DATE ----------
48796-1 3/15/16 CUST# 0438001 CUST TAG#S# 42770

---------- ITEM DESCRIPTION ----------
GRADE 304L/304/302 PRODEC QUALITY Ship Condition CONDA
Size304L RND CFA CONDA 1.5000 x 149.000-155.000
Country of Melt: UNITED KINGDOM Country of Mfg.: UNITED STATES
NAFTA Country of Origin is Country of Melt
No Weld repair
Free of mercury contamination, Free of radiation contamination
No WEEE relevant substances; Meets EU electrical ROHS

Total Bundles 2 Total Weight 5428 Approx. Hot Red. Ratio 18:1

WO 2068219 Bundles: 1B, 1C

---------- SPECIFICATIONS ----------
MFG TO FINISHED BAR IN THE USA FROM BILLETS IMPORTED UNITED KINGDOM

AMS 5639H, 5647J	SAE AMS-QQ-S-763D
AMS-S-7720B	ASME SA479 2007-2015 Ed.
ASME SA320 2015 Edition	ASTM A276-16a
ASTM A320 98	ASTM A479/A479M 16a
ASTM A484 16	ASTM A193 16 B8
MIL-S-7720A Amd2	Solution Annealed Condition
DFARS 252.225.7009 10/4/11	DFARS 225.7002-3(B)(1)
Federal Spec QQ-S-763F	UNS S30200
UNS S30400/S30403,AISI304/30	Fry Steel 302/304/304L
ASTM A262 15 Practice A/E	EN 10204 Type 3.1 Document
NACE MR0175-09, ISO 15156:09	NACE MR0103-10
Sol Ann 1900F min/WQ	CG equivalent surface
Bars are Eddy Current tested	
Sol Anneal at 1900F min/ Water Quench	

---------- MECHANICAL & OTHER TESTS ----------

Hardness as shipped	174 HB		
Hardness as shipped	(86 HRB)		
Grain size	9.0	Tensile strength,KSI (MPa)	93.3 (643)
Micro	OK	0.2% Yield Strngth,KSI(MPa)	42.3 (292)
Intergranular corrosion	OK		
Macro	OK	Elongation % in 4D	52.8
		Reduction of area %	66.9

-- Continued --

Outokumpu Stainless Bar, LLC
3043 Crenshaw Pkwy
Richburg, SC 29729

M.F. Marconi

outokumpu
high performance stainless steel

Certificate of Test

PRODEC QUALITY Page: 2

HEAT E160259 ORDER 665500/ 03 BOL 0235365 * RE-CERTIFICATION * 11/01/16

SHIP TO:
FRY STEEL C/O CMI
4201 WEST 36TH STREET

CHICAGO 606320000

CHEMICAL COMPOSITION

Carbon	(C)	.026	Manganese	(Mn)	1.410
Phosphorus	(P)	.036	Sulphur	(S)	.024
Silicon	(Si)	.430	Chromium	(Cr)	18.130
Nickel	(Ni)	8.050	Cobalt	(Co)	.156
Copper	(Cu)	.470	Moly	(Mo)	.420
Nitrogen	(N)	.004	Columbium	(Cb)	.016
Titanium	(Ti)	.010	Aluminum	(Al)	.005
Tin	(Sn)	.012	Boron	(B)	.001
Tantalum	(Ta)	.001	Vanadium	(V)	.070
Tungsten	(W)	.034			
Columbium/ Tantalum	(Cb+Ta)	.017			
Iron	(Fe)	Balance			
Melt Practice		EAF			
Refining Practice		AOD			
De-long Ferrite					

Knowingly & willfully falsifying or concealing a material act on this form, or making false, fictitious or fraudulent statements or representations herein could constitute a felony punishable under federal statutes. We hereby certify that the test results shown in this report are correct and accurate as contained in the records of the company and are in compliance with the specifications, codes, and standards listed above.

M.F. Marcanio, Quality Manager

FRY STEEL CO. CERTIFIES THAT THIS IS
A TRUE COPY OF THE ORIGINAL MILL TEST
REPORT NOW ON FILE
RECEIVED AND INSPECTED

NOV 0 2 2016

BY _____
CHIP SANDOVAL - Q.C. MANAGER

Outokumpu Stainless Bar, LLC
3043 Crenshaw Pkwy.
Richburg, SC 29726

M.F. Marcanio

FRANKLIN INSPECTION

1117 S. Euclid Ave. • San Gabriel, CA 91776
Tel: (626) 255-2148 • Fax: (626) 270-4420
E-mail: franklin tsai yahoo.com

Registered Inspector's Daily Report

Project Name	Shop	Field	Date
LA Turbine Corp. - Skid Assembly - LAT~~573~~ 574 FAC-EC (P.O.125795)	☑	☐	November 29, 2016

Inspection Address	Address of Project
11810 Center St., Southgate, CA	N/A

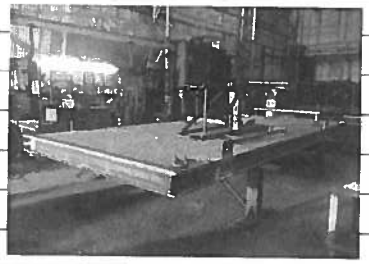
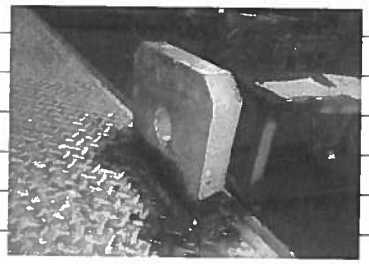
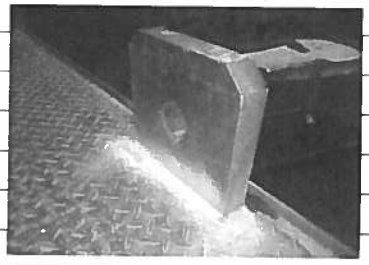
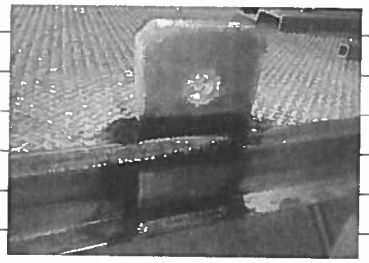
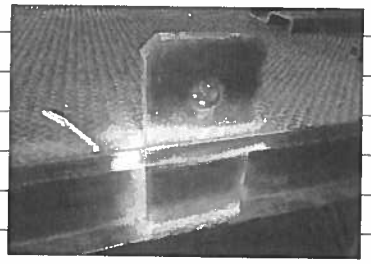
Applicable Code / Section	Permit No.	Issued by	Plan File No.
AWS D1.1/D1.1M - 2015			

Contractor	Architect
Metal Supply	N/A
Sub-Contractor	**Engineer**
N/A	N/A

Observations

Arrived at Metal Supply Fabrication as scheduled. Performed Dye Penetrant Testing on hoist ring base.

See attached PT Report.

Inspector Name (print):	Stephen Stephen	No.:	Continued on the next page ☐	Page 1 of 2
Certification No.:	PT Level II/SNT-TC-1A		Project #:	

Time In	Time Out	Reg. Hrs.	1.5x Hrs.	2x Hrs.	# of Samples
6:00 PM	10:00 PM	4			

Certification of Compliance

I hereby certify that I have inspected to the best of my knowledge, all of the above reported work. Unless otherwise noted, I have found this work to comply with the approved plans, specifications, and applicable sections of the governing building laws.

Inspector's Signature

All Field Services are based on a four (4) hour minimum and after four hours is an eight (8) hour minimum. In addition, any inspection extending past the noon hour will be an 8 hour minimum.

Authorized Signature

REPORT OF PENETRANT TESTING OF WELDS

Project Name LA Turbine Corp. - Skid Assembly - LAT573-EC (P.O.125795) **Project No.** n/a

Quality requirements-Section No. ASTM E 165 Procedure, AWS D1.1 Section 6 Part C Page 2 of 2

Items Examined / Tested: Fillet welds all around on hoist ring base

Weld ID, pc #	Description	Area Examined		Interpretation		Repairs		Remarks
		Entire	Specific	Accepted	Rejected	Accepted	Rejected	
Hoist ring base	Fillet weld all around (4 sets)	4		4				PTOK.

Quantity: 4 welds **Total Accepted:** 4 welds **Total Rejected:** 0

Comments:

METHOD OF INSPECTION

- ☒ Visible
- ☐ Water Washable
- ☐ Fluorescent
- ☒ Solvent Removable
- ☐ Emulsified
- ☐ Hydrophilic
- ☐ Post Emulsified
- ☐ Lipophilic

	Brand	Batch/Part #	Can #	Dwell Time
Penetrant	Spotcheck	12B24K	04716	10 minutes
Cleaner/Solvent	Spotcheck	13J09K	44499	n/a
Emulsifier	n/a	n/a	n/a	n/a
Developer	Spotcheck	12H21K	6682	10 minutes

1. Pre-cleaning with Spotcheck Nondestructive Testing Material, Batch #13J09K, Can #44499.
2. Penetrant application with Spotcheck Penetrant, Batch #12B24K, Can #04716 and dwell time of 10 minutes.
3. Penetrant removal with Spotcheck Nondestructive Testing Material, Batch #13J09K, Can #44499.
4. Developer application with Spotcheck Developer, Batch #12H21K, Can #6682 and dwell time of 10 minutes.
5. Post-cleaning with Spotcheck Nondestructive Testing Material, Batch #13J09K, Can #44499.

Lighting Equipment: CREE Flashlight 1800 Lumen Zoomable.

I, the undersigned, certify that the statements in this record are correct and that the test welds were prepared and tested in conformance with the requirements of AWS D1.1 (2015) (year) Structural Welding Code - Steel.

Inspector Stephen Stephen Level PT Level II/SNT-TC-1A Date 11/29/2016

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 9: PUMP/MOTOR - LUBE OIL

- CERTIFICATE OF CONFORMANCE

Leistritz	Abnahmeprüfzertifikat Inspection Test Certificate 3.1 nach/acc. to DIN EN 10204	Auftragsbestätigung Order confirmation N-41013168-0010 Ausgabe / Edition 0 Seite / Page 1/1 Datum / Date 28.12.2016

Anlage / Equipment	LA Turbine	Endkunde / Customer	
Besteller / Purchaser	Leistritz Advanced	Auftrags-Nr. / Order No.	46827 / SO 23081
Artikel / Object	L3MG-038/076-IFOGNO-G	Serien-Nr. / Serial No.	013878

Betriebsbedingungen / Operating conditions

Förderflüssigkeit / Flow liquid		Crude			
Viskosität / Viscosity	mm²/s	12,0	32,0	12,0	32,0
Betriebstemperatur / Op. Temperature	°C	66,0	38,0	66,0	38,0
Förderstrom / Delivery	l/min	77,0	81,0	75,0	79,0
Förderdruck gesamt / Tot. man. Pressure	bar	8,60	8,60	13,80	13,80
Drehzahl / Speed	1/min	1780	1780	1780	1780
NPSH / NPSH	m	2,00	2,20	2,00	2,20
Leistungsbedarf / Power input	kW	1,60	1,70	2,40	2,50
Test Toleranz / Test tolerance		VDMA 24284 II			

Messergebnisse / Test results

Förderflüssigkeit / Flow liquid		Morlina 5
Viskosität / Viscosity	mm²/s	18,0
Temperatur / Temperature	°C	21,8
Förderstrom / Delivery	l/min	74,4
Druck / Pressure	bar	13,81
Drehzahl / Speed	1/min	1789
Max. Saugdruck / Max.suct.pressure	bar	-0,74
Leistungsbedarf / Power input	kW	2,49
NPSH / NPSH	m	2,46

Umgerechnet auf Betriebsdaten / Calculated to operating conditions

Viskosität / Viscosity	mm²/s	12,0	32,0	12,0	32,0
Fördermenge / Capacity	l/min	78,0	80,7	71,9	76,4
Druck / Pressure	bar	8,6	8,6	13,8	13,8
Drehzahl / Speed	1/min	1780	1780	1780	1780
Leistungsbedarf / Power input	kW	1,66	1,81	2,42	2,57

Sicherheitsventil / Safety valve

Öffnet bei / Opens at	bar		Offen bei / Open at	bar		Schließt bei / Closed at	bar	
---	---	---	---	---	---	---	---	---

Statische Druckprüfung nach/ Hydrostatic test / acc. QSP 114

Prüfteil / Test part	Werkstoff / Material	Prüfdruck / Test pressure	
Pumpengehäuse/Pump casing	1.0038	24,0	bar
			bar
			bar
			bar
			bar

Prüfmedium / Test fluid	KSS	Prüfdauer / Test duration	15	min

Geprüft/Tested	Abnahme	Bemerkungen
Unterschrift/Signature Bingöl Datum/Date 28.12.2016	Acceptance	Remarks

Das Protokoll ist elektronisch erstellt und ohne Unterschrift gültig. Der Aussteller ist QS- autorisiert.
The certificate was written electronically and is valid without signature. The issuer is quality assurance - authorized.

Leistritz

Abnahmeprüfzertifikat / Inspection Test Certificate 3.1

nach/acc. to DIN EN 10204

Auftragsbestätigung / Order confirmation	N-41013168-0010
Ausgabe / Edition	0
Seite / Page	1/1
Datum / Date	28.12.2016

Anlage / Equipment	LA Turbine	Endkunde / Customer	
Besteller / Purchaser	Leistritz Advanced	Auftrags-Nr. / Order No.	46827 / SO 23081
Artikel / Object	L3MG-038/076-IFOGNO-G	Serien-Nr. / Serial No.	013877

Betriebsbedingungen / Operating conditions

Förderflüssigkeit / Flow liquid		Crude			
Viskosität / Viscosity	mm²/s	12,0	32,0	12,0	32,0
Betriebstemperatur / Op. Temperature	°C	66,0	38,0	66,0	38,0
Förderstrom / Delivery	l/min	77,0	81,0	75,0	79,0
Förderdruck gesamt / Tot. man. Pressure	bar	8,60	8,60	13,80	13,80
Drehzahl / Speed	1/min	1780	1780	1780	1780
NPSH / NPSH	m	2,00	2,20	2,00	2,20
Leistungsbedarf / Power input	kW	1,60	1,70	2,40	2,50
Test Toleranz / Test tolerance		VDMA 24284 II			

Messergebnisse / Test results

Förderflüssigkeit / Flow liquid		Morlina 5
Viskosität / Viscosity	mm²/s	18,6
Temperatur / Temperature	°C	21,1
Förderstrom / Delivery	l/min	75,2
Druck / Pressure	bar	13,86
Drehzahl / Speed	1/min	1780
Max. Saugdruck / Max.suct.pressure	bar	-0,75
Leistungsbedarf / Power input	kW	2,30
NPSH / NPSH	m	2,35

Umgerechnet auf Betriebsdaten / Calculated to operating conditions

Viskosität / Viscosity	mm²/s	12,0	32,0	12,0	32,0
Fördermenge / Capacity	l/min	78,8	81,3	73,3	77,3
Druck / Pressure	bar	8,6	8,6	13,8	13,8
Drehzahl / Speed	1/min	1780	1780	1780	1780
Leistungsbedarf / Power input	kW	1,49	1,58	2,25	2,34

Sicherheitsventil / Safety valve

Öffnet bei / Opens at	bar		Offen bei / Open at	bar	
Schließt bei / Closed at	bar				

Statische Druckprüfung nach/ Hydrostatic test / acc. QSP 114

Prüfteil / Test part	Werkstoff / Material	Prüfdruck / Test pressure	
Pumpengehäuse/Pump casing	1.0038	24,0	bar
			bar
			bar
			bar
			bar

Prüfmedium / Test fluid	KSS	Prüfdauer / Test duration	15	min

Geprüft/Tested Unterschrift/Signature Bingöl Datum/Date 28.12.2016	Abnahme Acceptance	Bemerkungen Remarks

Das Protokoll ist elektronisch erstellt und ohne Unterschrift gültig. Der Aussteller ist QS- autorisiert.
The certificate was written electronically and is valid without signature. The issuer is quality assurance - authorized.

Leistritz

Customer Name or Project Name:	LA Turbine	Sales Order No.	23081
Customer Job No.	LAT-574	Pump Model	L3MG 38/76 IFOGNO-G
Customer PO No.	23715	Pump Type	3 Screw
Application / Pumped Fluid	ISO VG 32 Lube Oil	Quantity	1

Pump

	Rated	Alt 1	Alt 2	Alt 3	
Temperature	150	100	150	100	deg. F
Viscosity	12	32	12	32	cSt
Capacity	20.5	21.3	19.7	20.8	gpm
Suction Pressure	245	245	160	160	psig
Discharge Pressure	370	370	360	360	psig
Differential Pressure	125	125	200	200	psi
Required Net Positive Inlet Pressure	2.9	3	2.9	3	psia
Required Power	2.1	2.3	3.2	3.4	bhp
Speed	1780	1780	1780	1780	rpm
Overall Efficiency	71.2	67.5	71.8	71.4	%
Estimated Noise Level	58.3	58.3	58.8	58.8	dB(A)
Relief Valve Cracking Pressure					psig
Power Required					bhp

Pump Construction

Casing	Carbon Steel ASTM A106	Orientation	Horizontal
Liner	Cast Iron, ASTM A48	Mount	Flange
Rotors	Hardened Steel, ASTM A322-70	Coupling	Direct
Bearing - Axial	N/A		
Bearing - Radial	Internal Ball Bearing, 4-Point		
Bearing Lubrication	Product	Suction	3" ANSI R.F. 300#
Mechanical Seal Manufacturer	John Crane	Discharge	2" ANSI R.F. 600#
Seal Type/Model	Mechanical - 58B	Rotation	CW
Seal Face Materials	SiC vs. Carbon	Flow direction	NO, Top/Top (viewed from shaft)
Seal Plan	API Plan 13 (Internal)	Estimated Weight	100 lbs.
Integral Relief Valve	Not Included		

Motor

Rated Power	5	Hp	Manufacturer	WEG
Speed	1800	rpm	Enclosure	TEFC
Voltage	460	V	Type	Class 1 Div 2 Groups C/D
Phase/Hertz	3/60	Hz	Design	IEEE 841
			Frame	184TC
Service Factor	1.15		Estimated Weight	TBD

Baseplate and Coupling

Coupling Manufacturer	Lovejoy
Coupling Type / Model	Jaw Type
Additional Description	L-099
Adaptor Type	Leistritz Standard
Additional Description	Pump-Motor with Feet

Notes

1. Pump operating data guaranteed in accordance with VDMA 24284, class II, group II standards.
2. Pump materials built to DIN standards, ASTM equivalents listed above.
3. Leistritz standard paint color is RAL 5021- water blue.
4. All orders are processed in accordance with Leistritz' Quality Control Procedure LC-IP-010, latest revision.
5. Pump is API 676 3rd edition compliant except for the attached comments and exceptions.
6. Leistritz standard testing and 3.1 material test certificates are included(rotors and casing), for additional testing please contact Leistritz.
7. Motor testing includes: routine test report, FM or CSA/US certificate.

Test Report
Three Phase Induction Motor

Motor's Serial Number
1032916769

WEG Equipamentos Elétricos S/A. - Motores | **Quality Control - Electric Laboratory IV**
Av. Pref. Waldemar Grubba, 3000 - 89256-900, Jaragua do Sul - Santa Catarina - Brasil

Customer: WEG ELECTRIC CORPORATION - WEC
Sales Order: 4121607

1. Motor Identification

TAG: -
Material: 11433391
Frame: 182/4TC
Mounting: B34R(D)
Approximate Weight (LBS): 113
Drawing: -

Enclosure: IP55
Altitude (m): 1000
Duty Cycle: S1
Design: B

Insulation Class: F
Temperature Rise (K): 80
Ambient Temperature (°C): 40
Service Factor: 1.25

Voltage (V)	Current (A)	Power (HP)	Freq. (Hz)	Speed (rpm)	P.F.	Eff. (%)
460	6.45	5	60	1755	0.8	89.5

2. Tests

2.1. Electric Resistance

Resistance (Ohms): 2.444 / 2.431 / 2.444
Ambient Temperature (°C): 13.6

Unbalance (%): 0.53
Connection Type: T1-T2-T3

2.2. Vibration

Unfiltered vibration (mm/s peak // in/s peak)*			
Position	**Horizontal**	**Vertical**	**Axial**
DE	0.10 // 0.00	0.18 // 0.01	0.16 // 0.01
NDE	0.11 // 0.00	0.15 // 0.01	-

* Test performed on rigid mounting

2.3. No Load

Voltage (V): 459.1
Frequency (Hz): 60.0

Current (A): 3.11
Speed (rpm): 1800

Power (W): 225.00
Direction of Rotation: Clockwise

2.4. Withstand Voltage AC

Voltage (kV): 1.92

Time (s): 60

Current (mA): 4.80

2.5. Insulation Resistance

Resistance (MOhms): 11000

Time (s): 60

Ambient Temperature (°C): 13.6

3. Result

Test approved in accordance with the requirements of IEEE 841: 2009

* Confidential report. Reproduction of this document shall not be partial and depends on the written approval of the laboratory;
* The results presented in this document refer exclusively to the electric motor subjected to the specified tests and do not extend to any batch;
* WEG will keep the original document archived for at least five years.

WEG Motors	Customer
Sidnei Borgonovo Test Date: 7/28/2016	Inspector

Test Report
Three Phase Induction Motor

Motor's Serial Number
1032916775

WEG Equipamentos Elétricos S/A. - Motores | Quality Control - Electric Laboratory IV
Av. Pref. Waldemar Grubba, 3000 - 89256-900, Jaragua do Sul - Santa Catarina - Brasil

Customer: WEG ELECTRIC CORPORATION - WEC
Sales Order: 4121607

1. Motor Identification

TAG: -
Material: 11433391
Frame: 182/4TC
Mounting: B34R(D)
Approximate Weight (LBS): 113
Drawing: -

Enclosure: IP55
Altitude (m): 1000
Duty Cycle: S1
Design: B

Insulation Class: F
Temperature Rise (K): 80
Ambient Temperature (°C): 40
Service Factor: 1.25

Voltage (V)	Current (A)	Power (HP)	Freq. (Hz)	Speed (rpm)	P.F.	Eff. (%)
460	6.45	5	60	1755	0.8	89.5

2. Tests

2.1. Electric Resistance

Resistance (Ohms): 2.435 / 2.446 / 2.445
Ambient Temperature (°C): 16.8

Unbalance (%): 0.45
Connection Type: T1-T2-T3

2.2. Vibration

Unfiltered vibration (mm/s peak // in/s peak)*			
Position	**Horizontal**	**Vertical**	**Axial**
DE	0.08 // 0.00	0.14 // 0.01	0.11 // 0.00
NDE	0.15 // 0.01	0.12 // 0.00	-

* Test performed on rigid mounting

2.3. No Load

Voltage (V): 460.9
Frequency (Hz): 60.0

Current (A): 3.09
Speed (rpm): 1800

Power (W): 232.50
Direction of Rotation: Clockwise

2.4. Withstand Voltage AC

Voltage (kV): 1.92

Time (s): 60

Current (mA): 4.90

2.5. Insulation Resistance

Resistance (MOhms): 11000

Time (s): 60

Ambient Temperature (°C): 16.8

3. Result

Test approved in accordance with the requirements of IEEE 841: 2009

* Confidential report. Reproduction of this document shall not be partial and depends on the written approval of the laboratory;
* The results presented in this document refer exclusively to the electric motor subjected to the specified tests and do not extend to any batch;
* WEG will keep the original document archived for at least five years.

WEG Motors	Customer
Sidnei Borgonovo Test Date: 7/28/2016	Inspector

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 10: OIL COOLER

- MATERIAL CERTIFICATION
- HYDROSTATIC TEST REPORT

AXH air-coolers
WESTLAND ENGINEERING SOLUTIONS

401 E. Lowry Road
Claremore, OK 74017
info@axh.com

Phone (918) 283-9200
Fax (918) 283-9229
www.axh.com

Proposal / Job No.	165400
Date	9/6/2016
Page	1 OF 1

1	*Purchaser*	LAT			*Ultimate User*			
2	*Inquiry / PO#*				*Destination*			
3	*# Units*	1	*Model*	42ZF	*Reference*	LAT573		
4	*Assembly*	PACKAGED	*Draft*	FORCED	*Overall Size , Ft*	~4'Wx7'L	*Est Wt*	2620 LBS

THERMAL & MECHANICAL DESIGN

5	***Service***	S1
6	*Flow*	21GPM
7	*Fluid*	ISO VG 32
8	*Temp. In / Out, °F*	152.4 / 120.0
9	*Pressure, PSI*	285 / 370PSIG
10	*Pressure Drop, PSI*	12.3
11	*Heat Load, BTU/HR*	140000
12	*True LMTD*	17.1
13	*Overall Rate, U*	72.4
14	*Fouling Factor*	.0010
15	*Surface, Tube / Total, Sq Ft*	117 / 2513
16	***Sections, #***	(1)
17	*Design Temp, °F Max / Min*	200 / -20
18	*MWP / Test Press, PSIG*	850 / 1275
19	*Pass Arrangement*	CROSSFLOW
20	*# Tube Rows*	4
21	*# Tube Passes*	6
22	***Tubes, OD x BWG***	1X16
23	*Material*	SA179 STEEL
24	*# Per Section / Length, Ft*	78 / 6
25	*Turbulators*	WIRE CORE
26	*Accelerators*	
27	***Fins, Type***	HI-EFF
28	*Material*	AL
29	***Nozzles, Rating / Type***	600RF
30	*Material*	SA105
31	*#-Inlets / Size In*	(1) 2
32	*#-Oulets / Size In*	(1) 2
33	***Headers, Type***	BOX
34	*Material*	SA516-70
35	*Corrosion Allow, In*	
36	*Grooved Tubesheet*	DBL
37	*Plugs, Type*	SHOULDER
38	*Plugs Material*	A105 STEEL
39	*PWHT*	
40	*ASME Code & Nat'l Board*	YES
41	*CRN*	
42	***Add'l Specs & Options***	
43	*API*	
44	*Louvers / Hail Screen*	/
45	***Inspection / NDT***	

FX= *100% X-Ray of all header seam, attachment & nozzle butt welds.* ***SX=*** *Spot X-Ray of 1 long seam & 1 end closure, per header*
BX= *100% X-Ray of all nozzle butt welds.* ***UT =*** *100% UT of all header seam, attachment & nozzle butt welds.* ***H*** *= Hardness testing.*

	AIR-SIDE PERFORMANCE		FAN DATA		DRIVER DATA	STRUCTURAL	
46	*Ambient Air Temp, In °F*	110	*Fan(s)*	(1) MOORE-1K-10	*Type*	*Guards*	FAN/DRIVE
47	*Elevation, Ft*	2900	*Blade Material*	ALUMINUM	DIRECT DRIVE BY (1) 5HP,		
48	*Air Flow, SCFM*	11,124	*HP / Fan*	2.75	900RPM, 460/60/3, TEFC,		
49	*Outlet Air Temp, °F*	121.1	*Dia, In / # Blades*	42 / 4	MOTOR (CSA)		
50	*Min Air Temp, °F*	-20	*RPM*	875			
51			*Tipspeed, FPM*	9621			
52			*Pitch, Deg*	31.8			

53	***Additional Info.***
54	
55	
56	
57	
58	

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS

(ALTERNATIVE FORM FOR SINGLE CHAMBER, COMPLETELY SHOP OR FIELD FABRICATED VESSELS ONLY)

AS REQUIRED BY THE PROVISIONS OF THE ASME BOILER AND PRESSURE VESSEL CODE RULES, SECTION VIII, DIVISION 1

1. Manufactured and certified by: AXH air-coolers, LLC - 401 EAST LOWRY ROAD - CLAREMORE, OKLAHOMA 74017
(Name and address of manufacturer)

2. Manufactured for: L.A. TURBINE CORPORATION, 28557 INDUSTRY DRIVE, VALENCIA, CA 91355

3. Location of installation: UNKNOWN
(Name and address)

4. Type: HORZ. H. EXCHANGER (Horizontal, or vertical, tank) | 165400A-B.1 (Manufacturer's serial no.) | NONE (CRN) | 165400-HDR-S1 R1 (Drawing number) | 36255-36256 (National Board number) | 2016 (Year built)

5. ASME CODE, SECTION VIII, DIVISION 1 | 2015 EDITION / NONE (Edition and Addenda, if applicable (date)) | - (Code Case numbers) | - (Special service per UG-120(D))

6. Shell | TUBE/PLUG: SA-516-70 (Material spec. number, grade) | FR & BK 1 1/2" (Nominal thickness) | NONE (Corr. Allow.) | FR & BK 0' 8 3/4" (Inner diameter) | 3' 9 5/8" (Length (overall))

Body Flanges on Shells

No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Bolting: Num & Size	Bolting: Bolting Material	Bolting: Washer (OD, ID, thk)	Bolting: Washer Material
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

7. Seams | CORNER JOINT (Long. (welded, dbl., sngl., lap, butt)) | NONE (R.T. (spot or Full)) | 1.0 (Eff., %) | NONE (H.T. temp.°F) | NONE (Time, hr) | - (Girth (welded, dbl., sngl., lap, butt)) | - (R.T. (spot or full)) | - (Eff., %) | *2 (No. of courses)

8. Heads (a) Material: WRAPPERS: SA-516-70 (Spec. no., grade) (b) Material: ENDS: SA-516-70 (Spec. no., grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	WRAPPERS	1/2"	NONE	-	-	-	-	-	**	FLAT
(b)	ENDS	1/2"	NONE	-	-	-	-	-	***	FLAT

Body Flanges on Heads

	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Bolting: Num & Size	Bolting: Bolting Material	Bolting: Washer (OD, ID, thk)	Bolting: Washer Material
(a)	-	-	-	-	-	-	-	-	-	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-

9. MAWP: 850 psi. (Internal) | N/A (External) | at max. temp 200 °F (Internal) | N/A (External)

Min. design metal temp. -20 °F at 850 psi Hydro. ~~pneu. or comb.~~ test pressure 1275 psi.

Proof test NONE

10. Nozzles, inspection, and safety valve openings:

Purpose (Inlet,Outlet,Drain)	No.	Diameter or size	Type	Material: Nozzle	Material: Flange	Nozzle Thickness: Nom.	Nozzle Thickness: Corr.	Reinforcement Material	Attachment Details: Nozzle	Attachment Details: Flange	Location (Insp. Open.)
INLET/OUTLET	2	2"-600#	PIPE/RFWN	SA106B	SA105	S/80	NONE	NONE	UW-16(a)	UW-12(1)	HEADER
INSTRUMENT	3	1"	CPLG	SA105	-	6000#	NONE	NONE	UW-16(a)	-	HEADER
PLUGS	156	1 1/8"-12	UNF	SA105	-	-	-	-	-	-	HEADER

11. Supports: Skirt NO (Yes or no) Lugs N/A (Number) Legs N/A (Number) Other STRUCTURE (Describe) Attached BOLTED (Where and How)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report:
(Name of part, item number, Manufacturer's name and identifying stamp)

*2 HEADERS, ONE AT EACH END. **WRAPPERS FLAT DIA. 3" X 3' 9 5/8". ***ENDS FLAT DIA. 3" X 7 3/4".

78 TUBES SA-179 1" O.D. X .065 MW 6' 0" LG.

IMPACTS EXEMPT PER UG-20(f). PRESSURE RELIEF DEVICE BY OTHERS PER UG-125. CONSTRUCTED IN ACCORDANCE WITH APPENDIX 28.

FORM U-1A (Back)

CERTIFICATE OF SHOP / FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 34,950 expires 02/07/2017

Date 12-6-16 Co. name AXH air-coolers, LLC. (Manufacturer) Signed [signature] (Representative)

CERTIFICATE OF SHOP / FIELD INSPECTION

Vessel constructed by AXH air-coolers, LLC. at 401 E LOWRY ROAD - CLAREMORE, OKLAHOMA 74017

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by ONECIS INSURANCE COMPANY OF LYNN, MA

have inspected the component described in this Manufacturer's Data Report on 12-1-16, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 12-6-16 Signed [signature] (Authorized Inspector) Commissions NB12461A [National Board (incl endorsements)]

NB 36255

CERTIFIED BY **AXH air-coolers, LLC**

CLAREMORE, OKLAHOMA S1

U

W

MAX. ALLOWABLE WORKING PRESSURE 850 PSI @ 200 °F

MIN. DESIGN METAL TEMP. -20 °F @ 850 PSI

SER. NO. 165400A.1 CRN. -

YEAR 2016 HYDRO. 1275 PSIG SERVICE

NB 36256

CERTIFIED BY **AXH air-coolers, LLC**

CLAREMORE, OKLAHOMA S1

U

W

MAX. ALLOWABLE WORKING PRESSURE 850 PSI @ 200 °F

MIN. DESIGN METAL TEMP. -20 °F @ 850 PSI

SER. NO. 165400B.1 CRN. -

YEAR 2016 HYDRO. 1275 PSIG SERVICE

11-29-16

FINAL IN PROCESS
INSPECTION CHECKLIST

AXH air-coolers

CUSTOMER:	L.A. TURBINE
JOB / MODEL NUMBER:	165400 / 42ZF
UNIT:	A

	PROD.	LEAD	Q.C.	CUST.	
NOZZLE ARRANGEMENT AND FLANGE FACING	JN. Ec 12-5-16 X	F.O. X	ZZA 12-8 X		
RUST PREVENTION OF NOZZLE FACES	X				
RUST PREVENTION OF SHAFTS	JN 12-6-16 X				
DIMENSIONAL INSPECTION OF COLUMNS	JN. FO 12-5-16 X	F.O X	ZZA 12-8 X		
DIMENSIONAL INSPECTION OF BASE HOLES	JN 12-5-16	F.O			
TORQUING OF FAN HUB & BLADES	JN 12-8-16 X	F.O X			
CHECK FAN BLADE CLEARANCE AND PITCH 31.8°	JN. 12-8-16 X	F.O X	ZZA 12-8 X		
PARAFLEX CPLG, FAN BUSHING, AND BEARINGS SECURED	JN. 12-8-16 X	F.O X	ZZA 12-8 X		
BEARINGS GREASED	X		X		
IDLER ALIGNMENT					
ELECTRIC MOTOR / SHEAVE ALIGNMENT	JN. 12-8-16 X	F.O X	ZZA 12-8 X		
MANUAL AND/OR AIR MOTORS					
SHUTTERS OPERATE CORRECTLY, PICTURES TAKEN					
SIDE FLAP INSTALLATION (FRONT HEADER END) (BACK HEADER END)					
FINAL FINISH AVG. MIL. (HEADERS & SIDEFRAMES) 4	EP 12-6-16 X	MM 12-7-16 X	ZZA 12-8 X		
CLEANING OF GALVANIZED PARTS AS REQUIRED	JN.F.O 12-8-16 X				
HAIL GUARD, FAN GUARD, AND/OR BUGSCREENS	JN.F.O 12-8-16 X				
UNIT / MISC NAMEPLATE INSPECTION & ATTACHMENT	JN 12-8-16 X	FO X	ZZA 12-8 X		
TEST FIT OF LADDERS / PLATFORMS, PICTURES TAKEN					
PARTS SHIPPING LOOSE					
VIBRATION SWITCH	JN 12-5-16 X		ZZA 12-8 X		
ELECTRIC MOTOR VERIFICATION	JN 11-30-16 X	FO X	KD 11-30-16 X		
RUN TEST AND VIBRATION CHECK		TMK X	ZZA 12-8 X		
VERIFY WEIGHT #2945	JN 12-8-16 X				
Q.C. RELEASE FOR SHIPMENT: ZZA 12-8-16					

COMMENTS: OIL FLUSH PER JOB INSTRUCTIONS.

FINAL IN PROCESS
INSPECTION CHECKLIST

AXH air-coolers

CUSTOMER:	L.A. TURBINE
JOB / MODEL NUMBER:	165400 / 42ZF
UNIT:	B

	PROD.	LEAD	Q.C.	CUST.
NOZZLE ARRANGEMENT AND FLANGE FACING	JN 12-5-16 X	FO X	YZA 12-8 X	
RUST PREVENTION OF NOZZLE FACES	X			
RUST PREVENTION OF SHAFTS	JN 12-5-16 X			
DIMENSIONAL INSPECTION OF COLUMNS	JN FO 12-8-16 X	FO X	YZA 12-8 X	
DIMENSIONAL INSPECTION OF BASE HOLES				
TORQUING OF FAN HUB & BLADES	JN 12-8-16 X	FO X		
CHECK FAN BLADE CLEARANCE AND PITCH 31.8 °	JN 12-8-16 X	FO X	YZA 12-8 X	
PARAFLEX CPLG, FAN BUSHING, AND BEARINGS SECURED	JN 12-8-16 X	FO X	YZA 12-8 X	
BEARINGS GREASED	X		X	
IDLER ALIGNMENT				
ELECTRIC MOTOR / SHEAVE ALIGNMENT	JN 12-8-16 X	FO X	YZA 12-8 X	
MANUAL AND/OR AIR MOTORS				
SHUTTERS OPERATE CORRECTLY, PICTURES TAKEN				
SIDE FLAP INSTALLATION (FRONT HEADER END) (BACK HEADER END)				
FINAL FINISH AVG. MIL. (HEADERS & SIDEFRAMES) 4	EP 12-6-16 X	mm 12-7-16 X	YZA 12-8 X	
CLEANING OF GALVANIZED PARTS AS REQUIRED	JN FO 12-8-16 X			
HAIL GUARD, FAN GUARD, AND/OR BUGSCREENS	JN FO 12-8-16 X			
UNIT / MISC NAMEPLATE INSPECTION & ATTACHMENT	JN 12-8-16 X	FO X	YZA 12-8 X	
TEST FIT OF LADDERS / PLATFORMS, PICTURES TAKEN				
PARTS SHIPPING LOOSE				
VIBRATION SWITCH	JN 12-5-16 X		YZA 12-8 X	
ELECTRIC MOTOR VERIFICATION	JN 11-30-16 X	FO X	KP 11-30-16 X	
RUN TEST AND VIBRATION CHECK		TMK X	YZA 12-8 X	
VERIFY WEIGHT #2,945	JN 12-8-16 X			

Q.C. RELEASE FOR SHIPMENT: YZA 12-8-16

COMMENTS: CAR FLUSH PER JOB INSTRUCTIONS.

AXH air-coolers

REPORT OF NONDESTRUCTIVE TESTING
MAGNETIC PARTICLE EXAMINATION RECORD

REFERENCE STANDARD: ASME SECT.V, ASME SECT. VIII DIV.1, APPENDIX 6
AXH AIR-COOLERS STANDARD MS-20.0 REVISION: 0

EXAMINATION EQUIPMENT & METHOD

MAGNETIZING EQUIPMENT: Parker Research Contour Probe SERIAL #: 3563

CURRENT TYPE: [X] AC [ ] DC

MT TYPE: [ ] WET [X] DRY [ ] FLOURESCENT [X] VISIBLE

LIGHTING EQUIPMENT:
[X] FLOURESCENT LIGHT
[X] WHITE LIGHT USING PARKER RESEARCH Y300 OR Y400 PROBE LIGHTING
[ ] FLASHLIGHT [ ] # OF BATTERIES TYPE: ____ CELL ____
MAXIMUM DISTANCE FROM OBJECT: ____ FEET
[ ] OTHER ____

MINIMUM LIGHT INTENSITY ON SURFACE TO BE EXAMINED: 100 FOOT CANDLES

EXAMINATION RESULTS

IDENTIFICATION:

CUSTOMER: L.A. Turbine DATE: 11-28-16

JOB #: 165402 A,B ITEM #: .1 (EXAMPLE: .1, .2, .3)

MATERIAL TYPE: SA51670 MATERIAL THICKNESS: ____

EXAMINATION PERFORMED:

[X] PLATE EDGES PER ASME SECTION VIII, DIV. 1, UG-93: BEFORE WELDING - WELD JOINT PREPARATION (OR AREA TO BE WELDED) OF ALL TUBE AND PLUG SHEETS, AND AFTER WELDING - PERIPHERAL EDGE OF TUBE AND PLUG SHEETS
BEFORE 11-15-16 AFTER 11-28-16
[ ] ALL WELDED SEAMS WHERE ACCESSIBLE
[ ] ALL FINAL WELD SEAMS, NOZZLES, & COUPLINGS WHERE ACCESSIBLE
[ ] ALL NOZZLE & COUPLING ROOT PASSES WHERE ACCESSIBLE
[ ] OTHER ____

EXAMINATION RESULTS:

[X] ACCEPT [ ] REJECT

DESCRIPTION AND/OR MAP OF INDICATIONS FOUND

T.J. Feff — EXAMINER

II — QUALIFICATION LEVEL

AXH air-coolers

HYDROSTATIC TEST REPORT

MANUFACTURED FOR L.A. TURBINE

AXH JOB NUMBER 165400

VESSEL TESTED 165400A-B.1 S1

TEST PRESSURE 1275 PSI

HYDRO TEST HELD FOR 1 HR.

THIS REPORT IS TO CERTIFY THAT THE AFOREMENTIONED VESSEL (OR) VESSELS WERE HYDROSTATIC TESTED IN ACCORDANCE WITH ASME SECTION VIII DIV 1.

CUSTOMER WITNESS _____

ACCEPTED BY R. Bergeron DATE 12-1-16

QUALITY CONTROL REPRESENTATIVE

AXH air-coolers

SECTION FLUSHING REPORT
REFERENCE: AXH AIR-COOLERS STANDARD MS-32.0

CUSTOMER: L.A. Turbine PO #: _____

AXH JOB #: 165400, 1A-B SECTION: S1

FLUSHING OIL USED: Industrial Oils Unlimited, Premium Flushing Oil No. 7

FLOW RATE REQ'D: 100 GPM TEMPERATURE: 155 +/- °F

RECORDED FLOW RATE: 400 GPM TEMPERATURE: 155 °F

MINIMUM REQUIRED FLUSHING TIME: 8 HOURS

MAXIMUM NUMBER OF PARTICLES ALLOWED: _____

NUMBER OF PARTICLES FOUND: 150 psc.
(GREATEST DIMENSION OF ANY PARTICLE FOUND SHALL NOT EXCEED 0.010 INCHES)

On Pre-Flush (if required) Date: 12/2/16 Time: 6:00 A.M.

Off Pre-Flush (if required) Date: 12/2/16 Time: 10:00 A.M.

On Flush Date: 12/2/16 Time: 11:00 A.M.

Off Flush Date: 12/2/16 Time: 3:00 P.M. -

TOTAL SECTION FLUSHING TIME: 8 HOURS

FLUSHING OIL ADDED (COVERING BOTTOM TUBE ROW) BY: Kevin M

SIGN OFF:

MANUFACTURING: Kevin M DATE: 12-2-16

QUALITY CONTROL: D. Ty DATE: 12-5-16

CUSTOMER INSPECTOR: _____ DATE: _____

OIL FLUSH LOG

JOB #: 165400 A-B

DATE: 12/2/16

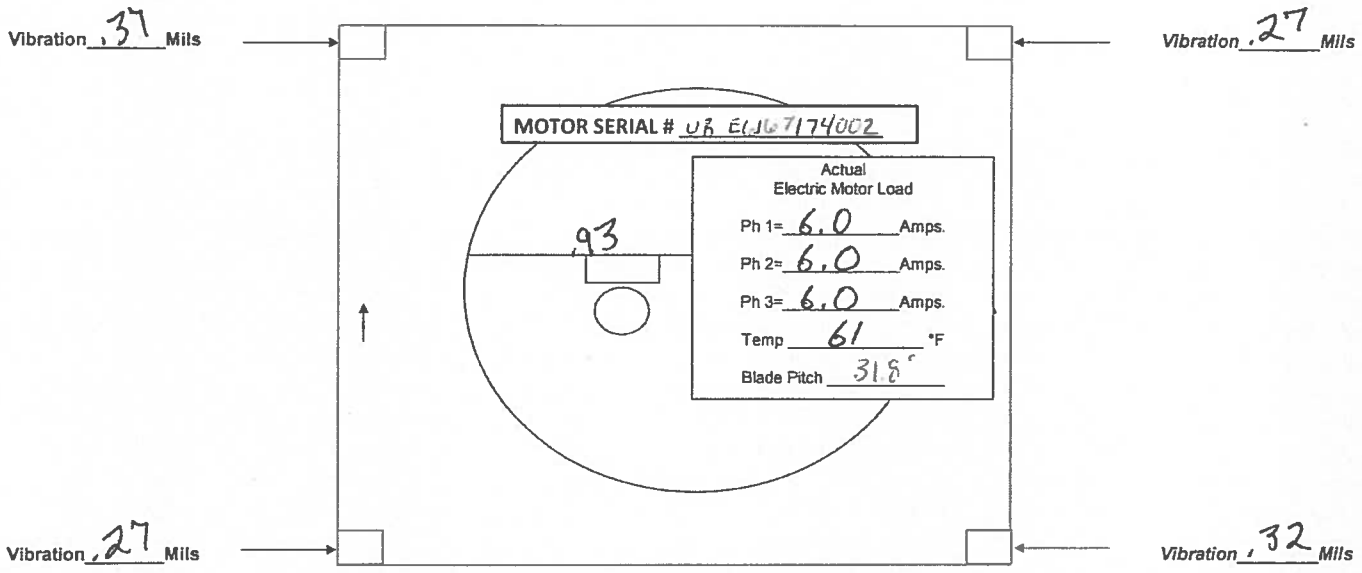
	BASKET CHECK	PARTICLES	FLOW RATE	TEMP	DIRECTION	INITIALS	NOTES
	12-1-16	Started	Pre	flush	3:00 Pm		
6:00 am	12-2-16	1000	400	155	Reverse	KP	
	12-2-16	wire	inserts	installed	flush		started 11:00 am
3:30 Pm	12-2-16	150		155	forward		Blow down

AXH air-coolers
401 East Lowery Rd. - Claremore, Ok. 74017
918-283-9200 - fax. 918-283-9229
www.axh.com

JOB NUMBER(S): 165400A
CUSTOMER: L.A. TURBINE
QUANTITY: 1-MOTOR
MODEL: 42ZF

RUN-IN TESTING

BACK HEADER END



FRONT HEADER END

TESTING PERFORMED

1. Vibration Displacement in Mils. Peak to peak
2. Vibration Meter: Balmac Model 205

AXH air-coolers

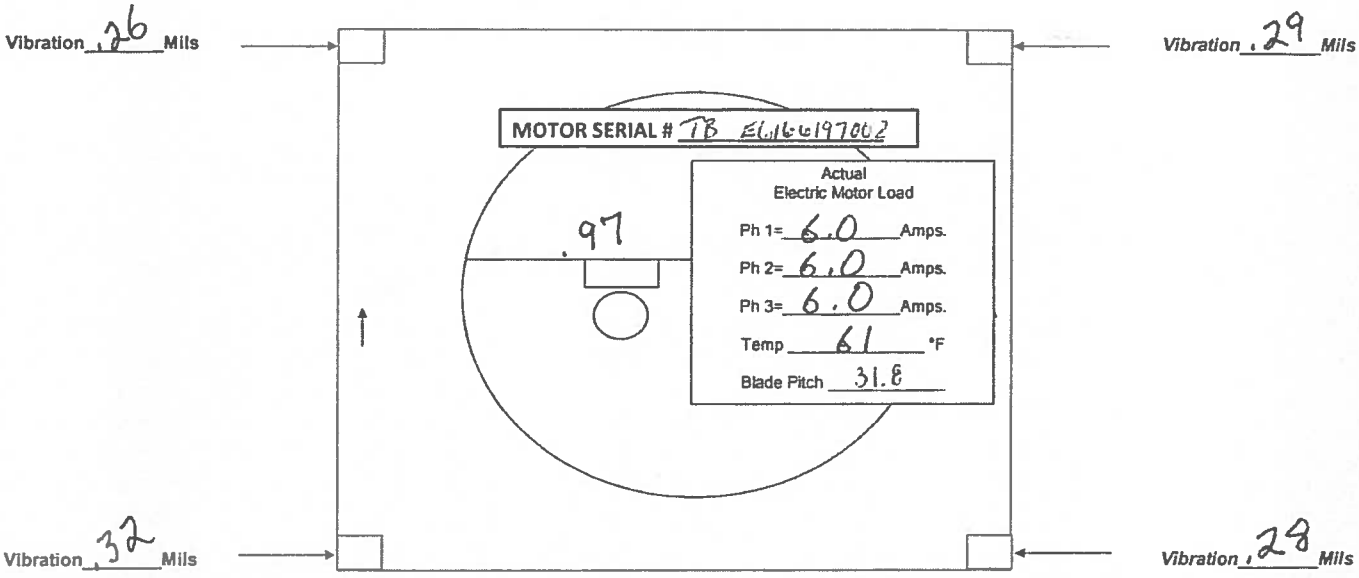
Tested By: [signature]
Date Tested: 12-8-16
Time Tested: 3:35 am (pm)

AXH air-coolers
401 East Lowery Rd. - Claremore, Ok. 74017
918-283-9200 - fax: 918-283-9229
www.axh.com

JOB NUMBER(S): 165400B
CUSTOMER: L.A. TURBINE
QUANTITY: 1-MOTOR
MODEL: 42ZF

RUN-IN TESTING

BACK HEADER END



FRONT HEADER END

TESTING PERFORMED

1. Vibration Displacement in Mils. Peak to peak
2. Vibration Meter: Balmac Model 205

AXH air-coolers

Tested By: [signature]
Date Tested: 12-8-16
Time Tested: 3:15 am (pm)

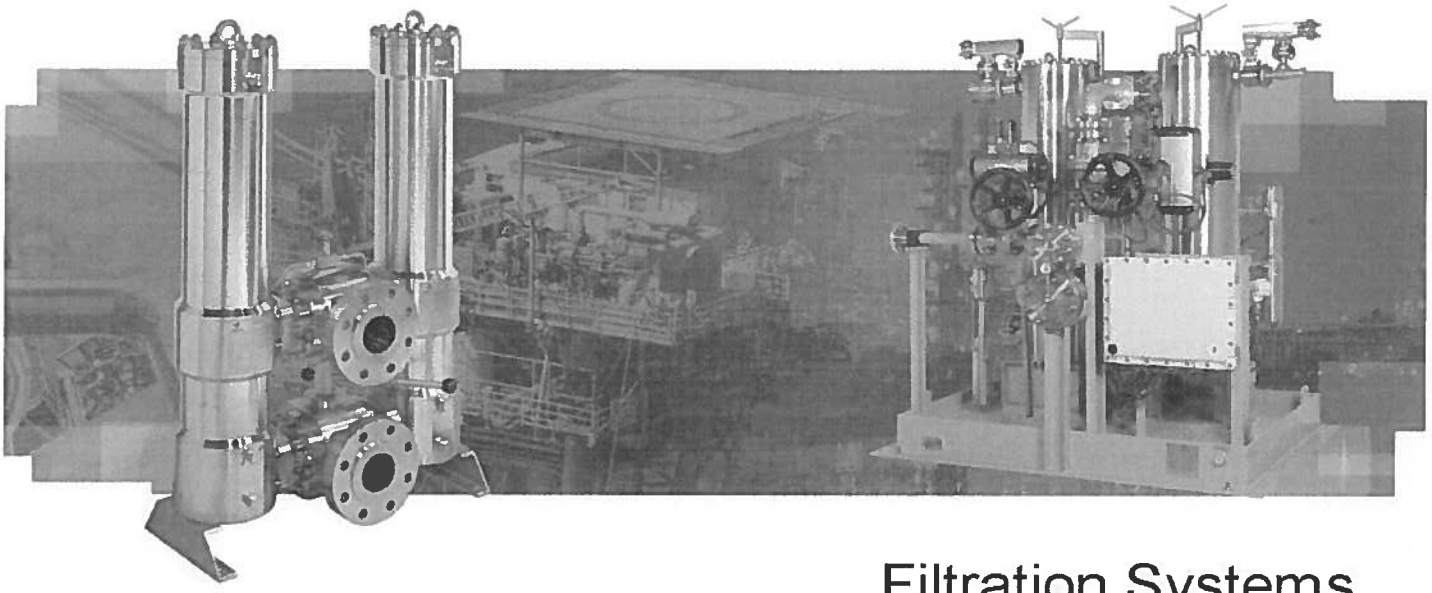
L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 11: FILTERS - LUBE OIL & SEAL GAS

- MATERIAL CERTIFICATION
- HYDROSTATIC TEST



Filtration Systems

DATA BOOK

LA Turbine Corp. 23716 (JCI# 854084)

Tag no.: F-201
LAT574

Indufil Ordernr.: 4000859267-110.1

Quality rep.	Date	Description of change	Rev.
AVS	13-Jan-2017	As Built	0

DATABOOK BEHÄLTERPASS	DOSSIER CONSTRUCTEUR	REV. 0	john crane a Smiths company

Indufil BV, Hydrograaf 25, 6921 RS Duiven, The Netherlands, P.O. Box 442, 6900 AK Zevenaar, The Netherlands
VAT.No.: NL-802897782 B01, Telephone: +31 (0)26 3190800, Telefax: +31 (0)26 3190808. E-mail: quality@johncrane-indufil.com

Customer	Kunde	Client	**LA Turbine Corp.**
Purchase ordernr.	Bestell-Nr	No de cde. Client	**23716 (JCI# 854084)**
Subject code nr.	System-Nr	Codification client	
Purchase tag nr.	Tag-Nr	Position repère	**F-201**
Project	Projekt	Project	**LAT574**
Indufil ordernr.	Indufil Auftr.-Nr.	No de fabr. Indufil	**4000859267-110.1**
Subject	Gegenstand	Désignation	**FILTER ISSH 1-00085 1"ANSI-600#**
Drawing number	Zeichnungsnummer	No de plan	**GA-195476-1**
Filterelement	Filterelement	Type de cartouche	**INR-S-00085-BAS-GF3-ED**
Total Weight	Gesamtgewicht	Poids total	**24 kg / 52,9 lb**
Third party	Abnamegeselschaft	Organisme certifié	**NB26763**

CONTENTS / INHALT / INDEX

			PAGE
VQP	VQP	VQP	**2**
Test reports	Prüfzeugnisse	PV des tests	**3**
TPI Certificate	TPI Zertifikaten	Certificate TPI	**7**
Declaration of conformity Cleanliness certificate	Konformitätserklärung Zertifikat von Reinheit	Déclaration de conformité Certificat de propreté	**9**
Rubbing of nameplate	Kopie Typenschild	Copie plaque de signalétique	**10**
Material certificates	Werkstoffzeugnisse	Certificats matière	**Section i**
Instruction and operation manual	Montage und Betriebsvorschriften	Instructions d'utilisation et d'entretien	**Appendix 1**
Design Calculations	Konstruktionsberechnungen	Calculs de Conception	**Appendix 2**
Shop drawing / parts list	Konstruktionszeichnung / Stücklist	Plan de construction / liste des pièces détachées	**Appendix 3**

This data report has been carefully produced according to our manufacturing standard. If you have any questions or remarks about it, please contact the Indufil quality department.

Dieses Behälterpass ist sorgfältig hergestellt worden laut unser manufacturing standard. Wenn Sie Fragen order Bemerkungen haben, bitte rufen Sie die Indufil Qualitätsabteilung an.

Le dossier constructeur à été établi avec soins en accord avec notre procédure de fabrication. Veuillez adresser vos éventuelles questions ou remarques directement à notre service qualité Indufil.
Tel : +31 (0) 26 319 0800 or E-mail : quality@johncrane-indufil.com

AVS

INDUFIL BV
Quality Dept
Signed: A. van Santen

Date 29-07-2016

Vendor Quality Plan (Inspection and Test Plan)

Rev

Indufil Order Number	4000859267-110.1		
Document Number	4000859267-110.VQP		
Customer	LA Turbine Corp.		
Customer Reference	PO: 23716 (JCI# 854084)		
Customer Product Code	Tag# F-201		
Project Name	LAT574		
Design Code	ASME VIII div 1		
Third Party / Certification	U-Stamp (NB)		
Revision	0	Drawn by	BBU
Date	10-11-2016	Checked by	SPI

Inspection Activities

A= Approval
H= Hold (written release required)
W= Witness (no release required)
R= Review
SW= Spot Witness
N/A= Not Applicable

John Crane

Notification Time: 10 working days

No	Activity	Procedure and drawing specifications	Acceptance criteria	Verifying document	Supplier Indufil	Cust. LAT	Contr.	TPI N.B.
1	Issue design drawing(s) and calculation(s)	Drawing(s) and calculation(s) according code requirements	Design code	Approved documents	H	A		A
2	Issue VQP and applicable procedure(s)	Procedure(s) Indufil BV	Design code	Approved documents	H	A		
3	Manufacturing process	Drawing(s)	Drawing(s)	Certificate of Compliance	H	R		
4	Check identification and compliance of materials	-	Material specifications	*	H	R		R
5	US Examination Filter Housing(s) before machining	Code case 2155 + 2156	ASME SA 388	US Statement and/or US Report *	H	R		R
6	Liquid Penetrant Test	-	-	LPT Report	N/A	N/A		
7	PMI	WI-09.15E	-	PMI Report	N/A	N/A		
8	Hardness Test	Nace MR0175 / ISO 15156	Nace MR0175 / ISO 15156	Hardness Test Report *	N/A	N/A		
9	Dimensional check	-	Drawing(s)	Certificate of Compliance	H	R		
10	Hydrostatic Test	Hydro test instruction WI-09.13E	Design code	Hydro Test Certificate	H	R		H
11	Filter element control	Drawing(s)	-	-	H	R		
12	Ball Valve Testing	Indufil standard WI-09.18E	Indufil standard	Test Certificate	N/A	N/A		
13	Leak Test assembled filter	Leak test procedure WI-04.09E	No leaks	Leak Test Certificate	H	R		
14	Cleanliness check	Cleaning and check pro. WI-09.14E	Liquid/gas < 3/0.3 µm	Cleanliness Certificate	H	R		
15	Paint acc. Indufil std.	-	Paint specification	Paint Thickness Report	N/A	N/A		
16	Weighing complete assembly	-	-	-	H	R		
17	Review data book and stamp nameplate (traceable materials only)	- -	Design code	Data book	H	R		H
18	Final inspection before shipment	-	Assembly drawing	Certificate of Compliance	H	R		

Note(s):

* Included in the material certificates (EN 10204 - 3.1)

CERTIFICATE OF PRESSURE TESTING
ZERTIFIKAT FÜR DRUCKPRÜFUNG
CERTIFICAT DE TEST DE PRESSION

Customer	Kunde	Client	**LA Turbine Corp.**
Purchase ordernr.	Bestell-Nr	No de cde. Client	**23716 (JCI# 854084)**
Purchase tag nr.	Tag-Nr	Position repère	**F-201**
Indufil ordernr.	Indufil Auftr.-Nr.	No de fabr. Indufil	**4000859267-110.1**
Subject	Gegenstand	Désignation	**FILTER ISSH 1-00085 1"ANSI-600#**
Third party reg. nr.	Vorprüfungsnr.	No de reg. Org. cert.	**NB26763**
Year Built	Herstellungsjahr	Année de construct.	**2017**
Drawing number	Zeichnungsnummer	No de plan	**GA-195476-1**

Procedure nr.	Prozedur-Nr.	No de procédure	**WI-09.13 E**
Design pressure	Auslegungsdruck	Pression de calcul	**-14,5 / 1200 psi(g)**
Test pressure	Prüfüberdruck	Pression de test	**1800 psi(g)**
Capacity	Inhalt	Capacité	**0,16 USG**
Test medium	Prüfmittel	Fluide d'épreuve	**Water [Cl^-] ≤ 30 ppm**
Test temperature	Prüftemperatur	Temp. d'épreuve	**Ambient (20 °C / 68 °F)**
Test duration	Prüfzeit	Temps de test	**30 min.**
Pressure gauge	Manometer	Manomètre	**11033QCM; 11033QCN**
Test location	Prüfort	Lieu d'épreuve	**Duiven**
Test date	Prüfdatum	Date d'épreuve	**4-1-2017**
Results	Ergebnis	Résultats	**Satisfactory**

AVS

INDUFIL BV
Quality Dept
Signed: A. van Santen

John Crane Indufil B.V.

Pressure Gauges Calibration Certificate

Indufil BV
Duiven, the Netherlands

Calibration was carried out according to EN 837-1

Certificate No. 2016 -11033QCM
Date: 07-10-2016
Expiring date: 08-10-2017

Reference Instrument	P#14020064 - CPG500	Accuracy	0.25%
Range:	0...1000 bar	Serial No.	1015ZZN

Results:

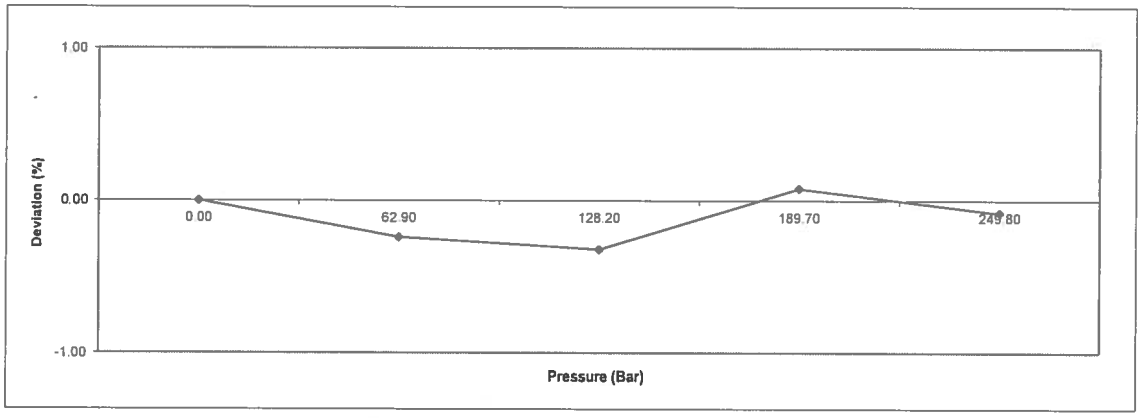
Maximum test pressure: **250 bar**
Temperature: 20 +/- 5 °C

Range: 0 ... 250 bar rel.
Serial No: 11033QCM

Type: 233.50
Class: 1.00%

Reference	up	down	avg	Deviation	Hysteresis
Bar	Bar	Bar	Bar	%	%
0.00	0.00	0.00	0.00	0.00	0.00
62.90	63.00	64.00	63.50	-0.24	-0.40
128.20	128.00	130.00	129.00	-0.32	-0.80
189.70	189.00	190.00	189.50	0.08	-0.40
249.80	250.00	250.00	250.00	-0.08	0.00

accuracy: 0.32 %
Demand: <1 %
Aproved **Yes**



Calibration performed by: Ton Huberts

Remarks:

This document was created automatically and needs no signature

INDUFIL B.V.
Quality Dept.
Signed: T. Huberts

John Crane Indufil B.V.

Pressure Gauges Calibration Certificate

Indufil BV
Duiven, the Netherlands

Calibration was carried out according to EN 837-1

Certificate No. 2016 -11033QCN
Date: 07-10-2016
Expiring date: 08-10-2017

Reference Instrument	P#14020064 - CPG500	Accuracy	0.25%
Range:	0...1000 bar	Serial No.	1015ZZN

Results:

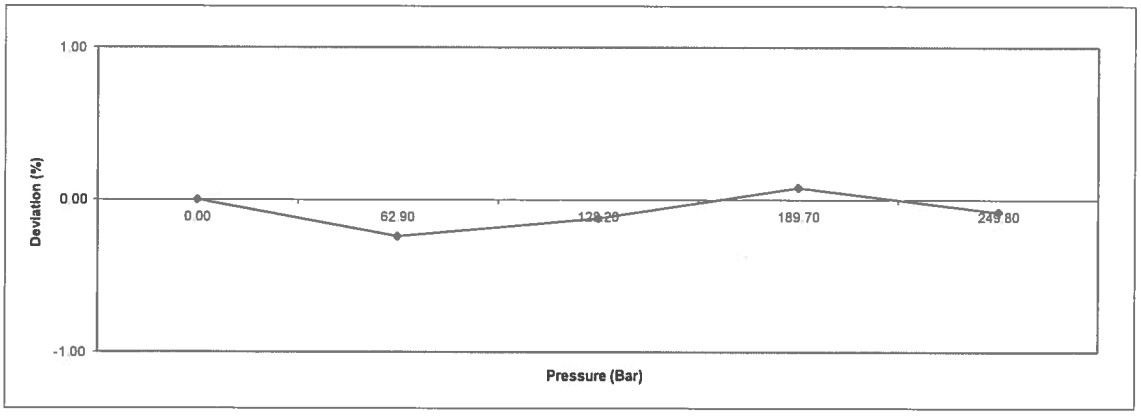
Maximum test pressure: **250 bar**
Temperature: 20 +/- 5 °C

Range: 0 ... 250 bar rel.
Serial No: 11033QCN

Type: 233.50
Class: 1.00%

Reference	up	down	avg	Deviation	Hysteresis
Bar	Bar	Bar	Bar	%	%
0.00	0.00	0.00	0.00	0.00	0.00
62.90	63.00	64.00	63.50	-0.24	-0.40
128.20	128.00	129.00	128.50	-0.12	-0.40
189.70	188.00	191.00	189.50	0.08	-1.20
249.80	250.00	250.00	250.00	-0.08	0.00

accuracy: 0.24 %
Demand: <1 %
Aproved **Yes**



Calibration performed by: Ton Huberts

Remarks:

This document was created automatically and needs no signature

INDUFIL B.V. Quality Dept. Signed: T. Huberts

CERTIFICATE OF LEAK TESTING
ZERTIFIKAT FÜR DICHTIGKEITSPRÜFUNG
CERTIFICAT DE TEST D'ÉTANCHÉITÉ

Customer	Kunde	Client	**LA Turbine Corp.**
Purchase ordernr.	Bestell-Nr	No de cde. Client	**23716 (JCI# 854084)**
Purchase tag nr.	Tag-Nr	Position repère	**F-201**
Indufil ordernr.	Indufil Auftr.-Nr.	No de fabr. Indufil	**4000859267-110.1**
Subject	Gegenstand	Désignation	**FILTER ISSH 1-00085 1"ANSI-600#**
Third party	Abnamegeselschaft	Organisme certifié	**NB26763**
Year Built	Herstellungsjahr	Année de construct.	**2017**
Drawing number	Zeichnungsnummer	No de plan	**GA-195476-1**

Acceptance standard	Akzeptierung laut	Etanchéité requise	**No leakage**
Procedure nr.	Prozedur-Nr.	No de procédure	**WI-04.09**
Test pressure	Prüfüberdruck	Pression de test	**5 bar(g) / 72,5 psi(g)**
Test date	Prüfdatum	Date d'épreuve	**5-1-2017**
Test medium	Prüfmittel	Fluide d'épreuve	**Nitrogen (N_2)**
Test location	Prüfort	Lieu d'épreuve	**Duiven**
Test duration	Prüfzeit	Temps de test	**2 min.**
Results	Ergebnis	Résultats	**Satisfactory**

AVS

INDUFIL BV
Quality Dept
Signed A. van Santen

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS (Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only) As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by INDUFIL BV, Hydrograaf 25, 6921 RS Duiven, The Netherlands (Name and address of manufacturer)
2. Manufactured for LA Turbine Corporation, 28557 Industry Drive, Valencia CA 91355, USA. (Name and address of purchaser)
3. Location of installation Unknown (Name and Address)
4. Type Vert. (Horizontal or vertical, tank) | 4000859267-110.1 (Manufufacturer's serial number) | - (CRN) | 4000859267-110.U-ISSUE A (Drawing number) | 26763 (National Board number) | 2017 (Year Built)
5. ASME Code, Section VIII, Division 1 | 2015 (Edition and Addenda, if applicable (date)) | 2155, 2156 (Code Case numbers) | - (Special service per UG-120(d))
6. Shell SA479 316L (Material spec. number, grade) | 0.52" (Nominal thickness) | 0.00" (Corr. Allow.) | 2.46" (Inner diameter) | 9.25" (Length (overall))

Body Flanges on Shells												
									Bolting			
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

7. Seams Sml (Long. (Welded, dbl., sngl., lap, butt)) | None (R.T. (spot or full)) | 100 (Eff., %) | - (H.T. temp) | - (Time, hr) | - (Girth (welded, dbl.,sngl., lap, butt)) | - (R.T. (spot or full)) | 100 Eff., (%) | 1 (No. of courses)
8. Heads: (a) Material SA479 316L (Spec. No. Grade) (b) Material: SA479 316L (Spec. No. Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	Top	1.57"	0.00"	-	-	-	-	-	4.29"	-
(b)	Bottom	0.69"	0.00"	-	-	-	-	-	4.29"	-

If removable, bolts used (describe other fastenings) Englin. studs: SA 193 B8M Cl.2, nuts: SA-194 8M, 4 pcs., 5/8"-11UNC for top cover only

Body Flanges on Heads												
									Bolting			
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
(a)	-	-	-	-	-	-	-	-	-	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-

9. MAWP 1200 (internal) | - (external) psi at max. temp. 200 (internal) | - (external) °F.
Min. Design metal temp. -20 °F at 1200 psi. Hydro~~, pneu., or comb.~~ test pressure 1800 psi.
Proof test - .

10. Nozzles, Inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Inlet / Outlet	3	1"SAE	Bolted	-	-	-	-	-	-	-	-
Drain / Vent	2	1"SAE	Bolted	-	-	-	-	-	-	-	-
Equal. Conn.	1	1"SAE	Bolted	-	-	-	-	-	-	-	-

11. Supports: Skirt No (Yes or no) Lugs - (Number) Legs - (Number) Other - (Describe) Attached - (Where and how)
12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: none
UG-125 is user's responsibility. Hydro test performed in the vertical position.
Impact testing: No, exempted per UHA51 (d) (1) for all components.
All nozzles are machined openings with no permanent attached nozzle necks.
Removable top cover identified with manufacturer's serial no. and used as inspection opening.

FORM U-1A (Back)

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 31,295 expires 17 May, 2019.

Date January 04th, 2017 Co. name INDUFIL BV THE NETHERLANDS (Manufacturer) Signed _____ (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by INDUFIL BV, THE NETHERLANDS at Hydrograaf 25, 6921 RS Duiven, The Netherlands.

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by Lloyd's Register Verification Limited of UK

have inspected the component described in this Manufacturer's Data on January 04th, 2017, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this Inspection.

Date Jan. 4, 2017 Signed _____ (Authorized Inspector) Commissions NB12110 A, B [National Board (Incl. endorsements)]

(07/13)

CERTIFICATE OF CONFORMITY
KONFORMITÄTSZERTIFIKAT
CERTIFICAT DE CONFORMITÉ

Customer	Kunde	Client	**LA Turbine Corp.**
Purchase ordernr.	Bestell-Nr	No de cde. Client	**23716 (JCI# 854084)**
Indufil ordernr.	Indufil Auftr.-Nr.	No de fabr. Indufil	**4000859267-110.1**
Subject	Gegenstand	Désignation	**FILTER ISSH 1-00085 1"ANSI-600#**

Pressure vessels have been designed, constructed and tested according to ASME VIII DIV.1 Edition 2015 , Indufil std. and customer requirements. The dimensions of the pressure vessels have been checked in accordance with the drawing nr 046.05.662.01-A. The sectional drawing as mentioned above is integrated in the general arrangement drawing GA-195476-1 and therefore not included in this data book.

Die Druckbehälter sind nach ASME VIII DIV.1 Edition 2015 , Indufil std. entworfen, hergestellt und getestet entsprechend der Kundenspezifikation. Die Abmessungen der Druckbehälter wurden gemäß Zeichnungs-Nr. 046.05.662.01-A kontrolliert. Die oben genannte Schnittzeichnung ist in das Maßbild GA-195476-1 integriert und deshalb nicht beim Behälterpass eingeschlossen.

Les équipements sous pressions ont été conçus, construits testés et suivant les standard ASME VIII DIV.1 Edition 2015 , Indufil std. et suivant les exigences du client. Les dimensions des équipements sous pression ont été vérifiées par rapport au plan No 046.05.662.01-A. Le plan en coupe mentionné ci-dessus à été intégré dans le plan général GA-195476-1 et de ce fait n´as pas été inclus dans le dossier constructeur.

CERTIFICATE OF CLEANLINESS
ZERTIFIKAT VON REINHEIT
CERTIFICAT DE PROPRETÉ

These filter and valve parts have been cleaned with a pre-filtered degreasing solution. After the degreasing all parts were dried and visually checked. During the assembly, no tools did come in contact with internal parts and the filter has been protected

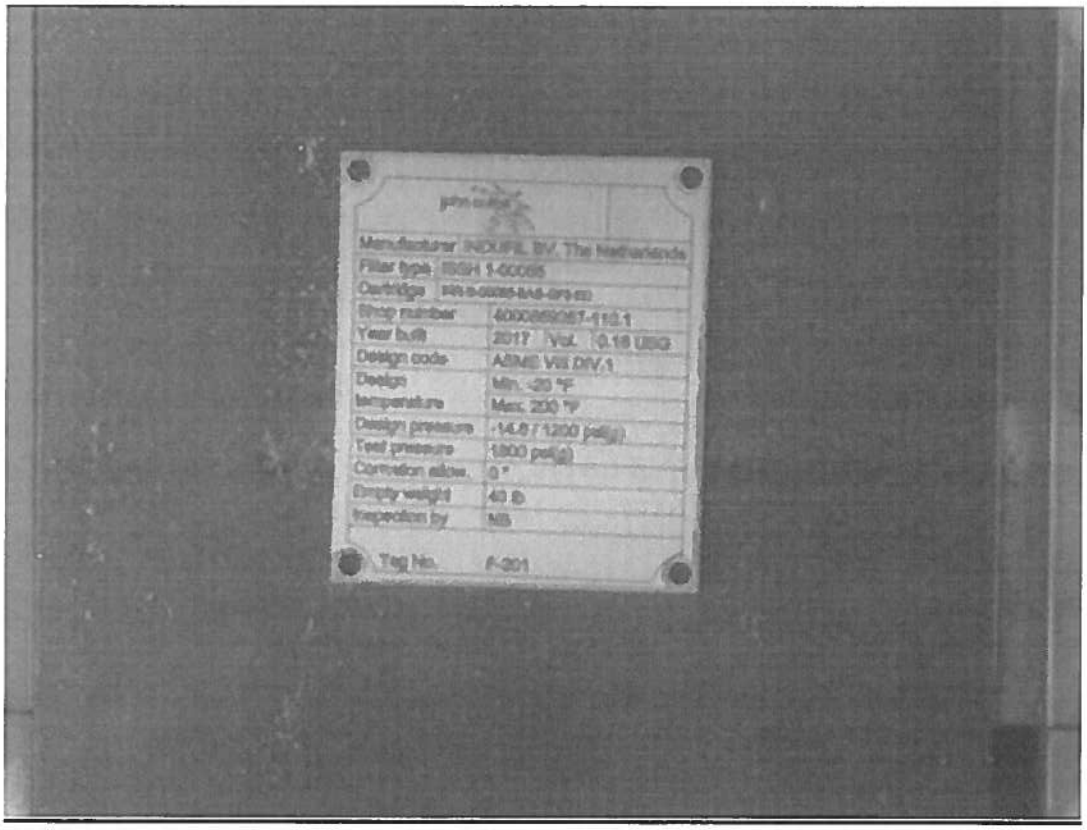
Alle Filter und Unterteile sind in einer entfettenden Lösung gereinigt. Nach diesem Vorgang sind alle Teile getrocknet und kontrolliert worden. Während der Montage sind alle Teile mit größter Vorsicht eingebaut worden. Wir garantieren Ihnen ein einwandfreies Produkt.

Toutes les pièces de filtres et vannes ont été rincées avec un fluide dégraissant. Après dégraissage, toutes les pièces ont été séchées et contrôlées visuellement. Pendant le montage, aucun outil ne doit venir en contact avec les pièces internes et le filtre doit être protégé contre les impuretés venant de l'extérieur.

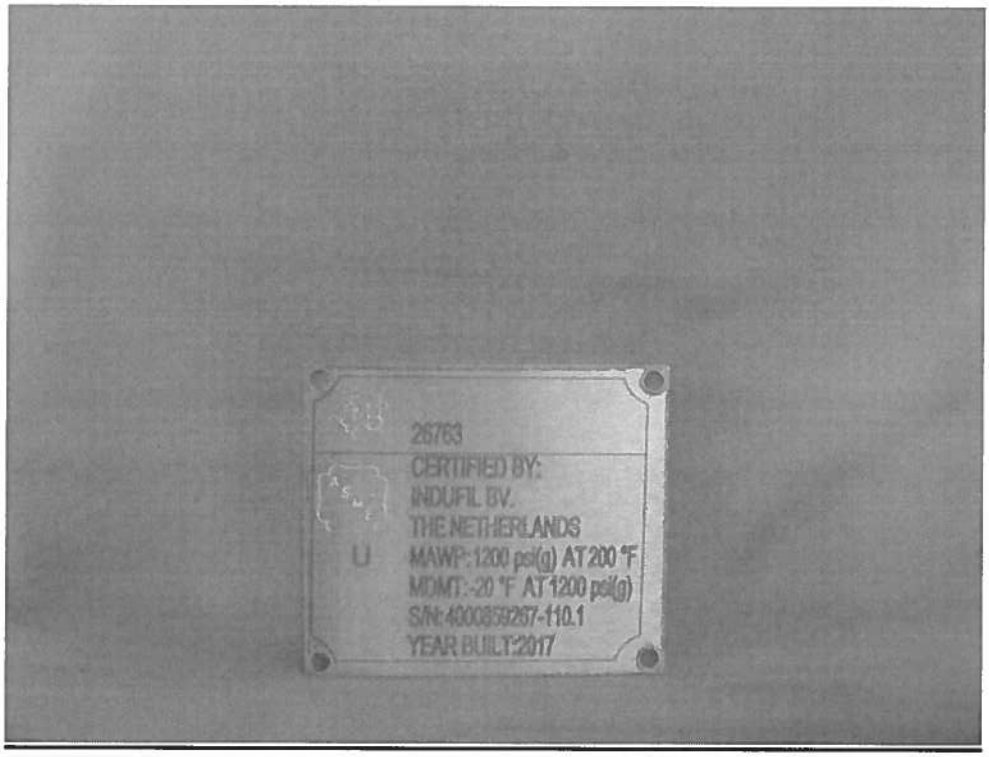
AVS

INDUFIL BV
Quality Dept
Signed: A. van Santen

Indufil BV, Hydrograaf 25, 6921 RS Duiven, The Netherlands, P.O. Box 442, 6900 AK Zevenaar, The Netherlands
VAT.No.: NL-802897782 B01, Telephone: +31 26 3190800, Telefax: +31 26 3190808. E-mail: quality@johncrane-indufil.com



Indufil BV, Hydrograaf 25, 6921 RS Duiven, The Netherlands, P.O. Box 442, 6900 AK Zevenaar, The Netherlands
VAT.No.: NL-802897782 B01, Telephone: +31 26 3190800, Telefax: +31 26 3190808. E-mail: quality@johncrane-indufil.com



MATERIAL INDEX – WERKSTOFF INHALT – INDEX MATIÈRE

Indufil Order No, No de fabr. Auftr.-Nr.:
4000859267-110.1
Purchase order No, Bestell-Nr, No de commande:
23716 (JCI# 854084)

Drawing No, Zeichnungs Nr, No de plan:
GA-195476-1
Subject, Gegenstand, Désignation:
FILTER ISSH 1-00085 1"ANSI-600#

Herewith we declare that for the manufacturing of the under mentioned materials, the material type are proven by works certificates, all engineered studs and nut have been supplied with 3.1 type certification and all pressure parts not identified with CE marking are manufactured according PED/SEP and are identified with the charge numbers listed below as required by the PED 2014/68/EU Annex 1, 4.3.

Wir bescheinigen hiermit, dass die Herstellung nachstehenden Werkstoffe verwendet und durch Werkstoffzertifikaten belegt sind, alle gebauten Bolzen und Muttern wurden mit 3.1 Material-Zeugnis geliefert, und alle Druck¬tragenden Teile die nicht mit CE-Kennzeichnung versehen sind, sind nach PED/SEP produziert und können anhand der unten stehenden Chargen-Nummer identifiziert werden, wie nach PED 92014/68/EU Annex 1, 4.3 vorgesehen.

Nous déclarons que pour la fabrication des matériaux mentionnés ci-dessus, les types de matériaux sont garantis par ces certificats, tous les goujons et écrous ont été livrés avec un certificat 3.1 et les pièces soumises à la pression, non identifiés par un marquage CE ont étés fabriqués selon la DESP/SEP et ont étés identifiés par des No. de coulées listé ci-dessous, suivant la réquisition art. 3.3 de la DESP 2014/68/EU Annex 1, 4.3.

Partnr. Teilnr. Pièce No.	Name of part. Teilnr. Désignation	Material type Werkstoff Matière	Type of certificate Art des Zertifikat Certificat type	charge Number Schmelzennummer No de coulée	Page nr. Seite Nr. Page No.
001	FILTER HOUS.	SA182 / SA479 S31600 / S31603	EN 10204 – 3.1	588140	i-2
002	TOP COVER	SA182 / SA479 S31600 / S31603	EN 10204 – 3.1	545372	i-5
011	FLANGE CONNECTION	SA182 / SA479 S31600 / S31603	EN 10204 – 3.1	570480	i-8
014	BLIND FLANGE	SA182 / SA479 S31600 / S31603	EN 10204 – 3.1	271308	i-11
016	FLANGE CONNECTION	SA182 / SA479 S31600 / S31603	EN 10204 – 3.1	269737	i-15
017	HEXAGON PLUG	SA182 / SA479 S31600 / S31603	EN 10204 – 3.1	H388	i-18

INDUFIL BV
Quality Dept.
Signed A. van Santen

TRUE COPY

Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date: 21.03.16

Zertifiziert nach:	AD2000 W 0 TRD 100	Werkstofflieferant gemäß Druckgeräte-richtlinie 97 / 23 EG

Abnahmeprüfzeugnis nach DIN EN 10204 3.1/01.05
Inspection Certificate acc.to/Certificat de réception selon

Zeugnis-Nr./Certificate No./No.de Certificat 2125974/7709387/ost

DEUTSCHE EDELSTAHLWERKE
ThyssenKrupp Materials
Nederland B.V.
Lorentzweg
NL-4131 PH Vianen

Herstellerzeichen/Supplier's Mark/Marque d'usine	DEW
Prüfstempel/Inspector's stamp/Poincon de l'expert	WA

Warenempfänger
ThyssenKrupp Materials
Nederland B.V.
Hoedemakersstraat
NL-3334 KK Zwijndrecht

Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	
5403686266 | 07.03.16	
Unsere Auftr.-Nr. Our order No./No.de notre Commande	**Unsere Material-Nr.** Our material No./No.de notre matériel
1647077 / 1	71020886
Unsere Abteilung/Our department/Notre département	**Telefon/Telephone/Téléphone**
VR-H	02302-29-4837

Produkt/Product/Produit

Stabstahl aus nichtrostendem Stahl
ACIDUR 4401/4404 NIROCUT, 316 / 316L / 14404/14401
gewalzt, lösungsgeglüht, abgeschreckt, gerichtet, geschält
gemäß EN 10088-3, EN 10272, AD2000-W2/W10, ASTM A182, 276, 479, ASME BPVC E.2013 S.2 P.A SA182, 276, 479, NACE MR 0103/0175, ISO 15156-3, Analyse + mech. Eigenschaften nach EN 10222-5,EN 10250-4

bar steel made of stainless steel
ACIDUR 4401/4404 NIROCUT, 316 / 316L / 14404/14401
hot rolled, solution annealed, quenched, straightened, peeled
acc. to EN 10088-3, EN 10272, AD2000-W2/W10, ASTM A182, 276, 479, ASME BPVC E.2013 S.2 P.A SA182, 276, 479, NACE MR 0103/0175,ISO 15156-3, analysis + mech. properties acc. to EN 10222-5,EN 10250-4

barre en acier inoxydable
ACIDUR 4401/4404 NIROCUT, 316 / 316L / 14404/14401
laminé, recuit de mise en solution, hypertrempe, dressé, écroûté
selon EN 10088-3, EN 10272, AD2000-W2/W10,ASTM A182,276,479, ASME BPVC E.2013 S.2 P.A SA182,276,479,NACE MR0103/0175, ISO 15156-3, analyse et caracteristique mech. suivant EN 10222-5, EN 10250-4

Fertigungsauftr.-Nr./Production lot-No./Lot de fabrication No.	:
Lieferschein-Nr./Delivery note/No. de l'avis de livraison	:
Schmelzen-Nr./Heat No./No.de coulée	: 588140
Stückzahl/Piece No./Nombre des pièces	: 9
Gewicht/Weight/Masse	: 3925 [kg]
Zeichnungs-Nr./Drawing No./No.du dessin	:
Format/Shape/Profil	: rund / round / rond
Durchm./Breite/Diameter/width/Diamètre/largeur	: 110 [mm] +0.350/-0.000 [mm]
Dicke/Thickness/Épaisseur	:
Länge/Length/Longueur	: 5000 - 6000 [mm]

Stückzahl und Gewicht siehe Rechnung. / Quantity and weight see delivery bill/invoice.
Nombre des pièces et masse voir facture.
Lieferzustand/Condition as supplied/Etat de livraison:
1920 DEGREE F SOLUTION ANNEALED AND QUENCHED, 1050 GRAD C
LOESUNGSGEGLUEHT UND ABGESCHRECKT, NO WELDING HAS BEEN PERFORMED,
AM MATERIAL WURDE NICHT GESCHWEISST

Die Prüfergebnisse zu Ihrer Lieferung finden Sie auf der Rückseite bzw. den nächsten Seiten
As for test results of your delivery see overleaf. / Vouz trouverez les resultats d'essais de votre livraison aux pages suivantes.

DEUTSCHE EDELSTAHLWERKE GMBH
Abnahmetechnik/Inspection department/Département de Réception

Krause
Abnahmebeauftragter/Der Werkssachverständige
Test House Manager/Works' inspector/Resousable Reception/L'Agent Réceptionnaire de l'usine

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Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date: 21.03.16

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
2125974/7709387/ost	1647077 / 1	5403686266	

Schmelzen-Nr. Heat No. No.de coulée	Erschmelzungsart Steelmaking process Procédé d'élaboration	Sekundärmetallurgie Secondary metallurgy Metallurgie secondaire	Gießverfahren Casting process Procédé de coulée
588140	E	VOD	VSG

Chemische Zusammensetzung/ Chemical Composition/ Composition chimique

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	V	W	Co	Al	
Ist/Actual/Actuel	0.017	0.25	1.64	0.025	0.029	16.59	2.04	10.17	0.26	0.03	0.03	0.071	< 0.003	[%]
	N													
Ist/Actual/Actuel	0.041													[%]

Härte/ Hardness/ Dureté

Lieferzustand/Condition as supplied/Etat de livraison

Proben-Nr./Specimen-No./No.d'eprouvette	17726	
Ist/Actual/Actuel	155	[HB]

MAX 22 HRC

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 7 mm rd	quer/transverse/traverse	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2[MPa (N/mm²)]	Rp1.o[MPa (N/mm²)]	Rm[MPa (N/mm²)]	A5[%]	A2"[%]	Z[%]
17725	309	366	567	45.2	47.1	53

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 7 mm rd	quer/transverse/traverse	1/2 Radius um 90 Grad versetzt	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2[MPa (N/mm²)]	Rp1.o[MPa (N/mm²)]	Rm[MPa (N/mm²)]	A5[%]	A2"[%]	Z[%]
17725	282	348	568	47.3	44.9	51

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 12,5 mm rd	längs/longitudinal/longueur	12.5mm unter der Oberfläche, (d-12,5mm)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2[MPa (N/mm²)]	Rp1.o[MPa (N/mm²)]	Rm[MPa (N/mm²)]	A5[%]	A2"[%]	Z[%]
17722	264	312	576	57.1	58.9	76
17721	269	310	579	55.2	57.1	76

Schlagbiegeversuch/ Impact test/ Essai de résilience

Lieferzustand/Condition as supplied/Etat de livraison

Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Prüftemp./Test temperature/Température d'essai
[CHARPY V]	längs/longitudinal/longueur	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	1.Prfl./Spec./Eprouvette	2.Prfl./Spec./Eprouvette	3.Prfl./Spec./Eprouvette
17724	236[J]	231[J]	234[J]
17723	288[J]	224[J]	250[J]

Korngröße/ Grain size/ Grosseur de grain

Lieferzustand/Condition as supplied/Etat de livraison

Richtreihe gemäß/Chart acc.to/Série type selon	Größe/Size/Grosseur
ASTM E 112	5 - 6

Interkristalline Korrosion/ Intergranular corrosion/ Corrosion intercristalline

Material bestaendig nach / material resistant according to / material resistant suivant ASTM A 262 Practice E, EN 114, ISO 3651-2 Verfahren A

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Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date: 21.03.16

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
2125974/7709387/ost	1647077 / 1	5403686266	

US-Prüfung/ Ultrasonic testing/ Contrôle par ultrasons

Die Lieferung wurde 100% US-geprüft nach/ Delivery US-checked 100% acc.to/ Livraison contrôlé par ultrasons selon: EN 10228-4 TYP 1A, TAB.4 KL.3

ENTSPRICHT AUCH/ ALSO CORRESPONDING TO/ CORRESPOND AUSSI A/ CORRESPOND TAMBIEN EN 10308 TYP 1A KL.3, ASTM A 388

Die Lieferung wurde auf Identität geprüft (Optische Emissionsspektrometrie) / Identity has been checked (Optical Emission Spectrometry) / Identification (Spectro.) a été effectué
Rißkontrolle wurde durchgeführt. / Testing for surface cracks has been performed. / Contrôle de fissures à la surface a été effectué.

Die Lieferung wurde besichtigt und auf Maß kontrolliert / Visual inspection and control of dimensional accuracy have been performed/
Contrôle visuel et inspection dimensionnelle ont été effectué

Umformgrad/ Reduction Ratio/ Ratio de déformation: 17: 1

Das Material ist frei von Radioaktivität (<0,1Bq/g bezogen auf Co-60). / The Product is free from radioactivity (<0,1Bq/g concerning Co-60).
La matière n'est pas radioactive (<0,1Bq/g, référence Co-60).
El material es libre de radioactividad.

Location of production: Germany

Das Qualitaetsmanagement-System wurde durch TUEV NORD (Kenn-Nr.0045)
gemäss der Richtlinie 97/23/EG Anhang 1, Abschnitt 4.3
(Druckgeräterichtlinie) überprüft (Zertifikats-Nr.: 07-202-1404
WZ-0857/13).

It is hereby certified that the quality management system has been
reviewed by TUEV NORD (identification no.0045) according to the
requirements of the Pressure Equipment Directive 97/23/EC Annex 1, 4.3
(guidelines for pressure instruments) (certificate no.: 07-202-1404
WZ-0857/13).

Le système d'assurance de qualité est verifié par la société TUEV NORD
(no. indicatif 0045) selon recommendation 97/23/EG annexe 1,
section 4.3 (Directive pour Appareils soumis a Pression)
(certificate no.: 07-202-1404 WZ-0857/13).

El Sistema de Calidad fue examinado por el TUEV NORD (no.de
identificación 0045) en conformidad con la directiva 97/23/EG anexo 1,
séccion 4.3 (para equipos de presión) (certificado no.: 07-202-1404
WZ-0857/13).

Erläuterung/ Explanations/ Explications

- **Erschmelzungsart/ Steelmaking process/ Procédé d'élaboration:**
  E = Elektrostahl / Electric-arc-furnace steel / Acier électrique
- **Sekundärmetallurgie/ Secondary metallurgy/ Metallurgie secondaire:**
  VOD = Vakuum-Sauerstoff-Entkohlungs-Verfahren / Vacuum-Oxygen-Decarburization / Vacuum-Oxygène-Décarburation
- **Gießverfahren/ Casting process/ Procédé de coulée:**
  VSG = Vorblock-Strangguß / Continuous casting bloom / Bloom de coulée continue

Die Lieferung wurde aus einem bevorrateten, geprüften Abnahmelos (Fertigungsauftr.-Nr. 715027) entnommen.
Material against this delivery has been taken from a stored and tested inspection lot. (Production lot-No. 715027).
La livraison a été pris d'un lot de réception stocké et éprouvé (Lot de fabrication No. 715027).

Es wird bestätigt, daß die Lieferung geprüft wurde und den Vereinbarungen bei der Bestellungsannahme enspricht.
We hereby certify that the material described above has been tested and complies with the terms of the order.
Nous certifions que la livraison été vérifiée et est conforme aux stipulations de l'acception de la commande.

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SANDVIK

CERTIFICATE No. A/16-584375 Rev 01

Date 2016-06-09 Page 1/3

Rev.date 2016-06-20

INSPECTION CERTIFICATE acc to EN 10204 3.1

INSPECTION STAMP
SVQ

CS STEEL, a.s.
Potstatska 613
753 01 HRANICE
CZECH REPUBLIC

Customer References

	Customer order
V100 013304	2016-06-08
332-07566 CS STEEL	

Sandvik References

Order No.	Subs No.	ABSMT Dispatch note
444042	611501	26843/53
ABSMT No.	C.Code	
284-15482	78	

Material description
HOT WORKED STAINLESS BAR STEEL
ROLLED
ANNEALED & STRAIGHTENED
PEEL TURNED AND POLISHED

Steel making process
E+AOD+LRF

Steel/material Designations
Sandvik
SANMAC 316/SANMAC 316L

AISI	UNS
316/316L	S31600/S31603
W.nr	EN no
1.4401/1.4404	1.4401/1.4404

Technical requirements
EN 10088-3:-2005, EN10272:-2007, NACE MR 0175/ISO 15156-3:2009
ASTM A-182-14, (Chemical composition and mechanical properties only)
ASTM A-276-16, A-479-16, ASME SA-479-ED-15 SEC II PART A
AD-2000-W2/W10

EXTENT OF DELIVERY

It	Product designation	Heat	Lot	Pieces	Kg
01	MBR-SANMAC316L-110	545372	75431	4	1865.0
	7111031605	545374	87161	3	1398.0
			Total	7	3263.0

TEST RESULTS
Chemical composition (weight%)

Heat	C	Si	Mn	P	S	Cr	Ni	Mo
545372	0.019	0.27	1.71	0.032	0.025	16.78	10.22	2.03
545374	0.013	0.27	1.77	0.031	0.025	16.82	10.20	2.02

Heat	N
545372	0.040
545374	0.041

Tensile test at room temperature
Longitudinal

	Yield strength MPa		Tensile strength MPa	Elongation %		Red.of Area %
Lot	Rp0.2	Rp1.0	Rm	A	2"	Z
75431	241	286	565	57	57	75
87161	254	299	580	54	54	76

Quality assurance - Viktor Hellberg/QA-manager Primary Products
MTC Service / Certificates

AB SANDVIK MATERIALS TECHNOLOGY Reg No. 556234-6832 VAT No. SE663000-060901
SE-81181 SANDVIKEN SWEDEN www.smt.sandvik.com mtc_service.smt@sandvik.com

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Hardness test

Lot	HB	HB	HB
75431	129	132	133
87161	141	143	141

Grain size acc to ASTM E-112.

Lot	
75431	6.0
87161	8.0

Impact test, J, 20 °C, Longitudinal

	Single values			Average
Lot	Joule			Joule
75431	281	284	306	290
87161	291	311	289	297

Following controls/tests have been satisfactorily performed:
- Intergranular corrosion test acc to ASTM A-262 PR.E
- Material Identification.
- Ultrasonic test acc to EN 10228-4, Scan coverage 1, Quality Class 3, Tab 4. AD2000 - A4-2003, 6.3. 1 F, ASTM A-388
- Visual inspection and dimensional control.

Heat Treatment:
Solution annealed and quenched.

Marking:
SANDVIK, W.NR, HEAT, LOT, INSPECTION STAMP.

Intergranular corrosion test acc to EN ISO 3651-2 Method A.

The raw material is free from radioactive contamination.

Material free from mercury contamination.

No welding or weld repair.

This is to certify that the contents of this certified material test report are correct and accurate and that all test results and operations are in compliance with the material specification.

Approved acc. AD 2000-Merkblatt W0 and certified acc. to Pressure Equipment Directive (97/23/EC) by TUEV NORD GmbH; notified body, reg.no. 0045.

The delivered products comply with the specifications and requirements of the order.

The material is manufactured according to a Quality system, approved and registered to ISO 9001:2008.

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No unauthorized alterations. The contents of this Inspection Certificate may not be modified or revised in any way without the prior written approval of AB Sandvik Materials Technology. Unauthorized alterations to the Inspection Certificate, including introduction of false, fictitious or fraudulent statements or entries, may be punishable by fines, imprisonment, or both. This Inspection Certificate may be copied only in the manner and for the purposes specified in Section 6 of EN 10204:2004. Contravention of this notice will be prosecuted to the fullest extent of applicable law.

The certificate is produced with EDP and valid without signature.

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Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date: 17.11.15

Zertifiziert nach:	AD2000 W 0 TRD 100	Werkstofflieferant gemäß Druckgeräte-richtlinie 97 / 23 EG

Abnahmeprüfzeugnis nach

Inspection Certificate acc.to/Certificat de réception selon DIN EN 10204 3.1/01.05

Zeugnis-Nr./Certificate No./No.de Certificat 2092737/1561762/bit

DEUTSCHE EDELSTAHLWERKE
ThyssenKrupp Materials
Nederland B.V.
Lorentzweg
NL-4131 PH Vianen

Herstellerzeichen/Supplier's Mark/Marque d'usine	DEW
Prüfstempel/Inspector's stamp/Poincon de l'expert	WA

Warenempfänger
ThyssenKrupp Materials
Nederland B.V.
Hoedemakersstraat
NL-3330 AE Zwijndrecht

Ihre Auftr.-Nr. vom
Your order No. date /No.de votre commande du
5550337813/125+130 | 24.09.15

Unsere Auftr.-Nr. Our order No./No.de notre Commande	**Unsere Material-Nr.** Our material No./No.de notre matériel
1619120 / 1	2287271
Unsere Abteilung/Our department/Notre département	**Telefon**/Telephone/Téléphone
VR-H	0271/808-2252

Produkt/Product/Produit

STAEBE AUS NICHTROSTENDEM STAHL
ACIDUR 4401/4404 MOD NIROCUT, F316/F316L
UNS S31600/S31603,GEWALZT, ABGESCHRECKT, GERICHTET, GESCHAELT
EN 10088-3, EN 10272, AD 2000 W2/W10,
ASTM A 182/276/479, ASME SA 182/276/479,
NACE MR 0175, ISO 15156-3, NACE MR 0103,
TKM NL LV REV.02, 10.2014

STAINLESS STEEL BARS
ACIDUR 4401/4404 MOD NIROCUT, F316/F316L
UNS S31600/S31603, HOT ROLLED, QUENCHED, STRAIGHTENED, PEELED
EN 10088-3, EN 10272, AD 2000 W2/W10
ASTM A 182/276/479, ASME SA 182/276/479,
NACE MR 0175, ISO 15156-3, NACE MR 0103
TKM NL LV REV.02, 10.2014

Fertigungsauftr.-Nr./Production lot-No./Lot de fabrication No.	:697417
Lieferschein-Nr./Delivery note/No. de l'avis de livraison	:554775
Schmelzen-Nr./Heat No./No.de coulée	:570480
Stückzahl/Piece No./Nombre des pièces	:6
Gewicht/Weight/Masse	:5622 [kg]
Zeichnungs-Nr./Drawing No./No.du dessin	:
Format/Shape/Profil	:rund / round / rond
Durchm./Breite/Diameter/width/Diamètre/largeur	:125.000 [mm] +0.400/-0.000 [mm]
Dicke/Thickness/Épaisseur	:
Länge/Length/Longueur	:7000 - 10000 [mm]

Lieferzustand/Condition as supplied/Etat de livraison:
1920 DEGREE F SOLUTION ANNEALED AND QUENCHED, 1050 GRAD C
LOESUNGSGEGLUEHT UND ABGESCHRECKT, NO WELDING HAS BEEN PERFORMED,
AM MATERIAL WURDE NICHT GESCHWEISST

Die Prüfergebnisse zu Ihrer Lieferung finden Sie auf der Rückseite bzw. den nächsten Seiten
As for test results of your delivery see overleaf. / Vouz trouverez les resultats d'essais de votre livraison aux pages suivantes.

DEUTSCHE EDELSTAHLWERKE GMBH
Abnahmetechnik/Inspection department/Département de Réception

Krause
Abnahmebeauftragter/Der Werkssachverständige
Test House Manager/Works' inspector/Resousable Reception/L'Agent Réceptionnaire de l'usine

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Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE
Providing special steel solutions

D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date: 17.11.15

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
2092737/1561762/bit	1619120 / 1	5550337813/125+130	697417

Schmelzen-Nr. Heat No. No.de coulée	Herkunft Origin Origine	Erschmelzungsart Steelmaking process Procédé d'élaboration	Sekundärmetallurgie Secondary metallurgy Metallurgie secondaire
570480	Witten	E	VOD

Chemische Zusammensetzung/ Chemical Composition/ Composition chimique

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Co	N	
Ist/Actual/Actuel	0.019	0.35	1.62	0.024	0.029	16.65	2.01	10.37	0.20	0.068	0.052	[%]

Härte/ Hardness/ Dureté
Lieferzustand/Condition as supplied/Etat de livraison

Proben-Nr./Specimen-No./No.d'eprouvette	52148	
Ist/Actual/Actuel	182	[HB]

MAX 22 HRC

Zugversuch/ Tensile test/ Essai de traction
Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 12,5 mm rd	längs/longitudinal/longueur	12,5mm unter der Oberfläche, (d-12,5mm)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2 [MPa (N/mm²)]	Rp1.o [MPa (N/mm²)]	Rm [MPa (N/mm²)]	A5 [%]	A2'' [%]	Z [%]
52146	312	353	593	51.6	53.4	75

Zugversuch/ Tensile test/ Essai de traction
Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 7 mm rd	quer/transverse/traverse	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2 [MPa (N/mm²)]	Rp1.o [MPa (N/mm²)]	Rm [MPa (N/mm²)]	A5 [%]	A2'' [%]	Z [%]
52146	315	353	594	53.3	55.0	74

Zugversuch/ Tensile test/ Essai de traction
Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 7 mm rd	quer/transverse/traverse	1/2 Radius um 90 Grad versetzt	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2 [MPa (N/mm²)]	Rp1.o [MPa (N/mm²)]	Rm [MPa (N/mm²)]	A5 [%]	A2'' [%]	Z [%]
52146	313	344	596	52.7	54.6	78

Schlagbiegeversuch/ Impact test/ Essai de résilience
Lieferzustand/Condition as supplied/Etat de livraison

Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Prüftemp./Test temperature/Température d'essai
[CHARPY V]	längs/longitudinal/longueur	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	1. Prfl./Spec./Eprouvette	2. Prfl./Spec./Eprouvette	3. Prfl./Spec./Eprouvette
52146	272 [J]	248 [J]	255 [J]

Korngröße/ Grain size/ Grosseur de grain
Lieferzustand/Condition as supplied/Etat de livraison

Richtreihe gemäß/Chart acc.to/Série type selon	Größe/Size/Grosseur
ASTM E 112	2 und feiner/and smaller/et plus fin

Deltaferritgehalt/ Ferrite content/ Contens de delta-ferrite

Meth.	Delta-Ferrit/Delta ferrite/Ferrite delta
De Long D	2.7 [%]

Interkristalline Korrosion/ Intergranular corrosion/ Corrosion intercristalline
Material bestaendig nach / material resistant according to: ASTM A 262 Practice E, EURONORM 114, ISO 3651-2, Verfahren A

TRUE COPY

Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE
Providing special steel solutions

D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date: 17.11.15

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
2092737/1561762/bit	1619120 / 1	5550337813/125+130	697417

US-Prüfung/ Ultrasonic testing/ Contrôle par ultrasons

Die Lieferung wurde 100% US-geprüft nach/Delivery US-checked 100% acc.to: EN 10308 Typ 1a, Tab.3, Kl.3

entspricht auch/also correspond to/correspond aussi a:EN 10228-4 Typ 1a, Tab.4, Kl.3/ASTM A 388, Code Case 2155+2156

Die Lieferung wurde auf Identität geprüft (Optische Emissionsspektrometrie) /Identity has been checked (Optical Emission Spectrometry)

Die Lieferung wurde besichtigt und auf Maß kontrolliert/Visual inspection and control of dimensional accuracy have been performed

Umformgrad/Reduction Ratio: 13.17: 1

Das Material ist frei von Radioaktivität (<0,1Bq/g bezogen auf Co-60). /The Product is free from radioactivity (<0,1Bq/g concerning Co-60).
La matière n'est pas radioactive (<0,1Bq/g, référence Co-60).
El material es libre de radioactividad.

Location of production: Germany

Das Qualitaetsmanagement-System wurde durch TUEV NORD (Kenn-Nr.0045)
gemäss der Richtlinie 97/23/EG Anhang 1, Abschnitt 4.3
(Druckgeräterichtlinie) überprüft (Zertifikats-Nr.: 07-202-1404
WZ-0857/13).

It is hereby certified that the quality management system has been
reviewed by TUEV NORD (identification no.0045) according to the
requirements of the Pressure Equipment Directive 97/23/EC Annex 1, 4.3
(guidelines for pressure instruments) (certificate no.: 07-202-1404
WZ-0857/13).

Le système d'assurance de qualité est verifié par la société TUEV NORD
(no. indicatif 0045) selon recommendation 97/23/EG annexe 1,
section 4.3 (Directive pour Appareils soumis a Pression)
(certificate no.: 07-202-1404 WZ-0857/13).

El Sistema de Calidad fue examinado por el TUEV NORD (no.de
identificación 0045) en conformidad con la directiva 97/23/EG anexo 1,
séccion 4.3 (para equipos de presión) (certificado no.: 07-202-1404
WZ-0857/13).

Erläuterung/ Explanations/ Explications

- **Erschmelzungsart**/Steelmaking process/Procédé d'élaboration:
  E = Elektrostahl / Electric-arc-furnace steel / Acier électrique
- **Sekundärmetallurgie**/Secondary metallurgy/Metallurgie secondaire:
  VOD = Vakuum-Sauerstoff-Entkohlungs-Verfahren / Vacuum-Oxygen-Decarburization / Vacuum-Oxygène-Décarburation

Es wird bestätigt, daß die Lieferung geprüft wurde und den Vereinbarungen bei der Bestellungsannahme enspricht.
We hereby certify that the material described above has been tested and complies with the terms of the order.
Nous certifions que la livraison été vérifiée et est conforme aux stipulations de l'acception de la commande.

TRUE COPY

Made in Germany

ABNAHMEPRÜFZEUGNIS — EN 10204
INSPECTION CERTIFICATE ACCORDING TO — 3.1
CERTIFICAT DE RECEPTION

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

Hersteller / Manufacteur / Producteur: DEUTSCHE EDELSTAHLWERKE GMBH, D-57012 SIEGEN

Uns. Auftr.-Nr. / Order-No. / Notre Com. No.: 1677790

zertifiziert nach: ISO 9001, ISO / TS 16949, EN 9100, ISO 14001, DGR 2014/68/EU, PED 2014/68/EU

Prüf-Nr. 234284 / Seite / Page 1 / 4

Besteller / Customer / Client: ThyssenKrupp Materials

Bestell-Nr. / Order-No. / Commande No.: 5403809241

THYSSENKRUPP MATERIALS
NEDERLAND B.V.

POSTFACH 218
NL-3330 AE-ZWIJNDRECHT

Werkstoff / Quality / Nuance: 1.4404 / ACIDUR 4401/4404 NIROCUT / 316 / 316L

Gießverfahren / Casting process / Procédé de coulée: Strangguss / Continuous casting / Coulée Continue

Erschmelzungsart / Melting Furnance / Mode de fusion: Elektrostahl / Electric-arc-furnace steel / Acier électrique

Vertriebstext / Product / Produit: Stabstahl aus nichtrostendem Stahl
ACIDUR 4401/4404 NIROCUT, 316 / 316L
gewalzt, abgeschreckt, gerichtet, geschält
gemäß ASTM A 182M/276M/479M, ASME BPVC E.2013 S.2 P.A, SA182M/276/479M, NACE MR0103/0175, ISO 15156-3, EN 10088-3/5, 10272, AD2000-W2/W10, Analyse und mech. Eigenschaften nach EN 10222-5, EN 10250-4

weitere Anforderungen vorhanden, siehe Zusatztexte

Schmelzen-Nr. Cast No./Coulée No.	Proben-Nr. Test N./Eprouv.N.	Fertigungsauftrag Lot no./Lot fabr.	Pos. Item/Poste	Abmessung mm Dimensions/Dimensions	Stückzahl Quantity / Nombre	Gewicht KG Weight / Masse	Stempel Abnahmebeauftragter Inspector's stamp
271308	761445	761445	008	80,00 + 0,300/-0,000 RD		854	WA

Schmelzen-Nr. Cast No/Coulée No	% C	% SI	% MN	% P	% S	% CR	% MO	% NI	% V	% W	% CO	% CU	% N	% AL
271308	0,016	0,53	1,31	0,026	0,022	16,60	2,010	11,13	0,070	0,04	0,130	0,45	0,0360	< 0,002

Proben-Nr. Test No. Eprouv.N.	Ref. Zust	Probenabm. Samp.Dim. Dim.d'epr.	Probelg. Spec.Pos. Pos.d'epr	Zugversuch Tensile test / Essai de traction								Kerbschlagversuch Impact test / Essai de résilience					Härteprüfung Hardness Dureté	
				Temp °C	RP0,2 MPA	RP1,0 MPA	RM MPA	A5 %	A2" %	Z %		°C	JOULE	JOULE	JOULE			
761445		12.43 mm	L	23	353	390	582	49.5	53.1	77		23	425	414	422	DIN EN ISO 148-1	180HB	
		12.43 mm	L	23	349	385	583	50.5	54.1	77		23	436	417	414	DIN EN ISO 148-1		

Schmelze wurde VOD behandelt.

MAX 22 HRC
DER WERKSTOFF IST INTERKRIST. BESTAEND. NACH: DIN EN ISO 3651-2
MAT. IS RESIST. TO INTERCR. CORR. PURS. TO: DIN EN ISO 3651-2
L'ACIER EST RESIST. A LA CORR. INTERGR. S.: DIN EN ISO 3651-2
Material beständig nach: ASTM A 262 Practice E /

Das Zeugnis wurde maschinell erstellt und ist gemäß EN 10204 ohne Unterschrift rechtsverbindlich.
This certificate was generated by data system, acc. to EN 10204, it need not to be signed for validity.
Ce certificat a été établi sur système informatique et est valable selon EN 10204 sans signature.

Tel: 0271/808-2642
Fax: 0271/808-2521
Email: verena.hertz@dew-stahl.com

Datum: 22.09.2016
Hertz
(Abnahmebeauftragter/ Inspector)

TRUE COPY

Made in Germany		
ABNAHMEPRÜFZEUGNIS INSPECTION CERTIFICATE ACCORDING TO CERTIFICAT DE RECEPTION	EN 10204 3.1	DEUTSCHE EDELSTAHLWERKE Providing special steel solutions
Besteller Customer Client: ThyssenKrupp Materials		Bestell Nr. Order-No.: 5403809241 Commande No.
Hersteller Manufacteur Producteur: DEUTSCHE EDELSTAHLWERKE GMBH D-57012 SIEGEN		Uns. Auftr.-Nr. Order-No.: 1677790/008 Notre Com. No.

Prüf-Nr. 234284 / Seite Page / Page 2 / 4

Proben-Nr. Test N. Eprouv.N.: 761445

EURONORM 114 / ISO 3651-2 Verfahren A. T1
material resistant according: ASTM A 262 Practice
E / EURONORM 114 / ISO 3651-2 Verfahren A, T1
materiel resistant suivant: ASTM A 262 Practice E
/ EURONORM 114 / ISO 3651-2 Verfahren A, T1
100% RISSGEPRUEFT OHNE BEANSTANDUNG

100% SURFACE CRACK TEST WITHOUT INDICATION

CONTROLE A FISSURE DE 100% SANS DETECTION
Die Lieferung wurde 100 % US-geprüft nach EN 10308 Typ 1a, Tab.3, Qk.3:
ohne Beanstandung.
Delivery 100 % US-checked acc. to EN 10308 Typ 1a, Tab.3, Qk.3:
satisfactory.
Livraison controlé par 100 % ultrasons selon EN 10308 Typ 1a, Tab.3,
Qk.3: satisfaisant.
entspricht auch/also corresponding to/correspond
aussi a: EN 10228-4, Typ 1a, Tab.4, Kl.3/ASTM A
388/ASME SA 388, ASTM A 745
Das Qualitätsmanagement-System wurde durch TÜV NORD (Kenn-Nr.0045) gemäß
der Richtlinie 2014/68/EU Anhang 1, Abschnitt 4.3
(Druckgeräterichtlinie) überprüft (Zertifikats-Nr.: 07-202-1404
WZ-0857/13).
It is hereby certified that the quality management system has been
reviewed by TÜV NORD (identification no.0045) according to the
requirements of the Pressure Equipment Directive 2014/68/EU Annex 1, 4.3
(guidelines for pressure instruments) (certificate no.: 07-202-1404
WZ-0857/13).
Le système d'assurance de qualité est verifié par la société TÜV NORD
(no. indicatif 0045) selon recommendation 2014/68/EU annexe 1, section
4.3 (Directive pour Appareils soumis a Pression) (certificate no.:
07-202-1404 WZ-0857/13).
MASS UND OBERFLAECHENKONTROLLE: KEINE BEANSTANDUNG
DIMENSIONS AND SURFACE INSPECTION: SATISFACTORY

DIMENSIONS ET SURFACE CONTROLE: SATISFAISANTS
WIR BESTAETIGEN, DASS DIESE LIEFERUNG DEN SCHRIFTLICHEN
VEREINBARUNGEN BEI DER BESTELLUNG ENTSPRICHT
We confirm the production of your order is according to the written
agreement of our order acknowledgement
Nous certifions que la livraison est conforme aux accords
complémentaires par écrit convenus à la commande.
DAS MATERIAL IST FREI VON RADIOAKTIVITÄT

Das Zeugnis wurde maschinell erstellt und ist gemäß EN 10204 ohne Unterschrift rechtsverbindlich.
This certificate was generated by data system, acc. to EN 10204, it need not to be signed for validity.
Ce certificat a été établi sur système informatique et est valable selon EN 10204 sans signature.

Tel: 0271/808-2642
Fax: 0271/808-2521
Email: verena.hertz@dew-stahl.com

Datum: 22.09.2016
Hertz
(Abnahmebeauftragter/ Inspector)

TRUE COPY

Made in Germany		
ABNAHMEPRÜFZEUGNIS INSPECTION CERTIFICATE ACCORDING TO CERTIFICAT DE RECEPTION	EN 10204 3.1	DEUTSCHE EDELSTAHLWERKE Providing special steel solutions
Besteller Customer Client: ThyssenKrupp Materials		Bestell Nr. Order-No.: 5403809241 Commande No.
Hersteller Manufacteur Producteur: DEUTSCHE EDELSTAHLWERKE GMBH D-57012 SIEGEN		Uns. Auftr.-Nr. Order-No.: 1677790/008 Notre Com. No.

Prüf-Nr. 234284 / Seite Page / Page 3 / 4

Proben-Nr. Test N. Eprouv.N.: 761445

(<0,1Bq/g bezogen auf Co-60).

Herstellland: Deutschland
THE PRODUCT IS FREE FROM RADIOACTIVITY.
(<0,1Bq/g based on Co-60).

Location of production: Germany
LE MATÉRIEL N'EST PAS RADIOACTIF
(<0,1Bq/g basé sur Co-60).

Pays de production: Allemagne
PRUEF. AUF WERKSTOFFIDENTITAET:100% SPEKTROSKOP.OB
TEST TO VERIFY QUAL.:100% SPECTROSC. WITHOUT INDIC.

CONTROLE D'IDENTITE:100% SPECTROS. PAS D'OBJECTION
weitere Anforderungen:
bar steel made of stainless steel
ACIDUR 4401/4404 NIROCUT, 316 / 316L
hot rolled, quenched, straightened,
peeled
according to ASTM A 182M/276M/479M,
ASME BPVC E.2013 S.2 P.A,
SA182M/276/479M, NACE MR0103/0175, ISO
15156-3, EN 10088-3/5, 10272,
AD2000-W2/W10, analysis and mech.
properties acc. to EN 10222-5, EN
10250-4
---
barre en acier inoxydable
ACIDUR 4401/4404 NIROCUT, 316 / 316L
laminé, hypertrempe, dressé, écroûté
selon ASTM A 182M/276M/479M, ASME BPVC
E.2013 S.2 P.A, SA182M/276/479M, NACE
MR0103/0175, ISO 15156-3, EN 10088-3/5,
10272, AD2000-W2/W10, analyse et
caractéristique mech. suivant EN
10222-5, EN 10250-4

VERFORMUNGSGRAD / HOT FORMING RATIO: 13:1

Das Zeugnis wurde maschinell erstellt und ist gemäß EN 10204 ohne Unterschrift rechtsverbindlich.
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Datum: 22.09.2016
Hertz
(Abnahmebeauftragter/ Inspector)

TRUE COPY

Made in Germany

ABNAHMEPRÜFZEUGNIS EN 10204
INSPECTION CERTIFICATE ACCORDING TO 3.1
CERTIFICAT DE RECEPTION

DEUTSCHE EDELSTAHLWERKE
Providing special steel solutions

Prüf-Nr. 234284 / Seite Page / Page 4 / 4

Besteller / Customer / Client: ThyssenKrupp Materials

Bestell Nr. / Order-No. / Commande No.: 5403809241

Hersteller / Manufacteur / Producteur: DEUTSCHE EDELSTAHLWERKE GMBH
D-57012 SIEGEN

Uns. Auftr.-Nr. / Order-No. / Notre Com. No.: 1677790/008

Proben-Nr. / Test N. / Eprouv N.: 761445

CE

16

0432-CPR-00150-01/02

Deutsche Edelstahlwerke GmbH
Auestrasse 4
Witten

1.4404 1X - EN 10088-5

warmgewalzter Stab, Draht, rund, geschält
aus korrossionsbest. Stahl
Stahlbauwerken, Metall-/Beton-
Verbundbauwerken, Hochbauten
und Ingenieurbauwerken

Leistungserklärung (LE) 1.4404 1X

Die Leistungserklärung (LE) ist zu finden unter: www.dew-stahl.com/1.4404 1X

Das Zeugnis wurde maschinell erstellt und ist gemäß EN 10204 ohne Unterschrift rechtsverbindlich.
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Tel: 0271/808-2642
Fax: 0271/808-2521
Email: verena.hertz@dew-stahl.com

Datum: 22.09.2016
Hertz
(Abnahmebeauftragter/ Inspector)

TRUE COPY

Acciaierie Valbruna S.p.A.

36100 VICENZA (Italia) - Viale della scienza, 25 z.i.
Telefono 0444.968211 - Fax 0444.963836
Stab.: 39100 BOLZANO (Italia) - Via A. Volta, 4/37
Telefono 0471.924111 - Fax 0471.924497

CERTIFICATO DI COLLAUDO - ABNAHMEPRUEFZEUGNIS - INSPECTION CERTIFICATE - CERTIFICAT DE RECEPTION

In conformità a : EN 10204 (2004) , 3.1
Nach/According to/Selon

Certificato nr. MEST892705 / 2016 /
Prüfung/Test/Essai

Cliente / Besteller/Purchaser/Client
VALBRUNA CENTRAL EUROPE S.R.O.
LIBUSINA 342/97
77900 - OLOMOUC - CZECH REPUBLIC - CZ

Ordine nr: PO16000437 JC
Bestell Your order Commande

Conferma ordine nr: EI16003908
Werks/Our Order/Rel nr.

Avviso di Spedizione: D-VI16016271
Lieferanzeige/Packing list/B.L.

Stato di fornitura : Hot rolled - Annealed Peeled
Lieferzustand Delivery state Etat de livraison

Tipo di Elaborazione: E+AOD
Erschmelzungsart Melting process Mode d'elaboration

Qualità: 1.4401/1.4404/316/316L
Werkstoff/Grade/Nuance

Marca: MVAPML MAXIVAL
Markenbezeichnung Brand / Nuance

Produttore :
Hersteller/Kern/Usine productrice
ACCIAIERIE VALBRUNA S.P.A.

Marchi di Fabbrica: AV
Zeichen des Lieferwerkes Trade marks Sigles de l'usine productrice

Punzone del Collaudatore: MR
Stempel des Werkssachverständigen Inspector's stamp/Poinçon de l'assayeur

Punzonatura: 1.4401/4/316/L
Kennzeichnung Marking Marquage

SPECIFICHE : Anforderungen / Requirements / Exigences	Note: Aufzeichnungen / Notes / Notes
VAL STOCK 2010 1.4404/316L A	
MDS S01 5 316 A (0)	(0)Norsok-standard M-630 Edition 6, October 2013
AISI 316	
AISI 316L	
ASME SA182 2015 S31600 A (1)	(1)SEC.II PT.A 2015 EDITION For products machined directly from bar refer to ASME SA479.
ASME SA182 2015 S31603 A (2)	(2)SECTION II PT.A 2015 EDITION For products machined directly from bar refer to ASME SA479.
ASME SA193 2015 B8M CLASS1 (3)	(3)SECTION II PT.A 2015 EDITION
ASME SA276 2015 S31600 A (4)	(4)SECTION II PT.A 2015 EDITION
ASME SA276 2015 S31603 A (5)	(5)SECTION II PT.A 2015 EDITION
ASME SA320 2015 B8M CLASS1 (6)	(6)SECTION II PT.A 2015 EDITION
ASME SA479 2015 S31600 A (7)	(7)SECTION II PT.A 2015 EDITION
ASME SA479 2015 S31603 A (8)	(8)SECTION II PT.A 2015 EDITION
ASTM A182 2015 S31600 A (9)	(9)For products machined directly from bar refer also to ASTM A479.
ASTM A182 2015 S31603 (A)	(A)For products machined directly from bar refer also to ASTM A479.
ASTM A193 2016 B8M CLASS1	
ASTM A262 PR. E 2015 316/316L	
ASTM A276 2016 S31600 A	
ASTM A276 2016 S31603 A	
ASTM A314 2015 S31600	
ASTM A320 2015A B8M CLASS1	
ASTM A370 2015 .	
ASTM A479 2016 S31600 A	
ASTM A479 2016 S31603 A	
DIN 17440 96 1.4401 A	
DIN 17440 96 1.4404 A	
EN 10088-3 2014 1.4401 A	
EN 10088-3 2014 1.4404 A	
EN 10272 2007 1.4401 A	
EN 10272 2007 1.4404 A	
ISO 6892-1 2009 .	
NACE MR0103 2010 S31600 A	
NACE MR0103 2010 S31603 A	
NACE MR0175 2009 S31600 A (B)	(B)ANSI/NACE MR0175/ISO 15156-3, second edition 2009-10-15 Technical circular 1 2011 Published 2011-06-14
NACE MR0175 2009 S31603 A (C)	(C)ANSI/NACE MR0175/ISO 15156-3, second edition 2009-10-15 Technical circular 1 2011 Published 2011-06-14

		Tolleranza: k12 Tolleranza/Allowance/Tolerance					
Pos. nr. Pos. nr. Item nr. Nr. de poste	Oggetto Gegenstand Product description Descrip. du produit	Dimensioni - mm Abmessungen Dimension Dimension	Lunghezza - mm Länge Length Longueur	Colata Schmelze Heat Coulée	Pezzi Stückzahl Pieces Pieces	Peso - KG Gewicht Weight Poids	Lotto nr. Losnr. Lot nr. Lot nr.
0100	Round	80,000	5240/ 5240	269737	6	1252,0	610905150

Vicenza, 01/07/16
VCQ008 - MEST892705 / 2016
(Mod. MCE2)

Il collaudatore di stabilimento / der Werkssachverständige / Works inspector / L'agent d'usine
M.Rizzotto

TRUE COPY

Acciaierie Valbruna S.p.A.

36100 VICENZA (Italia) - Viale della scienza, 25 z.i.
Telefono 0444.968211 - Fax 0444.963836
Stab.: 39100 BOLZANO (Italia) - Via A. Volta, 4/37
Telefono 0471.924111 - Fax 0471.924497

CERTIFICATO DI COLLAUDO - ABNAHMEPRUEFZEUGNIS - INSPECTION CERTIFICATE - CERTIFICAT DE RECEPTION

In conformità a / Nach/According to/Selon: EN 10204 (2004) , 3.1

Certificato nr. / Prüfung/Test/Essai: MEST892705 / 2016 /

Cliente / Besteller/Purchaser/Client:
VALBRUNA CENTRAL EUROPE S.R.O.
LIBUSINA 342/97
77900 - OLOMOUC - CZECH REPUBLIC - CZ

Ordine nr / Bestell / Your order / Commande: PO16000437 JC

Conferma ordine nr / Werks/Our Order/Ref nr.: EI16003908

Avviso di Spedizione / Lieferanzeige/Packing Est/B.L.: D-VI16016271

Stato di fornitura / Lieferzustand / Delivery state / Etat de livraison: Hot rolled - Annealed Peeled

Tipo di Elaborazione / Erschmelzungsart / Melting process / Mode d'elaboration: E+AOD

Qualità / Werkstoff/Grade/Nuance: 1.4401/1.4404/316/316L

Marca / Markenbezeichnung / Brand / Nuance: MVAPML MAXIVAL

Produttore / Hersteller/Item/Usine productrice:
ACCIAIERIE VALBRUNA S.P.A.

Marchi di Fabbrica / Zeichen des Lieferwerkes / Trade marks / Sigles de l'usine productrice: AV

Punzone del Collaudatore / Stempel des Werkssachverständigen / Inspector's stamp/Poinçon de l'assayeur: MR

Punzonatura / Kennzeichnung / Marking / Marquage: 1.4401/4/316/L

TEST ALLO STATO DI FORNITURA

Test on delivery condition / Prüefung auf lieferbereitem produkt / test a l'etat de fourniture / Prueba sobre el material asi come entregado

1) L=longitudinale/längs, T=trasversale/quer, O=Tangenziale/tangential

TEST	Provetta / Probestab Specimen/Eprouvette Larg.diam.Spess. Brite Diam. Dicke Width Diam. Thickness Larg. diam. epais mm	°C	Posiz. Saggio Position Lage Emplacement 1)	Snervamento Streckgrenze Yield Stress Limite elastique Rp 0,2% N/mm2	Snervamento Streckgrenze Yield Stress Limite elastique Rp 1% N/mm2	Resistenza Zugfestigkeit Tensile strength Resistance à traction Rm N/mm2	Allungamento Bruchdehnung Elongation Allongement A5 %	Allungamento E 4d %	Strizione Einschnürung Reduction of area Striction Z %	Strizione RA %	Resilienza Kerbschlagarbeit Impact Value Resilience KV J			Durezza Haerte Hardness Durete HB		
Valori richiesti / Anforderungen/Required values / Valeurs demandées		min		205	240	515	40	40	-	50	100			-		
		max				690								215		
A	10	20	L	291	331	607	54	57	69	69	249	250	239	177		

TEST ALLO STATO DI FORNITURA

Test on delivery condition / Prüefung auf lieferbereitem produkt / Test a l'etat de fourniture / Prueba sobre el material asi come entregado

TEST		min	max	
A	Grain size for ASTM E112			5

Mechanical properties according to ASTM A370.
Tensile testing according to EN ISO 6892-1

Analisi chimica

Chemische Zusammensetzung/Chemical Analysis/Analyse chimique

Colata / Heat Schmelze/Coulée																	
	min - max	- 0,030	- 1,00	- 2,00	16,50 18,00	2,00 2,50	10,00 13,00	- 0,045	- 0,030	- 0,100	-	-	-	-	-	-	-
	C %	Si %	Mn %	Cr %	Mo %	Ni %	P %	S %	N %								
269737	0,015	0,52	1,44	16,80	2,05	10,10	0,031	0,024	0,058								

Corrosion test in 16% sulfuric acid and copper sulfate solutions

Test standard: ASTM A262-Practice E

Test	Heat treatment before test	Length of Period (h)	Test temp (°C)	Bend Angle (°)	Ø spindle (mm)	Result of visual inspection at 20 x magnification after bend test	Result
Intergranular corrosion	Sensitization	15	boil	180	5	Absence of cracks	SATISFACTORY

Corrosion test in 16% sulfuric acid and copper sulfate solutions

Test standard: UNI EN ISO 3651-2 Method A

Test	Heat treatment before test	Length of Period (h)	Test temp (°C)	Bend Angle (°)	Ø spindle (mm)	Result of visual inspection at 20 x magnification after bend test	Result
Intergranular corrosion	Sensitized T1	20	boil	90	5	Absence of cracks	SATISFACTORY

Reduction ratio = 6,0 : 1
Solution annealing by process annealing 1040°C min /
/ cooling water
Ultrasonic volumetric test according to ASTM A388 : pass

Vicenza, 01/07/16
VCQ008 - MEST892705 / 2016
(Mod. MCE2)

Il collaudatore di stabilimento / der Werkssachverständige / Works Inspector / L'agent d'usine
M.Rizzotto

TRUE COPY

Acciaierie Valbruna S.p.A.

36100 VICENZA (Italia) - Viale della scienza, 25 z.i.
Telefono 0444.968211 - Fax 0444.963836
Stab.: 39100 BOLZANO (Italia) - Via A. Volta, 4/37
Telefono 0471.924111 - Fax 0471.924497

CERTIFICATO DI COLLAUDO - ABNAHMEPRUEFZEUGNIS - INSPECTION CERTIFICATE - CERTIFICAT DE RECEPTION

In conformità a : EN 10204 (2004) , 3.1
Nach/According to/Selon

Certificato nr. MEST892705 / 2016 /
Prüfung/Test/Essai

Cliente / Besteller/Purchaser/Client
VALBRUNA CENTRAL EUROPE S.R.O.
LIBUSINA 342/97
77900 - OLOMOUC - CZECH REPUBLIC - CZ

Stato di fornitura : Hot rolled - Annealed Peeled
Lieferzustand
Delivery state
Etat de livraison

Produttore :
Hersteller/Item/Usine productrice
ACCIAIERIE VALBRUNA S.P.A.

Ordine nr: PO16000437 JC
Bestell
Your order
Commande

Tipo di Elaborazione: E+AOD
Erschmelzungsart
Melting process
Mode d'elaboration

Marchi di Fabbrica: AV
Zeichen des Lieferwerkes
Trade marks
Sigles de l'usine productrice

Conferma ordine nr: EI16003908
Werks/Our Order/Ref nr.

Qualità: 1.4401/1.4404/316/316L
Werkstoff/Grade/Nuance

Punzone del Collaudatore: MR
Stempel des Werkssachverständigen
Inspector's stamp/Poinçon de l'assayeur

Avviso di Spedizione: D-VI16016271
Lieferanzeige/Packing list/B.L.

Marca: MVAPML MAXIVAL
Markenbezeichnung
Brand / Nuance

Punzonatura: 1.4401/4/316/L
Kennzeichnung
Marking
Marquage

Sono state soddisfatte tutte le condizioni richieste
Die gestellten Anforderungen sind lt. Anlage erfüllt
The material has been furnished in accordance with the requirements
Le materiel à été trouvé conforme aux exigences

Controllo antimescolanza: OK
Verwechslungprüfung: spektralanalytisch durchgeführt
Antimixing testing performed: OK
Contrôle antimelange fait: r.a.s.

Controllo visivo e dimensionale: soddisfa le esigenze
Besichtigung und Ausmessung: ohne Beanstandung
Visual inspection and dimensional checks:satisfactory
Contrôle visuel et dimensions: satisfaisant

Melted and manufactured in Italy No welding or weld repair Material free from Mercury contamination

We declare that the finished product is checked for radioactive contamination through Portal System when it leaves the production plant.

QUALITY MANAGEMENT SYSTEM CERTIFIED BY LLOYD'S REGISTER ACCORDING TO ISO 9001 : 2008, ISO/TS16949 : 2009, AS 9100C

The Quality Management System is Certified acc. Pressure Equipment Directive '97/23/EC' Annex 1,s.,4.3 by TUEV and LLOYD`S
Any act of tampering, modification, alteration, counterfeiting and/or falsification and/or any other action which modifies the contents of this test certificate shall constitute a violation of applicable civil and criminal laws. Acciaierie Valbruna shall protect its rights and interests before any competent court, authority and jurisdiction.

Maxival and/or Valplus grades/products are manufactured with ladle techniques to control composition, distribution, size and shape of non-metallic inclusions for improved machinability.

The supplied product conforms to requirements expressly requested by the purchaser and conforms to requirements specified by certified norms and standards. Should the product be used for more severe, critical and/ or in any case different applications than those the material is generally intended for, any different and/or supplementary requirements shall be specifically demanded, at least, upon order of the Product by the Purchaser. Acciaierie Valbruna SpA shall not be responsible for any improper use of the Products.

Vicenza, 01/07/16 VCQ008 - MEST892705 / 2016 (Mod. MCE2)	Il collaudatore di stabilimento / der Werkssachverständige / Works Inspector / L'agent d'usine M.Rizzotto	Pagina - 3 di 3

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HI-TECH
Special Steels Limited

Rotherham Road, Laughton Common,
Dinnington, Sheffield S25 3RF
Tel: Dinnington (01909) 564545
Fax No (01909) 550682

Registered in England No. 1921116

Customer

Parker Hannifin Manufacturing Ltd
Riverside Road
Pottington Business Park
Barnstaple
Devon EX31 1NP

TEST CERTIFICATE IN ACCORDANCE WITH BS EN 10204 3.1/ISO 10474 3.1

Certificate No.	T59119	Product	Stainless steel bar			
Order No.	Consignment	Cast No.	430087	Specification		1.4404
Our Reference	Z103264/P41178	Quantity	534 Kgs	Size	.875" A/F Hex	
Advice Note No.	C1763	Finish	Cold sized			
Heat Treatment	Fully solution treated and water quenched prior to cold sizing					

Chemical Analysis

C	0.016	Si	0.387	Mn	1.28	S	0.0289	P	0.0276
Ni	10.144	Cr	16.586	Mo	2.18	Ti		Nb	
Co	0.158	Cu	0.483	N	0.042	W		Ca	
Sn		Ta		V		Al		Fe	

Mechanical Properties

Tensile Strength	856 Mpa	0.2% Proof Stress	730 Mpa
Reduction of Area	67,0%	Elongation	25,0%
Hardness	30 HRC	Impact Tests	

Special Conditions / Processing Details

In accordance with BS EN 10088-3 2005 1.4404 — HCT No : H388

In accordance with M011/1 Concession — Part No : 7710884306

Free from mercury and radioactive contamination
ICC test to ASTM A262 'E' - Satisfactory
This material has been solution annealed and is free from grain boundary carbide precipitation
Also conforming to ASTM A276/A479 Gr 316/316L (Chemical analysis)
Country of origin/melt : France

Manufacturers Test Cert No.	Concessions Agreed

"Certified that the whole of the supplied detailed hereon, unless otherwise stated",are covered by the Sources Certificate of Conformity/Test Certificate referenced hereon,and has been subject to the Quality System requirements in accordance with the conditions of our BS EN ISO 9001 2008 registration,for lot traceable products".

"Certified that the supplies/services detailed hereon have been inspected and tested in accordance with the conditions,requirements of the contractor purchase order and,unless otherwise noted below,conform in all respects to the specification(s)/drawing(s) relevant thereto".

H.C.T. H388
Checked & Approved by
Parker Hannifin UPDF
16-09-2014 11:07:12 Page 1 of 4

15/09/2014 — Quality Controller

TRUE

Usine productrice/He steller/Manufacturer
Ugine
Avenue Paul Girod - CS
90100
73403 Ugine Cedex
France 5

CERTIFICAT DE RECEPTION 3.1
INSPECTION CERTIFICATE 3.1
ABNAHMEPRUEFZEUGNIS 3.1

EN 10204 / 3.1
NF L 00-015 Certified material test report

UGITECH
Providing special steel solutions 1

Numéro / Nummer / Number	Ordre de fab. / Auftrag / Prod. Order	N° coulée / Schmelzen Nr / Heat N°	N° lot MM / Chargen / Batch
81424650 000010 4	A1431GR12000 11-1	430087 11-2	1431GR1200 11-3

Certification - Werkzeugnis - Certificate
AD 2000-MERKBLATT W0/TRD100
Pressure Equipment Directive
97/23/EC
ISO 9001
ISO/TS 16949 99

ISO 9100
ISO 9120 98

98-2

Marque d'usine
Herstellerzeichen
Supplier's Mark UGITECH 97

Poinçon de l'expert
Prufstempe
Inpector's stamp IQ 96

UGIMA 4404HM WIRE ROLLED PICKLED SOLUTION ANNEALED HEXAGONAL 25,500MM

Produit UGIMA 4404HM FIL LAMINÉ(E) DÉCAPÉ HYPERTREMPÉ(E) HEXAGONAL(E) 25,500MM
Erzeugnisform UGIMA 4404HM WALZDRAHT GEWALZT GEBEIZT LÖSUNGSGEGLÜHT SECHSKANT 25,500MM
Product UGIMA 4404HM WIRE ROLLED PICKLED SOLUTION ANNEALED HEXAGONAL 25,500MM 6

Client - Besteller - Purchaser	N° de commande client - Kundebestellnummer - Purchase order number
19516 HI-TECH SPECIAL STEELS LTD 9	2959004987 10

Norme de référence / Besugsnorm / Standard for reference
ASME SA479/479M-10 Sec.II TYPE 316L
EN 10088-1/3ED2005 1.4404
AISI 316L

ASTM A479/A479M-14 TYPE 316L
UNS 10th Edition S31603

12-2

Spécification client / Kundenspezifikation / Customer's specification
ESS M011/1 FOR ANALYSIS ONLY Y4 18/12/2012 12-3

Nombre Stueckzahl Pieces Nbr	Profil Profile Shape	Dimension Ausmessung Dimension	Longueur Laenge Length	Poids Gewicht Weigh
24 18	HX 19	25,500 MM 21-1	21-2	8596 KG 22

Mode d'élaboration Erchmel zungsart Melting process	N° prélèvement Probenummer Test number	Demandé / Vorschrift / Required	42 % C	43 % SI	44 % MN	45 % NI	46 % CR	47 % MO	48 % CU	49 % S
		Min			1,2500	10,0000	16,5000	2,0000		0,0150
		Max	0,0300	0,7500	2,0000	13,0000	18,0000	2,5000	1,0000	0,0300
EAF + AOD + CC 38	7LUB 39A	coulée/ Schmelzen / Heat	0,0160	0,3870	1,2800	10,1440	16,5860	2,1800	0,4830	0,0289
		Produit / Erzeugnisform/ Product								

Demandé / Vorschrift / Required	50 % P	51 % N	52 % CO	53	54	55	70	71	72	73	74	75
Min												
Max	0,0400	0,1000										
coulée/ Schmelzen / Heat	0,0276	0,0420	0,1580									
Produit / Erzeugnisform/ Product												

Demandé / Vorschrift / Required	76	77	78	79	80	81	82	83	84	85	86	87
Min												
Max												
coulée/ Schmelzen / Heat												
Produit / Erzeugnisform/ Product												

H.C.T. H388
Checked & Approved by
Parker Hannifin IPDE 66-1
16-09-2014 11:07:12 Page 2 of 4

The contents of the report are accurate and all test results andoperations performed by UGITECH or its subcontractors are in compliancewith the material specification and the specific contract requirements of ASME Paragraph

i-19 66-2

Ugine le 28.07.2014
L'agent Réceptionnaire de l'usine
Der Werksachverständige
The work inspector
C.BIOTEAU

26/2/14

040000797823 Page 1/2 63

TRUE COPY

Usine/Hersteller/Manufacturer
avenue Paul Girod - CS
30100
73403 Ugine Cedex
France 5

CERTIFICAT DE RECEPTION 3.1
INSPECTION CERTIFICATE 3.1
ABNAHMEPRUEFZEUGNIS 3.1

EN 10204 / 3.1
NF L 00-015 Certified material test report

UGITECH
Providing special steel solutions 1

Numéro / Nummer / Number 4	Ordre de fab. / Auftrag / Prod. Order 11-1	N° coulée / Schmelzen Nr / Heat N° 11-2	N° lot MM / Chargen / Batch 11-3
81424650 000010	A1431GR12000	430087	1431GR1200

24	90	T°C	Limite d'élasticité Streckgrenze Yield Strength 0,2%	1%	RM Zugfestigkeit Tensile	Allongement Bruchdehnung Elongation A5D	A4D	Striction Einschnürung Red area	Dureté-Haerte-Hardness HB	HV	HRB	HRC
		°C	Mpa	Mpa	Mpa	%	%	%				
13	Min	20	170			30	30	40				
	Max	20					99					
	Min											
	Max											
N° prélèvement 7LUB Probenummer Test number 39B	1 L	20	261		600	52	54	78				
A l'état de Référence / treatment on test sample / Probestreifenbehandlung 14		25	26A	26B	27	28	89	29	30	88	100	37

Taux de corroyage
Forging ratio
Verschmiedungsgrad
74,6
101

Résilience-Kerbschlagzaehigkeit-Notch Toughness

	Type Form Type 31	T°C 33	Sens Richtung Direction 32	Min 95	Valeurs individuelles Einzelwerte Individual values 35	Moyenne Mittelwerte Average 36	Expansion latérale Seitliche Breitung Lateral Expansion 91
A l'état de livraison / Lieferzustand / As delivered 13		°C		J		J	
solution annealed							
A l'état de Référence / treatment on test sample / Probestreifenbehandlung 14							

ASTMA479-A479M 08-10A/ASMESA-479 ED .07 SECT.II 2010 NO ADD./QQ-S-763F/AMSQQ-S-763A/ASTMA276 8A-10 56
FREE FROM WELDS & WELD REPAIRS/FREE FROM MERCURY CONTAMINATION/FREE FROM CONTINUOUS CARBIDE NETWORK
QUALITY MANUAL REV.F OF 09 JUL.2012
MATERIAL IS SOLUTION ANNEALED
INTERGRANULAR CORROSION PER ASTM A262 PRACTICES A & E ACCEPTABLE
PROVISION OF 10 CFR PART 21 & 10 CFR PART 50 APP.B APPLY
COUNTRY OF MELT SOURCE : FRANCE

Quantité livrée / delivered quantity / gelieferte Quantität 92

H.C.T. H388
Checked & Approved by
Parker Hannifin IPDE

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliancewith the material specification and the specific applicable material requirements of ASME NCA-3800 66-1

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliancewith the material specification and the specific applicable material requirements of ASME NCA-3800 66-2

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Ugine le 28.07.2014
L'agent Réceptionnaire de l'usine
Der Werksachverständige
The work inspector
C.BIOTEAU

040000797823 Page 2/2 63

Special Testing Ltd
Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5566 Acc/Admin
www.specialtesting.co.uk

Test Certificate 281915

AUTHENTICATION CODE 5E27E9E5E5CE
ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191

CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS ROTHERHAM RD
LAUGHTON COMMON, DINNINGTON
SHEFFIELD S25 3RF
DATE RECEIVED 01 September 2014
TEST DATE 04 September 2014

CUSTOMER ORDER NO	PRD4427	TEST NUMBER	281915	IDENTITY	P41178	CAST*	430087	ALL REQUIREMENTS MIN UNLESS STATED
SPECIFICATION	BS EN10088-3:2005 1.4404					TEST PIECE FROM*		.875" / 22mm A/F Hex

TENSILE: BS EN ISO 6892-1:2009 A224						0.2% PROOF	1.0% PROOF	UTS	ELONG ON	%	R OF A %	COMMENTS
OR	TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS							
L	RT	10.01mm	78.67mm²	MPa	RESULTS	730	819	856	50mm	25.0	67.0	N/A

HARDNESS: BS EN ISO6506-1 2005	DESIGNATION	REQUIREMENTS	RESULTS
BRINELL (MID RADIAL)	HBW 10/3000		268

HARDNESS: BS EN ISO6508-1 2005	DESIGNATION	REQUIREMENTS	RESULTS
ROCKWELL C (MID RADIAL)	HRC		30

END OF CERTIFICATE

H.C.T. H388
Checked & Approved by
Parker Hannifin IPDE
16-09-2014 11:07:12 Page 4 of 4
I-21

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REPRESENTING*

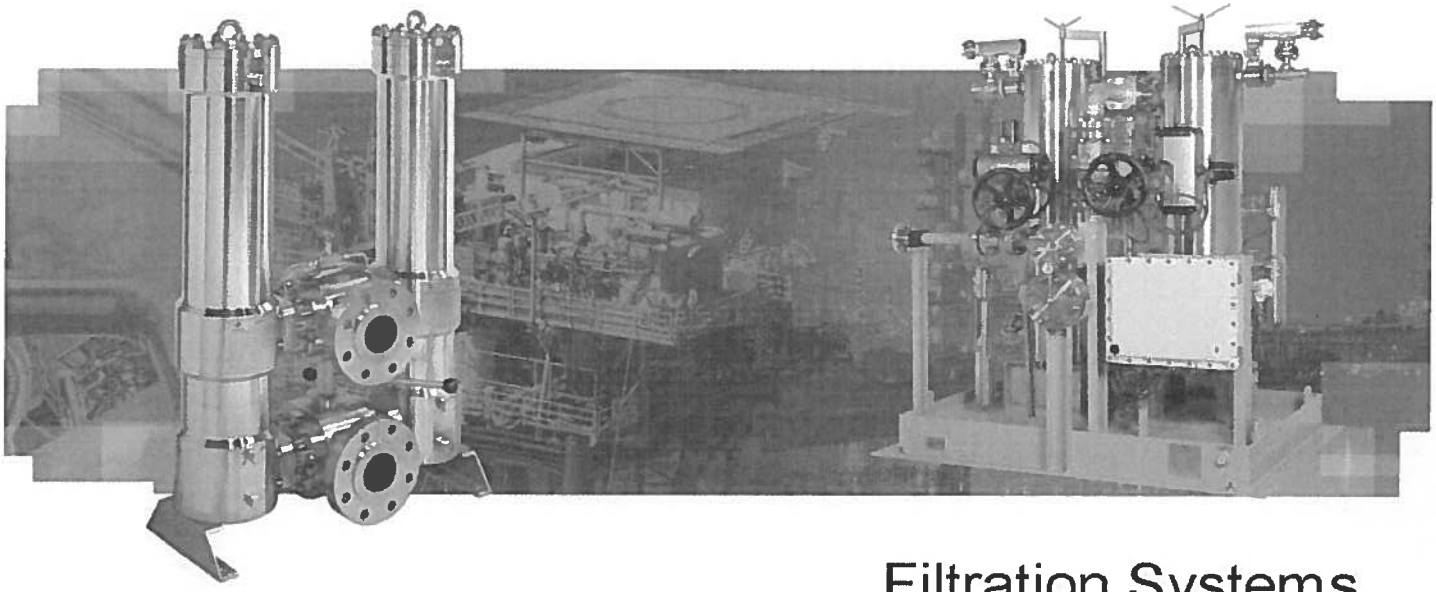
No copy is authentic without the embossed seal and signature. This certificate can be authenticated at www.specialtesting.co.uk with the code 5E27E9E5E5CE

This certificate shall not be reproduced, except in full, without the written approval of the laboratory.

For and on behalf of
SPECIAL TESTING LTD
A Member of the Special Steel Group of Companies

Steve Pearce
Certification Manager

Test results do not in any way confer approval of the quality of manufacture of the material. All results are subject to uncertainty of measurement budgets, details available upon request. Information marked * is supplied by the customer.



Filtration Systems

DATA BOOK

LA Turbine Corp. 23716 (JCI# 854084)

Tag no.: F-101A/B
LAT574

Indufil Ordernr.: 4000859267-10.1(A/B)

Quality rep.	Date	Description of change	Rev.
AVS	13-Jan-2017	As Built	0

DATABOOK BEHÄLTERPASS	DOSSIER CONSTRUCTEUR	REV. 0	john crane a smiths company

Indufil BV, Hydrograaf 25, 6921 RS Duiven, The Netherlands, P.O. Box 442, 6900 AK Zevenaar, The Netherlands
VAT.No.: NL-802897782 B01, Telephone: +31 (0)26 3190800, Telefax: +31 (0)26 3190808. E-mail: quality@johncrane-indufil.com

Customer	Kunde	Client	**LA Turbine Corp.**
Purchase ordernr.	Bestell-Nr	No de cde. Client	**23716 (JCI# 854084)**
Subject code nr.	System-Nr	Codification client	
Purchase tag nr.	Tag-Nr	Position repère	**F-101A/B**
Project	Projekt	Project	**LAT574**
Indufil ordernr.	Indufil Auftr.-Nr.	No de fabr. Indufil	**4000859267-10.1(A/B)**
Subject	Gegenstand	Désignation	**FILTER IDCL 2-00220 1.5"ANSI-600#**
Drawing number	Zeichnungsnummer	No de plan	**GA-195445-1**
Filterelement	Filterelement	Type de cartouche	**INR-Z-00220-API-PF25-V**
Total Weight	Gesamtgewicht	Poids total	**115 kg / 253 lb**
Third party	Abnamegeselschaft	Organisme certifié	**NB26731, NB26732**

CONTENTS / INHALT / INDEX			PAGE
VQP	VQP	VQP	**2**
Test reports	Prüfzeugnisse	PV des tests	**3**
TPI Certificate	TPI Zertifikaten	Certificate TPI	**8**
Paint	Anstrich	Peindre	**10**
Declaration of conformity Cleanliness certificate	Konformitätserklärung Zertifikat von Reinheit	Déclaration de conformité Certificat de propreté	**11**
Rubbing of nameplate	Kopie Typenschild	Copie plaque de signalétique	**12**
Material certificates	Werkstoffzeugnisse	Certificats matière	**Section i**
Instruction and operation manual	Montage und Betriebsvorschriften	Instructions d'utilisation et d'entretien	**Appendix 1**
Design Calculations	Konstruktionsberechnungen	Calculs de Conception	**Appendix 2**
Shop drawing / parts list	Konstruktionszeichnung / Stücklist	Plan de construction / liste des pièces détachées	**Appendix 3**

This data report has been carefully produced according to our manufacturing standard. If you have any questions or remarks about it, please contact the Indufil quality department.

Dieses Behälterpass ist sorgfältig hergestellt worden laut unser manufacturing standard. Wenn Sie Fragen order Bemerkungen haben, bitte rufen Sie die Indufil Qualitätsabteilung an.

Le dossier constructeur à été établi avec soins en accord avec notre procédure de fabrication. Veuillez adresser vos éventuelles questions ou remarques directement à notre service qualité Indufil.
Tel : +31 (0) 26 319 0800 or E-mail : quality@johncrane-indufil.com

AVS

INDUFIL BV
Quality Dept
Signed A. van Senten

Date 29-07-2016

Vendor Quality Plan (Inspection and Test Plan)

Rev

Indufil Order Number	4000859267-10.1(A/B)			Inspection Activities	
Document Number	4000859267-10.VQP			A= Approval H= Hold (written release required) W= Witness (no release required) R= Review SW= Spot Witness N/A= Not Applicable	
Customer	LA Turbine Corp.				
Customer Reference	PO: 23716 (JCI# 854084)				
Customer Product Code	Tag# F-101A/B				
Project Name	LAT574				
Design Code	ASME VIII div 1				
Third Party / Certification	U-Stamp (NB)				
Revision	0	Drawn by	BBU	Notification Time	10 working days
Date	13-1-2017	Checked by	SPI		

No	Activity	Procedure and drawing specifications	Acceptance criteria	Verifying document	Supplier Indufil	Cust. LAT	Contr.	TPI N.B.
1	Issue design drawing(s) and calculation(s)	Drawing(s) and calculation(s) according code requirements	Design code	Approved documents		A		A
2	Issue VQP and applicable procedure(s)	Procedure(s) Indufil BV	Design code	Approved documents		A		
3	Manufacturing process	Drawing(s)	Drawing(s)	Certificate of Compliance		R		
4	Check identification and compliance of materials	-	Material specifications	*		R		R
5	US Examination Filter Housing(s) before machining	Code case 2155 + 2156	ASME SA 388	US Statement and/or US Report *	N/A	N/A		
6	Liquid Penetrant Test	-	-	LPT Report	N/A	N/A		
7	PMI	WI-09.15E	-	PMI Report	N/A	N/A		
8	Hardness Test	Nace MR0175 / ISO 15156	Nace MR0175 / ISO 15156	Hardness Test Report *	N/A	N/A		
9	Dimensional check	-	Drawing(s)	Certificate of Compliance		R		
10	Hydrostatic Test	Hydro test instruction WI-09.13E	Design code	Hydro Test Certificate		R		H
11	Filter element control	Drawing(s)	-	-		R		
12	Ball Valve Testing	Indufil standard WI-09.18E	Indufil standard	Test Certificate		R		
13	Leak Test assembled filter	Leak test procedure WI-04.09E	No leaks	Leak Test Certificate		R		
14	Cleanliness check	Cleaning and check pro. WI-09.14E	Liquid/gas < 3/0.3 µm	Cleanliness Certificate		R		
15	Paint acc. Indufil std.	1a. C-Steel weld primer	Paint specification	Paint Thickness Report		R		
16	Weighing complete assembly	-	-	-		R		
17	Review data book and stamp nameplate (traceable materials only)	-	Design code	Data book		R		H
18	Final inspection before shipment	-	Assembly drawing	Certificate of Compliance		R		

Note(s):

* Included in the material certificates (EN 10204 - 3.1)

CERTIFICATE OF SEAT LEAK TESTING
ZERTIFIKAT FÜR DRUCKPRÜFUNG SITZDICHTIGKEIT
CERTIFICAT DE TEST D'ETANCHEITE DU SIEGE

Customer	Kunde	Client	**LA Turbine Corp.**
Purchase ordernr.	Bestell-Nr	No de cde. Client	**23716 (JCI# 854084)**
Purchase tag nr.	Tag-Nr	Position repère	**F-101A/B**
Indufil ordernr.	Indufil Auftr.-Nr.	No de fabr. Indufil	**4000859267-10.1(A/B)**
Subject	Gegenstand	Désignation	**3W BV IR-1.5"SAE-3KSI**
Third party	Abnamegeselschaft	Organisme certifié	**NB26731, NB26732**
Year Built	Herstellungsjahr	Année de construct.	**2016**
Drawing number	Zeichnungsnummer	No de plan	**GA-195445-1**

Acceptance standard	Akzeptierung laut	Etanchéité requise	**No leakage**
Procedure nr.	Prozedur-Nr.	No de procédure	**WI-04.08**
Test pressure	Prüfüberdruck	Pression de test	**5 bar(g) / 72,5 psi(g)**
Test date	Prüfdatum	Date d'épreuve	**15-11-2016**
Test medium	Prüfmittel	Fluide d'épreuve	**Nitrogen (N_2)**
Test location	Prüfort	Lieu d'épreuve	**Duiven**
Test duration	Prüfzeit	Temps de test	**2 min.**
Results	Ergebnis	Résultats	**Satisfactory**

AVS

INDUFIL BV
Quality Dept
Signed: A. van Santen

CERTIFICATE OF PRESSURE TESTING
ZERTIFIKAT FÜR DRUCKPRÜFUNG
CERTIFICAT DE TEST DE PRESSION

Customer	Kunde	Client	**LA Turbine Corp.**
Purchase ordernr.	Bestell-Nr	No de cde. Client	**23716 (JCI# 854084)**
Purchase tag nr.	Tag-Nr	Position repère	**F-101A/B**
Indufil ordernr.	Indufil Auftr.-Nr.	No de fabr. Indufil	**4000859267-10.1(A/B)**
Subject	Gegenstand	Désignation	**FILTER IDCL 2-00220 1.5"ANSI-600#**
Third party reg. nr.	Vorprüfungsnr.	No de reg. Org. cert.	**NB26731, NB26732**
Year Built	Herstellungsjahr	Année de construct.	**2016**
Drawing number	Zeichnungsnummer	No de plan	**GA-195445-1**

Procedure nr.	Prozedur-Nr.	No de procédure	**WI-09.13 E**
Design pressure	Auslegungsdruck	Pression de calcul	**-14,5 / 1360 psi(g)**
Test pressure	Prüfüberdruck	Pression de test	**2040 psi(g)**
Capacity	Inhalt	Capacité	**0,79 USG**
Test medium	Prüfmittel	Fluide d'épreuve	**Water [Cl^-] ≤ 30 ppm**
Test temperature	Prüftemperatur	Temp. d'épreuve	**Ambient (20 °C / 68 °F)**
Test duration	Prüfzeit	Temps de test	**30 min.**
Pressure gauge	Manometer	Manomètre	**11033QCM; 11033QCN**
Test location	Prüfort	Lieu d'épreuve	**Duiven**
Test date	Prüfdatum	Date d'épreuve	**28-12-2016**
Results	Ergebnis	Résultats	**Satisfactory**

AVS

INDUFIL BV
Quality Dept
Signed: A. van Santen

John Crane Indufil B.V.

Pressure Gauges Calibration Certificate

Indufil BV
Duiven, the Netherlands

Calibration was carried out according to EN 837-1

Certificate No. 2016 -11033QCM
Date: 07-10-2016
Expiring date: 08-10-2017

Reference Instrument	P#14020064 - CPG500	Accuracy	0.25%
Range:	0...1000 bar	Serial No.	1015ZZN

Results:

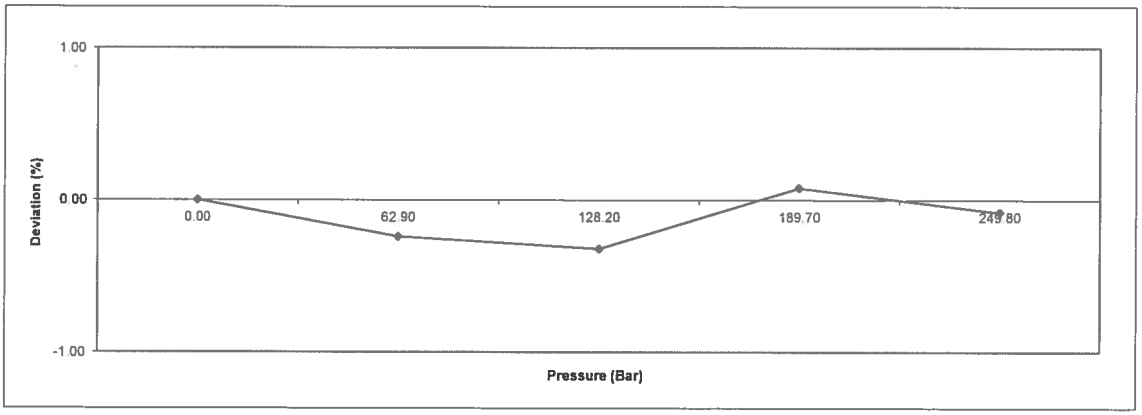
Maximum test pressure: **250 bar**
Temperature: 20 +/- 5 °C

Range: 0 ... 250 bar rel.
Serial No: 11033QCM

Type: 233.50
Class: 1.00%

Reference	up	down	avg	Deviation	Hysteresis
Bar	Bar	Bar	Bar	%	%
0.00	0.00	0.00	0.00	0.00	0.00
62.90	63.00	64.00	63.50	-0.24	-0.40
128.20	128.00	130.00	129.00	-0.32	-0.80
189.70	189.00	190.00	189.50	0.08	-0.40
249.80	250.00	250.00	250.00	-0.08	0.00

accuracy: 0.32 %
Demand: <1 %
Aproved **Yes**



Calibration performed by: Ton Huberts

Remarks:

This document was created automatically and needs no signature

INDUFIL B.V. Quality Dept. Signed: T. Huberts

John Crane Indufil B.V.

Pressure Gauges Calibration Certificate

Indufil BV
Duiven, the Netherlands

Calibration was carried out according to EN 837-1

Certificate No. 2016 -11033QCN
Date: 07-10-2016
Expiring date: 08-10-2017

Reference Instrument	P#14020064 - CPG500	Accuracy	0.25%
Range:	0...1000 bar	Serial No.	1015ZZN

Results:

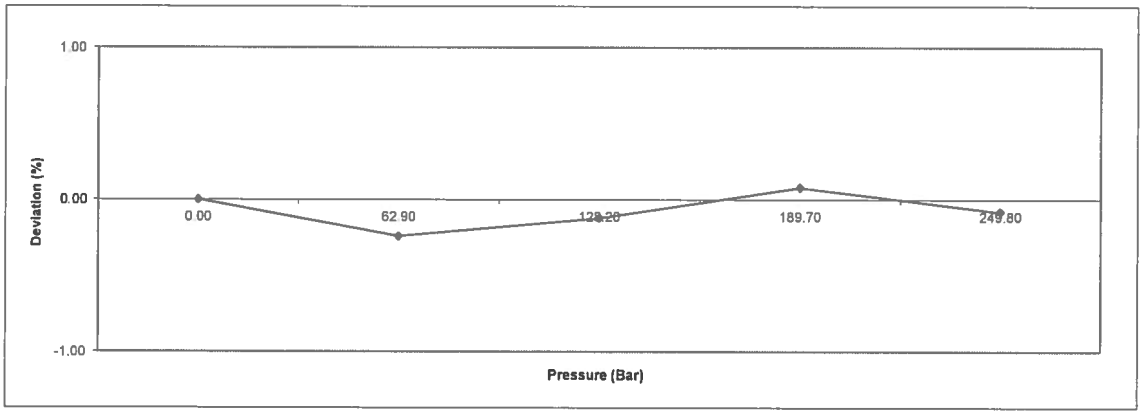
Maximum test pressure: **250 bar**
Temperature: 20 +/- 5 °C

Range: 0 ... 250 bar rel.
Serial No: 11033QCN

Type: 233.50
Class: 1.00%

Reference	up	down	avg	Deviation	Hysteresis
Bar	Bar	Bar	Bar	%	%
0.00	0.00	0.00	0.00	0.00	0.00
62.90	63.00	64.00	63.50	-0.24	-0.40
128.20	128.00	129.00	128.50	-0.12	-0.40
189.70	188.00	191.00	189.50	0.08	-1.20
249.80	250.00	250.00	250.00	-0.08	0.00

accuracy: 0.24 %
Demand: <1 %
Aproved **Yes**



Calibration performed by: Ton Huberts

Remarks:

This document was created automatically and needs no signature

INDUFIL B.V.
Quality Dept.
Signed: T. Huberts

CERTIFICATE OF LEAK TESTING
ZERTIFIKAT FÜR DICHTIGKEITSPRÜFUNG
CERTIFICAT DE TEST D'ÉTANCHÉITÉ

Customer	Kunde	Client	**LA Turbine Corp.**
Purchase ordernr.	Bestell-Nr	No de cde. Client	**23716 (JCI# 854084)**
Purchase tag nr.	Tag-Nr	Position repère	**F-101A/B**
Indufil ordernr.	Indufil Auftr.-Nr.	No de fabr. Indufil	**4000859267-10.1(A/B)**
Subject	Gegenstand	Désignation	**FILTER IDCL 2-00220 1.5"ANSI-600#**
Third party	Abnamegeselschaft	Organisme certifié	**NB26731, NB26732**
Year Built	Herstellungsjahr	Année de construct.	**2016**
Drawing number	Zeichnungsnummer	No de plan	**GA-195445-1**

Acceptance standard	Akzeptierung laut	Etanchéité requise	**No leakage**
Procedure nr.	Prozedur-Nr.	No de procédure	**WI-04.09**
Test pressure	Prüfüberdruck	Pression de test	**5 bar(g) / 72,5 psi(g)**
Test date	Prüfdatum	Date d'épreuve	**28-12-2016**
Test medium	Prüfmittel	Fluide d'épreuve	**Nitrogen (N_2)**
Test location	Prüfort	Lieu d'épreuve	**Duiven**
Test duration	Prüfzeit	Temps de test	**2 min.**
Results	Ergebnis	Résultats	**Satisfactory**

AVS

INDUFIL BV
Quality Dept.
Signed A. van Santen

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS (Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only)
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by: INDUFIL BV, Hydrograaf 25, 6921 RS Duiven, The Netherlands (Name and address of manufacturer)
2. Manufactured for: LA Turbine Corporation, 29151 Avenue Penn, Valencia CA 91355, USA. (Name and address of purchaser)
3. Location of installation: Unknown (Name and Address)

4. Type	Manufacturer's serial number	CRN	Drawing number	National Board number	Year Built
Vert. (Horizontal or vertical, tank)	4000859267-10.1(A/B)	-	4000859267-10.U-ISSUE A	26731-26732	2016

5. ASME Code, Section VIII, Division 1	Edition and Addenda, if applicable (date)	Code Case numbers	Special service per UG-120(d)
	2015	2155, 2156	-

6. Shell	Material spec. number, grade	Nominal thickness	Corr. Allow.	Inner diameter	Length (overall)
	SA105	0.58"	0.06"	4.47"	10.83"

Body Flanges on Shells

No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Bolting: Num & Size	Bolting: Bolting Material	Bolting: Washer (OD, ID, thk)	Bolting: Washer Material
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

7. Seams	Long. (Welded, dbl., sngl., lap, butt)	R.T. (spot or full)	Eff., %	H.T. temp	Time, hr	Girth (welded, dbl.,sngl., lap, butt)	R.T. (spot or full)	Eff., (%)	No. of courses
	Sml	None	100	-	-	-	-	100	1

8. Heads: (a) Material: SA105 (Spec. No. Grade) (b) Material: SA105 (Spec. No. Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	Top	1.34"	0.06"	-	-	-	-	-	6.30"	-
(b)	Bottom	0.94"	0.06"	-	-	-	-	-	6.30"	-

If removable, bolts used (describe other fastenings): Engin. studs: SA 193 B7, nuts: SA-194 2H, 8 pcs., ½"-13UNC for top cover only

Body Flanges on Heads

	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Bolting: Num & Size	Bolting: Bolting Material	Bolting: Washer (OD, ID, thk)	Bolting: Washer Material
(a)	-	-	-	-	-	-	-	-	-	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-

9. MAWP: 1360 (internal) / - (external) psi at max. temp. 200 (internal) / - (external) °F.

Min. Design metal temp. -20 °F at 1360 psi. Hydro~~, pneu., or comb.~~ test pressure 2040 psi.

Proof test -.

10. Nozzles, Inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain etc.)	No.	Diameter or Size	Type	Material: Nozzle	Material: Flange	Nozzle Thickness: Nom.	Nozzle Thickness: Corr.	Reinforcement Material	Attachment Details: Nozzle	Attachment Details: Flange	Location (Insp. Open.)
Inlet / Outlet	2	1½"SAE	Bolted	-	-	-	-	-	-	-	-
Drain / Vent	3	1"SAE	Bolted	-	-	-	-	-	-	-	-
Drain Clean	1	¾"NPT	Threaded	-	-	-	-	-	-	-	-
Equal. Conn.	1	1"SAE	Bolted	-	-	-	-	-	-	-	-

11. Supports: Skirt: No (Yes or no) Lugs: - (Number) Legs: - (Number) Other: Blocks (Describe) Attached: Mech.attached on bottom (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: none

UG-125 is user's responsibility. Hydro test performed in the vertical position.

Impact testing: No, exempted per UCS66 (b) for all components.

All nozzles are machined openings with no permanent attached nozzle necks.

Removable top cover identified with manufacturer's serial no. and used as inspection opening.

FORM U-1A (Back)

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 31,295 expires 17 May, 2019.

Date December 28th, 2016 Co. name INDUFIL BV THE NETHERLANDS (Manufacturer) Signed P Uiyen (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by INDUFIL BV, THE NETHERLANDS at Hydrograaf 25, 6921 RS Duiven, The Netherlands.

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by Lloyd's Register Verification Limited of UK

have inspected the component described in this Manufacturer's Data on December 28th, 2016, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date December 28, 2016 Signed (Authorized Inspector) Commissions NB12919AB [National Board (incl. endorsements)]

(07/13)

GACON
GRONDIG AFGEDEKT!

General application report

General:	
Purchase Order Number	4501618031
Order Number	4000859267-10
Type of Product	IDCL 2-00220 1 ½ ANSI-600
Drawing Number	GA-195445-1
Paint Spec	Indufil Standaard
Specified by / in order of	Indufil John Crane
Applicator	Gacon Straal- en Spuitinrichting BV
Measuring instrument	ELCOMETER 456
Pretreatment	SA2,5
Method of application	Airless

Paint work contractor:			
1	Gacon Straal- en Spuitinrichting bv	Contact	De heer J. Gasseling
		Adress	Groothandelsweg 5 6515 AH Nijmegen
		Phone	024-3481193

Protective paint system specification		Dry film thickness
1st coat	Zancor	60
2nd coat		
3rd coat		
Total DFT		60
Colour:		RAL 3009
Name of inspector: J. Gasseling		

	Type of coat	# measurements	Minimum	Maximum	Mean	Acceptable	Not acceptable
Pretreatment						☒	☐
1st coat	Zancor	12	67	179	86	☒	☐
2nd coat						☒	☐
3rd coat						☒	☐

T_{inside}: °C (av. between 18°-25°)	RH: % <85%	
Weather:	☐ sunny ☐ dry ☐ cloudy ☐ misty ☐ rain ☐ snow ☐ below 0 °C ☒ else.: shop application	

Remarks: Application conditions comply with requirements from paint specification

Date:	Signature:
2-1-2017	Jan Gasseling

CERTIFICATE OF CONFORMITY
KONFORMITÄTSZERTIFIKAT
CERTIFICAT DE CONFORMITÉ

Customer	Kunde	Client	**LA Turbine Corp.**
Purchase ordernr.	Bestell-Nr	No de cde. Client	**23716 (JCI# 854084)**
Indufil ordernr.	Indufil Auftr.-Nr.	No de fabr. Indufil	**4000859267-10.1(A/B)**
Subject	Gegenstand	Désignation	**FILTER IDCL 2-00220 1.5"ANSI-600#**

Pressure vessels have been designed, constructed and tested according to ASME VIII DIV.1 Edition 2015 , Indufil std. and customer requirements. The dimensions of the pressure vessels have been checked in accordance with the drawing nr 045.12.500.01-ARH-ALH-TC. The sectional drawing as mentioned above is integrated in the general arrangement drawing GA-195445-1 and therefore not included in this data book.

Die Druckbehälter sind nach ASME VIII DIV.1 Edition 2015 , Indufil std. entworfen, hergestellt und getestet entsprechend der Kundenspezifikation. Die Abmessungen der Druckbehälter wurden gemäß Zeichnungs-Nr. 045.12.500.01-ARH-ALH-TC kontrolliert. Die oben genannte Schnittzeichnung ist in das Maßbild GA-195445-1 integriert und deshalb nicht beim Behälterpass eingeschlossen.

Les équipements sous pressions ont été conçus, construits testés et suivant les standard ASME VIII DIV.1 Edition 2015 , Indufil std. et suivant les exigences du client. Les dimensions des équipements sous pression ont été vérifiées par rapport au plan No 045.12.500.01-ARH-ALH-TC. Le plan en coupe mentionné ci-dessus à été intégré dans le plan général GA-195445-1 et de ce fait n´as pas été inclus dans le dossier constructeur.

CERTIFICATE OF CLEANLINESS
ZERTIFIKAT VON REINHEIT
CERTIFICAT DE PROPRETÉ

These filter and valve parts have been cleaned with a pre-filtered degreasing solution. After the degreasing all parts were dried and visually checked. During the assembly, no tools did come in contact with internal parts and the filter has been protected

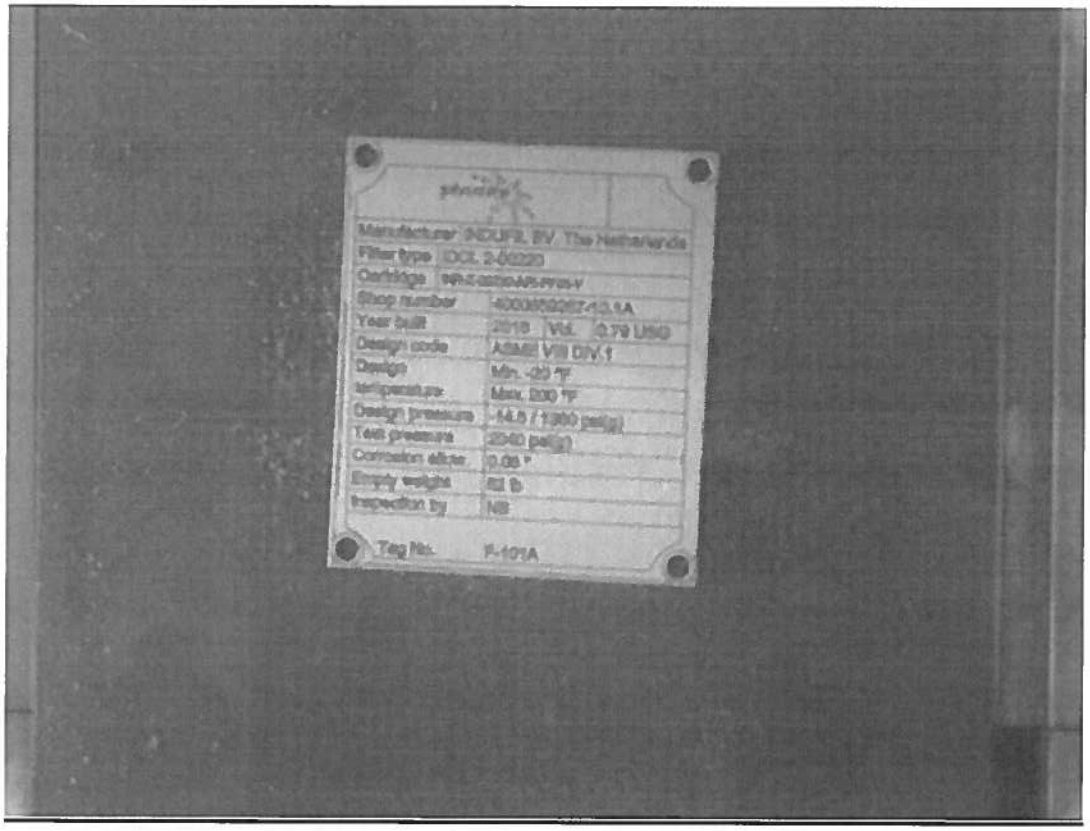
Alle Filter und Unterteile sind in einer entfettenden Lösung gereinigt. Nach diesem Vorgang sind alle Teile getrocknet und kontrolliert worden. Während der Montage sind alle Teile mit größter Vorsicht eingebaut worden. Wir garantieren Ihnen ein einwandfreies Produkt.

Toutes les pièces de filtres et vannes ont été rincées avec un fluide dégraissant. Après dégraissage, toutes les pièces ont été séchées et contrôlées visuellement. Pendant le montage, aucun outil ne doit venir en contact avec les pièces internes et le filtre doit être protégé contre les impuretés venant de l'extérieur.

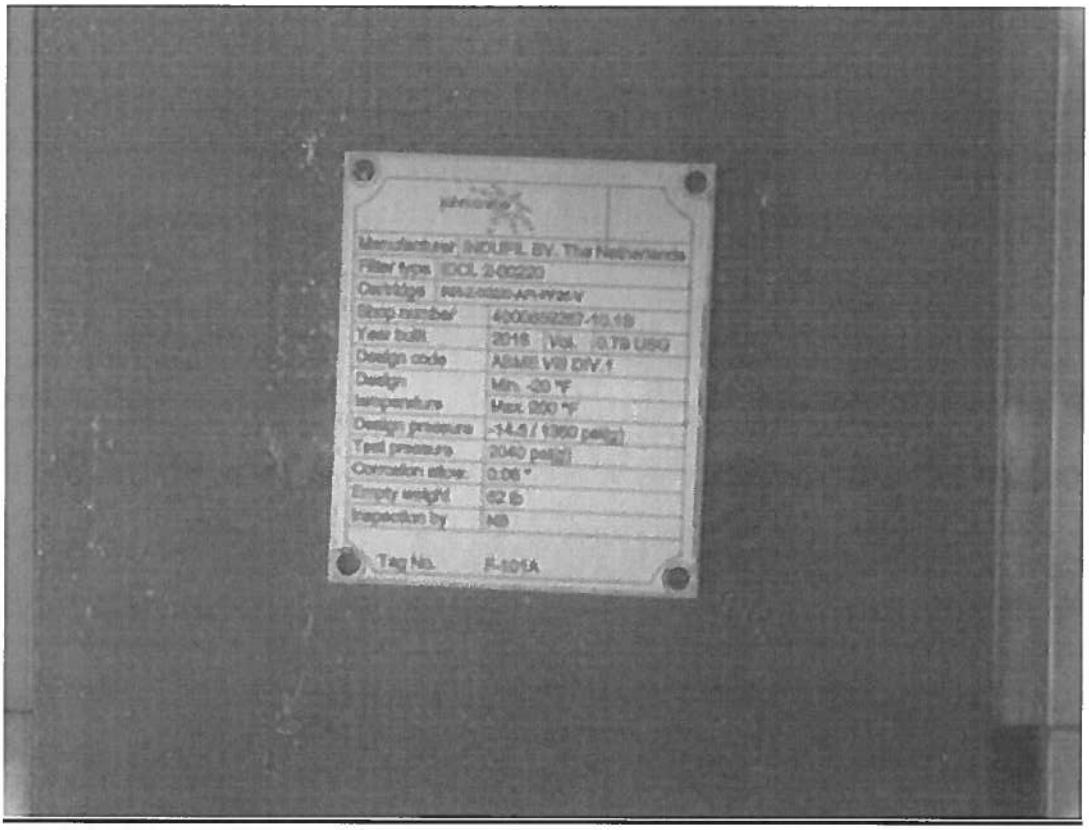
AVS

INDUFIL BV
Quality Dept
Signed: A. van Santen

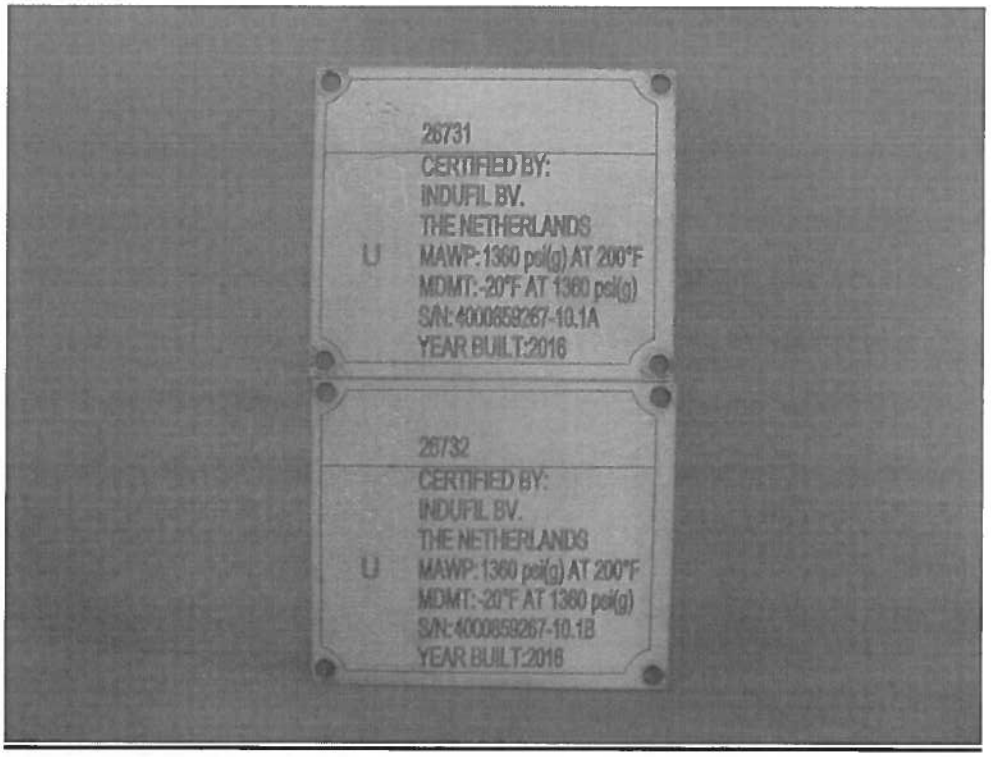
Indufil BV, Hydrograaf 25, 6921 RS Duiven, The Netherlands, P.O. Box 442, 6900 AK Zevenaar, The Netherlands
VAT.No.: NL-802897782 B01, Telephone: +31 26 3190800, Telefax: +31 26 3190808. E-mail: quality@johncrane-indufil.com



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VAT.No.: NL-802897782 B01, Telephone: +31 26 3190800, Telefax: +31 26 3190808. E-mail: quality@johncrane-indufil.com



Indufil BV, Hydrograaf 25, 6921 RS Duiven, The Netherlands, P.O. Box 442, 6900 AK Zevenaar, The Netherlands
VAT.No.: NL-802897782 B01, Telephone: +31 26 3190800, Telefax: +31 26 3190808. E-mail: quality@johncrane-indufil.com



MATERIAL INDEX – WERKSTOFF INHALT – INDEX MATIÈRE

Indufil Order No, No de fabr. Auftr.-Nr.:
4000859267-10.1(A/B)
Purchase order No, Bestell-Nr, No de commande:
23716 (JCI# 854084)

Drawing No, Zeichnungs Nr, No de plan:
GA-195445-1
Subject, Gegenstand, Désignation:
FILTER IDCL 2-00220 1.5"ANSI-600#

Herewith we declare that for the manufacturing of the under mentioned materials, the material type are proven by works certificates, all engineered studs and nut have been supplied with 3.1 type certification and all pressure parts not identified with CE marking are manufactured according PED/SEP and are identified with the charge numbers listed below as required by the PED 2014/68/EU Annex 1, 4.3.

Wir bescheinigen hiermit, dass die Herstellung nachstehenden Werkstoffe verwendet und durch Werkstoffzertifikaten belegt sind, alle gebauten Bolzen und Muttern wurden mit 3.1 Material-Zeugnis geliefert, und alle Druck¬tragenden Teile die nicht mit CE-Kennzeichnung versehen sind, sind nach PED/SEP produziert und können anhand der unten stehenden Chargen-Nummer identifiziert werden, wie nach PED 92014/68/EU Annex 1, 4.3 vorgesehen.

Nous déclarons que pour la fabrication des matériaux mentionnés ci-dessus, les types de matériaux sont garantis par ces certificats, tous les goujons et écrous ont été livrés avec un certificat 3.1 et les pièces soumises à la pression, non identifiés par un marquage CE ont étés fabriqués selon la DESP/SEP et ont étés identifiés par des No. de coulées listé ci-dessous, suivant la réquisition art. 3.3 de la DESP 2014/68/EU Annex 1, 4.3.

Partnr. Teilnr. Pièce No.	Name of part. Teilnr. Désignation	Material type Werkstoff Matière	Type of certificate Art des Zertifikat Certificat type	charge Number Schmelzennummer No de coulée	Page nr. Seite Nr. Page No.
001	FILTER HOUS.	SA105N	EN 10204 – 3.1	514520	i-2
002	FILTER HOUS.	SA105N	EN 10204 – 3.1	514520	i-5
003	HEXAGON PLUG	SA105N	EN 10204 – 3.1	PABB	i-8
005	TOP COVER	SA105N	EN 10204 – 3.1	413580 - 514520	i-9
014-001	BALL VALVE HOUS.	ST.52.3	EN 10204 – 3.1	17938	i-15
014-002	BALL	1.4571DIN17440/EN10222-5	EN 10204 – 3.1	263226	i-17
014-003	SHAFT	1.4404 DIN 17440 / EN10222-5	EN 10204 – 3.1	672665	i-20
014-004	BALL VALVE COV.	ST.52.3	EN 10204 – 3.1	14584 - 61230	i-23
014-006	SIDE CONNECTION	ST.52.3	EN 10204 – 3.1	514328 - J6253 - 36314	i-25
020	FLANGE CONNECTION	SA105N	EN 10204 – 3.1	28515	i-33
030	MALE CONNECTOR	STAINLESS STEEL 316L	EN 10204 – 3.1	933U - G314	i-35
035	BAR STOCK NEEDLE VALVE	SA182 / SA479 S31600 / S31603	EN 10204 – 3.1	H460 - G341	i-42
036	HEXAGON PLUG	SA182 / SA479 S31600 / S31603	EN 10204 – 3.1	G220	i-48
037	MALE ADAPTOR	STAINLESS STEEL 316L	EN 10204 – 3.1	G312	i-52
038	FLANGE CONNECTION	C22.8DIN17243/EN10222-2/P250GH	EN 10204 – 3.1	47393	i-56
040	HEXAGON PLUG	SA105N	EN 10204 – 3.1	MBAQ	i-58
043	FEMALE TO MALE ADAPTOR	SA105N	EN 10204 – 3.1	AG6	i-59
044	MALE ADAPTOR	STAINLESS STEEL 316L	EN 10204 – 3.1	962U - 834U	i-60

INDUFIL BV
Quality Dept.
Signed: A. van Santen

TRUE COPY

Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date : 22.08.14

Zertifiziert nach:	AD2000 W 0 TRD 100	Werkstofflieferant gemäß Druckgeräte-richtlinie 97 / 23 EG

Abnahmeprüfzeugnis nach

Inspection Certificate acc.to/Certificat de réception selon DIN EN 10204 3.2

Zeugnis-Nr./Certificate No./No.de Certificat 2007721/1428105/szumski

DEUTSCHE EDELSTAHLWERKE
ThyssenKrupp Materials
Nederland B.V.
POSTFACH 11
NL-5460 AA Veghel

Herstellerzeichen/Supplier's Mark/Marque d'usine	DEW
Prüfstempel/Inspector's stamp/Poincon de l'expert	WA

Warenempfänger
Heerbaart Jongman Metaal B.V.
Binnenhavenstraat
NL-7553 GH Hengelo

Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	
5510775558 | 18.11.13	
Unsere Auftr.-Nr. Our order No./No.de notre Commande	Unsere Material-Nr. Our material No./No.de notre matériel
1495773 / 18	2299376
Unsere Abteilung/Our department/Notre département	Telefon/Telephone/Téléphone
VS-O	02302/292221

Produkt/Product/Produit

STAEBE AUS EDELBAUSTAHL
THERMON C 22.8, LF2, P250GH
GEWALZT, NORMALISIERT, GERICHTET,
ASTM A 105, NACE MR 01-75
IN ANLEHNUNG AN ASME SA 105, SA 350
GEMAESS IMS CSF 0001

ENGINEERING STEEL BARS
THERMON C 22.8, LF2, P250GH
HOT ROLLED, NORMALISED,STRAIGHTENED
ASTM A 105, NACE MR 01-75,
FOLLOWING ASME SA 105, SA 350
REGARDING IMS CSF 0001

Fertigungsauftr.-Nr./Production lot-No./Lot de fabrication No.	: 554779
Lieferschein-Nr./Delivery note/No. de l'avis de livraison	:
Schmelzen-Nr./Heat No./No.de coulée	: 514520
Stückzahl/Piece No./Nombre des pièces	: 12
Gewicht/Weight/Masse	: 18085 [kg]
Zeichnungs-Nr./Drawing No./No.du dessin	:
Format/Shape/Profil	: rund / round / rond
Durchm./Breite/Diameter/width/Diamètre/largeur	: 165.000 [mm] +1.650/-1.650 [mm]
Dicke/Thickness/Épaisseur	:
Länge/Length/Longueur	: 8500 - 9500 [mm]

Lieferzustand/Condition as supplied/Etat de livraison:
900 °C Wasser/Water
NO WELDING HAS BEEN PERFORMED

Die Prüfergebnisse zu Ihrer Lieferung finden Sie auf der Rückseite bzw. den nächsten Seiten
As for test results of your delivery see overleaf. / Vouz trouverez les resultats d'essais de votre livraison aux pages suivantes.

DEUTSCHE EDELSTAHLWERKE GMBH
Abnahmetechnik/Inspection department/Département de Réception

Krause
Abnahmebeauftragter/Der Werkssachverständige
Test House Manager/Works' inspector/Resousable Reception/L'Agent Réceptionnaire de l'usine

TRUE COPY

Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

D-58452 Witten, D-57012 Siegen . http://www.dew-stahl.com

Datum/Date: 22.08.14

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
2007721/1428105/szumski	1495773 / 18	5510775558	554779

Schmelzen-Nr. Heat No./No.de coulée	Erschmelzungsart Steelmaking process/Procédé d'élaboration	Gießverfahren Casting process/Procédé de coulée
514520	E	VSG

Chemische Zusammensetzung/ Chemical Composition/ Composition chimique

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	V	Al	N	Ti	
Ist/Actual/Actuel	0.18	0.24	0.64	0.005	0.003	0.21	0.05	0.12	0.14	< 0.01	0.017	0.0081	< 0.002	[%]
	Nb													
Ist/Actual/Actuel	< 0.003													[%]

Härte/ Hardness/ Dureté

Lieferzustand/Condition as supplied/Etat de livraison

	Min.	Max.	
Ist/Actual/Actuel	150	169	[HB]
Soll/Required/Demandé	>= 137	<= 187	[HB]

NACE MR01-75 / ISO 25156: HRC <18 not testable, we guarantee the max.22 HRC

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 12,5 mm rd	längs/longitudinal/longueur	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2[MPa (N/mm²)]	Rm[MPa (N/mm²)]	A2''[%]	Z[%]
34015	349	509	37.1	72
34014	381	516	32.9	71

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 12,5 mm rd	quer/transverse/traverse	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2[MPa (N/mm²)]	Rm[MPa (N/mm²)]	A2''[%]	Z[%]
34015	370	522	32.5	65
34014	371	510	29.2	67

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 12,5 mm rd	quer/transverse/traverse	1/2 Radius um 90 Grad versetzt	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2[MPa (N/mm²)]	Rm[MPa (N/mm²)]	A2''[%]	Z[%]
34015	365	516	36.3	68
34014	381	532	29.4	66

Schlagbiegeversuch/ Impact test/ Essai de résilience

Lieferzustand/Condition as supplied/Etat de livraison

Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
[CHARPY V]	quer/transverse/traverse	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	1. Prfl./Spec./Eprouvette	2. Prfl./Spec./Eprouvette	3. Prfl./Spec./Eprouvette	Mittelwert/Average value/Valeur moyenne
34015	144[J]	159[J]	159[J]	154[J]
34014	140[J]	140[J]	124[J]	135[J]

Schlagbiegeversuch/ Impact test/ Essai de résilience

Lieferzustand/Condition as supplied/Etat de livraison

Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
[CHARPY V]	längs/longitudinal/longueur	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	1. Prfl./Spec./Eprouvette	2. Prfl./Spec./Eprouvette	3. Prfl./Spec./Eprouvette

TRUE COPY

Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

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Datum/Date : 22.08.14

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
2007721/1428105/szumski	1495773 / 18	5510775558	554779

Proben-Nr./Specimen-No./No.d'eprouvette	1. Prfl./Spec./Eprouvette	2. Prfl./Spec./Eprouvette	3. Prfl./Spec./Eprouvette
34015	192[J]	188[J]	189[J]
34014	182[J]	184[J]	180[J]

US-Prüfung/ Ultrasonic testing/ Contrôle par ultrasons
GEMAESS / ACC. TO EN 10228-3 TYPE 1a/TAB.5/CL.3, ASTM A 388

Die Lieferung wurde auf Identität geprüft (Optische Emissionsspektrometrie) / Identity has been checked (Optical Emission Spectrometry)

Die Lieferung wurde besichtigt und auf Maß kontrolliert / Visual inspection and control of dimensional accuracy have been performed

Das Material ist frei von Radioaktivität (<0,1Bq/g bezogen auf Co-60). / The Product is free from radioactivity (<0,1Bq/g concerning Co-60).
La matière n'est pas radioactive (<0,1Bq/g, référence Co-60).
El material es libre de radioactividad.

Location of production: Witten / Germany

Anlage zu / Enclosure of / Annex de LR: DTM 1410011

Erläuterung/ Explanations/ Explications

- **Erschmelzungsart** / Steelmaking process / Procédé d'élaboration:
  E = Elektrostahl / Electric-arc-furnace steel / Acier électrique
- **Gießverfahren** / Casting process / Procédé de coulée:
  VSG = Vorblock-Strangguß / Continuous casting bloom / Bloom de coulée continue

Es wird bestätigt, daß die Lieferung geprüft wurde und den Vereinbarungen bei der Bestellungsannahme enspricht.
We hereby certify that the material described above has been tested and complies with the terms of the order.
Nous certifions que la livraison été vérifiée et est conforme aux stipulations de l'acception de la commande.

TRUE COPY

Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date : 22.08.14

Zertifiziert nach:	AD2000 W 0 TRD 100	Werkstofflieferant gemäß Druckgeräte-richtlinie 97 / 23 EG

Abnahmeprüfzeugnis nach

Inspection Certificate acc.to/Certificat de réception selon DIN EN 10204 3.2

Zeugnis-Nr./Certificate No./No.de Certificat 2007721/1428105/szumski

DEUTSCHE EDELSTAHLWERKE
ThyssenKrupp Materials
Nederland B.V.
POSTFACH 11
NL-5460 AA Veghel

Herstellerzeichen/Supplier's Mark/Marque d'usine	DEW
Prüfstempel/Inspector's stamp/Poincon de l'expert	WA

Warenempfänger
Heerbaart Jongman Metaal B.V.
Binnenhavenstraat
NL-7553 GH Hengelo

Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	
5510775558 | 18.11.13	
Unsere Auftr.-Nr. Our order No./No.de notre Commande	**Unsere Material-Nr.** Our material No./No.de notre matériel
1495773 / 18	2299376
Unsere Abteilung/Our department/Notre département	**Telefon/Telephone/Téléphone**
VS-O	02302/292221

Produkt/Product/Produit

STAEBE AUS EDELBAUSTAHL
THERMON C 22.8, LF2, P250GH
GEWALZT, NORMALISIERT, GERICHTET,
ASTM A 105, NACE MR 01-75
IN ANLEHNUNG AN ASME SA 105, SA 350
GEMAESS IMS CSF 0001

ENGINEERING STEEL BARS
THERMON C 22.8, LF2, P250GH
HOT ROLLED, NORMALISED,STRAIGHTENED
ASTM A 105, NACE MR 01-75,
FOLLOWING ASME SA 105, SA 350
REGARDING IMS CSF 0001

Fertigungsauftr.-Nr./Production lot-No./Lot de fabrication No.	: 554779
Lieferschein-Nr./Delivery note/No. de l'avis de livraison	:
Schmelzen-Nr./Heat No./No.de coulée	: 514520
Stückzahl/Piece No./Nombre des pièces	: 12
Gewicht/Weight/Masse	: 18085 [kg]
Zeichnungs-Nr./Drawing No./No.du dessin	:
Format/Shape/Profil	: rund / round / rond
Durchm./Breite/Diameter/width/Diamètre/largeur	: 165.000 [mm] +1.650/-1.650 [mm]
Dicke/Thickness/Epaisseur	:
Länge/Length/Longueur	: 8500 - 9500 [mm]

Lieferzustand/Condition as supplied/Etat de livraison:
900 °C Wasser/Water
NO WELDING HAS BEEN PERFORMED

Die Prüfergebnisse zu Ihrer Lieferung finden Sie auf der Rückseite bzw. den nächsten Seiten
As for test results of your delivery see overleaf. / Vouz trouverez les resultats d'essais de votre livraison aux pages suivantes.

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Abnahmetechnik/Inspection department/Département de Réception

Krause
Abnahmebeauftragter/Der Werkssachverständige
Test House Manager/Works' inspector/Resousable Reception/L'Agent Réceptionnaire de l'usine

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Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

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Datum/Date: 22.08.14

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
2007721/1428105/szumski	1495773 / 18	5510775558	554779

Schmelzen-Nr. Heat No./No.de coulée	Erschmelzungsart Steelmaking process/Procédé d'élaboration	Gießverfahren Casting process/Procédé de coulée
514520	E	VSG

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Ist/Actual/Actuel	0.18	0.24	0.64	0.005	0.003	0.21	0.05	0.12	0.14	< 0.01	0.017	0.0081	< 0.002	[%]
	Nb													
Ist/Actual/Actuel	< 0.003													[%]

Härte/ Hardness/ Dureté

Lieferzustand/Condition as supplied/Etat de livraison

	Min.	Max.	
Ist/Actual/Actuel	150	169	[HB]
Soll/Required/Demandé	>= 137	<= 187	[HB]

NACE MR01-75 / ISO 25156: HRC <18 not testable, we guarantee the max.22 HRC

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 12,5 mm rd	längs/longitudinal/longueur	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2 [MPa (N/mm²)]	Rm [MPa (N/mm²)]	A2'' [%]	Z [%]
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Zugversuch/ Tensile test/ Essai de traction

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Zugprobe; 12,5 mm rd	quer/transverse/traverse	1/2 Radius,(1/4d)	23[°C]

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Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 12,5 mm rd	quer/transverse/traverse	1/2 Radius um 90 Grad versetzt	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2 [MPa (N/mm²)]	Rm [MPa (N/mm²)]	A2'' [%]	Z [%]
34015	365	516	36.3	68
34014	381	532	29.4	66

Schlagbiegeversuch/ Impact test/ Essai de résilience

Lieferzustand/Condition as supplied/Etat de livraison

Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
[CHARPY V]	quer/transverse/traverse	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	1. Prfl./Spec./Eprouvette	2. Prfl./Spec./Eprouvette	3. Prfl./Spec./Eprouvette	Mittelwert/Average value/Valeur moyenne
34015	144[J]	159[J]	159[J]	154[J]
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Schlagbiegeversuch/ Impact test/ Essai de résilience

Lieferzustand/Condition as supplied/Etat de livraison

Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
[CHARPY V]	längs/longitudinal/longueur	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	1. Prfl./Spec./Eprouvette	2. Prfl./Spec./Eprouvette	3. Prfl./Spec./Eprouvette

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Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date : 22.08.14

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
2007721 / 1428105 / szumski	1495773 / 18	5510775558	554779

Proben-Nr. / Specimen-No. / No.d'eprouvette	1. Prfl. / Spec. / Eprouvette	2. Prfl. / Spec. / Eprouvette	3. Prfl. / Spec. / Eprouvette
34015	192 [J]	188 [J]	189 [J]
34014	182 [J]	184 [J]	180 [J]

US-Prüfung / Ultrasonic testing / Contrôle par ultrasons
GEMAESS / ACC. TO EN 10228-3 TYPE 1a/TAB.5/CL.3, ASTM A 388

Die Lieferung wurde auf Identität geprüft (Optische Emissionsspektrometrie) / Identity has been checked (Optical Emission Spectrometry)

Die Lieferung wurde besichtigt und auf Maß kontrolliert / Visual inspection and control of dimensional accuracy have been performed

Das Material ist frei von Radioaktivität (<0,1Bq/g bezogen auf Co-60). / The Product is free from radioactivity (<0,1Bq/g concerning Co-60).
La matière n'est pas radioactive (<0,1Bq/g, référence Co-60).
El material es libre de radioactividad.

Location of production: Witten / Germany

Anlage zu / Enclosure of / Annex de LR: DTM 1410011

Erläuterung/ Explanations/ Explications

- **Erschmelzungsart / Steelmaking process / Procédé d'élaboration:**
  E = Elektrostahl / Electric-arc-furnace steel / Acier électrique
- **Gießverfahren / Casting process / Procédé de coulée:**
  VSG = Vorblock-Strangguß / Continuous casting bloom / Bloom de coulée continue

Es wird bestätigt, daß die Lieferung geprüft wurde und den Vereinbarungen bei der Bestellungsannahme enspricht.
We hereby certify that the material described above has been tested and complies with the terms of the order.
Nous certifions que la livraison été vérifiée et est conforme aux stipulations de l'acception de la commande.

TRUE COPY

DELCORTE s.a.s
FORGED STEEL & STAINLESS STEEL
Quality system certified ISO9001:2008 by BSI-Q05524

DELCORTE FITTINGS

17, Avenue du Corbeau - CS10597
59605 MAUBEUGE CEDEX FRANCE
Tél : +33 (0)327 691 414 Fax : +33 (0)327 642 569
info@delcorte.com

BE - 21804

CERTIFICAT DE RECEPTION - ACCEPTANCE CERTIFICATE EN 10204 3.1 (Ex EN 10204 3.1.b)

Customer : FLENZEN BUIZEN FITTINGS BVBA
DYNAMICALAAN 4-8
B 2610 ANTWERPEN (WILRIJK)
BELGIQUE

Order : BE-3876700

F.B.F. b.v.b.a.
Tel. 03-828.50.80 - Fax 03-828.96.22
TEST CERTIFICATES DEPT.
DATUM 5/02/16
GOEDGEKEURD

Certificate n° : 192220 / 11 — 29/01/2016

Dispatch note 192220 — 28/01/2016

Material specification: ASTM/ASME A/SA105/14 - NACE MR 0175-09/MR 0103/12

Heat Treatment: NORMALIZED T° 843°-927° COOLED IN STILL AIR

DESCRIPTION

Item	Qty	Designation	Heat N°	Identification	Spec dimension				Localisation
27	300	HEX HD PLUG NPT 6M1/4"	311687	D06	ASME B16.11/11				05/11 30966
28	1 000	HEX HD PLUG NPT 6M1/2"	324349	N31	ASME B16.11/11				10/14 32006

CHEMICAL ANALYSIS

Item	Identif.	C %	Si%	Mn%	P%	S%	Cr%	Mo%	V%	Ni%	Cu%	Cb%		Ce%	Cr+Mo	Cu+Ni+Cr+Mo
mini			0.100	0.600												
maxi		0.250	0.350	1.350	0.035	0.040	0.300	0.120	0.050	0.400	0.400					1.000
27	D06	0.190	0.200	0.840	0.017	0.006	0.090	0.010	0.003	0.040	0.100	0.001		0.36	0.100	0.240
28	N31	0.200	0.190	0.830	0.014	0.009	0.080	0.020	0.002	0.050	0.160	0.001		0.37	0.100	0.310

MECHANICAL TESTS

CHARPY - V - J

Item	Identi-fication	Re 0.2% N/mm²	Rm N/mm²	A%	Z%	HB	T = +20° C - 27 JOULES MINI EP 1	EP 2	EP 3	AVERAGE	
mini		250.0	485.0	22.0	30.0						
maxi						187.0					
27	D06	327.0	508.0	34.0	62.4	141 - 140	71.0	71.0	118.0	86.7	
28	N31	339.0	524.0	34.8	63.6	141 - 141	195.0	150.0	129.0	158.0	

TRUE CERTIFIED COPY
OF THE ORIGINAL

Others
MATERIAL CONFORM TO THE PED 97/23/CE (AN1 PAR4.3)

"GUARANTEE OF HOT YIELD VALUES AS PER ASME SECTION II PART D TABLE Y1"

SERVICE QUALITE
J.D
Quality département
04/02/16

Nous certifions que les produits énumérés ci-dessous sont conformes aux prescriptions de la commande et des spécifications et ont subi, sans objection, les contrôles d'aspect et de dimensions.
We hereby certify that above mentioned products are in accordance with the requirements of the order and specifications and have been checked without objection for surface and dimensionnel control.

TRUE COPY

SA105N

+ US A181 +50

12552 A

A04 **HUTA BANKOWA**
Spółka z o.o.
ul. Sobieskiego 24
41-300 Dąbrowa Górnicza

A02 **Świadectwo odbioru 3.2 Nr 06800/15**
Inspection certificate 3.2
Abnahmeprüfzeugnis 3.2
Certificat de réception 3.2 Свидетельство приемки 3.2 PN-EN 10204

A08 Zamawiający / Ordered by - Besteller: PWT EUROSTAAL B.V.
ul. Nieuwland Parc 398 , 2952 DD Alblasserdam — Netherlands
VAT reg.nr NL806812850B01

A06 Adres wysyłkowy / Address - Versandadresse: PWT EUROSTAAL B.V. ul. Nieuwland Parc 398 , 2952 DD Alblasserdam

A07 Nr i data zamówienia klienta / Order No and date / Nr und Datum der Bestellung	A08 Zlecenie / Manuf. Order No / Auftrag Nr	Wykonano wg norm / Produced accoring to / Hergestellt gemäß Norm	Wagon / Car No / Wagen Nr
ALBLASSERDAM 174300 z dnia 15/06/18 LOT:	Hb/6206035/06/15 PL/273155484/2015/B1014 order: Number of dispatch:	ASTM A105 EN 10060:2003 EN10221:1995 Kl.B.	

B01 Przedmiot i wykonanie / Item and specification (Heat and mechanical treatement etc.) / Gegenstand und Ausführung (therm und mechan. Bearbeitung usw.)	B09 Wymiar lub rysunek / Dimension or drawing / Abmessung oder Zeichnung	B02 Gatunek / Steel grade / Güte	B07 Wytop / Heat / Schmelze	B06 Sztuk / Pieces / Stück	B14 Wiązki / Bundles / Bünde	B12 kg
Round bars normalised.	160 mm dł. 6000 mm	A 105	413580	10		9500

B08

B15 Reduction ratio 5,8 x.

Samples for mechanical properties tests were taken from 1/2 of radius in the longitudinal direction.

C71 **1. SKŁAD CHEMICZNY - CHEMICAL COMPOSITION - CHEMISCHE ZUSAMMENSETZUNG %**

B02 Wytop / Heat / Schmelze	C	Mn	Si	P	S	Cu	Cr	Ni	Mo	V	Sn	As	Ti
	0,20	0,85	0,300	0,014	0,009	0,03	0,05	0,01	0,003	0,003	0,004	0,001	0,002
	Al	Al met	Nb	N	H_2	O_2	--	--	--	--	CEV [%]	Ceq [%]	X [%]
413580	0,032	0,028	0,0000	0,0046	1,1 ppm		--	--	--	--	0,3655	--	--
	Analiza kontrolna / Control analysis / Verwechslungsprüfung												
	C	Mn	Si	P	S	Cu	Cr	Ni	Mo	V	Sn	As	Ti
	--	--	--	--	--	--	--	--	--	--	--	--	--
	Al	Al met	Nb	N	H_2	O_2	--	--	--	--	CEV [%]	Ceq [%]	X [%]
	--	--	--	--	--	--	--	--	--	--	--	--	--

D51 **2. BADANIA MECHANICZNE - MECHANICAL TEST - MECHANISCHE UNTERSUCHUNGEN**

C01 Próba Nr / Tests No / Probe Nr	B05 Rodzaj obróbki termicznej prób / Heat treatment of the sample. / Metallurgischer Zustand der Probe.	C11 Re [MPa]	C12 Rm [MPa]	C13 A_4 [%]	C14 Z [%]	Udarność temp. +20 °C / Impact test probe / Middle value, Mittelwert: C40 KV [J]	C40 KCU2 [J/cm²]	C40 KCU5 [J/cm²]	C31 Twardość / Hardness / Harte [HB]
303/TUV	Sample in the delivery condition	-	-	-	-	120,116,110	-	-	-
303/1/TUV	Sample in the delivery condition	348	509	34,2	69,0	-	-	-	-
2159/15	Sample in the delivery condition	-	-	-	-	-	-	-	166 - 185

D52 **3. BADANIA TECHNOLOGICZNE - TECHNOLOGICAL TESTS - TECHNOLOGISCHE UNTERSUCHUNGEN**

Ultrasonic testing SEP 1920-1 kl. B gr. 3.

D53 **4. BADANIA METALOGRAFICZNE - METALLOGRAPHIC TESTS - METALLOGRAPHISCHE UNTERSUCHUNGEN**

B02 Wytop Nr / Heat No / Schmelze	D54 Zanieczyszczenia niemetaliczne / Nometallic Impurities / Nichtmetallische Verunreinigungen	D55 Struktura / Structure / Struktur
413580		

Powierzchnię i wymiary zbadano przez wydz.prod. w 100% - Surface and dimension tested by Dept.at 100% - Oberfläche und Abmessungen geprüft von Prod.Abt. zu 100%

Z01 Deklarujemy, że wykonany wyrób jest zgodny z warunkami potwierdzenia zamówienia.
We declare that the final product comply with the order confirmation. Wir deklarieren, dass die herstellung gemäß auftragsbestätigungsbedindungen ist gemacht

O01 Material oznaczono - Material marked - Das Material wurde bezeichnet: No heat, "Hb" mark, "TUV" mark.

Material nie jest radioaktywny / Material weist keine radiation auf / The material has not displayed any radiation

B15

Z04

Z02 Kontrola jakości Control of Manufacture Fabrikationskontrolle

KJ -13- Data: 2015-08-18

Mistrz ds. Odbiorów Wyrobów Wakowanych
Z-ca Kierownika KJ ds. Jakości Wyrobów
Gerard Kulej

Inspektor Inspector Abnehmer

TÜV NORD SYS 0045

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12552

A04 **HUTA BANKOWA** Spółka z o.o. ul. Sobieskiego 24 41-300 Dąbrowa Górnicza

A02 **Świadectwo odbioru 3.2 Nr 06799/15**
Inspection certificate 3.2 Abnahmeprüfzeugnis 3.2 Certificat de réception 3.2 Свидетельство приемки 3.2 PN-EN 10204

A06 Zamawiający Ordered by - Besteller: PWT EUROSTAAL B.V. ul. Nieuwland Parc 398 , 2952 DD Alblasserdam Netherlands VAT reg.nr NL806812850B01

A08 Adres wysyłkowy Address - Versandadresse: PWT EUROSTAAL B.V. ul. Nieuwland Parc 398 , 2952 DD Alblasserdam

A07 Nr i data zamówienia klienta Order No and date Nr und Datum der Bestellung	A08 Zlecenie Manuf. Order No Auftrag Nr	Wykonano wg norm Produced acqoring to Hereste!lt gemaß Norm	Wagon Car No Wagen Nr
ALBLASSERDAM 174300 z dnia 15/06/18 LOT:	Hb/6206035/06/15 PL/273155484/2015/B1014 order: Number of dispatch:	DIN 17243, DIN 17243 EN 10060:2003 EN 10221:1995 Kl. B, EN 10273:2007	

B01 Przedmiot i wykonanie Item and specification (Heat and mechanical treatement etc.) Gegenstand und Ausfuhrung (therm und mechan. Bearbeitung usw.)	B09 Wymiar lub rysunek Dimension or drawing Abmessung oder Zeichnung	B02 Gatunek Steel grade Güte	B07 Wytop Heat Schmelze	B08 Sztuk Pieces Stück	B14 Wiązki Bundles Bünde	B12 kg
Round bars normalised.	160 mm dł. 6000 mm	C22.8 P250GH	413580	10		9500

B06

B15 Reduction ratio 5,6 x.

Samples for mechanical properties tests were taken from 1/2 of radius in the longitudinal direction.

C71 **1. SKŁAD CHEMICZNY** - CHEMICAL COMPOSITION - CHEMISCHE ZUSAMMENSETZUNG %

B02 Wytop Heat Schmelze	C	Mn	Si	P	S	Cu	Cr	Ni	Mo	V	Sn	As	Ti
	0,20	0,85	0,300	0,014	0,009	0,03	0,05	0,01	0,003	0,003	0,004	0,001	0,002
413580	Al	Al met	Nb	N	H_2	O_2	–	–	–	–	CEV [%]	Ceq [%]	X [%]
	0,032	0,028	0,0000	0,0046	1,1ppm		–	–	–	–	0,3555	–	–

Analiza kontrolna Control analysis Verwechslungsprüfung

	C	Mn	Si	P	S	Cu	Cr	Ni	Mo	V	Sn	As	Ti
	–	–	–	–	–	–	–	–	–	–	–	–	–
	Al	Al met	Nb	N	H_2	O_2	–	–	–	–	CEV [%]	Ceq [%]	X [%]
	–	–	–	–	–	–	–	–	–	–	–	–	–

D51 **2. BADANIA MECHANICZNE** - MECHANICAL TEST - MECHANISCHE UNTERSUCHUNGEN

C01 Próba Nr Tests No Probe Nr	B05 Rodzaj obróbki termicznej prób Heat treatment of the sample. Metallurgischer Zustand der Probe.	C11 Re [MPa]	C12 Rm [MPa]	C13 A_5 [%]	C14 Z [%]	Udarność temp. +20 °C Impact test probe Mittelwert C40 KV [J]	C40 KCU2 [J/cm²]	C40 KCU5 [J/cm²]	C31 Twardość Hardness Harte [HB]
303/TUV	Sample in the delivery condition	282	497	33,6	65,4	120,116,110	-	-	-
2159/15	Sample in the delivery condition	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	166 - 185

D52 **3. BADANIA TECHNOLOGICZNE** - TECHNOLOGICAL TESTS - TECHNOLOGISCHE UNTERSUCHUNGEN

Ultrasonic testing SEP 1920-1 kl. B gr. 3.

D53 **4. BADANIA METALOGRAFICZNE** - METALLOGRAPHIC TESTS - METALLOGRAPHISCHE UNTERSUCHUNGEN

B02 Wytop Nr Heat No Schmelze	D54 Zanieczyszczenia niemetaliczne Nometallic impurities Nichtmetallische Verunreinigungen	D55 Struktura Structure Struktur
413580		

Powierzchnię i wymiary zbadano przez wydz.prod. w 100% - Surface and dimension tested by Dept.at 100% - Oberflache und Abmessungen geprüft von Prod.Abt. zu 100%

Z01 Deklarujemy, że wykonany wyrób jest zgodny z warunkami potwierdzenia zamówienia.
We declare that the final product comply with the order confirmation. Wir deklarieren, dass die herstellung gemäß auftragsbestätigungsbedindungen ist gemacht

D01 Materiał oznaczono - Material marked - Das Material wurde bezeichnet: Steel grade, Nr heat, "Hb" mark, "TUV" mark.

Materiał nie jest radioaktywny Material weist keine radiation auf The material has not displayed any radiation

B15

Z04

Z02 Kontrola jakości Control of Manufacture Fabrikationskontrolle Inspektor Inspector Abnehmer

KJ -13- Data: 2015-08-18

Mistrz ds. Odbiorów Wyrobów Wekowanych
Z-ca Kierownika KJ ds. Jakości Wyrobów
Gerard Kulej

TÜV NORD System 0045

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MATERIAAL METINGEN TESTGROEP

Niet Destructief Onderzoek

MME GROUP

NON DESTRUCTIVE TESTING REPORT
NIET DESTRUCTIEF ONDERZOEK RAPPORT

Page 1 of 1 | MM order nr.: ND 1516575 | Report no. / Rapport nr. 15377322

Client: / Klant:	Mechanische Industrie Menzing	Project: / Project:	O 151308		
Test location: / Plaats onderzoek:	Haaksbergen	Subject: / Onderwerp:	20x Filter House RH		
Order number: / Order nummer:	15-02613-JN				
Reference client: / Referentie klant:	J. Nieuwenhuis	Charge no.: / Charge nr.:	413580	Request no.: / Opdracht nr.:	--
Examination: / Soort onderzoek:	Ultrasonic examination on steel forgings	Drawing no.: / Tekening. nr.:	045.14.501.01 ARH-D	Heat treat: / Warmtebeh.:	No
Specification: / Specificatie:	ASTM A388	Material type: / Materiaal soort:	A105N	Material dim.: / Materiaal afm.:	Ø 160 x -450mm[a]
Acceptance: / Acceptatie:	ASTM A388 / ASTM B16.34	Weld process: / Las methode:	n.a.	Weld preparation: / Las voorbewerking:	n.a.

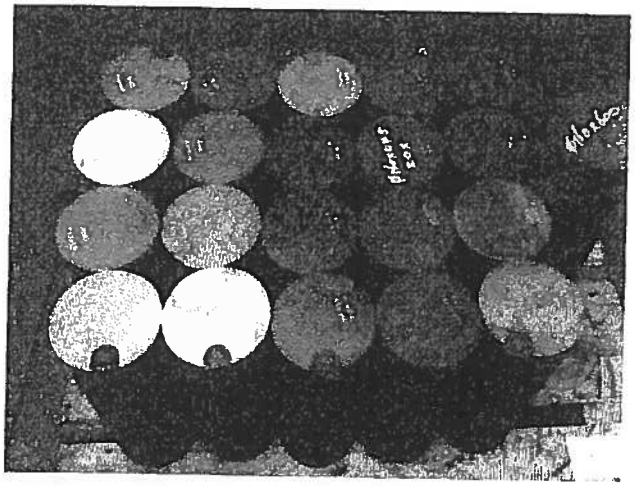
ULTRASONIC EXAMINATION / ULTRASOON ONDERZOEK — UT

Procedure: / Procedure:	MM 41300	Revision: / Revisie:	14	Equipment: / Apparaat:	Sonatest SS 250 ID.No.: MM4013
Reference block: / Referentie ijkblok:	FBH 6,4mm			Calibration block: / Standaard ijkblok:	K1
Object temperature: / Temperatuur object:	18°C	Couplant: / Koppelmiddel:	Oil	Time base range: / Meetbereik:	0 - 300mm
Surface condition: / Oppervlakte gesteldheid:	Acceptable	Transfer correction: / Oppervlakte verliezen:	--	Sensitivity: / Versterking:	Acc. procedure

Straight Probes / Rechte-tasters				Angle Probes / Hoek-tasters			
Type / Type	MB4S-N	--	--	Type / Type			
Crystal Ø / Kristal Ø	Ø 10mm			Crystal size / Kristal afmeting			
Frequency / Frequentie	4 MHz			Frequency / Frequentie			
Adaptor / Adapter	--			Angle/Index / Hoek/Index			
Serial no. / Serie nr.	50835			Serial no. / Serie nr.			

Results description: / Omschrijving resultaat: During examination no reportable or unacceptable indications were detected

Part examined: / Onderzochte gedeelte: 100% of 20 pieces Ø160 x - 450mm



Remarks/Opmerkingen: --

Inspector/Inspecteur(s)	Level:	Manufacturer/Fabrikant:	Client/Klant:	Insp.Authority/Keur instantie:
G. Wolbers	U2			
Date of report: / Rapport datum: 29 10 2015		Fabrication date: / Fabricatie datum:	Date: / Datum:	Date: / Datum:

UT-Rev.w8.4

MATERIAAL METINGEN TESTGROEP BV - Rietdekkerstraat 16 - 2984 BM Ridderkerk (The Netherlands) - Tel.: +31(0)180 48 28 28 - Fax: +31(0)180 46 22 40
Offices: Ridderkerk, Beverwijk, Hengelo, Dinteimond, Heerenveen, Eindhoven - E-mail: info@mme-group.com

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Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date: 22.08.14

Zertifiziert nach:	AD2000 W 0 TRD 100	Werkstofflieferant gemäß Druckgeräte-richtlinie 97 / 23 EG

Abnahmeprüfzeugnis nach

Inspection Certificate acc.to/Certificat de réception selon DIN EN 10204 3.2

Zeugnis-Nr./Certificate No./No.de Certificat 2007721 / 1428105 / szumski

DEUTSCHE EDELSTAHLWERKE
ThyssenKrupp Materials
Nederland B.V.
POSTFACH 11
NL-5460 AA Veghel

Herstellerzeichen/Supplier's Mark/Marque d'usine	DEW
Prüfstempel/Inspector's stamp/Poincon de l'expert	WA

Warenempfänger
Heerbaart Jongman Metaal B.V.
Binnenhavenstraat
NL-7553 GH Hengelo

Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	
5510775558 | 18.11.13	
Unsere Auftr.-Nr. Our order No./No.de notre Commande	**Unsere Material-Nr.** Our material No./No.de notre matériel
1495773 / 18	2299376
Unsere Abteilung/Our department/Notre département	**Telefon/Telephone/Téléphone**
VS-O	02302/292221

Produkt/Product/Produit

STAEBE AUS EDELBAUSTAHL
THERMON C 22.8, LF2, P250GH
GEWALZT, NORMALISIERT, GERICHTET,
ASTM A 105, NACE MR 01-75
IN ANLEHNUNG AN ASME SA 105, SA 350
GEMAESS IMS CSF 0001

ENGINEERING STEEL BARS
THERMON C 22.8, LF2, P250GH
HOT ROLLED, NORMALISED,STRAIGHTENED
ASTM A 105, NACE MR 01-75,
FOLLOWING ASME SA 105, SA 350
REGARDING IMS CSF 0001

Fertigungsauftr.-Nr./Production lot-No./Lot de fabrication No.	: 554779
Lieferschein-Nr./Delivery note/No. de l'avis de livraison	:
Schmelzen-Nr./Heat No./No.de coulée	: 514520
Stückzahl/Piece No./Nombre des pièces	: 12
Gewicht/Weight/Masse	: 18085 [kg]
Zeichnungs-Nr./Drawing No./No.du dessin	:
Format/Shape/Profil	: rund / round / rond
Durchm./Breite/Diameter/width/Diamètre/largeur	: 165.000 [mm] +1.650 / -1.650 [mm]
Dicke/Thickness/Épaisseur	:
Länge/Length/Longueur	: 8500 - 9500 [mm]

Lieferzustand/Condition as supplied/Etat de livraison:
900 °C Wasser/Water
NO WELDING HAS BEEN PERFORMED

Die Prüfergebnisse zu Ihrer Lieferung finden Sie auf der Rückseite bzw. den nächsten Seiten
As for test results of your delivery see overleaf. / Vouz trouverez les resultats d'essais de votre livraison aux pages suivantes.

DEUTSCHE EDELSTAHLWERKE GMBH
Abnahmetechnik/Inspection department/Département de Réception

Krause

Abnahmebeauftragter/Der Werkssachverständige
Test House Manager/Works' inspector/Resousable Reception/L'Agent Réceptionnaire de l'usine

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Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

DEUTSCHE EDELSTAHLWERKE

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D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date: 22.08.14

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
2007721 / 1428105 / szumski	1495773 / 18	5510775558	554779

Schmelzen-Nr. Heat No./No.de coulée	Erschmelzungsart Steelmaking process/Procédé d'élaboration	Gießverfahren Casting process/Procédé de coulée
514520	E	VSG

Chemische Zusammensetzung/ Chemical Composition/ Composition chimique

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	V	Al	N	Ti	
Ist/Actual/Actuel	0.18	0.24	0.64	0.005	0.003	0.21	0.05	0.12	0.14	< 0.01	0.017	0.0081	< 0.002	[%]
	Nb													
Ist/Actual/Actuel	< 0.003													[%]

Härte/ Hardness/ Dureté

Lieferzustand/Condition as supplied/Etat de livraison

	Min.	Max.	
Ist/Actual/Actuel	150	169	[HB]
Soll/Required/Demandé	>= 137	<= 187	[HB]

NACE MR01-75 / ISO 25156: HRC <18 not testable, we guarantee the max.22 HRC

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 12,5 mm rd	längs/longitudinal/longueur	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2 [MPa (N/mm²)]	Rm [MPa (N/mm²)]	A2'' [%]	Z [%]
34015	349	509	37.1	72
34014	381	516	32.9	71

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 12,5 mm rd	quer/transverse/traverse	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2 [MPa (N/mm²)]	Rm [MPa (N/mm²)]	A2'' [%]	Z [%]
34015	370	522	32.5	65
34014	371	510	29.2	67

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

Probenabm./Specimen dimension/Dimension d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
Zugprobe; 12,5 mm rd	quer/transverse/traverse	1/2 Radius um 90 Grad versetzt	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	Rpo.2 [MPa (N/mm²)]	Rm [MPa (N/mm²)]	A2'' [%]	Z [%]
34015	365	516	36.3	68
34014	381	532	29.4	66

Schlagbiegeversuch/ Impact test/ Essai de résilience

Lieferzustand/Condition as supplied/Etat de livraison

Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
[CHARPY V]	quer/transverse/traverse	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	1. Prfl./Spec./Eprouvette	2. Prfl./Spec./Eprouvette	3. Prfl./Spec./Eprouvette	Mittelwert/Average value/Valeur moyenne
34015	144[J]	159[J]	159[J]	154[J]
34014	140[J]	140[J]	124[J]	135[J]

Schlagbiegeversuch/ Impact test/ Essai de résilience

Lieferzustand/Condition as supplied/Etat de livraison

Probenform/Type of specimen/Type d'éprouvette	Probenrichtung/Specimen direction/Sens de Prélèvement	Pr.-ent./Specimen location/Point d'prélèv.	Prüftemp./Test temperature/Température d'essai
[CHARPY V]	längs/longitudinal/longueur	1/2 Radius,(1/4d)	23[°C]

Proben-Nr./Specimen-No./No.d'eprouvette	1. Prfl./Spec./Eprouvette	2. Prfl./Spec./Eprouvette	3. Prfl./Spec./Eprouvette

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Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001

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Providing special steel solutions

D-58452 Witten, D-57012 Siegen , http://www.dew-stahl.com

Datum/Date : 22.08.14

Zeugnis-Nr. Certificate No./No.de Certificat	Unsere Auftr.-Nr. Our order No./No.de notre Commande	Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du	Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No.
2007721/1428105/szumski	1495773 / 18	5510775558	554779

Proben-Nr./Specimen-No./No.d'eprouvette	1. Prfl./Spec./Eprouvette	2. Prfl./Spec./Eprouvette	3. Prfl./Spec./Eprouvette
34015	192[J]	188[J]	189[J]
34014	182[J]	184[J]	180[J]

US-Prüfung/ Ultrasonic testing/ Contrôle par ultrasons
GEMAESS / ACC. TO EN 10228-3 TYPE 1a/TAB.5/CL.3, ASTM A 388

Die Lieferung wurde auf Identität geprüft (Optische Emissionsspektrometrie) / Identity has been checked (Optical Emission Spectrometry)

Die Lieferung wurde besichtigt und auf Maß kontrolliert / Visual inspection and control of dimensional accuracy have been performed

Das Material ist frei von Radioaktivität (<0,1Bq/g bezogen auf Co-60). / The Product is free from radioactivity (<0,1Bq/g concerning Co-60).
La matière n'est pas radioactive (<0,1Bq/g, référence Co-60).
El material es libre de radioactividad.

Location of production: Witten / Germany

Anlage zu / Enclosure of / Annex de LR: DTM 1410011

Erläuterung/ Explanations/ Explications
- **Erschmelzungsart** / Steelmaking process / Procédé d'élaboration :
  E = Elektrostahl / Electric-arc-furnace steel / Acier électrique
- **Gießverfahren** / Casting process / Procédé de coulée :
  VSG = Vorblock-Strangguß / Continuous casting bloom / Bloom de coulée continue

Es wird bestätigt, daß die Lieferung geprüft wurde und den Vereinbarungen bei der Bestellungsannahme entspricht.
We hereby certify that the material described above has been tested and complies with the terms of the order.
Nous certifions que la livraison été vérifiée et est conforme aux stipulations de l'acception de la commande.

TRANSCRIPT

TŘINECKÉ ŽELEZÁRNY
MORAVIA STEEL

TŘINECKÉ ŽELEZÁRNY, a.s., Průmyslová 1000, Staré Město, 739 61 Třinec, Czech Republic/
Výrobní závod: 272 01 Kladno-Dříň

Ihr Auftrag – Your order – Voitre ordre: 41319827

Aviso – Advise note – Avis:

Werks Nr. – Our order – Ref. d'usine: 7000376367

Waggon No: 0441784

4500 595657-60

☐ **EN 10204 2.2 Werkszeugnis – Test report – Relevé de contrôle**

☒ **EN 10204.2004 3.2 Abnahmeprüfzeugnis – Inspection certificate – Certificate de réception**

Number: 2014/12/832

Lieferung – Delivery - Livraison	Gewicht – Weight – Poids	Güte – Quality – Qualité	Norm – Standard - Norme
HOT ROLLED ROUND STEEL BARS IN QUALITY S355J2+N ACC.TO EN10025-2:2004 ORDER NR.3047/14/33-4500595657 NORMALIZED 140 mm 6,0-6,5m	10 155 kg 14 pieces	S355J2+N Normalized annealed	EN10025/2- 04.10 LR RULES PART 2 CHAP 5 SEC 3 LATEST EDIT

CHEMISCHE ZUSAMMEN SETZUNG – CHEMICAL ANALYSIS – COMPOSITION CHIMIQUE (%)

Schmelze Melt Charge No	C	MN	SI	P	S	CU	CR	NI	
T17938	0,16	1,29	0,39	0,017	0,008	0,06	0,23	0,03	
	AL	MO	V	SN	CEQ				
cc blooms	0,029	0,007	0,038	0,004	0,44				R

MECHANISCHE WERTE – MECHANICAL VALUES - QUALITÉS MECHANIQUES

Schmelze Melt Charge No	Streckgrenze Yield point Limité d'elast. Reh (MPa)	Zugfestigkeit Tensile strenght Resistance R_m (MPa)	Bruchdehnung Extension Allongem A_5 (%)	Brucheinschn Contraction Contraction Z (%)	Schlagarbeit Energy of impact Resilience KV (J)	Microcleanness according to DIN 50 602	Brinell hardness HB Inf.
T17938	min315						152-154
test .Nr							
P819	360	531	32,6	72,4	-20°Cmin27 150,144,148 -40°Cinf 136,157,122 -50°Cinf 69,112,112	CE 1020 06	

Grain size ASTM E112:min5
Ultrasonic inspection results 100%SEP 1921 3D/d - satisfactory
Spectrotest 100 %
Vacuum degassed practice
100% Surface electronic crack detection :satisfactory
Rolling reduction ratio:8,6

Products which do not cause harmful emission of toxic gasses,dangerous particles or radiation to the indoor environment nor contamination of the outdoor environment (air,soil ,or water)
DIE RADIOISOTOPISCHEAKTIVITÄT MAX. 100 BQ/KG WURDE EINGEHALTET.
RADIO - ISOTOPIC ACTIVITY WAS CONTROLLED IN LADLE SAMPLE, IT WAS NO HIGHER THAN 100 BQ/KG.

Die obengenannten Erzeugnisse entsprechen den Bestellungsvorschriften – Products conform with the prescription of order

We hereby certify that the material has been made by an approved process and satisfactorily tested to accordance with the Rules of Lloyd s Register
LR reference No: PRA. 1400923

V Kladně dne 7.1.2015
T_PRINT 3022-97 D 3022-97 D

Lloyd's Register EMEA
Prague Office
Julius Fazekas
Lloyd's Register

TŘINECKÉ ŽELEZÁRNY, a.s. ATTESTATION 1-15

Josef Řeminek
independent authorized agent
unabhängiger berechtiger Vertreter
nezávislý oprávněný zástupce

TŽ TK-2-2/16

TRUE COPY

Inspection Certificate

Project: **Hot Rolled Steel Bars**

Client: **MORAVIA STEEL a.s. Prumyslova 1000 Trinec - Stare Mesto 739 70 Czech Republic Works: Sochorova valcovna TZ a.s. Kladno-Drin, Czech Republic**

Office: **Prague**

Client's Order Number: **7000378367**

41319827

Date: **02 November 2015**

Order Status: **Complete**

Inspection Dates

First: **06 November 2014**

Final: **07 January 2015**

This certificate is issued to **MORAVIA STEEL a.s., Prumyslova 1000, Trinec - Stare Mesto, 739 70 Czech Republic, Works: Sochorova valcovna TZ a.s., Kladno-Drin, Czech Republic**

To certify that the rolled steel products described below, have been inspected and tested at the manufacturer's works in accordance with applicable Standard with satisfactory results.

POS	MS ORDER	PCS	GRADE	STANDARD	DIA mm	QUANTITY kg /pcs	HEAT NO.	MILL CERTIFICATE
1	**7000378367**	7	S355J2+N	EN10025/2-04.10 LR Rules ,P.2, Ch5, S3, Edition 07/2014	140	10155 (14 pieces)	T17938	2014/12/832

The mechanical properties, manufacturer's declared chemical composition, performed heat treatment, non-destructive tests and details of supply condition are shown on the Manufacturer's Test Certificate indicated above, enclosed.

Enclosure:
Manufacturer's Mill Test Certificate type 3.2 acc. to EN10204.

Julius Fazekas
Prague Office

Lloyd's Register

Lloyd's Register EMEA

LR031 1 2013 12

Julius FAZEKAS
Senior Surveyor to Lloyd's Register EMEA

a member of the Lloyd's Register group

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Made in Germany

ABNAHMEPRÜFZEUGNIS EN 10204
INSPECTION CERTIFICATE ACCORDING TO 3.1
CERTIFICAT DE RECEPTION

DEUTSCHE EDELSTAHLWERKE

Providing special steel solutions

Hersteller / Manufacturer / Producteur: DEUTSCHE EDELSTAHLWERKE GMBH, D-57012 SIEGEN

Uns. Auftr.-Nr. / Order-No. / Notre Com. No.: 1629344

Besteller / Customer / Client: ThyssenKrupp Schulte GmbH

Bestell_Nr. / Order-No. / Commande No.: H41-6403620543

ThyssenKrupp Schulte GmbH

Westfaliastr. 185
DE-44147-Dortmund

zertifiziert nach: ISO 9001, ISO / TS 16949, EN 9100, ISO 14001, DGR 97/23/EG, PED 97/23/EU

Prüf-Nr. 216107 / Seite / Page / Page 1 / 3

Werkstoff / Quality / Nuance	1.4571 / X 6 CrNiMoTi 17-12-2 Acidur 4571 AISI 316 TI
Erzeugnisform / Product / Produit	Stabstahl, walzgeschaelt Abgeschreckt
Gießverfahren / Casting process / Procédé de coulée	Strangguss Continuous casting Coulée Continue
Erschmelzungsart / Melting Furnance / Mode de fusion	Elektrostahl Electric-arc-furnace steel Acier électrique
Anforderungen / Requirements / Prescriptions de controlé	DIN EN 10088-3 12/14 ASTM A 276/A 276M - 15 ASTM A 479/A479M 14 AD 2000-MERKBL.W 2 02/08 DIN EN 10272 01/08 MR0175/ISO 15156-3 10/09 NACE MR0103-2010 10/10 ASME SA-479/479M 13 weitere Anforderungen vorhanden, siehe Zusatztexte

Schmelzen-Nr. Cast No./Coulée No.	Proben-Nr. Test N./Eprouv.N.	Fertigungsauftrag Lot no./Lot fabr.	Pos. Item/Poste	Abmessung Dimensions/Dimensions mm	Stückzahl Quantity / Nombre	Gewicht KG Weight / Masse	Stempel Abnahmebeauftragter Inspector's stamp
263226	691424	691424	004	65,00 + 0,300/-0,000 RD		808	WA

Schmelzen-Nr. Cast No/Coulée No	% C	% SI	% MN	% P	% S	% CR	% MO	% NI	% V	% W	% CO	% CU	% N	% AL	% TI		
263226	0,013	0,57	1,84	0,027	0,015	16,60	2,050	10,77	0,070	0,04	0,098	0,22	0,0130	0,004	0,2100		

Proben-Nr. Test No. Eprouv.N.	Ref. Zust	Probenabmess. Sample Dim. Dim.d'epr.	Probenlg. Spec.Pos. Pos.d'epr	Zugversuch Tensile test / Essai de traction								Kerbschlagversuch Impact test / Essai de resilience					Härteprüfung Hardness Durete	
				Temp °C	RP0,2 MPA	RP1,0 MPA	RM MPA	A5 %	A2" %	Z %		Temp °C	JOULE	JOULE	JOULE			
691424		9.96 mm	L	20	366	417	605	47.5	50.9	75		23	216	205	209	DIN EN ISO 148-1 KV	170HB	
		9.91 mm	L	20	372	424	598	48.0	51.2	75								

weitere Anforderungen /
Additional requirements /
Exigences supplémentaires:
ASME SA-182/182M 13
AD 2000-MERKBL.W 10 11/07
EN 10222-5 02/00
WIR BESTAETIGEN, DASS DIESE LIEFERUNG DEN SCHRIFTLICHEN VEREINBARUNGEN BEI DER BESTELLUNG ENTSPRICHT
We confirm the production of your order is according to the written

Das Zeugnis wurde maschinell erstellt und ist gemäß EN 10204 ohne Unterschrift rechtsverbindlich.
This certificate was generated by data system, acc. to EN 10204, it need not to be signed for validity.
Ce certificat a été établi sur systéme informatique et est valable selon EN 10204 sans signature.

Tel: 0271/808-2642
Fax: 0271/808-2521
Email: verena.frisch@dew-stahl.com

Datum: 10.02.2016
Frisch
(Abnahmebeauftragter/ Inspector)

TRUE COPY

Made in Germany		
ABNAHMEPRÜFZEUGNIS INSPECTION CERTIFICATE ACCORDING TO CERTIFICAT DE RECEPTION	EN 10204 3.1	DEUTSCHE EDELSTAHLWERKE Providing special steel solutions
Prüf-Nr. 216107 / Seite Page / Page 2 / 3		

Besteller Customer Client	ThyssenKrupp Schulte GmbH	Bestell Nr. Order-No. Commande No.	H41-5403620543
Hersteller Manufacteur Producteur	DEUTSCHE EDELSTAHLWERKE GMBH D-57012 SIEGEN	Uns. Auftr.-Nr. Order-No. Notre Com. No.	1629344/004
Proben-Nr. Test N. Eprouv.N.	691424		

agreement of our order acknowledgement
Nous certifions que la livraison est conforme aux accords
complémentaires par écrit convenus à la commande.
Härte HRC =< 22
Hardness HRC =< 22
durete HRC =< 22
Die Schmelze wurde VOD-behandelt.
This cast has been VOD-treated.
La coulée a été décarburisée sous vide à l'oxygène.
100 % US-geprüft nach ASTM A 388: ohne Beanstandung.
100 % US Test acc. to ASTM A 388: without recordable indications
100% controle US ASTM A 388: satisfaisant
Das Material ist frei von Quecksilberverunreinigungen.
FREE FROM MERCURY CONTAMINATION
Produit exempt de mercure.
am Material wurde nicht reparaturgeschweißt
no weld repair
Absence de réparation par soudure sur la matière.
IK TEST NACH ASTM A 262 VERF. E : OHNE BEANSTANDUNG
IG CORROSION TEST ACC. TO ASTM A 262 PRACT. E : SATISFACTORY,,
Test d'attaque intergranulaire suivant ASTM A 262
pratique E: sans défaut.
DER WERKSTOFF IST INTERKRIST. BESTAEND. NACH: DIN EN ISO 3651-2
MAT. IS RESIST. TO INTERCR. CORR. PURS. TO: DIN EN ISO 3651-2
L'ACIER EST RESIST. A LA CORR. INTERGR. S.: DIN EN ISO 3651-2
MASS UND OBERFLAECHENKONTROLLE: KEINE BEANSTANDUNG
DIMENSIONS AND SURFACE INSPECTION: SATISFACTORY
DIMENSIONS ET SURFACE CONTROLE: SATISFAISANTS
100% US-Prüfung nach EN 10308, Tab 1, Typ 1A,
vollständige Prüfung, Tab.3, QK.3: ohne Beanstandung.
100% Rissgeprüft EN 10277, Kl.3: ohne Beanstandung
100% US-Test acc. to EN 10308,Tab.1, Type 1A,
complete test volume,Tab.3, QC3: without Indication.
100% Surface crack test acc. to EN 10277, Cl.3:
without indication
Contrôle US 100% suivant EN 10308, Tab. 1, type 1A,
Contrôle complet, Tab.3,CQ.3: sans défaut.
Contrôle défauts de surface 100% EN 20277, Cl.3:
sans défaut.
PRUEF. AUF WERKSTOFFIDENTITART:100% SPEKTROSKOP.OB
TEST TO VERIFY QUAL.:100% SPECTROSC. WITHOUT INDIC.
CONTROLE D'IDENTITE:100% SPECTROS. PAS D'OBJECTION
WAERMEBEH. 1050 C, WASSER ABGESCHRECKT

Das Zeugnis wurde maschinell erstellt und ist gemäß EN 10204 ohne Unterschrift rechtsverbindlich.
This certificate was generated by data system, acc. to EN 10204, it need not to be signed for validity.
Ce certificat a été établi sur système informatique et est valable selon EN 10204 sans signature.

Tel: 0271/808-2642
Fax: 0271/808-2521
Email: verena.frisch@dew-stahl.com

Datum: 10.02.2016
Frisch
(Abnahmebeauftragter/
Inspector)

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Made in Germany

ABNAHMEPRÜFZEUGNIS — EN 10204
INSPECTION CERTIFICATE ACCORDING TO — 3.1
CERTIFICAT DE RECEPTION

DEUTSCHE EDELSTAHLWERKE
Providing special steel solutions

Prüf-Nr. 216107 / Seite Page / Page 3 / 3

Besteller / Customer / Client: ThyssenKrupp Schulte GmbH

Bestell Nr. / Order-No. / Commande No.: H41-5403620543

Hersteller / Manufacteur / Producteur: DEUTSCHE EDELSTAHLWERKE GMBH
D-57012 SIEGEN

Uns. Auftr.-Nr. / Order-No. / Notre Com. No.: 1629344/004

Proben-Nr. / Test N. / Eprouv.N.: 691424

HEAT TREATMENT 1050 C, WATER QUENCHED
TTH 1050 C, trempé à l'eau
DAS MATERIAL IST FREI VON RADIOAKTIVITÄT
(<0,1Bq/g bezogen auf Co-60).
Herstellland: Deutschland
THE PRODUCT IS FREE FROM RADIOACTIVITY.
(<0,1Bq/g based on Co-60).
Location of production: Germany
LE MATÉRIEL N'EST PAS RADIOACTIF
(<0,1Bq/g basé sur Co-60).
Pays de production: Allemagne

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Tel: 0271/808-2642
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Email: verena.frisch@dew-stahl.com

Datum: 10.02.2016
Frisch
(Abnahmebeauftragter/ Inspector)

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COGNE ACCIAI SPECIALI S.p.a.
ITALY - 11100 AOSTA - VIA PARAVERA, 16
TEL.+ 39.0165.3021 - FAX + 39.0165.302296
CAP. SOC. 100.000.000 EUR INT. VERS.
C.F. 02167360967
VAT: IT00571320076 - R.E.A. n. AO-50474

Company with management systems IGQ approved and certified according to ISO 9001, ISO/TS 16949 e ISO 14001.

INSPECTION CERTIFICATE 3.1 (EN 10204:2004)
(A03) DOCUMENT NUMBER 2016038985

(A06) CUSTOMER : ALMIO S.R.O.
(A07) CUSTOMER'S ORDER : 162000749
(A01) MANUFACTURER'S WORKS .: AOSTA, VIA PARAVERA 16 - ITALY
(A05) PRODUCER OF THE DOC: QUALITY DEPARTMENT
(A08) MANUFACTURER'S WORKS ORDER NO: 25211634 /10 (A04) MARK OF THE MANUFACTURER : COGNE
THE CERTIFIED PRODUCTS ARE COMPLYING TO THE PURCHASE ORDER

INTERNAL SPEC. : STOCKBARREW2 TECHNICAL RULE .: AD2000
(B01) PRODUCT : 2234 PEL PEELED ROUND BARS TOLERANCE : ISOK11
(B03) SURFACE FINISH : 2B Cold Finished
(B04) PRODUCT DELIVERY CONDITION: RS SOLUTION ANNEALED
(B09) PRODUCT DIMENSIONS (mm): 35,000 (B10) LENGTH (mm) 06000 /06200
(B02) GRADE : AISI 316/316L EN1.4401/4404 INTERNAL GRADE : F316L IMCO
(B07) IDENTIFICATION HEAT NO: 672665 (B07) IDENTIFICATION LOT NO.: 524900
(B06) MARKING OF THE PRODUCT .: 1.4404 TEST PIECE N. : 490

STEELMAKING EAF + AOD + CONTINUOUS CASTING
HOT ROLLED
REDUCTION RATIO 24,5

(C71) CHEM. COMP. - LADLE ANALYSIS ACCORDING ASTME1019-A751-E1086-E415-A580
Control lot No. - Weight :020000636910 - 81.252 KG

ELEMENTS	C	Si	Mn	P	S	N	Cr	Mo	Ni	Cu
OBTAINED	0,012	0,35	1,84	0,029	0,025	0,077	17,02	2,03	10,14	0,37
ELEMENTS	Co									
OBTAINED	0,21									

HARDNESS TEST IN AS DELIVERED CONDITION
Control lot No. - Weight :020000637191 - 6.566 KG
SPECIFICATION ENISO6506 HARDNESS TEST HB TESTING METHOD : 10/3000
OBTAINED 192

IMPACT TEST IN AS DELIVERY CONDITION
Control lot No. - Weight :020000637191 - 6.566 KG
SPECIFICATION EN ISO 148-1-KV2 (C02) DIRECTION OF THE TEST PIECE: L
(C40) TYPE OF TEST PIECE KV
(C03) TEST TEMPERATURE °C 20
MEASUREMENT UNIT J
OBTAINED 255 252 245 248 253 247 250 246 253 250
251 249

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ITALY - 11100 AOSTA - VIA PARAVERA, 18
TEL.+ 39.0165.3021 - FAX + 39.0165.302296
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C.F. 02187360967
VAT: IT00571320076 - R.E.A. n. AO-50474

Company with management systems IGQ approved and certified according to ISO 9001, ISO/TS 16949 e ISO 14001.

TENSILE TEST IN AS DELIVERY CONDITION
Control lot No. - Weight :020000637191 - 6.566 KG
SPECIFICATION EN-ISO6892-1 (C02) DIRECTION OF THE TEST PIECE: L

MEASUREMENT UNIT	RM MPA	RP02 MPA	A5 % 5.0 D	Z %	RP1 NMM
OBTAINED	646	300	56,3	75,6	348
	641	303	54,2	73,8	343
	627	305	55,8	75,0	343
	638	303	51,6	75,2	345

GRAIN SIZE
Control lot No. - Weight :020000637191 - 6.566 KG
SPECIFICATION ASTME112 --
OBTAINED 5 7

TENSILE TEST
Control lot No. - Weight :020000637191 - 6.566 KG
SPECIFICATION ASTMA370-E8-0.5"SPEC (C02) DIRECTION OF THE TEST PIECE: L

MEASUREMENT UNIT	RMB KSI	RP02B KSI	A5B % 5.0 D	ZB %	AL2 %
OBTAINED	93	44	54,8	76,9	60,3
	94	45	55,5	76,4	57,6
	93	44	56,3	77,3	59,8
	92	44	52,4	77,5	54,9

COUNTRY OF ORIGIN: ITALY, THE MATERIAL COMPLIES WITH FAR DFARS 252.225-7009 ALT 1.
The products delivered are conforming to EN10088-5 and bear the CE marking on the basis of the test results here reported and the continuous surveillance, assessment and approval by MPA NRW (certificate no. 0432-CPR-00166-01)
Material produced according to the system #Regulation 305/2011/EU of the European Parliament and of the Council of 9 March 2011#
DOCUMENT ISSUED IN AGREEMENT WITH TUEV BAYERN(11.1972) WAVING OF COUNTERSIGNING (SEE TUEV BAYERN LETTER DATED 17.01.80).
MARKING: SYMBOL OF THE MANUF. WORK, MATERIAL N. , CAST N., LOT N., RECEIVING AGENT STAMP
CORROSION TEST ACCORDING TO ASTM A262 Practice E EN ISO 3651-2: SATISFACTORY.
ANTIMIXING TEST BY PORTABLE SPECTROMETRE: CONFORMING
EDDY CURRENT INSPECTION OF SURFACE ACCORDING TO EN 10277-1 Class.4.
DIMENSIONAL CONTROL ACCORDING TO EN 10278: SATISFACTORY.
NO WELDING REPAIR ON THE MATERIAL.
ULTRASONIC TEST ACCORDING TO EN 10308 Class.3
ALL THE NORMS MENTIONED ARE INTENDED IN THEIR LATEST REVISION AT THE DATE OF ISSUE OF THIS DOCUMENT.
(Z02) INSPECTOR'S STAMP LF
THE PRODUCT SATISFIES CE DIRECTIVES: 2011/65 - 2000/53 2002/95(RoHS) 2003/11 - 2005/618 AND PED PED 2014/68/EU.
THE MATERIAL IS FREE OF ANY MERCURY, MERCURY COMPOUNDS AND OR RADIUM CONTAMINATION AT TIME OF SHIPMENT AND WAS PRODUCED WITHOUT USING OZONE DEPLETING SUBSTANCES OF CLASS I AND II.
REFERENCE NORMS: EN 10088-3(05), EN 10272(08), ASTM A276(08), ASTM A479(08), ASTM A193(09) B8M CLASS1D, ASME SA276(10), ASME

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COGNE ACCIAI SPECIALI S.p.a.

ITALY - 11100 AOSTA - VIA PARAVERA, 16
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CAP. SOC. 100.000.000 EUR INT. VERS.
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Company with management systems IGQ approved and certified according to ISO 9001, ISO/TS 16949 e ISO 14001.

SA479(10), AMS 5653F, AMS 5648K, ISO15156-3/NACE MR0175(09), NACE MR0103(07), NORSOK M630 MDS S01Rev.5
REFERENCE NORMS FOR CHEMICAL COMPOSITION AND MECHANICAL PROPERIES: ASTM A182(10), ASME SA182(10).
REFERENCE NORMS FOR CHEMICAL COMPOSITION ONLY: EN 10222-5, ASTM A484, ASTM A403, ASTM A314, AMS-QQ-S-763B.
THE PRODUCT IS CONFORMING TO THE CONTRACT AGREEMENT AND TO THE RULE AD2000-MERKBLATT W0/W2.
ASTM A484 DOES NOT APPLY FOR SIZE AND LENGTH TOLERANCES.

CE 0432

(Z01) DATE 23.06.2016

POLLASTRELLI ANDREA FC

Cogne Acciai Speciali S.p.a.

TRUE COPY

GERDAU SIDENOR

MILL TEST CERTIFICATE

Basauri Plant — ISO 9001 - ISO/TS 16949 — Product Made in Spain

CUSTOMER: **ODS BV**		WORKS REFERENCE: **1551811**
REFERENCE: **4500159073**	SALES ORDER: **239661-13**	HEAT NUMBER: **61230**
PRODUCT NR: **910300052**	MASTER REFERENCE: **154857**	ROLLED: **06.11.2011**

REQUIRED PRODUCT

S355J2G3AV/EXM ROUND BARS AS ROLLED UNTREATED 70 -1/+1 mm EN 10060, Tol normal
6.000/7.000 mm RANDOM

EXPEDITION — **DELIVERY:** 80367948 **WEIGHT (KG):** 4.098 **BUNDLES:** 1 **UNITS:** 20

MADE ACCORDING TO

EN 10060 - OCT. 2003 ; EN 10025:90+A1:93 - . .1993 ; EN 10204 :2004 OCT. 2004 3.1

CHEMICAL ANALYSIS OF HEAT — **U:% HEAT NUMBER: 61230**

	C	Mn	Si	P	S	Al	Ca	N
Min.					0,020	0,020	0,0015	
Max.	0,220	1,600	0,550	0,035	0,035		0,0030	0,0120
Cer.	**0,110**	**1,180**	**0,310**	**0,010**	**0,028**	**0,020**	**0,0015**	**0,0095**

MECHANICAL PROPERTIES OF REFERENCE (CONDITIONS)

Specimen Test location:Tracción: 1/3 Radio; Resiliencia: <=2 mm ; Tratamiento Térmico:Normalising

MECHANICAL PROPERTIES OF REFERENCE (TEST)

Tensile test specimen direction (Longitudinal)**:Longitudinal**
Tensile Strength (490/630 N/mm2)**:507 N/mm2**
Yield Strength (Rp(0,2%) >= 325 N/mm2)**:Rp(0,2%) 380 N/mm2 ; Elongation** ((5d) >= 20 %)**:(5d) 29,56 %**
Notch impact sample direction (Longitudinal)**:Longitudinal ; Notch Impact sample type** (KV)**:KV**
Notch Impact test Temperature (-20 °C)**:-20 ºC ; K(1):199 J ; K(2):206 J ; K(3):213 J**
K (average) (>= 27 J)**:206 J ; K (single)** (>= 18,9 J)**:199 J**

NON DESTRUCTIVE TESTS

Internal defects standard (STAHL EISEN SEP1921-01.12.1984)
Internal defects type/method (Test group 3 - Defect <= C/c) **; ULTRASONIC INSPECTION 100% : O.K.**

ADDITIONAL INFORMATION

CALCIUM TREATED ; The delivered material is free of radioactivity.

TECHNOLOGY & QUALITY CERTIFIES THAT THE PRODUCT FULL FILLS THE ORDER´S SPECIFICATION

APPROVED BY: MARCELINO GARCIA ZAYAS **SIGN:**

GERDAU SIDENOR BASAURI

DATE: 16.11.2011

REF.: 1001700110000

i-23 Metallurgical Technical annalist level II

TRUE COPY

TŘINECKÉ ŽELEZÁRNY
MORAVIA STEEL
TŘINECKÉ ŽELEZÁRNY, a.s., Průmyslová 1000, Staré Město, 739 61 Třinec, Czech Republic/
Výrobní závod: 272 01 Kladno-Dříň

Thyssen Krupp Materials
Hoedemakersstraat 9
3334 KK Zwijndrecht
Nederland

Ihr Auftrag – Your order – Votre ordre: 41319362

Aviso – Advise note – Avis:

Werks Nr. – Our order – Ref. d'usine: 7000377838

Waggon No:

☐ EN 10204 2.2 Werkszeugnis – Test report – Relevé de contrôle

☒ EN 10204.2004 3.2 Abnahmeprüfzeugnis – Inspection certificate – Certificate de réception

Number: 2014/12/794

Lieferung – Delivery - Livraison	Gewicht – Weight – Poids	Güte – Quality – Qualité	Norm – Standard - Norme
HOT ROLLED ROUND STEEL BARS IN QUALITY S355J2+N ACC.TO EN10025-2:2004 ORDER NR.3043/14/33,313-5403290101 NORMALIZED 70 mm 6,00m + 0,200-0	6470 kg 36 pieces	S355J2+N Normalized annealed	EN10025/2- 04.10 LR RULES PART 2 CHAP 5 SEC 3 LATEST EDIT

CHEMISCHE ZUSAMMEN SETZUNG – CHEMICAL ANALYSIS – COMPOSITION CHIMIQUE (%)

Schmelze Melt Charge No	C	MN	SI	P	S	CU	CR	NI
T14584	0,19	1,28	0,39	0,018	0,027	0,04	0,22	0,03
	AL	MO	V	SN	CEQ			
cc blooms	0,027	0,011	0,036	0,014	0,46			

MECHANISCHE WERTE – MECHANICAL VALUES - QUALITÉS MECHANIQUES

Schmelze Melt Charge No	Streckgrenze Yield point Limité d'elast. Reh (MPa)	Zugfestigkeit Tensile strenght Resistance R_m (MPa)	Bruchdehnung Extension Allongem A_5 (%)	Brucheinschn. Contraction Contraction Z (%)	Schlagarbeit Energy of impact Resilience KV (J)	Microcleanness according to DIN 50 602	Brinell hardness HB Inf.
T14584 test .Nr P875	376	547	31,4	70,3	-20°Cmin27J 143,167,170 -40°C/inf. 147,134,140	CE	157-157

Grain size ASTM E112:min5
Ultrasonic inspection results 100% SEP 1921 3C/c - satisfactory
Spectrotest 100 %
Vacuum degassed practice
100% Surface electronic crack detection :satisfactory
Rolling reduction ratio:34,3

Products which do not cause harmful emission of toxic gasses,dangerous particles or radiation to the indoor environment nor contamination of the outdoor environment (air,soil ,or water)
DIE RADIOISOTOPISCHEAKTIVITÄT MAX. 100 BQ/KG WURDE EINGEHALTET.
RADIO - ISOTOPIC ACTIVITY WAS CONTROLLED IN LADLE SAMPLE. IT WAS NO HIGHER THAN 100 BQ/KG.

Die obengenannten Erzeugnisse entsprechen den Bestellungsvorschriften – Products conform with the prescription of order

We hereby certify that the material has been made by an approved process and satisfactorily tested to accordance with the Rules of Lloyd s Register

LR reference No: PRA. 1400922

V Kladně dne 18.12.2014
T_PRINT 3022-97 D 3022-97 D

Lloyd's Register EMEA
Prague Office
Julius Fazekas

Jitka Jermanová
independent authorised agent

TŽ TK-2-2/16

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ASCOMETAL

Département Métallurgie Qualité
Usine des Dunes - Boite postale 41
59941 Dunkerque Cedex 2
Téléphone : 03 28 29 60 00
Télécopie : 03 28 29 60 03

DOCUMENT DE CONTROLE

Inspection Documents / Prüfbescheinigungen

Certificat de réception 3.1
EN 10204
2004

Livraison	**80222609 / 000002**	**Date**	**15.12.2015**
N° Contrôle	**030000331727**	**Date d'édition**	**15.12.2015**

ORDRE DE FABRICATION *WORKS ORDER NUMBER / WERKBESTELLUNG* **J6253AA**
COULEE *CAST / SCHMELZE* **J6253**
AFFAIRE SUIVIE PAR *YOUR CONTACT IS / BEARBEITER* **GUILBAUD Patricia**
N/REFERENCE *ASCOMETAL ORDER / WERKBESTELLUNG* **229565304 / 000010 (70078203)**
V/REFERENCE *YOUR ORDER / IHRE ZEICHE* **314-5403584995**
13.10.2015
QUANTITE *QUANTITY / MENGE* **4,560 TO**
NUANCE *GRAD / WERKSTOFF* **S355J2**
PRODUIT *PRODUCT DESCRIPTION / BESCHREIBUNG* **S355J2 ROL.ROUNDS BLACK 115,000 MM UNTREATED**
SPECIFICATION CLIENT *SPECIFICATION / SPEZIFIKATION* **THYSSENKRUPP S355J2UHR**
IND *REV / ENTWURF* **2**
DATE *DATE / DATUM* **24.02.2015**
SPECIFICATIONS SUPP. **SANS**

DESTINATAIRE DOCUMENT *DOCUMENT FOR / EMPFANGER*
Société
THYSSENKRUPP MATERIALS NEDERLD
HOEDEMAKERSSTRAAT, 9
3334 KK ZWIJNDRECHT
Pays-Bas

MARQUE
CCU **D000009519**

Analyse chimique de coulée / Ladle analysis / Schmelzeanalyse

Elément (%)

Elément	Element	Teil	C	Mn	Si	Cr	Ni	Mo	Cu	P	S	Al
Mini	Spec min	Min		1,000	0,150						0,010	0,020
Valeur	**Actual**	**Werte**	**0,162**	**1,215**	**0,261**	**0,093**	**0,140**	**0,039**	**0,133**	**0,005**	**0,012**	**0,026**
Maxi	Spec max	Max	0,200	1,500	0,550		0,300	0,080	0,300	0,025	0,025	0,050

Elément	Element	Teil	V	Ti	B	N2	H2
Mini	Spec min	Min					
Valeur	**Actual**	**Werte**	**0,016**	**0,0010**	**0,0003**	**0,00580**	**0,000107**
Maxi	Spec max	Max		0,0100	0,0005	0,01200	0,000200

Contraintes groupées / combination of elements

Elément	Mini	Valeur	Maxi
Ni+Cr+Mo		0,272	0,480
C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15		0,412	0,450

Caract. mec. de coulée / TC coupon mechanicals values / Probestab mechanische kennwerte

Traction / tensile test /Zugversuch
Nappe / Batch number / Loss nummer : *
TC dimension : **10**
Testing at core
Longitudinal test

Elément	Element	Teil	Ys.2%	UTS	E
Unité	Unit	Meinheit	N/mm2	N/mm2	%
Mini	Spec min	Min	355,0	470,0	22,0
Valeur	**Actual**	**Werte**	**359,5**	**512,8**	**32,7**
Maxi	Spec max	Max		630,0	

Résilience / Impact test / Kerbschlagproben
Nappe / Batch number / Los nummer : *
notch test 10 x 10
TC dimension : **10**
Core testing
Charpy V notch
Longitudinal test
Impact test temperature (°C) **-20**

Elément	Element	Teil	Joules	Joules	Joules	Average
Unité	Unit	Meinheit	J	J	J	J
Mini	Spec min	Min	27,0	27,0	27,0	27,0
Valeur	**Actual**	**Werte**	**152,7**	**161,8**	**171,3**	**161,9**
Maxi	Spec max	Max				

Nous certifions que les produits ci-dessus sont conformes aux prescriptions de la commande, respectent la directive européenne 2000/53/CE du 18 septembre 2000 et présentent un niveau de radioactivité au plus égal à la radioactivité ambiante.

We hereby certify the above mentioned products are complying with the order requirements, are respectful of the September, 18th 2000 - 2000/53/CE - european directive, and have a radioactivity level which does not exceed that present in the environment.

Wir bestätigen hiermit dass die obengenannten Erzeugnisse den Bestellungvorschriften, der EU-Richtlinie 2000/53/CE von 18 September 2000 entsprechen und die gelieferten Produkte keine Radioaktivität, die höher ist als natürliche Strahlung der Umwelt, aufweisen.

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ASCOMETAL

afaq ISO/TS 16949 Automobile AFNOR CERTIFICATION — afaq ISO 9001 Qualité AFNOR CERTIFICATION

Département Métallurgie Qualité
Usine des Dunes - Boîte postale 41
59941 Dunkerque Cedex 2
Téléphone : 03 28 29 60 00
Télécopie : 03 28 29 60 03

DOCUMENT DE CONTROLE
Inspection Documents / Prüfbescheinigungen

Certificat de réception 3.1
EN 10204
2004

Livraison 80222609 / 000002 — **Date** 15.12.2015
N° Contrôle 030000331727 — **Date d'édition** 15.12.2015

ORDRE DE FABRICATION J6253AA — *WORKS ORDER NUMBER / WERKBESTELLUNG*
COULEE J6253 — *CAST / SCHMELZE*

AFFAIRE SUIVIE PAR GUILBAUD Patricia — *YOUR CONTACT IS / BEARBEITER*

N/REFERENCE 229565304 / 000010 (70078203) — *ASCOMETAL ORDER / WERKBESTELLUNG*

V/REFERENCE 314-5403584995 — *YOUR ORDER / IHRE ZEICHE*
13.10.2015

QUANTITE 4,560 TO — *QUANTITY / MENGE*
NUANCE S355J2 — *GRAD / WERKSTOFF*

PRODUIT S355J2 ROL.ROUNDS BLACK 115,000 MM UNTREATED — *PRODUCT DESCRIPTION / BESCHREIBUNG*

SPECIFICATION CLIENT THYSSENKRUPP S355J2UHR — *SPECIFICATION / SPEZIFIKATION*

IND 2 — *REV / ENTWURF*
DATE 24.02.2015 — *DATE / DATUM*

SPECIFICATIONS SUPP. SANS

DESTINATAIRE DOCUMENT — *DOCUMENT FOR / EMPFANGER*
Société
THYSSENKRUPP MATERIALS NEDERLD
HOEDEMAKERSSTRAAT, 9
3334 KK ZWIJNDRECHT
Pays-Bas

MARQUE

Dureté de surface sur barres / Bars surface hardness / Stäbe Randhärte

Elément	Element	Teil	BHN top
Mini	Spec min	Min	
Valeur	**Actual**	**Werte**	**170**
Maxi	Spec max	Max	

Autres résultats / Other results / Andere Prüfergebnisse

Elément	Mini	Valeur	Maxi
Reduction ratio		7,99	
Grain size per ASTM E112 =	6	7	
A fin/thin =		2,0	3,0
A épais/thick =		1,5	2,5
B fin/thin =		1,5	2,0
B épais/thick =		1,0	1,0
C fin/thin =		0,0	1,0
C épais/thick =		0,0	1,0
D fin/thin =		1,0	1,5
D épais/thick =		0,5	1,0

Ultrasonic testing 100% satisfactory
Ultrasonic testing per NF EN 10308 cl.2

Anti-mixing control satisfactory
Electric furnace - vacuum degassed
Surface defects control 100% satisfactory
No lead has been added to the steel

Continuous cast
Produit en France / Product of France / In Frankreich hergestellt

Visa du chef de service
Stamp of inspection supervisor
Der Werkssachverständige
Anne Fasquelle

A Fasquelle

Nous certifions que les produits ci-dessus sont conformes aux prescriptions de la commande, respectent la directive européenne 2000/53/CE du 18 septembre 2000 et présentent un niveau de radioactivité au plus égal à la radioactivité ambiante.

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EXAMEN PAR ULTRASONS
ULTRASONIC EXAMINATION

ASCO INDUSTRIES Usine des Dunes
Boite postale 41
59941 Dunkerque cedex 2

LOT DE CONTROLE : 030000331727

LIVRAISON : 80222609 / 000002
DATE : 13.10.2015

ORDRE DE FABRICATION : J6253AA
WORKS ORDER

COULEE : J6253
CAST

DESTINATAIRE DOCUMENT :
DOCUMENT FOR

AFFAIRE SUIVIE PAR : GUILBAUD
YOUR CONTACT

THYSSENKRUPP MATERIALS NEDERLD
HOEDEMAKERSSTRAAT, 9
3334 KK ZWIJNDRECHT
PAYS-BAS

N/REFERENCE : 229565304 / 000010 (70078203)
ASCOMETAL ORDER

QUANTITE : 4.56
QUANTITY

NUANCE : S355J2
GRADE

PRODUIT : S355J2 ROL.ROUNDS BLACK 115,000 MM UNTREATED
PRODUCT DESCRIPTION

SPECIFICATION CLIENT : THYSSENKRUPP S355J2UHR
SPECIFIACTION

IND : 2
REV

DATE : 24.02.2015
DATE

CCU : D000009519

SPECIFICATION SUPP : SANS

PRODUIT / PRODUCT

BARRES LAMINEES :115,000 MM

NOMBRE : 09
QUANTITY

REPERE :
REF N°

SPECIFICATIONS APPLIQUEES / APPLIED SPECIFICATIONS

CLIENT :
CUSTOMER

USINE : Cons. US 2L007
WORKS

ORGANISME CONTROLE CLIENT :
CUSTOMER INSPECTION AUTHORITY

CONDITIONS D'EXAMEN / TEST CONDITIONS

STADE D'INSPECTION : APRES TRAITEMENT THERMIQUE
TESTING PERFORMED

ETAT DE SURFACE : BRUT.LAMIN
SURFACE CONDITION

AGENT DE COUPLAGE : WATER
COUPLANT

ETENDUE DU CONTROLE / TESTING RANGE

DIRECTION DE SONDAGE : RADIAL
SCANNING DIRECTION

GENERATRICES : 12 GÉNÉRATRICES À 30°
GENERATORS OR SIDES QUANTITY

CONTROLE A 100%

APPAREILLAGE UTILISE / SCANNING EQUIPEMENT

BANC DE CONTROLE AUTOMATIQUE : BANC_TD

MARQUE APPAREIL : RDTECH
DEVICE TRADE MARK

TYPE APPAREIL : QUISCAN UT
DEVICE TYPE

TRANSDUCTEUR :
TRANDUCERS
L = LONGITUDINAL
S = SURFACES

01- MODE : L	MARQUE : SONAXIS *TRADE MARK*	TYPE : DROIT	DIMENSION : 15 MM *CRISTAL SIZE*	FREQUENCE : 2 MHZ *FREQUENCY*	Angle : 0 °
02- MODE : S	PAR COURANTS DE FOUCAULT				

RESULTAT DE CONTROLE / EXAMINATION RESULT

BARRES CONTROLEES : 09
QUANTITY INSPECTED

BARRES ACCEPTEES : 09
QUANTITY ACCEPTED

OBSERVATIONS :
GENERAL REMARKS

BARRES CONFORMES AUX SPÉCIFICATIONS

DATE DU CONTROLE *DATE OF TESTING*	OPERATEUR *OPERATOR*	CONTRÔLEUR COFREND NIVEAU 2 *COFREND LEVEL 2*	ORGANISME DE CONTROLE CLIENT *CUSTOMER INSPECTION AUTHORITY*
30.11.2015	Cofrend UT1		

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ASCOMETAL

0333

Département Métallurgie Qualité
Usine des Dunes - Boîte postale 41
59941 Dunkerque Cedex 2
Téléphone : 03 28 29 60 00
Télécopie : 03 28 29 60 03

DOCUMENT DE CONTROLE
Inspection Documents / Prüfbescheinigungen

Certificat de réception 3.1
EN 10204
2004

Livraison	**80222799 / 000001**	**Date**	**18.12.2015**
N° Contrôle	**030000332859**	**Date d'édition**	**18.12.2015**

ORDRE DE FABRICATION *WORKS ORDER NUMBER / WERKBESTELLUNG*	**J6314AF**	**COULEE** *CAST / SCHMELZE*	**J6314**	**DESTINATAIRE DOCUMENT** *DOCUMENT FOR / EMPFANGER*	
AFFAIRE SUIVIE PAR *YOUR CONTACT IS / BEARBEITER*	**GUILBAUD Patricia**			**Société**	
N/REFERENCE *ASCOMETAL ORDER / WERKBESTELLUNG*	**229590808 / 000010 (70078440)**			**ODS B V**	
				DONK 6	
				MR P VAN 00STERHOUT	
V/REFERENCE *YOUR ORDER / IHRE ZEICHE*	**4500730849**			**2991 LE BARENDRECHT**	
	20.10.2015			**Pays-Bas**	
QUANTITE *QUANTITY / MENGE*	**4,290 TO**	**NUANCE** *GRAD / WERKSTOFF*	**S355J2**	**MARQUE**	
PRODUIT *PRODUCT DESCRIPTION / BESCHREIBUNG*	**S355J2 ROND LAM BRUT.LAMIN 115,000 MM NATUREL**				
SPECIFICATION CLIENT *SPECIFICATION / SPEZIFIKATION*	**ODS R52R-ASCO-1**				
IND *REV / ENTWURF*	**SANS**	**DATE** *DATE / DATUM*	**07.10.2015**	**CCU**	**D000009530**
SPECIFICATIONS SUPP.	**SANS**				

Analyse chimique de coulée / Ladle analysis / Schmelzeanalyse

Elément (%)

Elément	Element	Teil	C	Mn	Si	Cr	Ni	Mo	Cu	P	S	Al
Mini	Spec min	Min										
Valeur	**Actual**	**Werte**	**0,184**	**1,354**	**0,205**	**0,136**	**0,111**	**0,033**	**0,135**	**0,008**	**0,023**	**0,020**
Maxi	Spec max	Max	0,220	1,600	0,550					0,025	0,025	

Contraintes groupées / combination of elements

Elément	Mini	Valeur	Maxi
CEq		0,46	0,47

Composition chimique produit / Product analysis / Stückanalyse

Elément (%)

Elément	Element	Teil	C	Mn	Si	Cr	Ni	Mo	Cu	P	S	Al
Mini	Spec min	Min										
Valeur	**Actual**	**Werte**	**0,170**	**1,325**	**0,205**	**0,122**	**0,100**	**0,021**	**0,160**	**0,009**	**0,020**	**0,020**
Maxi	Spec max	Max	0,240	1,700	0,600				0,600	0,035	0,035	

Dureté éprouvette / Test coupon hardness / Probestück Härte

Nappe / Batch number / Loss nummer : *
Distance essai surface Distance essai surface

Elément	Element	Teil	HB
Mini	Spec min	Min	
Valeur	**Actual**	**Werte**	**156**
Maxi	Spec max	Max	

Caractéristiques mécaniques / Mechanical properties / Mechanische Kennwerte

Traction / tensile test /Zugversuch
Nappe / Batch number / Loss nummer : *
Classement de coulée sur diamétre livré
Distance prélèvement 1/3 Rayon exterieur
Diamétre de l'éprouvette (mm) **10,0**
Eprouvette sens long
Température essai traction °C **20**
Classement coulée Tp° Normalisation °C **900**

Elément	Element	Teil	Rp0.2%	Rm	A	Z
Unité	Unit	Meinheit	N/mm2	N/mm2	%	%
Mini	Spec min	Min	295,0	450,0	18,0	
Valeur	**Actual**	**Werte**	**360,5**	**514,8**	**33,7**	**72,5**
Maxi	Spec max	Max		600,0		

Nous certifions que les produits ci-dessus sont conformes aux prescriptions de la commande, respectent la directive européenne 2000/53/CE du 18 septembre 2000 et présentent un niveau de radioactivité au plus égal à la radioactivité ambiante.

We hereby certify the above mentioned products are complying with the order requirements, are respectful of the September, 18th 2000 - 2000/53/CE - european directive, and have a radioactivity level which does not exceed that present in the environment.

Wir bestätigen hiermit dass die obengenannten Erzeugnisse den Bestellungvorschriften, der EU-Richtlinie 2000/53/CE von 18 September 2000 entsprechen und die gelieferten Produkte keine Radioaktivität, die höher ist als natürliche Strahlung der Umwelt, aufweisen.

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ASCOMETAL

0333

Département Métallurgie Qualité
Usine des Dunes - Boîte postale 41
59941 Dunkerque Cedex 2
Téléphone : 03 28 29 60 00
Télécopie : 03 28 29 60 03

DOCUMENT DE CONTROLE

Inspection Documents / Prüfbescheinigungen

Certificat de réception 3.1
EN 10204
2004

Livraison 80222799 / 000001 — **Date** 18.12.2015
N° Contrôle 030000332859 — **Date d'édition** 18.12.2015

ORDRE DE FABRICATION *WORKS ORDER NUMBER / WERKBESTELLUNG*	J6314AF	**COULEE** *CAST / SCHMELZE* J6314	**DESTINATAIRE DOCUMENT** *DOCUMENT FOR / EMPFANGER*
AFFAIRE SUIVIE PAR *YOUR CONTACT IS / BEARBEITER*	GUILBAUD Patricia		Société ODS B V DONK 6 MR P VAN 00STERHOUT 2991 LE BARENDRECHT Pays-Bas
N/REFERENCE *ASCOMETAL ORDER / WERKBESTELLUNG*	229590808 / 000010 (70078440)		
V/REFERENCE *YOUR ORDER / IHRE ZEICHE*	4500730849 20.10.2015		
QUANTITE *QUANTITY / MENGE*	4,290 TO	**NUANCE** *GRAD / WERKSTOFF* S355J2	**MARQUE**
PRODUIT *PRODUCT DESCRIPTION / BESCHREIBUNG*	S355J2 ROND LAM BRUT.LAMIN 115,000 MM NATUREL		
SPECIFICATION CLIENT *SPECIFICATION / SPEZIFIKATION*	ODS R52R-ASCO-1		
IND *REV / ENTWURF*	SANS	**DATE** *DATE / DATUM* 07.10.2015	**CCU** D000009530
SPECIFICATIONS SUPP.	SANS		

Résilience / Impact test / Kerbschlagproben
Nappe / Batch number / Los nummer : *
Eprouvette 10 X 10 (mm)
Classement de coulée sur diamétre livré
Distance prélèvement 1/3 Rayon extérieur
Eprouvette KV
Eprouvette sens long
Température essai résilience °C **-20**
Classement coulée Tp° Normalisation °C **900**

Elément	Element	Teil	Joules	Joules	Joules	Moyenne
Unité	Unit	Meinheit	J	J	J	J
Mini	Spec min	Min	27,0	27,0	27,0	27,0
Valeur	**Actual**	**Werte**	**155,7**	**162,8**	**172,3**	**163,6**
Maxi	Spec max	Max				

Autres résultats / Other results / Andere Prüfergebnisse

Elément	Mini	Valeur	Maxi
Cleanliness K4(oxyde)<=		0	30
Taux de corroyage		7,34	
Grain size M-Quaid Ehn	5	7	

Ultrasonic testing 100% satisfactory
Anti-mixing control satisfactory
Dimension defects control 100% satisfactory
Surface defects control 100% satisfactory
ultrasonic testing per SEP1921 Gr.3 C/c

Free from Mercury contamination
Electric furnace - vacuum degassed

Filière Coulée Continue
Produit en France / Product of France / In Frankreich hergestellt

Nous certifions que les produits ci-dessus sont conformes aux prescriptions de la commande, respectent la directive européenne 2000/53/CE du 18 septembre 2000 et présentent un niveau de radioactivité au plus égal à la radioactivité ambiante.

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ASCOMETAL

0333

Département Métallurgie Qualité
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59941 Dunkerque Cedex 2
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2004

Livraison 80222799 / 000001 **Date** 18.12.2015
N° Contrôle 030000332859 **Date d'édition** 18.12.2015

ORDRE DE FABRICATION *WORKS ORDER NUMBER / WERKBESTELLUNG*	**J6314AF**	**COULEE** *CAST / SCHMELZE*	**J6314**	**DESTINATAIRE DOCUMENT** *DOCUMENT FOR / EMPFANGER*	
AFFAIRE SUIVIE PAR *YOUR CONTACT IS / BEARBEITER*	**GUILBAUD Patricia**			**Société**	
				ODS B V	
N/REFERENCE *ASCOMETAL ORDER / WERKBESTELLUNG*	**229590808 / 000010 (70078440)**			**DONK 6**	
				MR P VAN 00STERHOUT	
V/REFERENCE *YOUR ORDER / IHRE ZEICHE*	**4500730849**			**2991 LE BARENDRECHT**	
	20.10.2015			**Pays-Bas**	
QUANTITE *QUANTITY / MENGE*	**4,290 TO**	**NUANCE** *GRAD / WERKSTOFF*	**S355J2**	**MARQUE**	
PRODUIT *PRODUCT DESCRIPTION / BESCHREIBUNG*	**S355J2 ROND LAM BRUT.LAMIN 115,000 MM NATUREL**				
SPECIFICATION CLIENT *SPECIFICATION / SPEZIFIKATION*	**ODS R52R-ASCO-1**				
IND *REV / ENTWURF*	**SANS**	**DATE** *DATE / DATUM*	**07.10.2015**	**CCU**	**D000009530**
SPECIFICATIONS SUPP.	**SANS**				

Visa du chef de service
Stamp of inspection supervisor
Der Werkssachverständige
Anne Fasquelle

A Fasquelle

Nous certifions que les produits ci-dessus sont conformes aux prescriptions de la commande, respectent la directive européenne 2000/53/CE du 18 septembre 2000 et présentent un niveau de radioactivité au plus égal à la radioactivité ambiante.

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A04 **HUTA BANKOWA**
Spółka z o.o.
ul. Sobieskiego 24
41-300 Dąbrowa Górnicza

A02 **Świadectwo odbioru 3.1 Nr** 01580/16
Inspection certificate 3.1
Abnahmeprüfzeugnis 3.1
Certificat de reception 3.1 Свидетельство приемки 3.1 PN-EN 10204

A06 **Zamawiający** ODS B.V.
Ordered by - Besteller
ul. Donk 6, Postbus 69 , 2990 AB Barendrecht Netherlands
VAT reg.nr NL 801137391B01

A06 **Adres wysyłkowy** ODS B.V.
Address - Versandadresse ul. Donk 6, Postbus 69 , 2990 AB Barendrecht

A07 Nr i data zamówienia klienta Order No and date Nr und Datum der Bestellung	A08 Zlecenie Manuf. Order No Auftrag Nr	Wykonano wg norm Produced accoring to Herestellt gemäß Norm	Wagon Car No Wagen Nr
BARENDRECHT 4500750802 z dnia 15/12/30 LOT:	Hb/6206978/12/15 PL/273155484/2015/B1938 order: Versandnummer:	EN 10025-2, EN 10025-1:2004 EN 10060:2003 EN 10221:1995 Kl.B, AD2000-W13.	WPR73664 , ST6861A

B01 Przedmiot i wykonanie Item and specification (Heat and mechanical treatement etc.) Gegenstand und Ausfuhrung (therm und mechan. Bearbeitung usw.)	B09 Wymiar lub rysunek Dimension or drawing Abmessung oder Zeichnung	B02 Gatunek Steel grade Güte	B07 Wytop Heat Schmelze	B08 Sztuk Pieces Stück	B14 Wiązki Bundles Bünde	B12 kg
Rundstahl, Warmgewalzt - Normalisiert.	115 mm dł. 5000÷6200 mm	S355J2+N	**514328**	10	2	4900

B06

B15 Umformungsgrad 10,8 x.

C71 **1. SKŁAD CHEMICZNY** - CHEMICAL COMPOSITION - CHEMISCHE ZUSAMMENSETZUNG %

B02 Wytop Heat Schmelze	C	Mn	Si	P	S	Cu	Cr	Ni	Mo	V	Sn	As	Ti
	0,16	1,42	0,179	0,012	0,008	0,02	0,02	0,007	0,001	0,004	0,001	0,001	0,001
	Al	Al met	Nb	N	H_2	O_2	--	--	--	--	CEV [%]	Ceq [%]	X [%]
514328	0,037	0,035	0,001	0,0052	1,6ppm		--	--	--	--	0,4035	--	--
	Analiza kontrolna				Control analysis				Verwechslungsprüfung				
	C	Mn	Si	P	S	Cu	Cr	Ni	Mo	V	Sn	As	Ti
	--	--	--	--	--	--	--	--	--	--	--	--	--
	Al	Al met	Nb	N	H_2	O_2	--	--	--	--	CEV [%]	Ceq [%]	X [%]
	--	--	--	--	--	--	--	--	--	--	--	--	--

D51 **2. BADANIA MECHANICZNE** - MECHANICAL TEST - MECHANISCHE UNTERSUCHUNGEN

C01 Próba Nr Tests No Probe Nr	B05 Rodzaj obróbki termicznej prób Heat treatment of the sample. Metallurgischer Zustand der Probe.	C11 Re [MPa]	C12 Rm [MPa]	C13 A_5 [%]	C14 Z [%]	Udarność temp .....°C Impact test probe Middle value, Mittelwert C40 KV [J]	C40 KCU2 [J/cm²]	C40 KCU [J/cm²]	C31 Twardość Hardness Harte [HB]
221	Proben aus material im lief erzustand	332	500	31,4	68,6	218,220,192/210/-20C	-	-	-
221/A	Proben aus material im lief erzustand	-	-	-	-	158,176,164/166/-50C	-	-	-
216/16	Proben aus material im lief erzustand	-	-	-	-	-	-	-	178-207

D52 **3. BADANIA TECHNOLOGICZNE** - TECHNOLOGICAL TESTS - TECHNOLOGISCHE UNTERSUCHUNGEN

"US-geprufl" nach SEP 1920-1 kl. B gr. 3.

D53 **4. BADANIA METALOGRAFICZNE** - METALLOGRAPHIC TESTS - METALLOGRAPHISCHE UNTERSUCHUNGEN

B02 Wytop Nr Heat No Schmelze	D54 Zanieczyszczenia niemetaliczne Nometallic Impurities Nichtmetallische Verunreinigungen	D55 Struktura Structure Struktur
514328	K4 - 16,9 - DIN 50602.	Austernitkorn nr 8 - DIN 50601:1985.

Powierzchnię i wymiary zbadano przez wydz.prod. w 100% -Surface and dimension tested by Dept at 100% -Oberflache und Abmessungen geprüft von Prod.Abt. zu 100%

Z01 Deklarujemy, że wykonany wyrób jest zgodny z warunkami potwierdzenia zamówienia.
We declare that the final product comply with the order confirmation. Wir deklarieren,dass die herstellung gemäß auftragsbestätigungsbedindungen ist gemacht

D01 **Materiał oznaczono** -Material marked -Das Material wurde bezeichnet
Eine grun, rot, strich.
Schmelze Nr, Stahlsorte, Hb zeichen, Probe Nr, ZR zeichen.

Materiał nie jest radioaktywny
Material weist keine radiation auf The material has not displayed any radiation

B15 Leistungserklärung - 009/CPR/2015 (www.hutabankowa.pl) Fur baukonstruktion.

Z04 CE
1436
06
1436-CPR-0009
1436-CPR-0025/A
EN 10025-1:2004

Z02 **Kontrola jakości** Control of Manufacture Fabrikationskontrolle

KJ -12-

Data: ....2016-02-29.....

Z-ca Kierownika KJ ds. Jakości Wyrobów
Gerard Kulej

ZR-6

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Producent uznany wg AD-2000-Merkblatt W0 przez TÜV NORD Systems GmbH & Co. KG. Certyfikowany zgodnie z dyrektywą dotyczącą urządzeń ciśnieniowych 97/23/WE, zał. I, pkt. 4.3 przez jednostkę certyfikującą dla urządzeń ciśnieniowych TÜV NORD Systems GmbH & Co. KG, jednostka notyfikowana 0045, nr certyfikatu 07-202-9120 WZ-1000/13, 07-203-9120-WP-1000/13.
Approved acc. to AD2000-Merkblatt W0 by TÜV NORD Systems GmbH & Co. KG. Certified acc. to Pressure Equipment Directive 97/23/EC annex I, sec 4.3 by the Certification body for pressure equipment of the TÜV NORD Systems GmbH & Co. KG., reg.-no. 0045, certificate no. 07-202-9120 WZ-1000/13, 07-203-9120-WP-1000/13.

Überprüft nach AD2000-Merkblatt W0 durch den TÜV NORD Systems GmbH & Co. KG. Zertifiziert nach Richtlinie 97/23/EG, Anh. I, Kap. 4.3 durch die Zertifizierungsstelle für Druckgeräte der TÜV NORD Systems GmbH & Co. KG, Benannte Stelle, Kenn-Nr. 0045, Zertifikat Nr. 07-202-9120 WZ-1000/13, 07-203-9120-WP-1000/13.

Kontrola Jakości Control of Manufacture - Fabrikationskontrolle

Data .....2016-02-29.....

Mistrz ds. Ogólnych
Z-ca Kierownika KJ ds. Jakości Wyrobów
Gerard Kuc

TRUE COPY

A04 **HUTA BANKOWA**
Spółka z o.o.
ul. Sobieskiego 24
41-300 Dąbrowa Górnicza

A02 **Świadectwo odbioru 3.1 Nr** 06346/16
Inspection certificate 3.1
Abnahmeprüfzeugnis 3.1
Certificat de reception 3.1 Свидетельство приемки 3.1 PN-EN 10204

A06 Zamawiający Ordered by - Besteller: Kloeckner & Co Deutschland GmbH
ul. Am Silberpalais 1 , D-47057 Duisburg
Germany
VAT reg.nr DE 149880250

A06 Adres wysyłkowy Address - Versandadresse: Kloeckner & Co Deutschland GmbH
ul. Am Silberpalais 1 , D-47057 Duisburg

A07 Nr i data zamówienia klienta Order No and date Nr und Datum der Bestellung	A08 Zlecenie Manuf. Order No Auftrag Nr	Wykonano wg norm Produced according to Hergestellt gemäß Norm	Wagon Car No Wagen Nr
MANNHEIM 4500792872 z dnia 16/04/18 LOT:	Hb/6205664/04/16 PU/273155484/2016/B0655 order: 910001255 Number of dispatch:	DIN 17243, HB/C22.8/P250GH - Klockner/2014 EN 10060:2003 EN 10221:1995 Kl. B, NACE MR 0175, EN 10273, AD2000 - W13	SK761AN/ SK785AJ

B01 Przedmiot i wykonanie Item and specification (Heat and mechanical treatement etc.) Gegenstand und Ausführung (therm und mechan. Bearbeitung usw.)	B09 Wymiar lub rysunek Dimension or drawing Abmessung oder Zeichnung	B02 Gatunek Steel grade Güte	B07 Wytop Heat Schmelze	B08 Sztuk Pieces Stück	B14 Wiązki Bundles Bünde	B12 kg
Round bars normalised.	160 mm dł. 6000 mm	C22.8 P250GH	28515	5	3	4750

B06

B15 Reduction ratio 4,3 x.

Temperature normalization 910 [C]. Samples for mechanical properties tests were taken from 1/2 of radius in the longitudinal direction.

C71 **1. SKŁAD CHEMICZNY - CHEMICAL COMPOSITION - CHEMISCHE ZUSAMMENSETZUNG %**

B02 Wytop Heat Schmelze	C	Mn	Si	P	S	Cu	Cr	Ni	Mo	V	Sn	As	Ti
	0,22	0,84	0,28	0,011	0,011	0,16	0,11	0,11	0,03	0,001	0,014	0,0011	0,002
	Al	Al met	Nb	N	H_2	O_2	Ca	--	--	--	CEV [%]	Ceq [%]	X [%]
28515	0,032	0,029	0,002	0,0075	1,5ppm	16ppm	-	--	--	--	0,41	--	--
	Analiza kontrolna Control analysis Stückanalyse												
	C	Mn	Si	P	S	Cu	Cr	Ni	Mo	V	Sn	As	Ti
	--	--	--	--	--	--	--	--	--	--	--	--	--
	Al	Al met	Nb	N	H_2	O_2	--	--	--	--	CEV [%]	Ceq [%]	X [%]
	--	--	--	--	--	--	--	--	--	--	--	--	--

D51 **2. BADANIA MECHANICZNE - MECHANICAL TEST - MECHANISCHE UNTERSUCHUNGEN**

C01 Próba Nr Tests No Probe Nr	B05 Rodzaj obróbki termicznej prób Heat treatment of the sample. Metallurgischer Zustand der Probe.	C11 Re [MPa]	C12 Rm [MPa]	C13 A_5 [%]	C14 Z [%]	Udarność temp. ....-.....°C Impact test probe Middle value, Mittelwert C40 KV [J]	C40 KCU2 [J/cm²]	C40 KCU [J/cm²]	C31 Twardość Hardness Harte [HB]
1835	Sample in the delivery condition	322	511	31,0	59,0	135,154,124/138/+20C	-	-	-
	Sample in the delivery condition	-	-	-	-	96,102,90/96/-20C	-	-	-
	Sample in the delivery condition	-	-	--	-	85,100,82//89/-29C	-	-	-
-	-	-	-	-	-	-	-	-	-
153/LB 1279/16	Rp 0,2 / + 500 C	195	-	-	-	-	-	-	-
	Sample in the delivery condition	-	-	-	-	-	-	-	183-185

D52 **3. BADANIA TECHNOLOGICZNE - TECHNOLOGICAL TESTS - TECHNOLOGISCHE UNTERSUCHUNGEN**

Ultrasonic testing SEP 1920-1 kl. B gr. 3.

D53 **4. BADANIA METALOGRAFICZNE - METALLOGRAPHIC TESTS - METALLOGRAPHISCHE UNTERSUCHUNGEN**

B02 Wytop Nr Heat No Schmelze	D54 Zanieczyszczenia niemetaliczne Nometallic Impurities Nichtmetallische Verunreinigungen	D55 Struktura Structure Struktur
28515	K4 - 21,8 - DIN 50602.	Grain no 8 - DIN 50601:1985.

Powierzchnię i wymiary zbadano przez wydz.prod. w 100% -Surface and dimension tested by Dept.at 100% -Oberflache und Abmessungen geprüft von Prod.Abt. zu 100%

Z01 Deklarujemy, że wykonany wyrób jest zgodny z warunkami potwierdzenia zamówienia.
We declare that the final product comply with the order confirmation. Wir bestätigen, dass der Auftrag gemäß der Auftragsbestätigungsbedingungen gefertig ist.

D01 Materiał oznaczono Material marked Das Material wurde gekennzeichnet:
Both foreheads green.
Steel grade, Nr heat, "Hb" mark, Testes no, "ZR" mark.

Materiał nie jest radioaktywny
Das Material weist keine Radioaktivität. The material has not displayed any radiation

B15

Z04

Z02 Kontrola jakości Control of Manufacture Fertigungskontrolle

Data: 2016-08-16

Mistrz ds. Dział Kontroli Jakości
Z-ca Kierownika Działu Jakości
Gerard Kulej

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Producent uznany wg AD-2000-Merkblatt W0 przez TÜV NORD Systems GmbH & Co. KG. Certyfikowany zgodnie z dyrektywą dotyczącą urządzeń ciśnieniowych 97/23/WE, zał. I, pkt. 4.3 przez jednostkę certyfikującą dla urządzeń ciśnieniowych TÜV NORD Systems GmbH & Co. KG, jednostka notyfikowana 0045, nr certyfikatu 07-202-9120 WZ-1000/13, 07-203-9120-WP-1000/13.
Approved acc. to AD2000-Merkblatt W0 by TÜV NORD Systems GmbH & Co. KG. Certified acc. to Pressure Equipment Directive 97/23/EC annex I, sec 4.3 by the Certification body for pressure equipment of the TÜV NORD Systems GmbH & Co. KG., reg.-no. 0045, certificate no. 07-202-9120 WZ-1000/13, 07-203-9120-WP-1000/13.

Überprüft nach AD2000-Merkblatt W0 durch den TÜV NORD Systems GmbH & Co. KG. Zertifiziert nach Richtlinie 97/23/EG, Anh. I, Kap. 4.3 durch die Zertifizierungsstelle für Druckgeräte der TÜV NORD Systems GmbH & Co. KG, Benannte Stelle, Kenn-Nr. 0045, Zertifikat Nr. 07-202-9120 WZ-1000/13, 07-203-9120-WP-1000/13.

Kontrola Jakości Control of Manufacture - Fabrikationskontrolle

Z-ca Kierownika ds. Jakości Wyrobów

Gerard Kuter

Data .....2016-08-16.....

TRUE COPY

Customer	Delivery Address
WEST END PRECISION LTD CADDSDOWN IND PARK CLOVELLEY ROAD BIDEFORD DEVON EX39 3DX	WEST END PRECISION LTD CADDSDOWN IND PARK CLOVELLEY ROAD BIDEFORD DEVON EX39 3DX

HI-TECH
Special Steels Limited
Rotherham Road, Laughton Common,
Dinnington, Sheffield S25 2RF
Tel: Dinnington (01909) 564545
Fax No (01909) 550682

Report No. 035500 Test No. 309792 Despatch Note No. 050852	Our Ref. 099039 Customer O/No. 7365	Date 24/08/15 Specification BS EN 10088-3 1.4404

TEST CERTIFICATE

Item	Quantity	Weight Kg	Part No.	Heat No.	Batch No.
001	33	451 Total		524038	P215907

Description

22MM A/F HEX COLD DRAWN BAR
I.A.W. PARKER MO11/1 CONCESSION
450 KILOS
HCT: G314
FREE FROM MERCURY & RADIOACTIVE CONTAMINATION
FREE FROM GRAIN BOUNDARY CARBIDE PRECIPITATION
ICC TEST TO ASTM A262 'E' - SATISFACTORY

A. HEAT TREATMENT SUPPLY CONDITION
B. TEST PIECE TREATMENT CONDITION

MELTING PRACTICE

TEST COUPON SIZE

Tensile Tests — Units MPa

Temp oC	*	0.20% Proof Result	0.20% Proof Spec-Min	Maximum Stress Result	Maximum Stress Spec-Min	%Elong 50MM Result	%Elong 50MM Spec-Min	% Reduction of Area Result	% Reduction of Area Spec-Min
20	L	738	555	841	790	24	15	66	

Impact Tests

Temp oC	*	ENERGY 1	ENERGY 2	ENERGY 3	ENERGY MIN	ENERGY AV	SHEAR % 1	SHEAR % 2	SHEAR % 3	SHEAR % MIN	SHEAR % AV	LATERAL EXPANSION 1	LATERAL EXPANSION 2	LATERAL EXPANSION 3	LATERAL EXPANSION MIN	LATERAL EXPANSION AV

Hardness 27.5 HRC

Component Hardness

Heat No.	C	Si	Mn	S	P	Cr	Ni	Mo	Cu	Co	N
524038	0.018	0.445	1.298	0.0276	0.0281	16.606	10.066	2.027	0.473	0.144	0.043

* Test Direction: L = Longitudinal; T = Transverse

TEST CERTIFICATE in accordance with BS EN 10204 3.1 / ISO 10474 3.1
Certified that the whole of the supplied detailed hereon, unless otherwise stated, are covered by the Sources Certificate of Conformity/Test Certificate referenced hereon, and has been supplied to the Quality System requirements in accordance with the conditions of our BSI/ BS EN ISO 9001 2008 registration for lot traceable products.

Signature

Position Quality Controller

H.T. G314
Checked & Approved by
Parker Hannifin PDE
24.08.2015 12:51:43 Page 1 of 4

TRUE COPY

Usine productrice/Hersteller/Manufacturer
Ugine
Avenue Paul Girod - CS
90100
73403 Ugine Cedex
France 5

CERTIFICAT DE RECEPTION 3.1
INSPECTION CERTIFICATE 3.1
ABNAHMEPRUEFZEUGNIS 3.1

EN 10204 / 3.1
NF L 00-015 Certified material test report

UGITECH
Providing special steel solutions 1

Numéro certificat/Nummer/Number	Ordre de fab. / Auftrag / Prod. Order	N° coulée / Schmelzen Nr / Heat N°	N° lot MM / Chargen / Batch
81552281 000010 4	A1522SG47000 11-1	524038 11-2	1522SG4700 11-3

Certification - Werkzeugnis - Certificate
AD 2000-MERKBLATT W0/TRD100
Pressure Equipment Directive
97/23/EC
ISO 9001
ISO/TS 16949 99

ISO 9100
ISO 9120 98

98-2

Marque d'usine
Herstellerzeichen
Supplier's Mark 97

Poinçon de l'expert
Prufstempe
Inpector's stamp IQ 96

UGIMA 4404HM WIRE ROLLED PICKLED SOLUTION ANNEALED HEXAGONAL 25,500MM

Produit UGIMA 4404HM FIL LAMINÉ(E) DÉCAPÉ HYPERTREMPÉ(E) HEXAGONAL(E) 25,500MM
Erzeugnisform UGIMA 4404HM WALZDRAHT GEWALZT GEBEIZT LÖSUNGSGEGLÜHT SECHSKANT 25,500MM
Product UGIMA 4404HM WIRE ROLLED PICKLED SOLUTION ANNEALED HEXAGONAL 25,500MM 6

Client - Besteller - Purchaser	N° cde client - Kundebestellnummer - Purchase order number	Commande - Bestellung - Order
19516 HI-TECH SPECIAL STEELS LTD 9	2959008385 10	693586 10 20

Norme de référence / Besugsnorm / Standard for reference
ASME SA479/479M-13 Sec.II TYPE 316L
EN 10088-1/3 ED2014 1.4404
AISI 316L
ASTM A479/A479M-14 TYPE 316L
UNS 12th Edition S31603
12-2

Spécification client / Kundenspezifikation / Customer's specification
ESS M011/1 FOR ANALYSIS ONLY Y4 18/12/2012 12-3

Nombre / Stueckzahl / Pieces Nbr	Profil / Profile / Shape	Dimension / Ausmessung / Dimension	Longueur / Laenge / Length	Poids / Gewicht / Weight
17 18	HX 19	25,500 MM 21-1	21-2	18861 KG 22

Mode d'élaboration / Erschmelzungsart / Melting process	N° prélèvement / Probenummer / Test number		42 % C	43 % SI	44 % MN	45 % NI	46 % CR	47 % MO	48 % CU	49 % S
		Demandé / Vorschrift / Required Min				10,0000	16,5000	2,0000		0,0150
		Max	0,0300	0,7500	2,0000	13,0000	18,0000	2,5000	1,0000	0,0300
EAF + AOD + CC 38	9KB5 39A	coulée/ Schmelzen / Heat	0,0180	0,4450	1,2980	10,0660	16,6060	2,0270	0,4730	0,0276
		Produit / Erzeugnisform/ Product								

Demandé / Vorschrift / Required	50 % P	51 % N	52 % CO	53	54	55	70	71	72	73	74	75
Min												
Max	0,0400	0,1000										
coulée/ Schmelzen / Heat	0,0281	0,0430	0,1440									
Produit / Erzeugnisform/ Product												

Demandé / Vorschrift / Required	76	77	78	79	80	81	82	83	84	85	86	87
Min												
Max												
coulée/ Schmelzen / Heat												
Produit / Erzeugnisform/ Product												

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800 66-1

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800 66-2

Ugine le 22.07.2015
Le Responsable Métallurgie Qualité
Der Qualitätsbeauftragter
The Quality Manager
B. POLLET

040000895992 Page 1/2 63

HCT G314
Checked & Approved by
Parker Hannifin IPDE
24-08-2015 12:51:43 Page 2 of 4

Usine prod nce/Hersteller/Manufacturer	CERTIFICAT DE RECEPTION 3.1 INSPECTION CERTIFICATE 3.1 ABNAHMEPRUEFZEUGNIS 3.1	UGITECH Providing special steel solutions
Ugine Avenue Paul Girod - CS 90100 73403 Ugine Cedex France 5	EN 10204 / 3.1 NF L 00-015 Certified material test report	1

Numéro certificat/Nummer/Number	Ordre de fab. / Auftrag / Prod. Order	N° coulée / Schmelzen Nr / Heat N°	N° lot MM / Chargen / Batch
81552281 000010 4	A1522SG47000 11-1	524038 11-2	1522SG4700 11-3

24	90	T°C	Limite d'élasticité Streckgrenze Yield Strength 0,2%	1%	RM Zugfestigkeit Tensile	Alongement Bruchdehnung Elongation A5D	A4D	Striction Einschnürung Red area	Dureté-Haerte-Hardness HB	HV	HRB	HRC
		°C	Mpa	Mpa	Mpa	%	%	%				
13	Min	20	170			30	30	40				
	Max	20					99					
	Min											
	Max											
N° prélèvement 9KB5 Probenummer Test number 398	1 L	20	279		600	56	58	74				
A l'état de Référence / treatment on test sample / Probestreifenbehandlung 14		25	26A	26B	27	28	89	29	30	88	100	37

Taux de corroyage / Forging ratio / Verschmiedungsgrad 74,6 101	Résilience-Kerbschlagzaehigkeit-Notch Toughness							
	Type Form Type 31	T°C 33	Sens Richtung Direction 32	Min 95	Valeurs individuelles Einzelwerte Individual values 35	Moyenne Mittelwerte Average 36	Expansion latérale Seitliche Breitung Lateral Expansion 81	
A l'état de livraison / Lieferzustand / As delivered 13		°C		J		J		
TEMPERATURE OVER 1040°C AIR SOLUTION ANNEALED 1040°C								
A l'état de Référence / treatment on test sample / Probestreifenbehandlung 14								

ASTMA479-A479M 08-10A/ASMESA-479 ED .07 SECT.II 2010 NO ADD./QQ-S-763F/AMSQQ-S-763A/ASTMA276 8A-10 56
FREE FROM WELDS & WELD REPAIRS/FREE FROM MERCURY CONTAMINATION/FREE FROM CONTINUOUS CARBIDE NETWORK
QUALITY MANUAL REV.G OF 05 MAR.2015
MATERIAL IS SOLUTION ANNEALED
INTERGRANULAR CORROSION PER ASTM A262 PRACTICES A & E ACCEPTABLE
PROVISION OF 10 CFR PART 21 & 10 CFR PART 50 APP.B APPLY
COUNTRY OF MELT SOURCE : FRANCE

H.C.T. G314
Checked & Approved by
Parker Hannifin IPDE

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800 97

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800 66-1

66-2

Ugine le 22.07.2015 94
Le Responsable Métallurgie-Qualité
Der Qualitätsbeauftragter
The Quality Manager
POLLET

24-08-2015 12:31:43 Page 3 of 4

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Special Testing Ltd
Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5566 Acc/Admin
www.specialtesting.co.uk

Test Certificate 309792

AUTHENTICATION CODE 53EB90184E8C
ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191

CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS, ROTHERHAM RD
LAUGHTON COMMON, DINNINGTON
SHEFFIELD S25 3RF
DATE RECEIVED 20 August 2015
TEST DATE 24 August 2015

CUSTOMER ORDER NO	PRD5119	TEST NUMBER	309792	IDENTITY	P41488	CAST*	524038	ALL REQUIREMENTS MIN UNLESS STATED		
SPECIFICATION	BS EN 10088-3:2005 1.4404					TEST PIECE FROM*		0.875"/22mm A/F HEX		

TENSILE: BS EN ISO 6892-1:2009 A224						0.2% PROOF	1.0% PROOF	UTS		ELONG ON	%	R OF A %	COMMENTS
OR	TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS								
L	RT	10.00mm	78.54mm²	MPa	RESULTS	738	811	841		50mm	24.0	66.0	centre

HARDNESS: BS EN ISO6508-1 2005	DESIGNATION	REQUIREMENTS	RESULTS
ROCKWELL C (mid radial)	HRC		27.5

END OF CERTIFICATE

H.C.T. G314
Checked & Approved by
Parker Hannifin IPDE
24-08-2015 12:51:43 Page 4 of 4

REPRESENTING*		
		No copy is authentic without the embossed seal and signature. This certificate can be authenticated at www.specialtesting.co.uk with the code 53EB90184E8C This certificate shall not be reproduced, except in full, without the written approval of the laboratory. For and on behalf of **SPECIAL TESTING LTD** A Member of the Special Steel Group of Companies Steve Pearce Certification Manager

Test results do not in any way confer approval of the quality of manufacture of the material. All results are subject to uncertainty of measurement budgets, details available upon request.
Information marked * is supplied by the customer.

24/8/15

Customer	Delivery Address
Parker Hannifin Manufacturing Ltd Switzerland Branch, Etoy c/o Parker Hannifin Manufacturing Ltd Riverside Road Pottington Business Park Barnstaple EX31 1NP	Parker Hannifin Manufacturing Ltd

Toll Point
Lichfield Road
Brownhills
WS8 6JZ
t. 01922 414003 f. 01922 414606
e sales@offshorestainless.co.uk

OFFSHORE STAINLESS SUPPLIES LTD.
Supplier of 1.4003 and producers of specialist stainless and high nickel products

Report No. 016618
Test No. oss001589
Despatch Note No. 000000

Our Ref. 093872
Customer O/No. Cons stock

Date 11/05/15
Specification MO11/1

TEST CERTIFICATE

Item	Quantity	Weight Kg	Part No.	Heat No.	Batch No.
001	0	1347 Total	7610444302	385583	F55118

Description

22mm AF hex bar to MO11/1 Rev Y h11 to

HCT Code: 933U

Part code : 7610444302

A. HEAT TREATMENT SUPPLY CONDITION
B. TEST PIECE TREATMENT CONDITION
Solution annealed prior to cold drawing

MELTING PRACTICE
Capaaro test report ST0009296 refers

TEST COUPON SIZE

Tensile Tests — Units N/mm2

Temp °C	*	0.20% Proof Result	0.20% Proof Spec-Min	Maximum Stress Result	Maximum Stress Spec-Min	%Elong 4D Result	%Elong 4D Spec-Min	% Reduction of Area Result	% Reduction of Area Spec-Min
20		785		900		24.5		64	

Impact Tests

Temp °C	*	ENERGY 1	ENERGY 2	ENERGY 3	ENERGY MIN	ENERGY AV	SHEAR % 1	SHEAR % 2	SHEAR % 3	SHEAR % MIN	SHEAR % AV	LATERAL EXPANSION 1	LATERAL EXPANSION 2	LATERAL EXPANSION 3	LATERAL EXPANSION MIN	LATERAL EXPANSION AV	Hardness
																	HRC

Component Hardness
18/32 HRC

Heat No.	C	Si	Mn	P	S	Cr	Mo	Ni	Co	N
385583	0.023	0.45	1.58	0.035	0.029	16.50	2.04	10.00	0.18	0.0320

Material free from mercury contamination during manufacturing process.
Material free from radioactivity and inspected during manufacture.
In accordance with EN 10204 3.1

Signature *Position*

H.C.T. 933U
Checked & Approved by
Parker Hannifin IPD
13-05-2015 12:00:00 Page 1 of 3
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F55118.

Larrondo 1,OLD (VIZCAYA) España
P.O. Box 1.323/48080 Bilbao
Tel. 34-(4) 4 71 13 00
Fax.34-(4) 4 53 16 36

Management Systems Certified by LRQA
ISO 9001 / Ref: 6006346
ISO 14001 / Ref: 1879479

ACEROS INOXIDABLES

OLARRA

OLARRA U.K. LTD.
FOREST PARK - CLEOBURY MORTIMER
NR KIDDERMINSTER - DY14 9BD - ENGLAND

Trade Mark - Zeichen des Lieferwerkes / Anagrama del suministrador
Works Inspector Stamp - Werkssachverständiger / Sello del Inspector 3

Certificate type - APZ Nach / Certificado tipo		Certificate nº - Prüf-Nr / Certificado nº		Date - Datum - Fecha
	EN 10204/3.1		222427	18 - 02 - 2015

Our order Nº / Werks - Nr / Nº de Referencia		Heat / Schmelze / Colada		Your order Nº / Bestell - Nr / Pedido Nº	
	565622		385583		OLF773

Steel Grade / Werkstoff / Calidad		According to / Entsprechend / Corresponde	
	AISI-316 MECAMAX		ASTM A 580 / A 580M-13a.

Shape and Size - Gegenstad / Perfil y dimensión	Tolerance - Toleranz / Tolerancia	Bundles / Bunde / Bultos		Bars / Stäbe / Barras	Weight / Gewicht / Peso	
HEXAGON 25,5 mm			10			13347 Kg

Requirements - Anforderungen - Exigencias

EN 10.088-3.2005.
NACE MR-0103-12.
NACE MR-0175-2003/ISO 15156-3 2009.
1.4401-1.4404-Type 316L.

Verified True Copy of Original
Signed:.....
Offshore Stainless Supplies Ltd

Melting process / Erschmelzungsart / Proceso de Fusión	Heat treatment / Wärmebehandlung / Tratamiento térmico
E.A.F. / A.O.D.	1060C 4H/Std WATER/WASSER/AGUA

Solution annealed/Abgeschreckt/Hipertemple-Pickled/Gebeizt/Decapado-

Test results - Ergebnis der Prüfungen - Resultados de los ensayos

Dimension of Specimen / Abmessungen des Probestabes / Medida de las probetas		Rp0,2% N/mm2 MPA	Rp 1% N/mm2 MPA	Rm N/mm2 MPA	A %L 5D	A %L 4D	Z %	Hardness Härte HBw	Impact test / Kerbschlag / Resiliencia ISO V Jules
RD. 12,50 mm.	Min	205		515		40	50		
	Max								
Temperature ºC 20 / Spec. Nº. Probe Nr. Pro Nº. 1		250	284	570		59	74	143	

	C	Si	Mn	P	S	Cr	Mo	Ni	N	Co
Min						16,00	2,00	10,00		
Max	0,080	1,00	2,00	0,045	0,030	18,00	3,00	14,00	0,1000	
	0,023	0,45	1,58	0,035	0,029	16,50	2,04	10,00	0,0320	0,18

Visual and dimensional inspection / Besichtigung und Ausmessung / Control visual y dimensional	Radioactivity inspection / Radioaktivitätskontrolle / Control de Radioactividad	Antimixing test / Spektroek Verwechslungspr / Antimezcla	Grain Size / Korngrösse / Tamaño de grano
O.K.	O.K.	O.K.	

Remarks - Bemerkungen - Observaciones

IC test acc./IK prüfung nach ASTM A 262 E.13. OK
Free From Mercury contamination/Quecksilberfreiheit.

EDV / EDP
Acc. EN 10.204
Alfredo Molina
Certification Mng.

Works Inspector
Der Werkssachverständige
Inspector de fábrica

H.C.T. 933U
Checked & Approved by
~~Parker Hannifin IPDE~~
13-05-2015 12:00:00 Page 2 of 3

OSS001589. PRD003300. F55118.

Laboratory Test Certificate

Certificate No.	ST0009296 Amd3 Page 1 of 1
Date Received/Tested	15/04/2015
Material Specification	316
Reference No.	385583
Dimensions	22mm HEX
Order No.	E003491

UKAS TESTING 0561

Remarks :-

PASSED

Verified True Copy of Original
Signed
Offshore Stainless Supplies Ltd

Mechanical Test	HARDNESS TEST					TENSILE TEST (ASTM-A370: 2012A)								
				ASTM E 18: 2012		Test Piece Dimensions (mm)			Proof	Strass Rp0.2	Tensile Strength		% Elong on G.L. 4D	% Red'n of Area
Sample No.	HBW	HV kg	HRC	HRBW	Width	Gauge	C.S.A	Load (kN)	Nmm^{-2}	Load (kN)	Nmm^{-2}		
			24		12.56ø		123.90	97.10	785	111.51	900	24.5	64
REQUIREMENTS									*550 MIN*		*790 MIN*	*15 MIN*	*40 MIN*

N.B. Results obtained from testing that has been subcontracted to an alternative UKAS laboratory shall be clearly identified.

N.B. All results are subject to uncertainty of measurement budgets, available on request.

N.B. Opinions and interpretations based on test results are outside the scope of UKAS Accreditation.

N.B. The test results reported on this test certificate only relate to the item(s) submitted for testing on the Purchased Order detailed.

N.B. The results on this test certificate do not in anyway confer approval of the quality of Manufacture of the Material.

N.B. Document Control No. 20. Laboratory Test Certificate. Issue No.: 18 Issue Date: January 2015.

Checked by: [illegible]
Parker Hannifin PLC
13-05-2015 12:00:00 Page 3 of 3
i-41

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F.A.O
Company Offshore Stainless Supplies
Address Toll Point
Lichfield Road
Brownhills
West Midlands

Signed for and on behalf of CTT Willenhall:

☐ Mr G E Conde (Chief Chemist)
☐ Mr J Thompson (Operations Manager)
☑ Miss A Owen (General Manager)

Date Of Signing: 07/05/2015

Caparo TESTING TECHNOLOGIES Willenhall

Unit 11, Planetary Road Industrial Estate, Planetary Road, Willenhall, West Midlands WV13 3XA

Tel: 01902 305200 Fax: 01902 303200

CTT Willenhall is a business name of Caparo Engineering Limited Registered in England Registration No. 3450375 Registered office: Caparo House, 103 Baker Street, London W1U 6LN

TRUE COPY

Customer	Delivery Address
JAMES BROWN IND LTD TY COCH WAY TORFAEN CWMBRAN NP44 7HF	JAMES BROWN IND LTD TY COCH WAY TORFAEN CWMBRAN NP44 7HF

HI-TECH
Special Steels Limited
Rotherham Road, Laughton Common,
Dinnington, Sheffield S25 3RF
Tel: Dinnington (01909) 564545
Fax No (01909) 550682

Report No. 033592	Our Ref. 097921	Date 18/11/14
Test No. 289153	Customer O/No. MB5431	Specification BS EN 10088-3 1.4404
Despatch Note No. 049459		

TEST CERTIFICATE

Item	Quantity	Weight Kg	Part No.	Heat No.	Batch No.
003	15	294 Total		56141450	P214315

Description

1.1/8" SQ LINISHED BAR
CONFORMING TO NACE MR0175
IN ACCORDANCE WITH PARKER MO19/1
HCT: H460
FREE FROM MERCURY CONTAMINATION
CONFORMING TO NACE MR0175-2003/MR0103-2005
ICC TEST TO ASTM A262 'E' - SATISFACTORY
ALSO CONFORMING TO ASTM A182 F316/316L &
ASTM A276/A479 GR 316/316L

A. HEAT TREATMENT SUPPLY CONDITION
B. TEST PIECE TREATMENT CONDITION

MELTING PRACTICE AOD

TEST COUPON SIZE

Tensile Tests — Units MPa

Temp °C	*	0.20% Proof Result	0.20% Proof Spec-Min	Maximum Stress Result	Maximum Stress Spec-Min	%Elong 50MM Result	%Elong 50MM Spec-Min	% Reduction of Area Result	% Reduction of Area Spec-Min
20	L	486	200	673	500	37	30	72	50

Impact Tests

Temp °C	*	ENERGY 1	ENERGY 2	ENERGY 3	ENERGY MIN	ENERGY AV	SHEAR % 1	SHEAR % 2	SHEAR % 3	SHEAR % MIN	SHEAR % AV	LATERAL EXPANSION 1	LATERAL EXPANSION 2	LATERAL EXPANSION 3	LATERAL EXPANSION MIN	LATERAL EXPANSION AV

Hardness 15
HRC

Component Hardness

H.C.T. H460
Checked & Approved by
Parker Hannifin IPDE
20-11-2014 12:19:29 Page 1 of 3

Heat No.	C	Si	Mn	S	P	Cr	Ni	Mo	Cu	Ti	Co	N
56141450	0.020	0.52	1.53	0.028	0.034	16.63	10.11	2.03	0.47	0.004	0.285	0.050

* Test Direction: L = Longitudinal; T = Transverse

TEST CERTIFICATE in accordance with BS EN 10204 3.1 / ISO 10474 3.1
Certified that the whole of the supplied detailed hereon, unless otherwise stated, are covered by the Sources Certificate of Conformity/Test Certificate referenced hereon, and has been supplied to the Quality System requirements in accordance with the conditions of our BSI/ BS EN ISO 9001 2008 registration for lot traceable products.

Signature

Position Quality Controller

BÖLLINGHAUS® STEEL

Abnahmeprüfzeugnis/Mill Test Certificate/Certif. de Qualidade	No.: / Nr.: /Nr.:
EN 10204:2004 / 3.1	0000098785

Bollinghaus Steel, SA DIN EN ISO 9001:2008 TÜV CERT No. 01 100 030458	Unsere innere Verweisung /Our int. Ref/ N/ ref int	Datum / Date / Data
	5600023362 000010	30.09.2014

Normen / Standards / Normas

1.4401/1.4404 acc. to BS EN 10088-3:2005 "Improved Machinability"
I.C.C. Tested to ASTM A262-13a Practice E, valid in dual certified as AISI 316/316L acc. to ASTM 278-13a, ASTM A479/A479M-13, NACE MR 0175, NACE MR 0103.

Kunde / Customer / Cliente	Endgültiger Kunde / Final Customer / Cliente Final
Hi-Tech Special Steels Limited Rotherham Road S25 3RF Sheffield	Hi-Tech Special Steels Limited Rotherham Road S25 3RF Sheffield
Bestell Nr./Order Nr./ Enc.Nr. 004734	Bestell Nr./ Order Nr./ Enc.Nr. 004734.03

Produktgruppe / Product Group / Grupo Produto	Gewicht / Weight / Peso	Bunde / Bundle / Atados
AISI 316L SQ 30,60 mm	15.680 kg	15

Werkstoff-Nr. Material-no. Qualidade	Werkstoff-Normbezeichnung / Material standard grade / Norma do material
1.4404	X 2 CrNiMo 17-12-2

Beschreibung / Description / Descrição

Stainless steel square bars, hot rolled, annealed, pickled, straightened.

Schmelzen Nr. Cast nr. / Fusão nr.	Chemische Analyse in % / Chemical composition in % / Analise quimica em %													
56141450	C:	0.020	Si:	0.520	Mn:	1.530	P:	0.034	S:	0.028	Cr:	16.630	Ni:	10.110
EAF	Mo:	2.030	Co:	0.285	Cu:	0.470	N:	0.060	Ti:	0.004	W:	-	V:	-

Proben Nr. Test no. Amostra no.	DIN EN 10045	ISO 6892-1				
	Kerbschlagarbeit Impact Test Resiliência	Streckgrenze Yield point Tensão limite	Dehngrenze 1% point Limite de extensão	Zugfestigkeit Tensile strength Tensão de rotura	Dehnung Elongation Alongamento	Einschnürung Reduction of area Coef. Estrição
	(Charpy V)	Rp 0,2 %	Rp 1,0%	Rm	A (A50-80mm)	Z (A50-80mm)
	[J]	[MPa]	[MPa]	[MPa]	[%]	[%]
3040769.14.01	225	296	336	616	64.6	76.9
3040769.14.02	223	306	347	624	63.2	76.4
3040769.14.03	222	312	355	635	62.0	73.4
3040769.14.04	219	319	360	642	61.4	72.0

Visuelle Kontrolle Visual inspection Inspecção visual	☒ Ok	DIN EN 6506-1 Härte Hardness Dureza	160 [HB]	DIN 3651 - 2A Korrosionsbeständigkeit IC Test Corrosão intercristalina	☒ Ok
EN 10059 Maßkontrolle Dimensional inspection Inspecção dimensional	☒ Ok	Korngrösse Grain size Tamanho de grão	-	Werksachverständiger Quality Control Representative Inspector da Qualidade	
Verwechslungsprüfung Test of identity Teste de identificação	☒ Ok	Makroskopische Untersuchung Macrographic test Material free from segregation defects.	☒ Ok	David Reis (t. DR)	

Wärmebehandlung
Heat treatment
Tratamento térmico

Solution annealing 1050 °C

(Water quenched)

Bemerkungen / Remarks / Observações

Country of origin: Portugal. No weld repair done.
Material is free of mercury and radiation contamination.
Certified acc. PED 97/23/EC-EN 764-5 and AD 2000 W0
Notified Body 0035 - TUV Rheinland Industrie Service GmbH
01 202 926/Q-02 0040

Bollinghaus Steel, SA

Hiermit bestätigen wir, dass das Material der oben genannten Spezifikation entspricht.
We confirm that this material meets the specification according the mentioned standards.
Confirmamos que este material respeita as especificações de acordo com as normas referidas.

H.C. Parker Hannifin PLC
Checked & Approved by
Parker Hannifin PLC
26-11-2014 12:19:29 Page 2 of 3

TRUE COPY

Special Testing Ltd
Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5566 Acc/Admin
www.specialtesting.co.uk

0046

Test Certificate 289153

AUTHENTICATION CODE 0C814BDDC818
ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191

CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS, ROTHERHAM RD
LAUGHTON COMMON, DINNINGTON
SHEFFIELD S25 3RF
DATE RECEIVED 19 November 2014
TEST DATE 21 November 2014

CUSTOMER ORDER NO	PRD4638			TEST NUMBER	289153	IDENTITY	P41263	CAST*	56141450			ALL REQUIREMENTS MIN UNLESS STATED		
SPECIFICATION	BS EN10088-3:2005 1.4404							TEST PIECE FROM*	1.1/8" SQ					
TENSILE: BS EN ISO 6892-1:2009 A224					0.2% PROOF	1.0% PROOF	UTS	ELONG ON	%	R OF A %		COMMENTS		
OR	TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS									
L	RT	10.01mm	78.76mm²	MPa	RESULTS	486	560	673	50mm	37.0	72.0	N/A		

HARDNESS: BS EN ISO6508-1 2005	DESIGNATION	REQUIREMENTS	RESULTS
ROCKWELL C (MID RADIAL)	HRC		15
ROCKWELL B (MID RADIAL)	HRBW		95

END OF CERTIFICATE

H.C.T. H460
Checked & Approved by
Parker Hannifin IPDE
26-11-2014 12:19:29 Page 3 of 3

REPRESENTING*		
		No copy is authentic without the embossed seal and signature. This certificate can be authenticated at www.specialtesting.co.uk with the code 0C814BDDC818 This certificate shall not be reproduced, except in full, without the written approval of the laboratory. For and on behalf of **SPECIAL TESTING LTD** A Member of the Special Steel Group of Companies Steve Pearce Certification Manager

Test results do not in any way confer approval of the quality of manufacture of the material. All results are subject to uncertainty of measurement budgets, details available upon request.
Information marked * is supplied by the customer.

Customer	Delivery Address
JAMES BROWN IND LTD TY COCH WAY TORFAEN CWMBRAN NP44 7HF	JAMES BROWN IND LTD TY COCH WAY TORFAEN CWMBRAN NP44 7HF

HI-TECH
Special Steels Limited
Rotherham Road, Laughton Common,
Dinnington, Sheffield S25 3RF
Tel: Dinnington (01909) 564545
Fax No (01909) 550682

Report No.	035722	Our Ref.	099217	Date	21/09/15
Test No.	310374	Customer O/No.	MB5833	Specification	BS EN 10088-3 1.4404
Despatch Note No.	051043				

TEST CERTIFICATE

Item	Quantity	Weight Kg	Part No.	Heat No.	Batch No.
002	14	272 Total		56142010	P216046

Description

1.1/8" SQ LINISHED BAR
CONFORMING TO NACE MR0175
IN ACCORDANCE WITH PARKER MO19/1
HCT: G341
FREE FROM MERCURY/RADIOACTIVE CONTAMINATION
CONFORMING TO NACE MR0175-2003/MR0103-2005
ICC TEST TO ASTM A262 'E' - SATISFACTORY
ALSO CONFORMING TO ASTM A182 F316/316L &
ASTM A276/A479 GR 316/316L

A. HEAT TREATMENT SUPPLY CONDITION
B. TEST PIECE TREATMENT CONDITION

MELTING PRACTICE AOD

TEST COUPON SIZE

H.C.T. G341
Checked & Approved by
Parker Hannifin PDE
13-10-2015 09:41:46 Page 1 of 3
i-45

Tensile Tests — Units MPa

Temp °C	*	0.20% Proof Result	0.20% Proof Spec-Min	Maximum Stress Result	Maximum Stress Spec-Min	%Elong 50MM Result	%Elong 50MM Spec-Min	% Reduction of Area Result	% Reduction of Area Spec-Min
20	L	610	200	757	500	33	30	64	50

Impact Tests

Temp °C	*	ENERGY 1	ENERGY 2	ENERGY 3	ENERGY MIN	ENERGY AV	SHEAR % 1	SHEAR % 2	SHEAR % 3	SHEAR % MIN	SHEAR % AV	LATERAL EXPANSION 1	LATERAL EXPANSION 2	LATERAL EXPANSION 3	LATERAL EXPANSION MIN	LATERAL EXPANSION AV

Hardness 20.1 HRC

Component Hardness

Heat No.	C	Si	Mn	S	P	Cr	Ni	Mo	Cu	Co	N
56142010	0.019	0.53	1.53	0.025	0.036	16.98	10.09	2.06	0.46	0.341	0.056

* Test Direction: L = Longitudinal; T = Transverse

TEST CERTIFICATE in accordance with BS EN 10204 3.1 / ISO 10474 3.1
Certified that the whole of the supplied detailed hereon, unless otherwise stated, are covered by the Sources Certificate of Conformity/Test Certificate referenced hereon, and has been supplied to the Quality System requirements in accordance with the conditions of our BSI/ BS EN ISO 9001 2008 registration for lot traceable products.

Signature

Position Quality Controller

TRUE COPY

BÖLLINGHAUS STEEL

Bollinghaus Steel, SA
DIN EN ISO 9001:2008
TÜV CERT No. 01 100 090458

Abnahmeprüfzeugnis/Mill Test Certificate/Certif. de Qualidade	No.: / Nr.: /Nr.:
EN 10204:2004 / 3.1	0000101647
Unsere innere Verweisung /Our int. Ref/ N/ ref int	**Datum / Date / Data**
5600024521 000010	27.01.2015

Normen / Standards / Normas

1.4401/1.4404 acc. to BS EN 10088-3:2014 "Improved Machinability"
I.C.C. Tested to ASTM A262-14 Practice E, valid in dual certified as AISI 316/316L acc. to ASTM 276-13a, ASTM A479/A479M-13, NACE MR 0175, NACE MR 0103

Kunde / Customer / Cliente	Endgültiger Kunde / Final Customer / Cliente Final
Hi-Tech Special Steels Limited Rotherham Road S25 3RF Sheffield	Hi-Tech Special Steels Limited Rotherham Road S25 3RF Sheffield

Bestell Nr./Order Nr./ Enc.Nr.	Bestell Nr./ Order Nr./ Enc.Nr.
004810	004810.02

Produktgruppe / Product Group / Grupo Produto	Gewicht / Weight / Peso	Bunde / Bundle / Atados
AISI 316L SQ 30,60 mm	10.781 kg	10

Werkstoff-Nr. Material-no. Qualidade	Werkstoff-Normbezeichnung / Material standard grade / Norma do material
1.4404	X 2 CrNiMo 17-12-2

Beschreibung / Description / Descrição

Stainless steel square bars, hot rolled, annealed, pickled, straightened.

Schmelzen Nr. Cast nr. / Fusão nr.	Chemische Analyse in % / Chemical composition in % / Analise quimica em %													
56142010	C:	0.019	Si:	0.630	Mn:	1.630	P:	0.036	S:	0.025	Cr:	16.980	Ni:	10.090
EAF	Mo:	2.060	Co:	0.341	Cu:	0.460	N:	0.058	Ti:	-	W:	-	V:	-

Proben Nr. Test no. Amostra no.	DIN EN 10045	ISO 6892-1				
	Kerbschlagarbeit Impact Test Resilência	Streckgrenze Yield point Tensão limite	Dehngrenze 1% point Limite de extensão	Zugfestigkeit Tensile strength Tensão de rotura	Dehnung Elongation Alongamento	Einschnürung Reduction of area Coef. Estrição
	(Charpy V)	Rp 0,2 %	Rp 1,0%	Rm	A (A5 / 4D)	Z
	[J]	[MPa]	[MPa]	[MPa]	[%]	[%]
3042823.04.01	217	306	352	632	62.3	73.1
3042823.04.02	217	312	361	637	62.0	72.4
3042823.04.03	214	322	369	644	60.2	72.0
3042823.04.04	213	329	369	657	60.0	71.4

Visuelle Kontrolle Visual inspection Inspecção visual ☒ Ok	DIN EN ISO 6506-1 Härte Hardness Dureza 169 [HB]	DIN EN ISO 3651 - 2A Korrosionsbeständigkeit IC Test Corrosão intercristalina ☒ Ok	Wärmebehandlung Heat treatment Tratamento térmico Solution annealing 1050 °C (Water quenched)
DIN EN 10059 Maßkontrolle Dimensional inspection Inspecção dimensional ☒ Ok	Korngrösse Grain size Tamanho de grão -	Werksachverständiger Quality Control-Representative Inspector da Qualidade Bayid-Reis (D - DR)	
Verwechslungsprüfung Test of identity Teste de identificação ☒ Ok	Makroskopische Untersuchung Macrographic test Material free from segregation defects. ☒ Ok		

Bemerkungen / Remarks / Observações

Country of origin: Portugal. No weld repair done.
Material is free of mercury and radiation contamination.
Certified acc. PED 97/23/EC-EN 764-5 and AD 2000 W0
Notified Body 0035 - TUV Rheinland Industrie Service Gmbh
01 202 926/Q-02 0040

Bollinghaus Steel, SA 2/2/15

Hiermit bestätigen wir, dass das Material der oben genannten Spezifikation entspricht.
We confirm that this material meets the specification according the mentioned standards.
Confirmamos que este material respeita as especificações de acordo com as normas referidas.

I29.B PP

I.C.T. G311
Checked & Approved by
Parker Hannifin IPDE
13-10-2015 09:41:46 Page 2 of 3

Special Testing Ltd
Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5566 Acc/Admin
www.specialtesting.co.uk

Test Certificate 310374

AUTHENTICATION CODE D344556F0515
ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191

CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS, ROTHERHAM RD
LAUGHTON COMMON, DINNINGTON
SHEFFIELD S25 3RF
DATE RECEIVED 02 September 2015
TEST DATE 03 September 2015

CUSTOMER ORDER NO	PRD 5142				TEST NUMBER 310374	IDENTITY P41498		CAST* 58142010			ALL REQUIREMENTS MIN UNLESS STATED	
SPECIFICATION	BS EN10088-3:2005 1.4404							TEST PIECE FROM* 1.1/8" Sq				
TENSILE: BS EN ISO 6892-1:2009 A224						0.2% PROOF	1.0% PROOF	UTS		ELONG ON %	R OF A %	COMMENTS
OR	TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS							
L	RT	10.01mm	78.70mm²	MPa	RESULTS	610	666	757		50mm 33.0	64.0	12.5mm Below Surface

HARDNESS: BS EN ISO6508-1 2005	DESIGNATION	REQUIREMENTS	RESULTS
ROCKWELL C (Mid Radial)	HRC		20.1

END OF CERTIFICATE

REPRESENTING*

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This certificate shall not be reproduced, except in full, without the written approval of the laboratory.

For and on behalf of
SPECIAL TESTING LTD
A Member of the Special Steel Group of Companies

Steve Pearce
Certification Manager

Test results do not in any way confer approval of the quality of manufacture of the material. All results are subject to uncertainty of measurement budgets, details available upon request.
Information marked * is supplied by the customer.

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H.C.T. G341
Checked & Approved by
Parker Hannifin IPDE
13-10-2015 09:41:46 Page 3 of 3
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HI-TECH
Special Steels Limited

Rotherham Road, Laughton Common,
Dinnington, Sheffield S25 3RF
Tel: Dinnington (01909) 564545
Fax No (01909) 550682

Registered in England No. 1921116

Customer

Evenort Ltd
Houghton Road
North Anston Trading Est
Dinnington
Sheffield S25 4JJ

TEST CERTIFICATE IN ACCORDANCE WITH BS EN 10204 3.1/ISO 10474 3.1

Certificate No.	T59350	Product	Stainless steel bar		
Order No.	Consignment	Cast No.	503126	Specification	1.4404
Our Reference	Z103694/P41400	Quantity	556 Kgs	Size	.875" A/F Hex
Advice Note No.	EV028	Finish	Cold sized		
Heat Treatment	Fully solution treated and water quenched prior to cold sizing				

Chemical Analysis

C	0.018	Si	0.448	Mn	1.32	S	0.03	P	0.0293
Ni	10.064	Cr	16.532	Mo	2.021	Ti		Nb	
Co	0.144	Cu	0.486	N	0.04	W		Ca	
Sn		Ta		V		Al		Fe	

Mechanical Properties

Tensile Strength	807 Mpa	0.2% Proof Stress	693 Mpa
Reduction of Area	68,0%	Elongation	26,0%
Hardness	24.7 HRC	Impact Tests	

Special Conditions / Processing Details

In accordance with BS EN 10088-3 2005 1.4404 — HCT No : G220

In accordance with M011/1 Concession — Part No : 7710884306

Free from mercury and radioactive contamination
ICC test to ASTM A262 'E' - Satisfactory
This material has been solution annealed and is free from grain boundary carbide precipitation
Also conforming to ASTM A276/A479 Gr 316/316L (Chemical analysis)
Country of origin/melt : France

Manufacturers Test Cert No.	Concessions Agreed

"Certified that the whole of the supplied detailed hereon, unless otherwise stated*,are covered by the Sources Certificate of Conformity/Test Certificate referenced hereon,and has been subject to the Quality System requirements in accordance with the conditions of our BS EN ISO 9001 2008 registration,for lot traceable products".

"Certified that the supplies/services detailed hereon have been inspected and tested in accordance with the conditions,requirements of the contract or purchase order and,unless otherwise noted below,conform in all respects to the specification(s)/drawing(s) relevant thereto."

H.C.T. G220
Checked & Approved by
Parker Hannifin IPDF
07-05-2015 14:55:01 Page 1 of 4

07/05/2015 — Quality Controller

TRUE COPY

Usine productrice/Hersteller/Manufacturer
Ugine
Avenue Paul Girod - CS
90100
73403 Ugine Cedex
France 5

CERTIFICAT DE RECEPTION 3.1
INSPECTION CERTIFICATE 3.1
ABNAHMEPRUEFZEUGNIS 3.1

EN 10204 / 3.1
NF L 00-015 Certified material test report

UGITECH
Providing special steel solutions 1

Numéro certificat/Nummer/Number	Ordre de fab. / Auftrag / Prod. Order	N° coulée / Schmelzen Nr / Heat N°	N° lot MM / Chargen / Batch
81503764 000010 4	A1512AE36000 11-1	503126 11-2	1512AE3600 11-3

Certification - Werkzeugnis - Certificate			Marque d'usine / Herstellerzeichen / Supplier's Mark
AD 2000-MERKBLATT W0/TRD100 Pressure Equipment Directive 97/23/EC ISO 9001 ISO/TS 16949 99	ISO 9100 ISO 9120 98	98-2	UGITECH 97
			Poinçon de l'expert / Prufstempe / Inpector's stamp IQ 96

UGIMA 4404HM WIRE ROLLED PICKLED SOLUTION ANNEALED HEXAGONAL 25,500MM

Produit UGIMA 4404HM FIL LAMINÉ(E) DÉCAPÉ HYPERTREMPÉ(E) HEXAGONAL(E) 25,500MM
Erzeugnisform UGIMA 4404HM WALZDRAHT GEWALZT GEBEIZT LÖSUNGSGEGLÜHT SECHSKANT 25,500MM
Product UGIMA 4404HM WIRE ROLLED PICKLED SOLUTION ANNEALED HEXAGONAL 25,500MM 6

Client - Besteller - Purchaser	N° cde client - Kundenbestellnummer - Purchase order number	Commande - Bestellung - Order
19516 HI-TECH SPECIAL STEELS LTD 9	2959007078 10	669006 10 20

Norme de référence / Besugsnorm / Standard for reference
ASME SA479/479M-10 Sec.II TYPE 316L
EN 10088-1/3ED2005 1.4404
AISI 316L
ASTM A479/A479M-14 TYPE 316L
UNS 12th Edition S31603
12-2

Spécification client / Kundenspezifikation / Customer's specification
ESS M011/1 FOR ANALYSIS ONLY Y4 18/12/2012 12-3

Nombre / Stueckzahl / Pieces Nbr	Profil / Profile / Shape	Dimension / Ausmessung / Dimension	Longueur / Laenge / Length	Poids / Gewicht / Weight
21 18	HX 19	25,500 MM 21-1	21-2	22778 KG 22

Mode d'élaboration / Erschmelzungsart / Melting process	N° prélèvement / Probenummer / Test number	Demandé / Vorschrift / Required	42 % C	43 % SI	44 % MN	45 % NI	46 % CR	47 % MO	48 % CU	49 % S
		Min				10,0000	16,5000	2,0000		0,0150
		Max	0,0300	0,7500	2,0000	13,0000	18,0000	2,5000	1,0000	0,0300
EAF +AOD +CC 38	8LZE 39A	coulée/ Schmelzen / Heat	0,0180	0,4480	1,3200	10,0640	16,5320	2,0210	0,4860	0,0300
		Produit / Erzeugnisform/ Product								

Demandé / Vorschrift / Required	50 % P	51 % N	52 % CO	53	54	55	70	71	72	73	74	75
Min												
Max	0,0400	0,1000										
coulée/ Schmelzen / Heat	0,0293	0,0400	0,1440									
Produit / Erzeugnisform/ Product												

Demandé / Vorschrift / Required	76	77	78	79	80	81	82	83	84	85	86	87
Min												
Max												
coulée/ Schmelzen / Heat												
Produit / Erzeugnisform/ Product												

HI-TECH SPECIAL STEELS LTD. 5 7/4/15

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable requirements of ASME NQA 3800 66-1

Ugine le 17.03.2015
Le Responsable Métallurgie-Qualité
Der Qualitatsbeauftragter
The Quality Manager
B. POLLET

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable requirements of ASME NQA 3800 66-2

040000848044 Page 1/2 63

H.C.T. G220
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Parker Hannifin IPDE
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Usine productrice/Hersteller/Manufacturer
Ugine
Avenue Paul Girod - CS
90100
73403 Ugine Cedex
France 5

CERTIFICAT DE RECEPTION 3.1
INSPECTION CERTIFICATE 3.1
ABNAHMEPRUEFZEUGNIS 3.1

EN 10204 / 3.1
NF L 00-015 Certified material test report

UGITECH
Providing special steel solutions 1

Numéro certificat/Nummer/Number 4: 81503764 000010
Ordre de fab. / Auftrag / Prod. Order 11-1: A1512AE36000
N° coulée / Schmelzen Nr / Heat N° 11-2: 503126
N° lot MM / Chargen / Batch 11-3: 1512AE3600

			Limite d'élasticité Streckgrenze Yield Strength 0,2%	1%	RM Zugfestigkeit Tensile	Allongement Bruchdehnung Elongation A5D	A4D	Striction Einschnürung Red area	Dureté-Haerte-Hardness HB	HV	HRB	HRC
24	90	T°C										
		°C	Mpa	Mpa	Mpa	%	%	%				
13	Min	20	170			30	30	40				
	Max	20					99					
	Min											
	Max											
N° prélèvement BLZE Probenummer Test number 39B	1 L	20	285		593	53	55	75				
A l'état de Référence / treatment on test sample / Probestreifenbehandlung 14		25	26A	26B	27	28	89	29	30	88	100	37

Taux de corroyage / Forging ratio / Verschmiedungsgrad	Résilience-Kerbschlagzaehigkeit-Notch Toughness							
	Type Form Type	T°C	Sens Richtung Direction	Min	Valeurs individuelles Einzelwerte Individual values	Moyenne Mittelwerte Average	Expansion latérale Seitliche Breitung Lateral Expansion	
74,6	31	33	32	95	35	36	91	
101		°C		J		J		
A l'état de livraison / Lieferzustand / As delivered 13: TEMPERATURE OVER 1040°C AIR SOLUTION ANNEALED 1040°C								
A l'état de Référence / treatment on test sample / Probestreifenbehandlung 14								

ASTMA479-A479M 08-10A/ASMESA-479 ED .07 SECT.II 2010 NO ADD./QQ-S-763F/AMSQQ-S-763A/ASTMA276 8A-10 56
FREE FROM WELDS & WELD REPAIRS/FREE FROM MERCURY CONTAMINATION/FREE FROM CONTINUOUS CARBIDE NETWORK
QUALITY MANUAL REV.G OF 05 MAR.2015
MATERIAL IS SOLUTION ANNEALED
INTERGRANULAR CORROSION PER ASTM A262 PRACTICES A & E ACCEPTABLE
PROVISION OF 10 CFR PART 21 & 10 CFR PART 50 APP.B APPLY
COUNTRY OF MELT SOURCE : FRANCE

92 94

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800 55-1

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800 55-2

Ugine le 17.03.2015
Le Responsable Métallurgie-Qualité
Der Qualitätsbeauftragter
The Quality Manager
040000848044 Page 2/2 POLLET 63

H.C.T. C220
Checked & Approved by
Parker Hannifin IPDE
07-05-2015 14:55:01 Page 3 of 4

Special Testing Ltd
Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5566 Acc/Admin
www.specialtesting.co.uk

Test Certificate 301551

AUTHENTICATION CODE 644EF525961F
ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191

CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS, ROTHERHAM RD
LAUGHTON COMMON, DINNINGTON
SHEFFIELD S25 3RF
DATE RECEIVED 28 April 2015
TEST DATE 06 May 2015

CUSTOMER ORDER NO	PRD 4915			TEST NUMBER	301551	IDENTITY	P41400	CAST*	503126	ALL REQUIREMENTS MIN UNLESS STATED	
SPECIFICATION	BS EN 10088-3 2005 1.4404							TEST PIECE FROM*		0.875" AF / 22mm AF	
TENSILE: BS EN ISO 6892-1:2009 A224					0.2% PROOF	1.0% PROOF	UTS		ELONG ON %	R OF A %	COMMENTS
OR	TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS						
L	RT	10.02mm	78.85mm²	MPa	RESULTS	693	774	807		50mm 26.0	68.0	Centre

HARDNESS: BS EN ISO6508-1 2006	DESIGNATION	REQUIREMENTS	RESULTS
ROCKWELL C (Mid Radial)	HRC		24.7

END OF CERTIFICATE

H.C.T. G220
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I-51

REPRESENTING*		
		No copy is authentic without the embossed seal and signature. This certificate can be authenticated at www.specialtesting.co.uk with the code 644EF525961F This certificate shall not be reproduced, except in full, without the written approval of the laboratory. For and on behalf of **SPECIAL TESTING LTD** A Member of the Special Steel Group of Companies Steve Pearce Certification Manager

Test results do not in any way confer approval of the quality of manufacture of the material. All results are subject to uncertainty of measurement budgets, details available upon request.
Information marked * is supplied by the customer.

HI-TECH SPECIAL STEELS LTD. 5 6/5/15

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HI-TECH
Special Steels Limited

Rotherham Road, Laughton Common,
Dinnington, Sheffield S25 3RF
Tel: Dinnington (01909) 564545
Fax No (01909) 550682

Registered in England No. 1921116

Customer

Parker Hannifin Manufacturing Ltd
Riverside Road
Pottington Business Park
Barnstaple
Devon EX31 1NP

TEST CERTIFICATE IN ACCORDANCE WITH BS EN 10204 3.1/ISO 10474 3.1

Certificate No.	T59447	Product	Stainless steel bar		
Order No.	Consignment	Cast No.	522036	Specification	1.4404
Our Reference	Z105356/P41487	Quantity	236 Kgs	Size	1.062" A/F Hex
Advice Note No.	C1911	Finish	Linished		
Heat Treatment	Fully solution treated and water quenched prior to cold sizing				

Chemical Analysis

C	0.013	Si	0.38	Mn	1.278	S	0.0267	P	0.0291
Ni	10.081	Cr	16.556	Mo	2.029	Ti		Nb	
Co	0.218	Cu	0.493	N	0.037	W		Ca	
Sn		Ta		V		Al	0.007	Fe	

Mechanical Properties

Tensile Strength	791 Mpa	0.2% Proof Stress	668 Mpa
Reduction of Area	67,0%	Elongation	27,0%
Hardness	23.3 HRC	Impact Tests	

Special Conditions / Processing Details

In accordance with BS EN 10088-3 2005 1.4404 — HCT No : G312

In accordance with M011/1 Concession — Part No : 7711064304

Free from mercury and radioactive contamination
ICC test to ASTM A262 'E' - Satisfactory
This material has been solution annealed and is free from grain boundary carbide precipitation
Also conforming to ASTM A276/A479 Gr 316/316L (Chemical analysis)
Country of origin/melt : France

Manufacturers Test Cert No.	Concessions Agreed

"Certified that the whole of the supplied detailed hereon, unless otherwise stated*,are covered by the Sources Certificate of Conformity/Test Certificate referenced hereon,and has been subject to the Quality System requirements in accordance with the conditions of our BS EN ISO 9001 2008 registration,for lot traceable products".

"Certified that the supplies/services detailed hereon have been inspected and tested in accordance with the conditions,requirements of the contract or purchase order and,unless otherwise noted below,conform in all respects to the specification(s)/drawing(s) relevant thereto"

H.C.T. G312
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Parker Hannifin IPHE
27-08-2015 14:29:32 Page 1 of 4

27/08/2015 — Quality Controller

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Usine productrice/Hersteller/Manufacturer	CERTIFICAT DE RECEPTION 3.1 INSPECTION CERTIFICATE 3.1 ABNAHMEPRUEFZEUGNIS 3.1 EN 10204 / 3.1 NF L 00-015 Certified material test report	UGITECH Providing special steel solutions
Ugine Avenue Paul Girod - CS 90100 73403 Ugine Cedex France 5		1

Numéro certificat/Nummer/Number	Ordre de fab. / Auftrag / Prod. Order	N° coulée / Schmelzen Nr / Heat N°	N° lot MM / Chargen / Batch
81541895 000010 4	A1522SD23000 11-1	522036 11-2	1522SD2300 11-3

Certification - Werkzeugnis - Certificate			Marque d'usine / Herstellerzeichen / Supplier's Mark
AD 2000-MERKBLATT W0/TRD100 Pressure Equipment Directive 97/23/EC ISO 9001 ISO/TS 16949 99	ISO 9100 ISO 9120 98	98-2	UGITECH 97
			Poinçon de l'expert / Prufstempe / Inpector's stamp: IQ 96

UGIMA 4404HM BAR ROLLED BLACK SOLUTION ANNEALED HEXAGONAL 31,000MM LONG. 5,300M +2 00,000MM -0,000MM

Produit UGIMA 4404HM BARRE LAMINÉ(E) NOIR(E) HYPERTREMPÉ(E) HEXAGONAL(E) 31,000MM LONG. 5,300M +200,000

Erzeugnisform UGIMA 4404HM STAB GEWALZT SCHWARZ LÖSUNGSGEGLÜHT SECHSKANT 31,000MM LONG. 5,300M +200,000MM -0,

Product UGIMA 4404HM BAR ROLLED BLACK SOLUTION ANNEALED HEXAGONAL 31,000MM LONG. 5,300M +200,000MM -0,0 6

Client - Besteller - Purchaser	N° cde client Kundebestellnummer - Purchase order number	Commande - Bestellung - Order
19516 HI-TECH SPECIAL STEELS LTD 9	2959008387 10	693598 10 20

Norme de référence / Besugsnorm / Standard for reference

ASTM A276/A276M-15 TYPE 316L/316 ASTM A479/A479M-14 TYPE 316L/316

EN 10088-3 ED2014 1.4404/4401

12-2

Spécification client / Kundenspezifikation / Customer's specification

ESS M011/1 FOR ANALYSIS ONLY Y4 18/12/2012 12-3

Nombre / Stueckzahl / Pieces Nbr	Profil / Profile / Shape	Dimension / Ausmessung / Dimension	Longueur / Laenge / Length	Poids / Gewicht / Weight
210 18	HX 19	31,000 MM 21-1	5,300 21-2	7470 KG 22

Mode d'élaboration / Erschmelzungsart / Melting process	N° prélèvement / Probenummer / Test number	Demandé / Vorschrift / Required	42 % C	43 % SI	44 % MN	45 % NI	46 % CR	47 % MO	48 % CU	49 % S
		Min				10,0000	16,5000	2,0000		0,0150
		Max	0,0300	1,0000	2,0000	13,0000	18,0000	2,5000	1,0000	0,0300
EAF + AOD + CC 38	9KXV 39A	coulée/ Schmelzen / Heat Produit / Erzeugnisform/ Product	0,0130	0,3800	1,2780	10,0810	16,5560	2,0290	0,4930	0,0267

Demandé / Vorschrift / Required	50 % P	51 % N	52 % CO	53 % AL	54	55	70	71	72	73	74	75
Min												
Max	0,0400	0,1000										
coulée/ Schmelzen / Heat Produit / Erzeugnisform/ Product	0,0291	0,0370	0,2180	0,0070								

Demandé / Vorschrift / Required	76	77	78	79	80	81	82	83	84	85	86	87
Min												
Max												
coulée/ Schmelzen / Heat Produit / Erzeugnisform/ Product												

HI-TECH SPECIAL STEELS LTD 16/7/15

H.C.T. G312

Checked & Approved by Parker Hannifin IPDE

27-08-2015 14:29:32 Page 2 of 4

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements. ASME Mod. Sec. II

66-1

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements. ASME Mod. Sec. II

i-53 66-2

Ugine le 25.06.2015

Le Responsable Métallurgie Qualité

Der Qualitätsbeauftragter

The Quality Manager

B.POLLET

040000896043 Page 1/2 63

Usine productrice/Hersteller/Manufacturer	CERTIFICAT DE RECEPTION 3.1 INSPECTION CERTIFICATE 3.1 ABNAHMEPRUEFZEUGNIS 3.1	UGITECH Providing special steel solutions
Ugine Avenue Paul Girod - CS 90100 73403 Ugine Cedex France 5	EN 10204 / 3.1 NF L 00-015 Certified material test report	1

Numéro certificat/Nummer/Number	Ordre de fab. / Auftrag / Prod. Order	N° coulée / Schmelzen Nr / Heat N°	N° lot MM / Chargen / Batch
81541895 000010 4	A1522SD23000 11-1	522036 11-2	1522SD2300 11-3

			Limite d'élasticité Streckgrenze Yield Strength		RM Zugfestigkeit Tensile	Alongement Bruchdehnung Elongation		Striction Einschnürung Red area	Dureté-Haerte-Hardness			
24	90	T°C	0,2%	1%		A5D	A4D		HB	HV	HRB	HRC
		°C	Mpa	Mpa	Mpa	%	%	%				
13	Min	20	205	235	515	40	30	40				
	Max	20			700				215			
	Min											
	Max											
N° prélèvement 9KXV Probenummer Test number 39B	1 L	20	236	293	579	54	56	74	162			
A l'état de Référence / treatment on test sample / Probestreifenbehandlung 14		25	26A	26B	27	28	89	29	30	88	100	37

Taux de corroyage Forging ratio Verschmiedungsgrad	Résilience-Kerbschlagzaehigkeit-Notch Toughness							
	Type Form Type	T°C	Sens Richtung Direction	Min	Valeurs individuelles Einzelwerte Individual values	Moyenne Mittelwerte Average	Expansion latérale Seitliche Breitung Lateral Expansion	
50,5	31	33	32	95	35	36		91
101		°C		J	J	J		
A l'état de livraison / Lieferzustand / As delivered 13	KISOV	20	L	100	228-227-228	228		
ON-LINE SOLUTION ANNEALED ON-LINE QUENCHED OVER 950°C					--			
					--			
A l'état de Référence / treatment on test sample / Probestreifenbehandlung 14								

MATERIAL IS FREE FROM MERCURY AND RADIOACTIVE CONTAMINATION , WELDS OR WELD REPAIRS AT TIME OF SHIPMENT 56
FREE OF RADIOACTIVITY STATEMENT & TOXIC PRODUCT
INTERGRANULAR CORROSION PER ASTM A262 PRACTICES A & E ACCEPTABLE
COUNTRY OF MELT SOURCE : FRANCE

H.C.T. G312
Checked & Approved by
Parker Hannifin IPDE
27-08-2015 14:29:21 Page 3 of 4

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3860 96

Ugine le 25.06.2015 94
Le Responsable Métallurgie Qualité
Der Qualitätsbeauftragter
The Quality Manager 86-1

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3860 86-2

040000896043 Page 2/2 PALLET 63

Special Testing Ltd
Bacon Lane, Sheffield S9 3NH
Tel: 0114 244 1061
Fax: 0114 244 0444 Works
Fax: 0114 244 5566 Acc/Admin
www.specialtesting.co.uk

Test Certificate 309614

AUTHENTICATION CODE 7A8E89F6B2B9
ROLLS ROYCE APPROVED LABORATORY
Approval No. 11191

CUSTOMER
HI-TECH SPECIAL STEELS LTD
ALLOY & METAL WORKS, ROTHERHAM RD
LAUGHTON COMMON, DINNINGTON
SHEFFIELD S25 3RF
DATE RECEIVED 18 August 2015
TEST DATE 27 August 2015

CUSTOMER ORDER NO	PRD5081	TEST NUMBER	309614	IDENTITY	P41487	CAST*	522036
SPECIFICATION	BS EN10088-3:2005 1.4404					TEST PIECE FROM*	1.062" A/F HEX

ALL REQUIREMENTS MIN UNLESS STATED

TENSILE: BS EN ISO 6892-1:2009 A224						0.2% PROOF	UTS	ELONG ON	%	R OF A %	COMMENTS
OR	TEMP	SECTION	AREA SQ	UNIT	REQUIREMENTS						
L	RT	10.00mm	78.54mm²	MPa	RESULTS	668	791	50mm	27.0	67.0	12.5mm below

HARDNESS: BS EN ISO6508-1 2005	DESIGNATION	REQUIREMENTS	RESULTS
ROCKWELL C (MID RADIAL)	HRC		23.3

END OF CERTIFICATE

H.C.T. G312
Checked & Approved by
Parker Hannifin IPDE
27-08-2015 14:29:32 Page 4 of 4
I-55

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Test results do not in any way confer approval of the quality of manufacture of the material. All results are subject to uncertainty of measurement budgets, details available upon request.
Information marked * is supplied by the customer.

HI-TECH SPECIAL STEELS LTD. 27/8/15

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10611 A

A04 Herstellungszeichen / Manufacturer's logo

SOCHOROVÁ VÁLCOVNA TŽ

A02 Art der Prüfbescheinigung / Type of inspection document

Abnahmeprüfzeugnis 3.1 - Inspection certificate 3.1, EN 10204:2004

A01/A05 Herstellerwerk / Manufacturer's works issued by

SOCHOROVÁ VÁLCOVNA TŽ, a.s.,
Průmyslová 1000, Staré Město, 739 61 Třinec , Czech Republic/
výrobní závod: 272 01 Kladno-Dříň

Seite / Page 1/2

A03 Bescheinigungsnummer / Document No.: 2013/03/005756-REI

A07 Kundenbestellnummer / Purchaser's order No.: KA12505-64700

A10 Kontraktnummer / Contract No.: 0041227849

A08 Werksauftragsnummer / Works order No.: 7000340049/000010

A06 Empfänger / Consignee:
ESRO Staal services B.v.
P.O. Box 94
2950 DD Ablasserdam
Niederlande

B01, B09-B11 Spezifikation der Produkt / Masse / Toleranz Product description / Dimensions / Tolerant	B02, B04 Stahlbezeichnung / Lieferzustand Steel designation / Deliv. state	B03 Materialnorm Classification standard	B03 Massnorm Dimensional standard
RUNDSTAHL KA12505 AUFTRAG 64700 NORMALISIERT 85 mm 6,000 m +200 -0	C22.8 +N P250GH +N	DIN 17243-87 AD2000-W13 TRB100	EN 10060

A11 Wagen Nr. Waggon No.		B07 Schmelze Heat No.	B08 Ringen / Stück Coils / Pieces	B08 Krbd Crbd	B13 Gewicht (kg) Weight (kgs)
2SJ5186 2SE2678	13/03/002462/04 13.03.2013	47393	11	2	2815

B07, B14, C70 Schmelze / Herstellungsjahr / Stahlherstellung. Heat No. / Year of product / Steelmaking process: 47393/2012 BO-Strangguss

C71-C92 Chemische Zusammensetzung-Chemical composition [%]

C	Mn	Si	P	S	Cr	Ni	Cu	Mo	Al
0.21	0.85	0.24	0.015	0.010	0.26	0.09	0.03	0.006	0.026
Sn	V	Ti	N	H	Nb				
0.003	0.006	0.0016	0.0039	1.10 ppm	0.003				

Mechanische Werte-Mechanical values

B07 Schmelze Heat No.	B05 Probezustand Test state	C11 Streckgrenze Yield point Re [MPa]	C12 Zugfestigkeit Tensile strength Rm [MPa]	C13 Bruchdehnung Elongation A5 [%]	C14 Brucheinschn. Contraction Z [%]	B05 Probezustand Test state	C03 Prüftemperatur Test temperature	C40, C42 Schlagarbeit Energy of impact KV [J] / KCV [J/cm2]
47393	Probe Nr: D406	Nr. of test: D406				+N	+20°C	140-170-174
	+N	326	501	33,6	67,4			
						+N	- 20°C	107-110-112
	TK-7					Richtung: L		
	1/6 Durchmesser		1/6 Diameter					

B07 Schmelze Heat No.	D56 Stampfproben Heading tests (EN 10263-1)	D57 Entkohlen Decarburization (max. / mm)	C54 Reinheitsgrad Micropurity (DIN 50602)	C57 Korngrösse Grain size	C30 Härte HB Hardness HB	C93 Vakuumentgast Vacuum degassing
47393					141 - 144	ja

CONTROLLED DATE 19/3

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A04 Herstellungszeichen / Manufacturer's logo

SOCHOROVA VALCOVNA TZ

A02 Art der Prüfbescheinigung / Type of inspection document

Abnahmeprüfzeugnis 3.1 - Inspection certificate 3.1, EN 10204:2004

A01/A05 Herstellerwerk / Manufacturer's works issued by		Seite / Page
SOCHOROVÁ VÁLCOVNA TŽ, a.s., Průmyslová 1000, Staré Město, 739 61 Třinec , Czech Republic/ výrobní závod: 272 01 Kladno-Dříň	A03 Bescheinigungsnummer / Document No. 2013/03/005756-REI	2/2

B07 Schmelze Heat No.	D53 Verwechselnprüfung 100% Sparking test 100%	D02 US Prüfung US test	D54 Oberflächenfehler Surface defects
47393	entspricht	AD2000-MERKBLATT A4/EN10308/3	2 %

B07 Schmelze Heat No.	D01 Umformungsgrad Reduction ratio
47393	23,3

Normalgeglüht: 920 °C / 80 ' Luft Normalized 920°C / 80 ' air

D05
Unsere Erzeugnisse sind frei von schädlichen Bestandteilen, welche zu toxischen Emissionen führen. Die Produkte sind ebenso frei von Radioaktivität und sonstigen Verunreinigungen, welche Erdboden, Luft und Wasser belasten könnten.
Products which do not cause harmful emission of toxic gasses,dangerous particles or radiation to the indoor environment nor contamination of the outdoor environment(air,soil,or water)
Die Radioisotopischeaktivität max. 100 Bq/kg wurde eingehaltet.
Radio - isotopic activity was controlled in ladle sample, it was no higher than 100 Bq/kg.

Z01
Die obengenannten Erzeugnisse entsprechen den Bestellungsvorschriften.
Products conform with the prescription of order.

Z03
Dieses Dokument wurde mit elektronischer Unterschrift im Einklang mit dem Gesetz Nr. 227/2000Slg. versehen.
This document was electronically according to Law No. 227/2000Coll undersigned.

Z02
Der Werksachverständige -Expert :
Reitmajerová Alena,

Kladno: 14.03.2013

Der Sachbearbeiter der Qualitätskontrolle fur Freigabe und Atteste, unabhängiger berechtiger Vertreter
Officer of Quality Inspection of Releasing and Attesting, Independent authorized agent

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LAME

RACCORDERIA FORGIATA E DERIVAZIONI
FORGED STEEL FITTINGS AND OUTLETS

CERTIFICATO DI COLLAUDO / TEST CERTIFICATE

BE - 21082

Cliente/Customer: FBF BVBA

Ordine cliente/Customer order n.: BE-3898800 DTD 07/01/16

Documento di trasporto: DTVEND201600000036

Lista/Job: 28

Certific. N.: CTCERT201600000037

Data/Date: 15/01/2016

Item	Quantity	Heat code	Heat Number	Description	Type and mat. specific./year date	Steel Mill	Steel mill cert. - forgemaster cert.
1	700	MB-AQ	H2684	HEX HEAD PLUGS 1/2 3/6000 NPT	ASTM SA/A105N-13	SWISS STEEL	305921 - 3966/001

	C%	Mn%	P%	S%	Si%	Cr%	Ni%	Mo%	Ti%	Cu%	Nb%	Co%	V%	N%	CE%	Al%	Zr%	
ANALISI CHIMICA DI ACCIAIERIA / STEEL MILL CHEMICAL ANALYSIS	0,150	1,050	0,0150	0,0220	0,240	0,110	0,100	0,020	0,000	0,220	0,000	0,000	0,070	0,000	0,382	0,022	0,000	TRATTAMENTO TERMICO / HEAT TREATMENT: Electric furnace - NORM. AT 900°C / cooled in still air

	Snervamento / Yeld str.		Rottura / Ten.Str.		Al% / El%	Con% / Red.of.	Durezza / Hardness		Resilienza / Impact test		Prova idraulica / H.Test	Pieg. / B.Test	Visual and dimensional check
CARATTERISTICHE MECCANICHE / MECHANICAL PROPERTIES	N/mm(2)	387,00	N/mm(2)	535,00	27,80	37,00	HBW	158 169	31 55 49	-46°C	0,00		**OK**

RACCORDI SECONDO /FITTINGS IN ACC.TO: ANSI/ASME B1.20.1-2013, ASME B16.11-2011, BS 3799-74, MSS SP-25-L.E., ASME SEC. II PART A L.E., NACE MR0175-2009/ISO 15156

TRUE CERTIFIED COPY
OF THE ORIGINAL

F.B.F. b.v.b.a.
Tel. 03-828.50.80 - Fax 03-828.96.22
TEST CERTIFICATES DEPT.

16/1/16
DATUM

GOEDGEKEURD

I risultati dell'analisi chimica sono la corretta trascrizione del certificato emesso dall'acciaieria.
I risultati delle prove meccaniche sono la corretta trascrizione del certificato emesso dall'azienda che ha eseguito l'ultima trasformazione del materiale.
Dichiariamo che il prodotto fornito è conforme alle normative sopraindicate ed ai requisiti dell'ordine.
The results of the chemical analysis are a true and correct copy of the steel mill certificate .
The results of the mechanical tests are the correct records of the certificate issued from the company that has executed the last transformation of the material.
We state that the delivered product complies with the above standards and to the order's requirements.

Certificato secondo / Certificate acc. to: EN 10204/3.1

ANNUAL BOOK ASTM SEZ.I VOL.01.01, 2014
MATERIAL MANUFACTURER APPROVED by TUV RHEINLAND INDUSTRIE SERVICE GmbH ACCORDING TO P.E.D. 97/23/EC ANNEX I POINT 4.3 & AD 2000 W0.

ENTE COLLAUDO / INSPECTOR

C. QUALITA'/QUALITY CONTROL

LAME Srl
Via Papa Giovanni XXIII, 1
21040 JERAGO CON ORAGO (VA) ITALY
CF/VAT IT 01681090121

TRUE COPY

DELCORTE s.a.s
FORGED STEEL & STAINLESS STEEL
Quality system certified ISO9001:2008 by BSI-Q05524

17, Avenue du Corbeau - BP 597
59605 MAUBEUGE CEDEX FRANCE
Tél. : +33 (0)327 691 414 Fax : +33 (0)327 642 569
info@delcorte.com

CERTIFICAT DE RECEPTION - ACCEPTANCE CERTIFICATE EN 10204 3.1 (Ex EN 10204 3.1.b)

Customer : APH Techniek BV

Schipluidenseweg 1-2
NL-2290 AD Wateringen, NIEDERL

Order : 40109235

Certificate n° : 2013020390 / 1 — 19/02/2013

Dispatch note : 2013020390

Material specification : **ASTM A105/10**

Heat Treatment : NORMALIZED T° 843-927 - COOLED IN STILLAIR

DESCRIPTION

Item	Qty	Designation	Heat N°	Identification	Spec dimension				Localisation
1	150	BUSHING API 3/6000 3/4"X1/2" A105.N	26418	AGG	ASME B16.11/05-ANSI/ASME B1.20.1/92				02/95 8067
2	10	RED NIPPLE API 6M 1/2"X1/4" A105.N	C39296	AAD	ASME B16.11/09				02/95 8048

CHEMICAL ANALYSIS

Item	Identif.	C %	Si%	Mn%	P%	S%	Cr%	Mo%	V%	Ni%	Cu%	Cb%			
mini			0.100	0.600											
maxi		0.250	0.350	1.350	0.035	0.040	0.300	0.120	0.080	0.400	0.400	0.020			
1	AGG	0.206	0.245	1.030	0.016	0.005	0.146	0.055	0.002	0.098	0.194	< 0.010			
2	AAD	0.190	0.125	0.900	0.013	0.036	0.180	0.020	0.001	0.110	0.200	0.001			

MECHANICAL TESTS

Item	Identi-fication	Re 0.2% N/mm²	Rm N/mm²	A%	Z%	HB
mini		250.0	485.0	22.0	30.0	
maxi			700.0			187.0
1	AGG	387.0	551.0	33.6	66.0	163 - 165
2	AAD	412.0	542.0	25.0	65.0	171 - 172

Nous certifions que les produits énumérés ci-dessous sont conformes aux prescriptions de la commande et des spécifications et ont subi, sans objection, les contrôles d'aspect et de dimensions.
We hereby certify that above mentioned products are in accordance with the requirements of the order and specifications and have been checked without objection for surface and dimensionnel control.

Quality département

Ets DELCORTE RACCORDS ACIER

Réalisation OECLIC 3000

TRUE COPY

Customer	Delivery Address
Parker Hannifin Maufacturing Limited Switzerland Branch, Etoy c/o Parker Hannifin Manufacturing Ltd Riverside Road Pottington Business Park Barnstaple EX31 1NP	Parker Hannifin Maufacturing Limited

Toll Point
Lichfield Road
Brownhills
WS8 6JZ
t. 01922 414003 f. 01922 414606
e. sales@offshorestainless.co.uk

OFFSHORE STAINLESS SUPPLIES LTD.
Supplier of 1.4003 and producers of specialist stainless and high nickel products

Report No. 013355	Our Ref. 092182	Date 07/01/15
Test No. oss001321	Customer O/No. Con stock	Specification MO11/1
Despatch Note No. 000000		

TEST CERTIFICATE

Item	Quantity	Weight Kg	Part No.	Heat No.	Batch No.
001	0	1000 Total	7610444302	442063	F54198

Description
22mm AF hex bar to MO11/1 h11 tols
Part code 7610444302
HCT Code: 962U

A. HEAT TREATMENT SUPPLY CONDITION
B. TEST PIECE TREATMENT CONDITION
Solution annealed prior to cold drawing

MELTING PRACTICE
Rotech test report 131119 refers

TEST COUPON SIZE

Tensile Tests — Units N/mm2

Temp °C	*	0.20% Proof Result	0.20% Proof Spec-Min	Maximum Stress Result	Maximum Stress Spec-Min	%Elong 4D Result	%Elong 4D Spec-Min	% Reduction of Area Result	% Reduction of Area Spec-Min
20		742		890		22		40	

Impact Tests

Temp °C	*	ENERGY 1	ENERGY 2	ENERGY 3	ENERGY MIN	ENERGY AV	SHEAR % 1	SHEAR % 2	SHEAR % 3	SHEAR % MIN	SHEAR % AV	LATERAL EXPANSION 1	LATERAL EXPANSION 2	LATERAL EXPANSION 3	LATERAL EXPANSION MIN	LATERAL EXPANSION AV

Hardness 380 HBW

Component Hardness

Heat No.	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Co	N
442063	0.0160	0.4190	1.3010	0.0264	0.0298	16.517	2.0320	10.066	0.4800	0.1310	0.0390

Material free from mercury contamination during manufacturing process.
Material free from radioactivity and inspected during manufacture.
In accordance with EN 10204 3.1

Signature *Position*

H.C.T. 962U
Checked & Approved by
Parker Hannifin IP DEL
07-01-2015 13:06:25 Page 1 of 4

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F54198

Usine productrice/Hersteller/Manufacturer	CERTIFICAT DE RECEPTION 3.1 INSPECTION CERTIFICATE 3.1 ABNAHMEPRUEFZEUGNIS 3.1	UGITECH Providing special steel solutions
Ugine Avenue Paul Girod - CS 90100 73403 Ugine Cedex France 5	EN 10204 / 3.1 NF L 00-015 Certified material test report 3	1

Numéro certificat/Nummer/Number	Ordre de fab. / Auftrag / Prod. Order	N° coulée / Schmelzen Nr / Heat N°	N° lot MM / Chargen / Batch
81455163 000010 4	A1441RT14000 11-1	442063 11-2	1441RT1400 11-3

Certification - Werkzeugnis - Certificate			Marque d'usine Herstellerzeichen Supplier's Mark
AD 2000-MERKBLATT W0/TRD100 Pressure Equipment Directive 97/23/EC ISO 9001 ISO/TS 16949 ISO 14001 99	ISO 9100 ISO 9120 98	98-2	UGITECH 97
			Poinçon de l'expert Prüfstempel Inpector's stamp IQ 96

UGIMA 4404HM WIRE ROLLED PICKLED SOLUTION ANNEALED HEXAGONAL 25,000MM

Produit	UGIMA 4404HM FIL LAMINÉ(E) DÉCAPÉ HYPERTREMPÉ(E) HEXAGONAL(E) 25,000MM
Erzeugnisform	UGIMA 4404HM WALZDRAHT GEWALZT GEBEIZT LÖSUNGSGEGLÜHT SECHSKANT 25,000MM
Product	UGIMA 4404HM WIRE ROLLED PICKLED SOLUTION ANNEALED HEXAGONAL 25,000MM 6

Client - Besteller - Purchaser	N° de commande client - Kundenbestellnummer - Purchase order number
19626 OFFSHORE STAINLESS SUPPLIES LTD 9	2959006103 10

Norme de référence / Bezugsnorm / Standard for reference

ASME SA479/479M-10 Sec.II TYPE 316L
EN 10088-1/3ED2005 1.4404
AISI 316L
ASTM A479/A479M-14 TYPE 316L
UNS 12th Edition S31603

12-2

Spécification client / Kundenspezifikation / Customer's specification
ESS M011/1 FOR ANALYSIS ONLY Y4 18/12/2012 12-3

Nombre Stueckzahl Pieces Nbr	Profil Profile Shape	Dimension Ausmessung Dimension	Longueur Laenge Length	Poids Gewicht Weight
7 18	HX 19	25,000 21-1	21-2	7636 KG 22

Mode d'élaboration Erschmelzungsart Melting process	N° prélèvement Probenummer Test number	Demandé / Vorschrift / Required	42 % C	43 % SI	44 % MN	45 % NI	46 % CR	47 % MO	48 % CU	49 % S
		Min			1,2500	10,0000	16,5000	2,0000		0,0150
		Max	0,0300	0,7500	2,0000	13,0000	18,0000	2,5000	1,0000	0,0300
EAF +AOD +CC 38	84PJ 38A	coulée/ Schmelzen / Heat	0,0160	0,4190	1,3010	10,0660	16,5170	2,0320	0,4800	0,0298
		Produit / Erzeugnisform/ Product								

Demandé / Vorschrift / Required	50 % P	51 % N	52 % CO	53	54	55	70	71	72	73	74	75
Min												
Max	0,0400	0,1000										
coulée/ Schmelzen / Heat	0,0264	0,0390	0,1310									
Produit / Erzeugnisform/ Product												

Demandé / Vorschrift / Required	76	77	78	79	80	81	82	83	84	85	86	87
Min												
Max												
coulée/ Schmelzen / Heat												
Produit / Erzeugnisform/ Product												

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800

Ugine le 01.11.2014
Le Responsable Métallurgie Qualité
Der Qualitätsbeauftragter
The Quality Manager
B. POLLET

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800

HCT-962U
Checked & Approved by
Parker Hannifin IPDE
07-01-2015 13:06:25 Page 2 of 4

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Usine productrice/Hersteller/Manufacturer	CERTIFICAT DE RECEPTION 3.1 INSPECTION CERTIFICATE 3.1 ABNAHMEPRUEFZEUGNIS 3.1	UGITECH Providing special steel solutions
Ugine Avenue Paul Girod - CS 90100 73403 Ugine Cedex France 5	EN 10204 / 3.1 NF L 00-015 Certified material test report 3	1

Numéro certificat/Nummer/Number	Ordre de fab. / Auftrag / Prod. Order	N° coulée / Schmelzen Nr / Heat N°	N° lot MM / Chargen / Batch
81455163 000010 4	A1441RT14000 11-1	442063 11-2	1441RT1400 11-3

			Limite d'élasticité Streckgrenze Yield Strength		RM Zugfestigkeit Tensile	Allongement Bruchdehnung Elongation		Striction Einschnürung Red area	Dureté-Haerte-Hardness			
24	90	T°C	0,2%	1%		A5D	A4D		HB	HV	HRB	HRC
		°C	Mpa	Mpa	Mpa	%	%	%				
13	Min	20	170			30	30	40				
	Max	20					99					
	Min											
	Max											
N° prélèvement 84PJ Probenummer Test number 39B	1 L	20	272		592	52	54	75				
A l'état de Référence / treatment on test sample / Probestreifenbehandlung 14		25	26A	26B	27	28	89	29	30	88	100	37

Taux de corroyage Forging ratio Verschmiedungsgrad 77,6 101	Résilience-Kerbschlagzaehigkeit-Notch Toughness						
	Type Form Type	T°C	Sens Richtung Direction	Min	Valeurs individuelles Einzelwerte Individual values	Moyenne Mittelwerte Average	Expansion latérale Seitliche Breitung Lateral Expansion
	31	33	32	96	35	36	91
A l'état de livraison / Lieferzustand / As delivered 13 solution annealed		°C		J		J	
A l'état de Référence / treatment on test sample / Probestreifenbehandlung 14							

ASTMA479-A479M 08-10A/ASMESA-479 ED .07 SECT.II 2010 NO ADD./QQ-S-763F/AMSQQ-S-763A/ASTMA276 8A-10 56
FREE FROM WELDS & WELD REPAIRS/FREE FROM MERCURY CONTAMINATION/FREE FROM CONTINUOUS CARBIDE NETWORK
QUALITY MANUAL REV.F OF 09 JUL.2012
MATERIAL IS SOLUTION ANNEALED
INTERGRANULAR CORROSION PER ASTM A262 PRACTICES A & E ACCEPTABLE
PROVISION OF 10 CFR PART 21 & 10 CFR PART 50 APP.B APPLY
COUNTRY OF MELT SOURCE : FRANCE

DIRECT SOLUTION TREATED AT TEMP.>1040°C - WATER QUENCHED

92

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800

99

The contents of the report are accurate and all test results and operations performed by UGITECH or its subcontractors are in compliance with the material specification and the specific applicable material requirements of ASME NCA-3800

94

Ugine le 01.11.2014
Le Responsable Métallurgie-Qualité
Der Qualitätsbeauftragte
The Quality Manager

HCT 962U
Checked & Approved by
Parker Hannifin IPDE
07-01-2015 13:06:25 Page 3 of 4

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0550013Z1

PRD002861

F5498

RO Tech LABORATORIES LIMITED

LABORATORY :- MOXLEY INDUSTRIAL CENTRE, WESTERN WAY,
ADDRESS WEDNESBURY, WEST MIDLANDS, WS10 7BG
TEL: 0121 505 4050 FAX: 0121 505 1115
www.rotechlabs.co.uk info@rotechlabs.co.uk

Test Report

UKAS TESTING 0368

ITEM	DESCRIPTION	SIZE	SPECIFICATION
1	Test Bar Cast No:442063	22mm A/F hex	Material: 316 Customer Requirements.

REPORT NUMBER	131119 ISSUE 2 PAGE 1 OF 1
REPORT DATE	06/01/2014 SAMPLE RECEIPT DATE 22/12/2014
CUSTOMER	Offshore Stainless Supplies Ltd Toll Point Lichfield Road Brownhills West Midlands WS8 6JZ
ACCOUNT NO.	O009
YOUR ORDER NO.	E003021

MECHANICAL TESTS in accordance with : ASTM A370-14 ASTM E18-14a

ITEM	DIMENSIONS OF TEST PIECE	YIELD STRESS	TENSILE STRENGTH	Lo 4D	Lo 5D	EL 4D	EL 5D	REDUCTION IN AREA	HARDNESS ROCKWELL
UNIT	mm Dia	MPa	MPa	mm	mm	%	%	%	HRC
1	12.60	742	890	50		22		40	32.3 ≡ 301HBW
	Requirements	550 min	790 min	50		15 min		40 min	247-301

Comments:- The sample(s) supplied satisfied the requirements outlined on the customer purchase order

TESTED IN THE PRESENCE OF _____

Report Compiled By A J Ashcroft

Report Approved By A J Ashcroft – Laboratory Manager

H.C.T. 962U
Checked & Approved by
Parker Hannifin IPDE
07-01-2015 13:06:25 Page 4 of 4

TESTS MARKED "NOT UKAS ACCREDITED" IN THIS REPORT/CERTIFICATE ARE NOT INCLUDED IN THE UKAS ACCREDITATION SCHEDULE FOR OUR LABORATORY
TESTS MARKED 'SC' HAVE BEEN SUBCONTRACTED
OPINIONS AND INTERPRETATIONS EXPRESSED HEREIN ARE OUTSIDE THE SCOPE OF UKAS ACCREDITATION
THIS TEST REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT WRITTEN APPROVAL OF THE LABORATORY.
RESULTS IN THIS REPORT RELATE ONLY TO THE ITEMS TESTED

Customer	Delivery Address
Parker Hannifin Manufacturing Ltd Switzerland Branch, Etoy c/o Parker Hannifin Manufacturing Ltd Riverside Road Pottington Business Park Barnstaple EX31 1NP	Parker Hannifin Manufacturing Ltd

Toll Point
Lichfield Road
Brownhills
WS8 6JZ
t. 01922 414003 f. 01922 414606
e. sales@offshorestainless.co.uk

OFFSHORE STAINLESS SUPPLIES LTD.
Supplier of 1.4003 and producers of specialist stainless and high nickel products

Report No. 019096	Our Ref. 095138	Date 12/08/15	Page 1 of 1
Test No. oss001768	Customer O/No. Consignment stock	Specification MO11/1	TEST CERTIFICATE
Despatch Note No. 000000			

Item	Quantity	Weight Kg	Part No.	Heat No.	Batch No.
001	0	1323 Total	7610444302	385583	F55778

Description
22mm AF hex bar to MO11/1 h11 tols
Part code 7610444302
HCT Code : 834U

A. HEAT TREATMENT SUPPLY CONDITION
B. TEST PIECE TREATMENT CONDITION
Solution annealed prior to cold drawing

MELTING PRACTICE
Caparo test report ST0012288 refers

TEST COUPON SIZE

Tensile Tests — Units N/mm2

Temp °C	*	0.20% Proof Result	0.20% Proof Spec-Min	Maximum Stress Result	Maximum Stress Spec-Min	%Elong 4D Result	%Elong 4D Spec-Min	% Reduction of Area Result	% Reduction of Area Spec-Min
20		765		875		26		65	

Impact Tests

Temp °C	*	ENERGY 1	ENERGY 2	ENERGY 3	ENERGY MIN	ENERGY AV	SHEAR % 1	SHEAR % 2	SHEAR % 3	SHEAR % MIN	SHEAR % AV	LATERAL EXPANSION 1	LATERAL EXPANSION 2	LATERAL EXPANSION 3	LATERAL EXPANSION MIN	LATERAL EXPANSION AV	Hardness HRC

Component Hardness
18/32 HRC

Heat No.	C	Si	Mn	P	S	Cr	Mo	Ni	Co	N
385583	0.023	0.45	1.58	0.035	0.029	16.50	2.04	10.00	0.18	0.0320

Material free from mercury contamination during manufacturing process.
Material free from radioactivity and inspected during manufacture.
In accordance with EN 10204 3.1

Signature *Position*

H.C.T. 834U Checked & Approved by Parker Hannifin IPD
13-08-2015 14:15:09 Page 1 of 3
I-64

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FS5778

Larrondo LOIU (VIZCAYA) España
P.O. Box 1.323/48080 Bilbao
Tel. 34-(4) 4 71 13 00
Fax 34-(4) 4 53 16 36

Management Systems Certified by LRQA ISO 9001 / SGI 6000360 ISO 14001 / SGI 1870670

ACEROS INOXIDABLES

OLARRA

OLARRA U.K. LTD.
FOREST PARK - CLEOBURY MORTIMER
NR KIDDERMINSTER - DY14 9BD - ENGLAND

Trade Mark - Zeichen des Lieferwerkes / Anagrama del suministrador

Works Inspector Stamp - Werkssachverständiger / Sello del Inspector: 3

Certificate type - APZ Nach / Certificado tipo	Certificate nº - Prüf-Nr / Certificado nº	Date - Datum - Fecha
EN 10204/3.1	218218	20 - 01 - 2015

Our order Nº / Werks - Nr / Nº de Referencia	Heat / Schmelze / Colada	Your order Nº / Bestell - Nr / Pedido Nº
565616	385583	OLF772

Steel Grade / Werkstoff / Calidad	According to / Entsprechend / Corresponde
AISI-316 MECAMAX	ASTM A 580 / A 580M-13a.

Shape and Size - Gegenstad / Perfil y dimensión	Tolerance - Toleranz / Tolerancia	Bundles / Bunde / Bultos	Bars / Stäbe / Barras	Weight / Gewicht / Peso
HEXAGON 25,5 mm		4		5260 Kg

Requirements - Anforderungen - Exigencias

EN 10.088-3.2005.
NACE MR-0103-12.
NACE MR-0175-2003/ISO 15156-3 2009.
1.4401-1.4404-Type 316L.

Melting process / Erschmelzungsart / Proceso de Fusión	Heat treatment / Wärmebehandlung / Tratamiento térmico
E.A.F. / A.O.D.	1060C 4H/Std WATER/WASSER/AGUA

Solution annealed/Abgeschreckt/Hipertemple-Pickled/Gebeizt/Decapado-

Test results - Ergebnis der Prüfungen - Resultados de los ensayos

Dimension of Specimen / Abmessungen des Probestabes / Medida de las probetas		Rp0,2% N/mm2 MPA	Rp 1% N/mm2 MPA	Rm N/mm2 MPA	A %L 5D	A %L 4D	Z %	Hardness Härte HBw	Impact test / Kerbschlag / Resiliencia ISO V - Jules
RD. 12,50 mm.	Min.	205		515		40	50		
	Max.								
Temperature °C: 20	Spec. Nº. / Probe Nr. / Pro Nº.: 1	271	328	590		52	75	159	

	C	Si	Mn	P	S	Cr	Mo	Ni	N	Co	
Min.						16,00	2,00	10,00			
Max.	0,080	1,00	2,00	0,045	0,030	18,00	3,00	14,00	0,1000		
	0,023	0,45	1,58	0,035	0,029	16,50	2,04	10,00	0,0320	0,18	

Visual and dimensional Inspection / Besichtigung und Ausmessung / Control visual y dimensional	Radioactivity inspection / Radioaktivitätskontrolle / Controlde Radioactividad	Antimixing test / Spektrosk Verwechslungspr / Antimezcla	Grain Size / Korngrösse / Tamaño de grano
O.K.	O.K.	O.K.	

Remarks - Bemerkungen - Observaciones

IC test acc./IK prüfung nach ASTM A 262 E.13. OK
Free From Mercury contamination/Quecksilberfreiheit.

EDV / EDP
Acc. EN 10.204
Alfredo Molina
Certification Mng.

Works Inspector
Der Werkssachverständige
Inspector de fábrica

H.C.T. 834U
Checked & Approved by
Parker Hannifin IPDE
13-08-2015 14:15:09 Page 2 of 3

OSS 001768 PR0003747. F55778.

Page 1 of 1
Amendment: none

PASSED

Offshore Stainless Supplies Ltd

Toll Point Lichfield Road
BROWNHILLS WS8 6JZ
GBR

Certificate No : ST0012288
Date Received : 10 Aug 2015
Reference No : REF00003605
Date Tested : 10 Aug 2015
Order No : E004086

UKAS TESTING 0561

Caparo TESTING TECHNOLOGIES

CTT Willenhall, Unit 11, Planetary Road Industrial Estate, Planetary Road,
Willenhall, West Midlands WV13 3XA
Tel. 01902 305200 FAX: 01902 303200

CTT Willenhall is a business name of Caparo Engineering Limited, Registered in England. Registration No. 3450375,
Registered Office: Caparo House, 103 Baker Street, London W1U 6LN

Sample: Cast:385583, Batch:, Dimensions:22mm A/F Hex, Spec/Grade:316, Qty:1

Tensile Test, Standard: Tensile Testing (Machined) ASTME8/E8M-13/ASTM A370-12a

Dimensions (mm)				Proof (Stress) Rp0.2		Tensile Strength		%Elong on GL	%Elong on GL	
Width	Diam	Gauge	C.S.A.	Load (kN)	N/mm²	Load (kN)	N/mm²	4D	Sides	%Red in Area
	12.50		122.72	93.95	765	107.55	875	28.0		65
				Requirements:	≥ 555		≥ 790	≥ 15		> 40

Hardness, Standard: Rockwell Hardness Test HRC - ASTM E18-14a

Load (kg)	Results
150	27
Required:	18 / 32

Prefered Hardness results 26-30 HRC

H.C.T. 834U
Checked & Approved by
Parker Hannifin IPDE

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i-66

TRUE COPY

Note: All results are subject to uncertainty of measurement budgets, available on request. Opinions and interpretations based on test results are outside the scope of UKAS Accreditation. Results obtained from testing that has been subcontracted to an alternative UKAS laboratory shall be clearly identified. The test results reported on this certificate only relate to the item(s) submitted for testing on the Purchased Order detailed.The results on this test certificate do not in anyway confer approval of the quality of Manufacture of the Material.

Without the embossed stamp mark on this test certificate it is not the original.
Document Control No.19, Laboratory Test Certificate Issue No.1, Issue Date June 2015.

Remarks:-

Mr John Thompson (Operations Manager)
Date of signing : 10 August 2015
Signed for and behalf of CTT Willenhall

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 12: ACCUMULATOR

- MATERIAL CERTIFICATION
- HYDROSTATIC TEST

Accumulators,Inc.®
accumulators.com

Accumulators, Inc.
18435 Morton Road
Houston, TX 77084

Certificate of Conformance

Customer Name	Sales Order #
LA TURBINE CORPORATION	79146
Customer PO	**Ship Date**
23872	12/14/2016

Qty Shipped	Part No.	Description	Customer No.
1	A153100CS	15 GAL ACCUMULATOR, 3000 PSI, 2" NPT, BUNA, CS	
		National Board Number: 113330S	
1	AI-CG3-.6KT-SS	C&G ASSEMBLY KIT, 3000 PSI, 8 FT HOSE, SS, 600 PSI GAUGE	

The above listed part(s) have been inspected and documented per applicable Accumulators, Inc. Quality Control standards and meet required drawing, design, and material specifications.

Released for Shipment by Accumulators, Inc.

The user is the sole responsible party for the proper selection, installation, operation, and maintenance of these products. Accumulators, Inc. expressly assumes no liability for the users' application. User must ensure that qualified fluid power personnel review all aspects of the intended application. If Accumulators, Inc. has provided any guidance, it is of a general nature based on similar application or theoretical evaluation and does in no way warrant any specific usage. Please see our website, accumulators.com, for the original equipment warranty.

This Product Certificate does not cover any component(s) or part(s) (if any) buyer has designed, manufactured or supplied, or any third party part(s) specified by buyer , any of which may have been attached to or incorporated in the Accumulators, Inc. product. Accumulators, Inc. disclaims any and all liability for the usage of such component(s) and does not warrant it in any way. For details please see our Terms and Conditions of Sale.

Accumulators, Inc.®
accumulators.com

Accumulators, Inc.
18435 Morton Road
Houston, TX 77084

Certificate of Origin

Customer Name	Sales Order #
LA TURBINE CORPORATION	79146
Customer PO	**Ship Date**
23872	12/14/2016

Qty Shipped	Part No.	Description	Customer No.
1	A153100CS	15 GAL ACCUMULATOR, 3000 PSI, 2" NPT, BUNA, CS	
		National Board Number: 113330S	
1	AI-CG3-.6KT-SS	C&G ASSEMBLY KIT, 3000 PSI, 8 FT HOSE, SS, 600 PSI GAUGE	

The products listed above are of USA manufacture.

Bladder Accumulators / Gas Bottles:

- The majority of finished components in bladder accumulators are from USA sources of supply.
- Assembly, quality inspections, sub-assembly, any additional testing, finishing and packaging are conducted in Houston, Texas, USA.
- All units are designed in the USA.

Accessories and Parts:

- The majority of finished components in accessories and replacement parts are from USA sources of supply.
- Assembly, quality inspections, sub-assembly, any additional testing, finishing and packaging are conducted in Houston, Texas, USA.
- All units are designed in the USA.

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
(Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only)
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by Chengdu Tianren Pressure Vessel Factory / 278#, Lingbo West Road, Xindu Chengdu, Sichuan Province, 610500, People's Republic of China
(Name and address of Manufacturer)

2. Manufactured for Accumulators, Inc., 1175 Baltimoore Rd. Houston, TX77043-5003 USA
(Name and address of Purchaser)

3. Location of installation Not Known
(Name and address)

4. Type Vert.(15 gal) (Horizontal or vertical, tank) | 1507437 - 1507535 (Manufacturer's serial number) | NA (CRN) | CAI-S3-200M Rev.4 (Drawing number) | 113254- 113352 (National Board number) | 2015 (Year built)

5. ASME Code, Section VIII, Division 1 | 2013 (Edition and Addenda, if applicable (date)) | NA (Code Case numbers) | NA (Special service per UG-120(d))

6. Shell | SA-372 Gr.E Cl.70 (Material spec. number, grade) | 0.449" (Nominal thickness) | 0" (Corr. allow.) | 8.118" (Inner diameter) | 5.27 (Length (overall))

Body Flanges on Shells									Bolting			
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

7. Seams | Seamless (Long. (welded, dbl., sngl., lap, butt)) | None (R.T. (spot or full)) | 100 (Eff., %) | (*1) (H.T. temp.) | (*1) (Time, hr) | Seamless (Girth (welded, dbl., sngl., lap, butt)) | None (R.T. (spot or full)) | 100 (Eff., %) | 1 (No. of courses)

8. Heads: (a) Material SA-372 Gr.E Cl.70 (*1) (Spec. no., grade) (b) Material SA-372 Gr.E Cl.70 (*1) (Spec. no., grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	Top	0.404"	0"	-	-	-	-	4.059"	-	Concave
(b)	Bottom	0.404"	0"	-	-	-	-	4.059"	-	Concave

Body Flanges on Heads									Bolting			
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
(a)	-	-	-	-	-	-	-	-	-	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-

9. MAWP 3000 psi (Internal) NA (External) at max. temp. 200°F (Internal) NA (External).

Min. design metal temp. -40°F (*2) at 3000 psi. Hydro., pneu., or comb. test pressure Hydro 4500 psi.

Proof test NA.

10. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Nitrogen	1	0.876"	(*3)	(*3)	(*3)	(*3)	(*3)	Inherent	(*3)	(*3)	Head
Oil	1	3.5"	(*3)	(*3)	(*3)	(*3)	(*3)	Inherent	(*3)	(*3)	Head

11. Supports: Skirt No (Yes or no) Lugs - (Number) Legs - (Number) Other No (Describe) Attached - (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: NA
(Name of part, item number, Manufacturer's name and identifying stamp)

(*1) Heat treatment: Quench and Temper, 1587°F x 0.97 hrs and 1153°F x 2.06hrs, Check List No. OAR124.

(*2) Impact test conducted according to UG-84 at temperature -40°F;

(*3) Proprietary fitting.

FORM U-1A (Back)

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 35,097 expires March 28, 2017

Date June .15, 2015 Co. name Chengdu Tianren Pressure Vessel Factory (Manufacturer) Signed (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Chengdu Tianren Pressure Vessel Factory at 2799 Lingbo West Road, Xindu Chengdu, Sichuan Province, P.R.China .

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by The Hartford Steam Boiler Inspection and Insurance Company of Connecticut

have inspected the component described in this Manufacturer's Data Report on June .15, 2015 , and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date June .15, 2015 Signed (Authorized Inspector) Commissions 13686 A B (National Board (incl. endorsements))

(07/13)

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 13: IGV ACTUATOR

- CERTIFICATION OF CONFORMANCE

CALTROL
Better Together

LA Turbine Corporation
28557 Industry Drive
Valencia, CA 91355

January 3, 2017

Attn: Linda Dennis
Email: ldennis@us.atlascopco.com
Fax: 888-674-6503

ACMTC Order No.: **PO # 23869** **Item(s): 10**
Caltrol Reference Number: SO # C106145

Description: **LAT 574 667 SZ 45 DVC 6200 (PV-301)**
(SN F001243819)

** CERTIFICATION OF CONFORMANCE **

CALTROL certifies that the items herein were assembled and shipped in conformance to purchase order specifications, and in accordance with quality control standards, common to the industry.

Thank you for your business,
CALTROL, INC.

Todd Holtschulte
Inspector and Technical Sales Engineer II

FM Approvals
1151 Boston Providence Turnpike
P.O. Box 9102 Norwood, MA 02062 USA
T: **781 762 4300** F: 781-762-9375 www.fmapprovals.com

CERTIFICATE OF COMPLIANCE

HAZARDOUS (CLASSIFIED) LOCATION ELECTRICAL EQUIPMENT

This certificate is issued for the following equipment:

Models DVC60a0b-c and DVC6200bc. Digital Valve Controllers.
XP / I / 1 / BCD / T5 Ta = 80°C, T6 Ta = 75°C; Type 4X/IP66
DIP / II, III / 1 / EFG / T5 Ta = 80°C, T6 Ta = 75°C; Type 4X/IP66
I / 1 / AEx d / IIC / T5 Ta = 80°C, T6 Ta = 75°C; Type 4X/IP66
IS / I, II, III / 1 / ABCDEFG / T* Ta = **°C - GE42819; Entity; Type 4X/IP66
I / 0 / AEx ia / IIC / T* - GE42819; Entity; Type 4X/IP66
NI / I, II, III / 2 / ABCDEFG / T5 Ta = 80°C, T6 Ta = 75°C; Type 4X/IP66
I / 2 / AEx nC / IIC / T5 Ta = 80°C, T6 Ta = 75°C; Type 4X/IP66

* T5 Ta = 80ºC / T6 Ta = 75ºC for (DVC60a0c, DVC6200c)
* T4 Ta = 80ºC / T5 Ta = 77ºC / T6 Ta = 62ºC for (DVC60a0Fc, DVC6200Fc, DVC6200Pc)

Models DVC60a0c and DVC6200c Entity Parameters (per Control Drawing GE42819):
Vmax = 30 V, Imax = 226 mA, Ci = 5 nF, Li = 0.55 mH, Pi = 1.4 W

Models DVC60a0Fc, DVC6200Fc, and DVC6200Pc Entity Parameters (per Control Drawing GE42819):
I. S. Entity; Vmax = 24 V, Imax = 380 mA, Ci = 5 nF, Li = 0, Pi = 1.4 W
FISCO; Vmax = 17.5 V, Imax = 380 mA, Ci = 5 nF, Li = 0, Pi = 5.32 W

where
a = Positioner Feedback Type: 1, 2 or 3.
b = Digital Valve Controller Type: Blank, F or P (only available with DVC2000 Series)
c = Body Parts First Character: Blank or S.

Special Conditions of Use:
1. When product is used with natural gas as the pneumatic medium, the maximum working pressure of the natural gas supply shall be limited to 145psi.
2. When product is used with natural gas as the pneumatic medium the product shall not be permitted in a Class I, Division 2, Group A, B, C, D location without the proper venting installation as per the manufacturer's instruction manual.

3. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.
4. Parts of the enclosure is constructed from plastic. To prevent the risk of electrostatic sparking the plastic surface should only be cleaned only with a damp cloth.

DVC6005b. Digital Valve Controller.
XP / I / 1 / BCD / T5 Ta = 80°C, T6 Ta = 75°C; Type 4X/IP66
DIP / II, III / 1 / EFG / T5 Ta = 80°C, T6 Ta = 75°C; Type 4X/IP66
I / 1 / AEx d / IIC / T5 Ta = 80°C, T6 Ta = 75°C; Type 4X/IP66
IS / I, II, III / 1 / ABCDEFG / T* Ta = **°C - GE42819; Entity; Type 4X/IP66
I / 0 / AEx ia / IIC T* - GE42819; Entity; Type 4X/IP66
NI / I, II, III / 2 / ABCDEFG / T5 Ta = 80°C, T6 Ta = 75°C; Type 4X/IP66
I / 2 / AEx nC / IIC / T5 Ta = 80°C, T6 Ta = 75°C; Type 4X/IP66

* T5 Ta = 80ºC / T6 Ta = 75ºC for (DVC6005)
* T4 Ta = 80ºC / T5 Ta = 77ºC / T6 Ta = 62ºC for (DVC6005F)

where
b = Digital Valve Controller Type: Blank or F.

Model DVC6005 Entity Parameters (per Control Drawing GE42819):
Vmax = 30 V, Imax = 226 mA, Ci = 5 nF, Li = 0.55 mH, Pi = 1.4 W
Voc = 9.6 V, Isc = 3.5 mA, Ca = 3.6 uF, La = 100 mH, Po = 8.4 mW

Model DVC6005F Entity Parameters (per Control Drawing GE42819):
I. S. Entity; Vmax = 24 V, Imax = 380 mA, Ci = 5 nF, Li = 0, Pi = 1.4W
Voc =24 V, Isc = 17.5 mA, Ca = 121nF, La = 100 mH, Po = 105 mW
FISCO; Vmax = 17.5 V, Imax = 380 mA, Ci = 5 nF, Li = 0, Pi = 5.32W
Voc = 17.5 V, Isc = 17.5 mA, Ca = 121nF, La = 100 mH, Po = 105 mW

Special Conditions of Use:
1. When product is used with natural gas as the pneumatic medium, the maximum working pressure of the natural gas supply shall be limited to 145psi.
2. When product is used with natural gas as the pneumatic medium the product shall not be permitted in a Class I, Division 2, Group A, B, C, D location without the proper venting installation as per the manufacturer's instruction manual.
3. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.
4. Parts of the enclosure is constructed from plastic. To prevent the risk of electrostatic sparking the plastic surface should only be cleaned only with a damp cloth.

DVC60a5. Remote Feedback Assembly.
XP / I / 1 / ABCD / T4 Ta = 125°C, T5 Ta = 95°C, T6 Ta = 80°C; Type 4X/IP66
DIP / II, III / 1 / EFG / T4 Ta = 125°C, T5 Ta = 95°C, T6 Ta = 80°C; Type 4X/IP66
I / 1 / AEx d / IIC / T4 Ta = 125°C, T5 Ta = 95°C, T6 Ta = 80°C; Type 4X/IP66
IS / I, II, III / 1 / ABCDEFG / T4 Ta = 125°C, T5 Ta = 95°C, T6 Ta = 80°C - GE42819; Entity; Type 4X/IP66
I / 0 / AEx ia / IIC / T4 Ta = 125°C, T5 Ta = 95°C, T6 Ta = 80°C - GE42819; Entity; Type 4X/IP66
NI / I, II, III / 2 / ABCDEFG / T4 Ta = 125°C, T5 Ta = 95°C, T6 Ta = 80°C; Type 4X/IP66
I / 2 / AEx nA / IIC / T4 Ta = 125°C, T5 Ta = 95°C, T6 Ta = 80°C; Type 4X/IP66
Max Entity Parameters (per Control Drawing GE42819):
Vmax = 30 V, Imax = 100 mA, Ci = 0, Li = 0, Pi = 160 mW

where
a = Positioner Feedback Type: 1, 2 or 3.

Special Conditions of Use:
1. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.

DVC6205. Digital Valve Controllers.
XP / I / 1 / BCD / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
DIP / II, III / 1 / EFG / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
I / 1 / AEx d / IIC / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
NI / I, II, III / 2 / ABCDEFG / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
I / 2 / AEx nC / IIC / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66

Special Conditions of Use:
1. When product is used with natural gas as the pneumatic medium, the maximum working pressure of the natural gas supply shall be limited to 145psi.
2. When product is used with natural gas as the pneumatic medium the product shall not be permitted in a Class I, Division 2, Group A, B, C, D location without the proper venting installation as per the manufacturer's instruction manual.
3. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.
4. Parts of the enclosure is constructed from plastic. To prevent the risk of electrostatic sparking the plastic surface should only be cleaned only with a damp cloth.

Models DVC6205F and DVC6205P. Digital Valve Controllers.
XP / I / 1 / BCD / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
DIP / II, III / 1 / EFG / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
I / 1 / AEx d / IIC / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
IS / I, II, III / 1 / ABCDEFG / T4 Ta = 80°C / T5 Ta = 77°C / T6 Ta = 62°C - GE42819; Entity; Type 4X/IP66
I / 0 / AEx ia / IIC / T4 Ta = 80°C / T5 Ta = 77°C / T6 Ta = 62°C - GE42819; Entity; Type 4X/IP66
NI / I, II, III / 2 / ABCDEFG / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
I / 2 / AEx nC / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66

Models DVC6205F and DVC6205P Entity Parameters (per Control Drawing GE42819):
I. S. Entity; Vmax = 24 V, Imax = 380 mA, Ci = 5 nF, Li = 0, Pi = 1.4 W
Voc =24 V, Isc = 44 mA, Ca = 121 nF, La = 30 mH, Po = 0.33 W
FISCO; Vmax = 17.5 V, Imax = 380 mA, Ci = 5 nF, Li = 0, Pi = 5.32 W
Voc = 17.5 V, Isc = 44 mA, Ca = 121 nF, La = 30 mH, Po = 0.33 W

Special Conditions of Use:
1. When product is used with natural gas as the pneumatic medium, the maximum working pressure of the natural gas supply shall be limited to 145psi.
2. When product is used with natural gas as the pneumatic medium the product shall not be permitted in a Class I, Division 2, Group A, B, C, D location without the proper venting installation as per the manufacturer's instruction manual.
3. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.
4. Parts of the enclosure is constructed from plastic. To prevent the risk of electrostatic sparking the plastic surface should only be cleaned only with a damp cloth.

DVC6215. Remote Feedback Assembly.
XP / I / 1 / ABCD / T4 Ta = 125°C, T5 Ta = 90°C, T6 Ta = 75°C; Type 4X/IP66
DIP / II, III / 1 / EFG / T4 Ta = 125°C, T5 Ta = 90°C, T6 Ta = 75°C; Type 4X/IP66
I / 1 / AEx d / IIC / T4 Ta = 125°C, T5 Ta = 90°C, T6 Ta = 75°C; Type 4X/IP66
IS / I, II, III / 1 / ABCDEFG / T4 Ta = 125°C, T5 Ta = 90°C, T6 Ta = 75°C - GE42819; Entity; Type 4X/IP66
I / 0 / AEx ia / IIC / T4 Ta = 125°C, T5 Ta = 90°C, T6 Ta = 75°C - GE42819; Entity; Type 4X/IP66
NI / I, II, III / 2 / ABCDEFG / T4 Ta = 125°C, T5 Ta = 90°C, T6 Ta = 75°C; Type 4X/IP66
I / 2 / AEx nA / T4 Ta = 125°C, T5 Ta = 90°C, T6 Ta = 75°C; Type 4X/IP66
Entity Parameters (per Control Drawing GE42819):
Vmax = 30 V, Imax = 226 mA, Ci = 50 nF, Li = 0.55 mH, Pi = 1.4W

Special Conditions of Use:
1. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.

Models DVC60a0c and DVC6200c. Digital Valve Controllers with HW2 Electronics.
XP / I / 1 / BCD / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
DIP / II, III / 1 / EFG / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
I / 1 / AEx d / IIC / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
IS / I, II, III / 1 / ABCDEFG / T5 Ta = 80°C, T6 Ta = 61°C - GE42819; Entity; Type 4X/IP66 (with I/O Package)
I / 0 / AEx ia / IIC / T5 Ta = 80°C, T6 Ta = 61°C - GE42819; Entity; Type 4X/IP66 (with I/O Package)
IS / I, II, III / 1 / ABCDEFG / T5 Ta = 80°C; T6 Ta = 74°C - GE42819 Entity; Type 4X/IP66 (without I/O Package)
I / 0 / AEx ia / IIC / T5 Ta = 80°C; T6 Ta = 74°C - GE42819 Entity; Type 4X/IP66 (without I/O Package)
NI / I, II, III / 2 / ABCDEFG / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
I / 2 / AEx nC / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66

where
a = Positioner Feedback Type: 1, 2 or 3.
c = Body Parts First Character: Blank or S.

Models DVC60a0c and DVC6200c Entity Parameters (per Control Drawing GE42819):
Loop: Vmax = 30 V, Imax = 130 mA, Ci = 15 nF, Li = 0.55 mH, Pi = 1.0 W
or when AUX Terminals not in use:
Loop: Vmax = 30 V, Imax = 130 mA, Ci = 15 nF, Li = 0.15 mH, Pi = 1.0 W
Output Terminals: Vmax = 28 V, Imax = 100 mA, Ci = 15 nF, Li = 0.5 mH, Pi = 1.0 W

Special Conditions of Use:
1. When product is used with natural gas as the pneumatic medium, the maximum working pressure of the natural gas supply shall be limited to 145psi.
2. When product is used with natural gas as the pneumatic medium the product shall not be permitted in a Class I, Division 2, Group A, B, C, D location without the proper venting installation as per the manufacturer's instruction manual.
3. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.
4. Parts of the enclosure is constructed from plastic. To prevent the risk of electrostatic sparking the plastic surface should only be cleaned only with a damp cloth.

DVC6005. Digital Valve Controller with HW2 Electronics.
XP / I / 1 / BCD / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
DIP / II, III / 1 / EFG / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
I / 1 / AEx d / IIC / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
IS / I, II, III / 1 / ABCDEFG / T5 Ta = 80°C, T6 Ta = 61°C - GE42819; Entity; Type 4X/ IP66 (with I/O Package)
I / 0 / AEx ia / IIC / T5 Ta = 80°C, T6 Ta = 61°C - GE42819; Entity; Type 4X/IP66 (with I/O Package)
IS / I, II, III / 1 / ABCDEFG / T5 Ta = 80°C; T6 Ta = 74°C - GE42819; Entity; Type 4X/IP66 (without I/O Package)
I / 0 / AEx ia / IIC / T5 Ta = 80°C; T6 Ta = 74°C - GE42819 Entity; Type 4X/IP66 (without I/O Package)
NI / I, II, III / 2 / ABCDEFG / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
I / 2 / AEx nC / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66

Model DVC6005 Entity Parameters (per Control Drawing GE42819):
Loop Terminals: Vmax = 30 V, Imax = 130 mA, Ci = 15 nF, Li = 0.55 mH, Pi = 1.0 W
or when AUX Terminals not in use:
Loop: Vmax = 30 V, Imax = 130 mA, Ci = 15 nF, Li = 0.15 mH, Pi = 1.0 W
Output Terminals: Vmax = 28 V, Imax = 100 mA, Ci = 15 nF, Li = 0.5 mH, Pi = 1.0 W
Remote Feedback Terminals: Voc = 30 V, Isc = 21.2 mA, Ca = 55 nF, La = 78 mH, Po = 160 mW

Special Conditions of Use:
1. When product is used with natural gas as the pneumatic medium, the maximum working pressure of the natural gas supply shall be limited to 145psi.
2. When product is used with natural gas as the pneumatic medium the product shall not be permitted in a Class I, Division 2, Group A, B, C, D location without the proper venting installation as per the manufacturer's instruction manual.
3. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.
4. Parts of the enclosure is constructed from plastic. To prevent the risk of electrostatic sparking the plastic surface should only be cleaned only with a damp cloth.

DVC6205. Digital Valve Controllers with HW2 Electronics.
XP / I / 1 / BCD / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
DIP / II, III / 1 / EFG / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
I / 1 / AEx d / IIC / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
IS / I, II, III / 1 / ABCDEFG / T5 Ta = 80°C, T6 Ta = 61°C - GE42819; Entity; Type 4X/ IP66 (with I/O Package)
I / 0 / AEx ia / IIC / T5 Ta = 80°C, T6 Ta = 61°C - GE42819; Entity; Type 4X/IP66 (with I/O Package)
IS / I, II, III / 1 / ABCDEFG / T5 Ta = 80°C; T6 Ta = 74°C - GE42819; Entity; Type 4X/IP66 (without I/O Package)
I / 0 / AEx ia / IIC / T5 Ta = 80°C; T6 Ta = 74°C - GE42819 Entity; Type 4X/IP66 (without I/O Package)
NI / I, II, III / 2 / ABCDEFG / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66
I / 2 / AEx nC / T5 Ta = 80°C / T6 Ta = 75°C; Type 4X/IP66

Model DVC6205 Entity Parameters (per Control Drawing GE42819):
Loop Terminals: Vmax = 30 V, Imax = 130 mA, Ci = 15 nF, Li = 0.55 mH, Pi = 1.0 W
or when AUX Terminals not in use:
Loop: Vmax = 30 V, Imax = 130 mA, Ci = 15 nF, Li = 0.15 mH, Pi = 1.0 W
Output Terminals: Vmax = 28 V, Imax = 100 mA, Ci = 15 nF, Li = 0.5 mH, Pi = 1.0 W
Remote Feedback Terminals: Voc = 30 V, Isc = 21.2 mA, Ca = 55 nF, La = 78 mH, Po = 160 mW

Special Conditions of Use:

1. When product is used with natural gas as the pneumatic medium, the maximum working pressure of the natural gas supply shall be limited to 145psi.

2. When product is used with natural gas as the pneumatic medium the product shall not be permitted in a Class I, Division 2, Group A, B, C, D location without the proper venting installation as per the manufacturer's instruction manual.

3. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.

4. Parts of the enclosure is constructed from plastic. To prevent the risk of electrostatic sparking the plastic surface should only be cleaned only with a damp cloth.

Equipment Ratings:

Explosionproof Apparatus for use in Class I, Division 1, Groups B, C and D (Group A, B, C and D for Remote Feedback Assemblies); Flameproof Apparatus AEx d for use in Class I, Zone 1, Group IIC; Dust-Ignitionproof Apparatus for use in Class II, III, Division 1, Groups E, F and G; Intrinsically Safe for Class I, II, & III, Division 1, Groups A, B, C, D, E, F, and G per Control Drawing No. GE42819; Intrinsically Safe for Class I, Zone 0, Group IIC; Nonincendive for Class I, II, & III, Division 2, Groups A, B, C, D, E, F, and G; Enclosed Break (Nonsparking for Remote Feedback Assemblies) for Class I, Zone 2, Group IIC, indoor and outdoor (Type 4X and IP66) hazardous (classified) locations.

FM Approved for:

Fisher Controls International LLC
Marshalltown, IA United States

FM Approvals

Member of the FM Global Group

This certifies that the equipment described has been found to comply with the following Approval Standards and other documents:

Class 3600	2011
Class 3610	2010
Class 3611	2004
Class 3615	2006
Class 3810	2005
ANSI/ISA 60079-0	2009
ANSI/ISA 60079-1	2009
ANSI/ISA 60079-11	2012
ANSI/ISA 60079-15	2009
ANSI/NEMA 250	1991
ANSI/IEC 60529	2003

Original Project ID: 0003010030 Approval Granted: August 3, 2001

Subsequent Revision Reports / Date Approval Amended

Report Number	Date	Report Number	Date
3014010	April 18, 2002		
3020841	June 10, 2004		
3025682	October 13, 2006		
061020	November 6, 2006		
3034118	February 5, 2009		
3036468	June 2, 2009		
3037162	August 31, 2009		
100329	June 30, 2010		
100810	August 16, 2010		
110608	June 15, 2010		
3045664	May 24, 2012		
3047130	February 5, 2013		
3050142	June 16, 2014		

FM Approvals LLC

J.E. Marquedant

J.E. Marquedant
Manager, Electrical Systems

16 June 2014
Date

To verify the availability of the Approved product, please refer to www.approvalguide.com

L.A.Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 14: PIPING, FITTINGS & FLANGES

- MATERIAL CERTIFICATION (MILL TEST REPORTS)
- VISUAL INSPECTION CERTIFICATE
- HYDROSTATIC TEST REPORT

ENFL1607017013

E N CORPORATION
Lot 2, 4 & 6, Block 16, Phase IV, Cavite Export Processing Zone
Authority, PEZA, Rosario, Cavite, Philippines 4106
TEL : (+63) 46-437-1022-25 FAX : (+63)46-437-1018, 21

MILL TEST REPORT

PURCHASER : TA CHEN INTERNATIONAL, INC.

DATE : 2016/07/18
P. O. NO.: L55800-S
S/C NO. : P433TC

PRODUCT : STAINLESS STEEL FORGED FLANGE RF

HEAT NO.	QTY.	DESIGNATION	SPECIFICATION
GL7CL	50	304L/304 1-1/2" W/N S-40 600LB	ASME B16.5-2013/MSS SP25-2013

CHEMICAL ANALYSIS OF MATERIAL

HEAT NO.	C	Mn	Si	P	S	Cr	Ni	Mo	N	SPECIFICATION
Maxi	0.030	2.00	1.00	0.045	0.030	18.0 - 20.0	8.0 - 11.0		0.100	ASTM A/SA182-2015
GL7CL	0.027	1.38	0.41	0.035	0.009	18.11	8.33		0.072	

MECHANICAL CHARACTERISTICS

HEAT NO.	T.S-PSI	Y.S-PSI	%-E.L.	%-R.A.	HEAT-TREAT.	HARDNESS	DIMENSION	P.M.I.
Mini	75,000	30,000	30	50	1040 - 1150 °C	≤90.0 HRB		
GL7CL	86,300	40,600	66	79	1060 °C	81.0 HRB	OK	OK

MATERIAL RESISTANT TO INTERCRYSTALLINE CORROSION ICC TEST ACCORDING TO ASTM A262-10 PRACTICE E. MATERIAL IS MANUFACTURED MERCURY FREE AND FREE FROM MERCURY CONTAMINATION AND RADIO ACTIVITY. MATERIAL IS IN ACCORDANCE WITH NACE MR0175-SECOND EDITION, MR0103-2007, ISO 15156-2009 COMPLIANT. ISO 9001:2008, PED 97/23/EC CERTIFIED. EN10204:2005-3.1
MATERIAL RECEIVED SOLUTION TREAT & WATER QUENCHED AT 1060 DEGREE C
MATERIAL WAS MANUFACTURED, SAMPLED, TESTED AND INSPECTED IN ACCORDANCE WITH ASTM A182-2015 AND ASTM A961-08A AND HAS BEEN FOUND TO MEET THE REQUIREMENTS. MATERIALS ARE FREE OF WELD REPAIR

Pb CONTENT, < 0.010%

COUNTRY OF ORIGIN: PHILIPPINES

COUNTRY OF MELT: PHILIPPINES

FACTORY INSPECTOR:

DAVID WANG
QUALITY ASSURANCE DEPARTMENT

F64L4W01D

NORMA (INDIA) LIMITED

48,Site IV industrial Area, Sahibabad, Ghaziabad-201010 (U.P) INDIA.
Tel: 91-120-2896091, 2895404 Fax: 91-120-2895930 E-mail: normaindia@gmail. com

Works Test Certificate

NORMA/LAB NO-2606/14-15		INVOICE NO. E-205		DATE:-25-07-14	
P. Order. No:	202003	Customer:-	FORGINGS.FLANGES& FITTINGS.LLC. U.S.A	Forging specification	ASME SA105 -09 ASTM A105 -12
Component	3"-300# SORF FLG.			Steel Supplier	Bhushan Steels Ltd.
Drawing No.				Mill Heat No.	14E 162
Machining STD	ANSI B16.5- 2009 ASME B16.5- 2009	Quantity:-	1500Nos.		

TEST RESULTS — NORMA HEAT NO-088

CHEMICAL COMPOSTION

Elements %	Specified Composition	Actual	
		NORMA LAB	MILL T.C.
Carbon	0.35max.	0.22	0.21
Manganese	0.60-1.05	0.96	0.89
Silicon	0.10-0.35	0.24	0.24
Sulphur	0.040max.	0.014	0.012
Phosphorous	0.035max.	0.019	0.021
Chromium	0.30max.	0.10	0.010
Nickel	0.40max.	0.024	0.035
Copper	0.40max.	0.026	0.026
Molybdenum	0.12max.	0.007	0.005
Vanadium	0.080max.	0.004	0.007
Carbon Equivalent (CE)	0.47max.	0.388	0.367

MECHANICAL PROPERTIES.

PROPERTIES	SPECIFIED	OBTAINED
Yield Strength (mpa)	250.00 min.	348.53
Tensile Strength (mpa)	485.00 min.	541.96
%Elongation in 50mm / 4D	22.00 min	31.60
Hardness HB.	187. max.	149-163
% Reduction of Area	30.00 min.	60.25

Remarks:- We here by certify that the material described here in has been tested in accordance with the applicable specifications referred above and meets the requirements as per EN10204/3.1B & NACE Standard-MR0175-2003.
"As per ASTM A105 Table 1 Note:-For each reduction of 0.01% below the specified carbon maximum(0.35%).an increase of 0.06% manganese above the specified maximum (1.05%)will be permitted up to maximum 1.35%.
Country of Origin-India.

Specified carbon as per Purchase Order 0.25max.

Serrated face as per MSS-SP-6 With in limits of 125-250AARH

CARBON EQUIVALENT (CE)

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

MARKING AS PER MSS-SP-25-2008
3"-300 SA/A105 088 B16.5 NORMA INDIA.

Checked by: Metallurgist

Certified by: Quality Control Manager

L.A. TURBINE CO PO#: 24047

DESCRIPTION:
3" 300# RF SO FLANGE SA105 FS
HEAT# NO-088

PO#: H3487G Pack#: 428387 Order#: 1039705 Lot#: NOR.088 Desc: 3 300 RF SO FLG A/SA 105 NOR

NORMA (INDIA) LIMITED

48,Site IV industrial Area, Sahibabad, Ghaziabad-201010 (U.P) INDIA.
Tel: 91-120-2896091, 2895404 Fax: 91-120-2895930 E-mail: normaindia@gmail. com

Works Test Certificate

NORMA/LAB NO-8816/14-15		INVOICE NO.E-566		DATE:-25.12.14	
P. Order. No:	205504	Customer:-	FORGINGS.FLANGES& FITTINGS.LLC. U.S.A	Forging specification	ASME SA105 -09 ASTM A105 -12
Component	2"-300# SORF FLG.			Steel Supplier	R.I.N.L
Drawing No.		Quantity:-	300Nos.	Mill Heat No.	406400
Machining STD	ANSI B16.5- 2009 ASME B16.5- 2009			NORMA HEAT NO-104	

TEST RESULTS

CHEMICAL COMPOSTION

Elements %	Specified Composition	Actual	
		NORMA LAB	MILL T.C.
Carbon	0.35max.	0.227	0.24
Manganese	0.60-1.05	1.12	1.10
Silicon	0.10-0.35	0.30	0.32
Sulphur	0.040max.	0.011	0.012
Phosphorous	0.035max.	0.027	0.029
Chromium	0.30max.	0.019	0.021
Nickel	0.40max.	0.003	---
Copper	0.40max.	0.004	---
Molybdenum	0.12max.	0.001	---
Vanadium	0.080max.	0.0007	---
Carbon Equivalent (CE)	0.47max.	0.418	0.428

MECHANICAL PROPERTIES.

PROPERTIES	SPECIFIED	OBTAINED
Yield Strength (mpa)	250.00 min.	351.17
Tensile Strength (mpa)	485.00 min.	542.05
%Elongation in 50mm / 4D	22.00 min	32.90
Hardness HB.	187. max.	149-163
% Reduction of Area	30.00 min.	58.98

Remarks:- We here by certify that the material described here in has been tested in accordance with the applicable specifications referred above and meets the requirements as per EN10204/3.1B & NACE Standard-MR0175-2003.MR0103.
"As per ASTM A105 Table 1 Note:-For each reduction of 0.01% below the specified carbon maximum(0.35%).an increase of 0.06% manganese above the specified maximum (1.05%)will be permitted up to maximum 1.35%.
Country of Origin-India.

Specified carbon as per Purchase Order 0.25max.

Serrated face as per MSS-SP-6 With in limits of 125-250AARH

CARBON EQUIVALENT (CE)

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

MARKING AS PER MSS-SP-25-2008
2"-300 SA/A105 104 B16.5 NORMA INDIA.

Checked by: Metallurgist

Certified by: Quality Control Manager

L.A. TURBINE CO PO#:
24047

DESCRIPTION:
2" 300# RF SO FLANGE SA105
HEAT# NO--104

PO#: H3487G Pack#: 428387 Order#: 1039705 Lot# : NOR.104 Desc: 2 300 RF SO FLG A/SA 105 NOR

NORMA (INDIA) LIMITED

48,Site IV industrial Area, Sahibabad, Ghaziabad-201010 (U.P) INDIA.
Tel: 91-120-2896091, 2895404 Fax: 91-120-2895930 E-mail: normaindia@gmail. com

Works Test Certificate

NORMA/LAB NO-8328/15-16		INVOICE NO.E-387		DATE:-28.11.15	
P. Order. No:	205506	Customer:-	FORGINGS.FLANGES& FITTINGS.LLC. U.S.A	Forging specification	ASME SA105 -13 ASTM A105 -13
Component	1½"-600# SORF FLG.			Steel Supplier	R.I.N.L
Drawing No.					
Machining STD	ANSI B16.5- 2013 ASME B16.5- 2013	Quantity:-	08Nos.	Mill Heat No.	412399

TEST RESULTS — NORMA HEAT NO-558

CHEMICAL COMPOSTION

Elements %	Specified Composition	Actual	
		NORMA LAB	MILL T.C.
Carbon	0.35max.	0.22	0.22
Manganese	0.60-1.05	0.98	1.00
Silicon	0.10-0.35	0.21	0.23
Sulphur	0.040max.	0.011	0.012
Phosphorous	0.035max.	0.026	0.030
Chromium	0.30max.	0.014	0.012
Nickel	0.40max.	0.004	---
Copper	0.40max.	0.010	---
Molybdenum	0.12max.	0.002	---
Vanadium	0.080max.	0.003	---
Carbon Equivalent (CE)	0.47max.	0.387	0.388

MECHANICAL PROPERTIES.

PROPERTIES	SPECIFIED	OBTAINED
Yield Strength (mpa)	250.00 min.	325.25
Tensile Strength (mpa)	485.00 min.	513.36
%Elongation in 50mm / 4D	22.00 min	28.60
Hardness HB.	187. max.	149-163
% Reduction of Area	30.00 min.	63.20

Remarks:- We here by certify that the material described here in has been tested in accordance with the applicable specifications referred above and meets the requirements as per EN10204/3.1B & NACE Standard-MR0175-2003.MRO103.
"As per ASTM A105 Table 1 Note:-For each reduction of 0.01% below the specified carbon maximum(0.35%).an increase of 0.06% manganese above the specified maximum (1.05%)will be permitted up to maximum 1.65%.
Country of Origin-India /Melt: INDIA.

Specified carbon as per Purchase Order 0.25max.

Serrated face as per MSS-SP-6 With in limits of 125-250AARH

H.T-: Normalized at temp 920•C

CARBON EQUIVALENT (CE)

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

MARKING AS PER MSS-SP-25-2008
1½"-600 SA/A105 N 558 B16.5 NORMA INDIA.

Checked by: Metallurgist

Certified by: Quality Control Manager

L.A. TURBINE CO PO#: 24047

DESCRIPTION:
1-1/2 600# RF SO FLANGE SA105
HEAT# NO-588

PO#: H3487G Pack#:428367 Order#: 1039705 Lot# : NOR.558 Desc: 1-1/2 600 RF SO FLG A/SA 105 NOR

NORMA (INDIA) LIMITED

48,Site IV Industrial Area, Sahibabad, Ghaziabad-201010 (U.P) INDIA.
Tel: 91-120-2896091, 2895404 Fax: 91-120-2895930 E-mail: normamdia@gmail. com

Works Test Certificate

NORMA/LAB NO-4403/14-15
INVOICE NO.E-255
DATE:-14-08-14

P. Order. No: #NM084RA
Component 1"-600# SORF FLG.
Drawing No.
Machining STD: ANSI B16.5- 2009 / ASME B16.5- 2009

Customer:- INDUSTRIAL VALCO (HSTN)
HOUSTON
U.S.A

Quantity:- 03Nos.

Forging specification: ASME SA105 -09 / ASTM A105 -12
Steel Supplier: R.I.N.L.
Mill Heat No. 110760
NORMA HEAT NO-743

TEST RESULTS

CHEMICAL COMPOSTION

Elements %	Specified Composition	Actual NORMA LAB	Actual MILL T.C.
Carbon	0.35max.	0.22	0.23
Manganese	0.60-1.05	0.90	0.91
Silicon	0.10-0.35	0.20	0.23
Sulphur	0.040max.	0.012	0.007
Phosphorous	0.035max.	0.022	0.026
Chromium	0.30max.	0.010	---
Nickel	0.40max.	0.008	---
Copper	0.40max.	0.007	---
Molybdenum	0.12max.	0.002	---
Vanadium	0.080max.	0.001	---
Carbon Equivalent (CE)	0.47max.	0.374	0.382

MECHANICAL PROPERTIES.

PROPERTIES	SPECIFIED	OBTAINED
Yield Strength (mpa)	250.00 min.	328.77
Tensile Strength (mpa)	485.00 min.	511.60
%Elongation in 50mm / 4D	22.00 min	30.24
Hardness HB.	187. max.	156-159
% Reduction of Area	30.00 min.	53.61

Remarks:- We here by certify that the material described here in has been tested in accordance with the applicable specifications referred above and meets the requirements as per EN10204/3.1B & NACE Standard-MR0175-2003.
"As per ASTM A105 Table 1 Note:-For each reduction of 0.01% below the specified carbon maximum(0.35%).an increase of 0.06% manganese above the specified maximum (1.05%)will be permitted up to maximum 1.35% .
Country of Origin-India.

Specified carbon as per Purchase Order 0.25max.

Serrated face as per MSS-SP-6 With in limits of 125-250AARH

H.T-: Normalized at temp 920°C

CARBON EQUIVALENT (CE)

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

MARKING AS PER MSS-SP-25-2008
1"-600 SA/A105 N 743 B16.5 NORMA INDIA.

Checked by:
Metallurgist

Certified by:
Quality Control Manager

L.A. TURBINE CO PO#:
24047

DESCRIPTION:
1" 600# ASA RF SO FLNGE SA105
HEAT#S NO-743

NORMA (INDIA) LIMITED

48,Site IV industrial Area, Sahibabad, Ghaziabad-201010 (U.P) INDIA.
Tel: 91-120-2896091, 2895404 Fax: 91-120-2895930 E-mail: normaindia@gmail. com

Works Test Certificate

NORMA/LAB NO-8226/14-15		INVOICE NO.E-529		DATE:-10.12.14	
P. Order. No:	#NM104RA	Customer:-	INDUSTRIAL VALCO, INC U.S.A	Forging specification	ASME SA105 -09 ASTM A105 -12
Component	1"-600# SORF FLG.			Steel Supplier	R.I.N.L
Drawing No.				Mill Heat No.	101152
Machining STD	ANSI B16.5- 2009 ASME B16.5- 2009	Quantity:-	05Nos.	NORMA HEAT NO-722	

TEST RESULTS

CHEMICAL COMPOSTION

Elements %	Specified Composition	Actual	
		NORMA LAB	MILL T.C.
Carbon	0.35max.	0.24	0.25
Manganese	0.60-1.05	0.90	0.86
Silicon	0.10-0.35	0.24	0.22
Sulphur	0.040max.	0.015	0.013
Phosphorous	0.035max.	0.021	0.019
Chromium	0.30max.	0.007	---
Nickel	0.40max.	0.003	---
Copper	0.40max.	0.002	---
Molybdenum	0.12max.	0.001	---
Vanadium	0.080max.	0.001	---
Carbon Equivalent (CE)	0.47max.	0.392	0.393

MECHANICAL PROPERTIES.

PROPERTIES	SPECIFIED	OBTAINED
Yield Strength (mpa)	250.00 min.	356.47
Tensile Strength (mpa)	485.00 min.	530.76
%Elongation in 50mm / 4D	22.00 min	34.70
Hardness HB.	187. max.	153-163
% Reduction of Area	30.00 min.	52.11

Specified carbon as per Purchase Order 0.25max.

Serrated face as per MSS-SP-6 With in limits of 125-250AARH

H.T-: Normalized at temp 920°C

CARBON EQUIVALENT (CE)

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

MARKING AS PER MSS-SP-25-2008
1"-600 SA/A105 N 722 B16.5 NORMA INDIA.

Remarks:- We here by certify that the material described here in has been tested in accordance with the applicable specifications referred above and meets the requirements as per EN10204/3.1B & NACE Standard-MR0175-2003. MRO103.
"As per ASTM A105 Table 1 Note:-For each reduction of 0.01% below the specified carbon maximum(0.35%).an increase of 0.06% manganese above the specified maximum (1.05%)will be permitted up to maximum 1.35%.
Country of Origin-India.

Checked by: Metallurgist

Certified by: Quality Control Manager

L.A. TURBINE CO PO#:
24047

DESCRIPTION:
1" 600# ASA RF SO FLNGE SA105
HEAT# NO-722

24047

DESCRIPTION:

1" 600# ASA RF SO FLNGE SA105
HEAT#S_____RRCB-0428

TEST CERTIFICATE

Test Report / Inspection Certificate No : RFPL/N.I.C./14-15/0246/660 | Datec : 28/Aug/2014 | BS EN 10204 - 3.1 (2004)

An ISO9001-2008 Certified Organization (Ref QM 02 00345)

PED 97/23/EC & AD-2000-MARKBLATT W9 CERT NO 01 202 IND/O-12-0003

Customer

Invoice No. & Date : 4040/28-Jul-2014 | Manufacturer's Mark : RWF/INDIA

ROLLWELL FORGE PVT. LTD.
Survey No. 239/1, B/h. G.E.B. Sub Station National Highway 8/B Shapar (Veraval), Rajkot - 360002.
Phone : +91-2827-253671 Fax : +91-2827-253571
Email : info@rollwellforge.com Website : www.rollwellforge.com

Designation of Article	Material	UNS No	Surface Condition	Melting Process	Steel Mill
CARBON STEEL FORGED FLANGE	ASTM A/ASME SA 105 Ed 2013		FINISH	EAF	BALRAM ROLLING

Item Sr. No.	Quantity	Description	P.O. No.	Heat No.	Mill Heat No.
1	10	0.75"-1500#-THRF-A105-FINISH	124/005006	RRCB-0428	86
2	20	1"-1500#-BLRF-A105-FINISH	124/005006	RRCB-0428	86
3	60	1"-600#-SORF-A105-FINISH	124/005006	RRCB-0428	86
4	20	1"-600#-THRF-A105-FINISH	124/005006	RRCB-0428	86

CHEMICAL ANALYSIS (As per ASTM E-415-08)

Elements	C %	Mn %	P %	S %	Si %	Cr %	Mo %	Ni %	Cu %	V %					CE
Specified	0.35 Max	0.6-1.05	0.035 Max.	0.04 Max.	0.1-0.35	0.3 Max.	0.12 Max.	0.4 Max.	0.4 Max	0.08 Max					0.47 Max.
Ladle Analysis	0.23	0.8	0.025	0.026	0.35	0.18	0.02	0.01	0.2	0.001					0.36
RRCB-0428	0.25	0.82	0.022	0.02	0.314	0.162	0.012	0.068	0.092	0.005					0.43

Heat Treatment : Normalized at 910° C & Air Cooled

MECHANICAL TESTS (As per ASTM A370-2010)

Test No	Direction	Tensile Testing: Yield Strength Re Rp 1%	Yield Strength Re ReH/Rp 0.2% MPA	Tensile Strength Rm MPA	Elongation A Lo = 4d %	Reduction of Area Z %	V - Notch Charpy / Impact Test: Energie of Impact (Temperature +20 c) SAMPLE SIZE(10X10X55MM) 1	2	3	In	Hardness BHN
Specified		-	250 Min	485 Min	22 Min	30 Min	-	-	-	-	187 Max
RRCB-0428	T	-	357.90	515.00	35.20	60.20	-	-	-	-	163 , 167

Additional Test As Per Client Requirement

Surface and Dimensional Inspection - Acceptable as per ASME B16.5 Ed 2013 | Marking - Acceptable as per ASME B16.5 Ed 2013

Ultrasonic Test - N.A | IGC Test - N.A

Magnetic Particle Examination - N.A

NACE MR-0175/Ed 2003 & NACE MR 0103 Ed 2012 & ISO 17945 Ed 2015 - N.A

For ROLLWELL FORGE PVT. LTD.

(Lab Incharge) (Q.C. Manager)

We Confirm That Material is Free From Mercury Contamination & Radioactive Contamination.

Remarks : WE CERTIFY THAT THE MATERIAL HAS BEEN TESTED AND COMPLIES WITH THE GIVEN PURCHASE ORDER

F.QC.12 (00 / 01.04.12)

MF RINGS AND BEARING RACES LIMITED

PLOT NO. 06, SECTOR-4, INDL. AREA, BALLABHGARH, FARIDABAD.121 004
REGD. OFF : 21, COMMUNITY CENTRE, MAYAPURI INDL. AREA,
NEW DELHI – 110064.
Ph.:- 40777222, 40777333, 28114458 Fax:- 28115759
E-mail :- metalforgings@metalforgings.co.in & sales@metalforgings.co.in

F/QC/13 REV-00

TEST CERTIFICATE

AS PER EN-10204:2004 TYPE 3.1

Work T.C. No. 24089 DATED 02.03.2015

Customer M/s. THE GLOBAL GROUP

Address 17006, SOUTH FIGUEROA GARDENA CA 90248-3019 U.S.A.

PO. No. & Date 205460 DATED DECEMBER 05, 2014

Material Specification ASTM A105-2013 / ASME SA105 OF ASME SEC.II PART-A (2013) & Product Specification GSS 7.4.2-02

Invoice No. MFRB-111

Dimension Std:- ASME B16.5 (2013)

We hereby certify that the material detailed meets the requirement of Purchase Order / Relevant specification.

Item No.	Description	Qty.	Heat Code (MF)	Raw Material Heat	H.T. /Temp.	Soaking Time	Cooling Media
AS PER ANNEXURE-A							

CHEMICAL COMPOSITION IN%

Raw Material Heat	Heat Code (MF)	Mn 0.60-1.05	P 0.035 Max.	S 0.040 Max.	Si 0.10-0.35	Ni 0.40 Max.	Cr 0.30 Max.	Mo 0.12 Max.	V 0.08 Max.	Cu 0.40 Max.	Al 0.02 Min.
					Mill Test Report						
22161	EX-3379	0.19	0.017	0.012	0.24	0.01	0.013	0.001	0.002	0.01	0.033
3404487	EX-3419	0.19	0.018	0.008	0.26	0.007	0.016	0.003	0.005	0.006	0.031
14AJ072	EX-3464	0.205	0.014	0.018	0.23	0.018	0.027	0.001	0.002	0.009	0.027
	EX-3479	0.197			Product Analysis						
	EX-3507	0.19	0.020	0.014	0.21	0.014	0.017	0.006	0.008	0.012	0.030
			0.020	0.012	0.235	0.011	0.019	0.006	0.007	0.009	0.028
			0.017	0.020	0.213	0.020	0.024	0.007	0.008	0.012	0.025
			0.021	0.015	0.22	0.013	0.019	0.006	0.006	0.013	0.029
			0.021	0.010	0.24	0.010	0.018	0.008	0.008	0.010	0.027

PHYSICAL PROPERITIES

Heat Code (MF)	Y (0.2% O M	UTS.(P.S.I.) Min 70,000	Elong% (4D) Min 22%	R.A.% Min 30%	Hardness (HBW) 187 Max.	Charpy 2mm V-Notch Test Temp. (mine in Joules) Specimen Size 10x10x55mm
AS PER ANNEXURE-B						

REMARKS.:-

1. Raw mate… production is free from mercury contamination and radiation.
2. Meet all (… of latest revision of NACE MR0103, NACE MR0175 and ISO 15156.
3. No weld r… carried out. Material is free of rust.
4. Hardness … Job two forgings per Heat Code (MF) & found 153 to 163 HBW.
5. Above flan… red in India from raw material manufactured in India.
6. Included e… t from ASTM A105 Section 12 & ASTM A961 Section 19, latest revision.

L.A. TURBINE CO PO#:
24047

DESCRIPTION:
2" 150# RF BLIND FLANGE SA105
HEAT# EX-3479

Signature/ Seal of Surve…

Incharge QC…

MILL TEST REPORT

TA CHEN INTERNATIONAL, INC.

Customer: DUHLOS PO#:H3487 SO#:LRH854

Item:F64L8010 Heat#:98994

This MTR contains 1 page (Page# 1)

MTR#:VIFL9406803.GIF

VIRAJ

PROFILES LTD.(FORGING DIVISION)

INSPECTION CERTIFICATE & MILL TEST REPORT - EN 10204 3.1

Customer :	ISO 9001:2008-TUV NORD REG.No-44100911170-E3	INVOICE NUMBER / MTR NO.	99406W3
TA CHEN INTERNATIONAL INC. 9525 WALLISVILLE ROAD HOUSTON, TX 77013	EXPIRY DATE : 21.01.2016	DATE	19.08.2015
	AD 2000 MERKBLATT WO-072031423 WP 1022/14 Q	MATERIAL SPECIFICATION	ASTM A182/A182M- 14B / ASME SA182/SA182M - 13
	AS PER W2/W9/W10 EXPIRY DATE FEBRUARY 2017		
	PED 97/23/EC QMS REG.NO.072021423 WZ 1022/14 Q	PURCHASE ORDER NO.	L50548
	EXPIRY DATE: FEBRUARY 2017	DESCRIPTION	STAINLESS STEEL FORGED FLANGES

CHEMICAL ANALYSIS

Sr.No	Item Description	Dimension Specification	Heat No	Qty	%C	%Mn	%Si	%S	%P	%Cr	%Ni	%Mo	%Ti	%N		
13	304/304L 1-1/4" BLRF 3000	B16.5	98978	11.000	0.0200	1.120	0.410	0.0250	0.0360	18.260	8.040	0.410	0.0030	0.07800		
14	304/304L 1" BLRF 6000	B16.5	98994	38.000	0.0180	1.100	0.390	0.0280	0.0370	18.150	8.090	0.300	0.0020	0.08100		

MECHANICAL PROPERTIES

Sr.No	Heat No.	Tensile Strength (MPA)	Proof Stress Rp=0.2 % (MPA)	Proof Stress Rp=1.0% (MPA)	% Elongation LO=4D	% Reduction of Area	Hardness BHN	IMPACT TEST-CHARPY V-NOTCH AT +20 DEG. C (JOULES) 1	2	3	AVG
13	98978	564.670	292.090	309.310	60.20	67.42	156.0	180.0	179.0	183.0	181.0
14	98994	574.220	277.510	327.200	58.80	69.70	155.0	180.0	184.0	176.0	180.0

NACE CERT	MATERIAL CONFORMS TO NACE MR 0175 / ISO 15156 - 2009 & NACE MR 0103 - 2012
MELTING PROCESS	: INDUCTION / AOD (IRS) / CONCAST
HEAT TREATMENT	: SOLUTION ANNEALED AT 1080°C AND WATER QUENCHED
DIMENSIONS	: CONFORM WITH THE SPECIFICATION (100% INSPECTED)
SURFACE QUALITY	: SATISFACTORY
PMI	: NO OBJECTION/100% TESTED WITH MOBILE SPECTRO)
INTER GRANULAR CORROSION TEST	: PASSED IGC TEST IN ACCORDANCE WITH ASTM A262 PRACTICE E
MICRO OBSERVATION	: NO CARBIDE PRECIPITATION OBSERVED ON GRAIN BOUNDARIES
RADIOACTIVITY TEST	: ALL THE ABOVE MATERIAL IS TESTED FOR RADIOACTIVITY AND FOUND WITH IN THE LIMIT OF BACKGROUND RADIATION
REMARKS	: MATERIAL WAS MANUFACTURED,SAMPLE TESTED & INSPECTED IN ACCORDANCE WITH INDICATED SPECIFICATION/SI & FOUND TO MEET THE REQUIREMENTS : NO WELD REPAIR WAS PERFORMED & ALL THE ITEMS ARE FREE OF WELD REPAIR

WE CERTIFY THAT THE MATERIAL DESCRIBED ABOVE HAS BEEN TESTED AND COMPLIES WITH THE ORDER/CONTRACT AND IS OF INDIAN ORIGIN

MANUFACTURER'S SYMBOL

WORKS INSPECTOR

FACTORY : Survey No. 1301, Saravali & 69-75, MIDC Tarapur Industrial Area Boisar, Dist. Thane, Maharashtra-401 506. (INDIA). Tel.:+91 (0) 9049999100/6 to 1041 Fax: (+6125253 375587. E-MAIL:viflqc@viraj.com

ENFL1607017006

E N CORPORATION
Lot 2, 4 & 6, Block 16, Phase IV, Cavite Export Processing Zone
Authority, PEZA, Rosario, Cavite, Philippines 4106
TEL : (+63) 46-437-1022-25 FAX : (+63)46-437-1018, 21

MILL TEST REPORT

PURCHASER : TA CHEN INTERNATIONAL, INC.

DATE : 2016/07/18
P. O. NO.: L55800-S
S/C NO. : P433TC

PRODUCT : STAINLESS STEEL FORGED FLANGE RF

HEAT NO.	QTY.	DESIGNATION	SPECIFICATION
GL7CD	50	304L/304 3/4' BL 600LB	ASME B16.5-2013/MSS SP25-2013

CHEMICAL ANALYSIS OF MATERIAL

HEAT NO.	C	Mn	Si	P	S	Cr	Ni	Mo	N	SPECIFICATION
Maxi	0.030	2.00	1.00	0.045	0.030	16.0 - 18.0	10.0 -14.0	2.0 - 3.0	0.100	ASTM A/SA182-2015
GL7CD	0.024	1.65	0.49	0.040	0.020	16.73	10.07	2.03	0.078	

MECHANICAL CHARACTERISTICS

HEAT NO.	T.S-PSI	Y.S-PSI	%-E.L.	%-R.A.	HEAT-TREAT.	HARDNESS	DIMENSION	P.M.I.
Mini	75,000	30,000	30	50	1040 - 1150 °C	≤90.0 HRB		
GL7CD	81,200	37,000	65	80	1060 °C	77.0 HRB	OK	OK

MATERIAL RESISTANT TO INTERCRYSTALLINE CORROSION ICC TEST ACCORDING TO ASTM A262-10 PRACTICE E. MATERIAL IS MANUFACTURED MERCURY FREE AND FREE FROM MERCURY CONTAMINATION AND RADIO ACTIVITY. MATERIAL IS IN ACCORDANCE WITH NACE MR0175-SECOND EDITION, MR0103-2007, ISO 15156-2009 COMPLIANT ISO 9001:2008, PED 97/23/EC CERTIFIED, EN10204 2005-3.1
MATERIAL RECEIVED SOLUTION TREAT & WATER QUENCHED AT 1060 DEGREE C
MATERIAL WAS MANUFACTURED, SAMPLED, TESTED AND INSPECTED IN ACCORDANCE WITH ASTM A182-2015 AND ASTM A961-08A AND HAS BEEN FOUND TO MEET THE REQUIREMENTS. MATERIALS ARE FREE OF WELD REPAIR

Pb CONTENT: < 0.010%

COUNTRY OF ORIGIN: PHILIPPINES

COUNTRY OF MELT: INDIA

FACTORY INSPECTOR:

DAVID WANG
QUALITY ASSURANCE DEPARTMENT

F64LB00E

N-1607017006

SM-005-0

ENFL1608024061

E N CORPORATION
Lot 2, 4 & 6, Block 16, Phase IV, Cavite Export Processing Zone
Authority, PEZA, Rosario, Cavite, Philippines 4106
TEL : (+63) 46-437-1022~25 FAX : (+63)46-437-1018, 21

MILL TEST REPORT

PURCHASER : TA CHEN INTERNATIONAL, INC.

DATE : 2016/08/20
P. O. NO.: L58934-S
S/C NO. : Q150TC

PRODUCT : STAINLESS STEEL FORGED FLANGE RF

HEAT NO.	QTY.	DESIGNATION	SPECIFICATION
GL849	50	304L/304 1" W/N S-80 600LB	ASME B16.5-2013/MSS SP25-2013

CHEMICAL ANALYSIS OF MATERIAL

HEAT NO.	C	Mn	Si	P	S	Cr	Ni	Mo	N	SPECIFICATION
Maxi	0.030	2.00	1.00	0.045	0.030	18.0 - 20.0	8.0 - 11.0		0.100	ASTM A/SA182-2015
GL849	0.022	1.73	0.36	0.029	0.002	18.30	8.01		0.077	

MECHANICAL CHARACTERISTICS

HEAT NO.	T.S-PSI	Y.S-PSI	%-E.L.	%-R.A.	HEAT-TREAT.	HARDNESS	DIMENSION	P.M.I.
Mini	75,000	30,000	30	50	1040 - 1150 °C	≤90.0 HRB		
GL849	75,400	39,900	56	75	1060 °C	79.0 HRB	OK	OK

MATERIAL RESISTANT TO INTERCRYSTALLINE CORROSION ICC TEST ACCORDING TO ASTM A262-10 PRACTICE E. MATERIAL IS MANUFACTURED MERCURY FREE AND FREE FROM MERCURY CONTAMINATION AND RADIO ACTIVITY. MATERIAL IS IN ACCORDANCE WITH NACE MR0175-SECOND EDITION, MR0103-2007, ISO 15156 2009 COMPLIANT ISO 9001:2008, PED 97/23/EC CERTIFIED. EN10204:2006-3.1
MATERIAL RECEIVED SOLUTION TREAT & WATER QUENCHED AT 1060 DEGREE C.
MATERIAL WAS MANUFACTURED, SAMPLED, TESTED AND INSPECTED IN ACCORDANCE WITH ASTM A182-2015 AND ASTM A961-08A AND HAS BEEN FOUND TO MEET THE REQUIREMENTS. MATERIALS ARE FREE OF WELD REPAIR

Pb CONTENT. < 0.010%

COUNTRY OF ORIGIN. PHILIPPINES

COUNTRY OF MELT. TAIWAN

FACTORY INSPECTOR:

DAVID WANG
QUALITY ASSURANCE DEPARTMENT

F64L8W010

N-1608024061

SM-005-0

PO#: 276679 Pack# :429354 Order#: 1040306 Lot# : TOP.141106V02 Desc: 1 X 3/4 80S SMLS CONC RED A/SA403 304/L TOP

TOPPER Piping Materials Co.,Ltd

TOPPER (Shanghai) Piping Materials Co., Ltd

Add: 3318 Tingwei Ave.,Jinshan District, Shanghai 201507 China
Tel:+8621 57259999 Fax:+862157256789 www.topperfitting.com

MILL TEST CERTIFICATE (EN10204 3.1)

检验证书：EN10204:2004	证书号：MTC-TOPPER-TOPPER15012-050	I
Certificate：EN10204:2004	Certificate No.: MTC-TOPPER1-TOPPER15012-050	I

客户/Customer: Intergrowth Industry Inc.
订单号/Order No.:207519
品名/Article:管件/ PIPE FITTINGS
技术条件/Specification: ANSI B16.9-2012
材料/Material: ASTM/ASME A/SA403-2013 WP304/304L-S
加工工艺/Workmanship:冷成型/Cold Forming
交货状态/Delivery Conditions: Solution .descaled .pickled and passivated

标识/Marking: to MSS SP-25
Manufacture's mark: TOPPER
Country of Melt: China
Heat Number:141106V02
05A0592/150123T10

产品交货范围/Extend of material delivery

序号 Item No.	品名 Description	规格 Dimension	数量 Quantity	炉号 Heat No.	备注 Remark
197	CONC RED	1"*½"*SCH 80S	50	141106V02	232
198	CONC RED	1"*¾"*SCH 80S	50	141106V02	233
199	CONC RED	1 ¼" *¾"*SCH 80S	10	05A0592	234
200	CONC RED	1 ¼"*½"*SCH 80S	25	150123T10	235

试验结果/Test Results: 标准要求已符合，见如下表格/The requirements are fulfilled as listed in Annex.
A 化学成分/chemical composition:

炉号/Heat No.	C%	Mn%	Si%	S%	P%	Cr%	Ni%
WP304/304L-S	≤ 0.030	≤ 2.00	≤ 1.00	≤ 0.030	≤ 0.045	18.00-20.00	8.00-11.00
141106V02	0.013	1.54	0.32	0.002	0.033	18.10	8.05
05A0592	0.023	1.23	0.39	0.007	0.033	18.23	8.16
150123T10	0.019	1.44	0.373	0.002	0.037	18.25	8.16

B 机械性能/Mechanical

试样号 Specimen	试验温度 Test Temp	屈服强度 Yield Strength	拉伸强度 Tensile Strength	延伸% Elongation	硬度 Hardness	冲击试验 Charpy IMPact
Nr./No.	25℃	MPa	MPa	%	HRB	–
WP304/304L-S		≥205	≥515	≥28	≤90	
197/198	141106V02	240	580	51	77	–
199	05A0592	249	546	46	75	–
200	150123T10	265	575	55	75	–

C 无损探伤，尺寸检查及水压试验/Hydrostatic Test, NDT and Dimension check:

试验/Testing	结果/Result	试验/Testing	结果/Results
尺寸检查/ Dimension check	OK	水压试验/Hydrostatic pressure test	N/A
表面检查/Surface quality inspection	OK	100% PMI Test	PASSED
晶间/IGC to ASTM A262-2013 "E"	OK .	X射线/X-ray test ASME Ⅷ UW-51	N/A

D 备注/Remarks: MANUFACTURER IS CERTIFIED ISO 9001:2008; MATERIAL IS EN10204-3.1 COMPLIANT; MATERIAL IS PED 97/23/EC CERTIFIED;

1.热处理 / Solution (at 1050℃ not less than 15.min) and quenched

2.We hereby certify that the product described herein has been manufactured in accordance with the specifications concerned and also with the purchaser's requirements and that the test results shown herein are correct

3. We hereby stae that material free from mercury and radiation contamination.Hardness test done per NACE MR0175-2009/MR 0103-2012;

地址：上海
Address: SHANGHAI CHINA

日期:2015-7-15
Date: July 15,2015

制单:
Inspector: 刘怡君

复验:
Approved:吴维东

审核:
Approval: 武智雄

L.A. TURBINE CO PO#:
24047 JOB LAT574

DESCRIPTION:
1" X 3/4 S80 SMLS CONC REDUCER
SA403 WP304/304L HT# 141106V02

Sold to: MACHINE & REGULATOR PO: VERBAL Part: Order No.:909337 TR.

304L
1-3/8"RD
Y4P0
B0816

NAS NORTH AMERICAN STAINLESS

METALLURGICAL TEST REPORT

6870 Highway 42 East
Ghent, KY 41045-9615
(502) 347-6000

Certificate: 158720 02

Mail To:
BRALCO METALS
ACCOUNTS PAYABLE
LA MIRADA CA 90638

Ship To:
BRALCO METALS
15090 NORTHAM STREET
LA MIRADA CA 90638

Date: 3/28/2016 Page: 1 Of 1
Steel: 304/304L
Finish: Cold Finish
Dia/Thk: 1.3750 in
Leg Length:
Length: 144.00 in
Corrosion: ASTM A262-10 Prac A/E OK

Customer: 0555 001
NAS Order: LP 45491 5
Your Order: 43-130338 Item Code:

PRODUCT DESCRIPTION:

Round Bar, Annealed, Smooth Turned, Cold Finished
UNS 30400/30403, EN 10204 3.1, ASTM A484/13a
ASTM A276/15, ASTM A479/15, ASTM A182/13 CHEM ONLY,
ASME SA479/13, ASME SA182/10 CHEM ONLY
AMS 5639H, AMS 5647J, AMS QQS-763C, QQS-763P
NACE MR0175/MR0103(MID RADIUS ONLY), ASTM F899/11
SOLUTION ANNEAL TEMP 1900F MIN, ASTM A320/08 CL 1 GR B8
ASTM A193/10A-ASME SA193/10 CL 1 GR B8(EXC PAR 7.2)

REMARKS:

COMPLIES W/REQUIREMENTS OF.DFAR 252.225-7009 EU DIRECTIVE
2011/65/EU.RoHS. EAF+AOD+CC. NO WELD REPAIR. MELTED AND MFG
IN USA FREE FROM MERCURY AND LOW MELTING ALLOY CONTAMINATION

Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight
BH85299	1377																

CHEMICAL ANALYSIS

CM(Country of Melt) ES(Spain) US(United States) ZA(South Africa) JP(Japan)

Lab Accreditation Bureau, ISO/IEC 17025, Certificate# L2323
Chemical Analysis per ASTM A751/14a

Heat	Supplier #	CM	C %	CO %	CR %	CU %	MN %	MO %	N %	NI %	P %	S %
Y4P0		US	.016	.21	18.04	.48	1.38	.31	.082	8.51	.028	.0270

SI %
.20

MECHANICAL PROPERTIES

	Loc	Dir	HB No.	.2YS KSI	UTS KSI	RA %	Elng % 4D
BH85299	R	L	159.0	42.00	85.00	68.00	53.00

L.A. TURBINE CO PO#:
24047 JOB LAT573

DESCRIPTION:
1" SW X 1/2 FNPT REDUCING INSRT
T304/304L SPECIAL HT# Y4P0

NAS hereby certifies that the analysis on this certification is correct. Based upon the results and the accuracy of the test methods used, the material meets the specifications stated. These results relate only to the items tested and this report cannot be reproduced, except in its entirety, without the written approval of NAS

Technical Dept.Mgr. KRIS LARK

Sold to: MACHINE & REGULATOR PO: VERBAL Part: Order No.:009337 TR:

304L
1-3/8"RD
Y4P0
B0816

NAS NORTH AMERICAN STAINLESS

METALLURGICAL TEST REPORT

6870 Highway 42 East
Ghent, KY 41045-9615
(502) 347-6000

Certificate: 158720 02

Mail To:
BRALCO METALS
ACCOUNTS PAYABLE
LA MIRADA CA 90638

Ship To:
BRALCO METALS
15090 NORTHAM STREET
LA MIRADA CA 90638

Customer: 0555 001
NAS Order: LP 45491 5
Your Order: 43-130338 Item Code:

Date: 3/28/2016 Page: 1 Of 1
Steel: 304/304L
Finish: Cold Finish
Dia/Thk: 1.3750 in
Leg Length:
Length: 144.00 in
Corrosion: ASTM A262-10 Prac A/E OK

PRODUCT DESCRIPTION:

Round Bar, Annealed, Smooth Turned, Cold Finished
UNS 30400/30403, EN 10204 3.1, ASTM A484/13a
ASTM A276/15, ASTM A479/15, ASTM A182/13 CHEM ONLY,
ASME SA479/13, ASME SA182/10 CHEM ONLY
AMS 5639H, AMS 5647J, AMS QQS-763C, QQS-763F
NACE MR0175/MR0103(MID RADIUS ONLY), ASTM F899/11
SOLUTION ANNEAL TEMP 1900F MIN, ASTM A320/08 CL 1 GR B8
ASTM A193/10A-ASME SA193/10 CL 1 GR B8(EXC PAR 7.2)

REMARKS:

COMPLIES W/REQUIREMENTS OF DFAR 252.225-7009 EU DIRECTIVE
2011/65/EU.RoHS. EAF+AOD+CC. NO WELD REPAIR. MELTED AND MFG
IN USA FREE FROM MERCURY AND LOW MELTING ALLOY CONTAMINATION

Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight	Bundle	Weight
BH85299	1377																

Lab Accreditation Bureau, ISO/IEC 17025, Certificate# L2323

CHEMICAL ANALYSIS

CM(Country of Melt) ES(Spain) US(United States) ZA(South Africa) JP(Japan)

Chemical Analysis per ASTM A751/14a

Heat	Supplier #	CM	C %	CO %	CR %	CU %	MN %	MO %	N %	NI %	P %	S %
Y4P0		US	.016	.21	18.04	.48	1.38	.31	.082	8.51	.028	.0270

SI %
.20

MECHANICAL PROPERTIES

	Lot	Dir	HB No.	.2YS KSI	UTS KSI	RA %	Elng % 4D
BH85299	R	L	159.0	42.00	85.00	68.00	53.00

L.A. TURBINE CO PO#:
24047 JOB LAT574

DESCRIPTION:
1" SW X 1/2 FNPT REDUCING INSRT
T304/304L SPECIAL HT# Y4P0

NAS hereby certifies that the analysis on this certification is correct. Based upon the results and the accuracy of the test methods used, the material meets the specifications stated. These results relate only to the items tested and this report cannot be reproduced, except in its entirety, without the written approval of NAS

Technical Dept.Mgr. KRIS LARK

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

AUXILIARY PIPING FOR FABRICATION WELDS VISUAL INSPECTION

WELDS VISUAL INSPECTION

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS) MOUNTED ON COMMON SKID

THIS IS TO CERTIFY THAT VISUAL INSPECTION HAS BEEN PERFORMED IN ACCORDANCE WITH ASME/ANSI B31.3 ON THE **AUXILIARY LUBE OIL AND SEAL GAS PIPING FABRICATION WELDS.**

THE INSPECTION RESULTS HAVE BEEN FOUND SATISFACTORY.

INSP. PERFORMED BY: _____ 03/01/17
Segundo Diaz, Supervisor **DATE**

INSP. CONFIRMED BY: _____ 3/1/17
Frank Loth, Quality Manager **DATE**

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

AUXILIARY SEAL GAS PIPING

HYDROSTATIC PRESSURE TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS) MOUNTED ON COMMON SKID

THIS IS TO CERTIFY THAT **AUXILIARY SEAL GAS PIPING** OF THE ABOVE REFERENCED PURCHASE ORDER HAS SUCCESSFULLY PASSED THE HYDROSTATIC PRESSURE TEST PERFORMED AT THE INDICATED CONDITIONS:

DESIGN PRESSURE: 1200 PSIG

TEST PRESSURE: 1800 PSIG

TEST MEDIUM: WATER

HOLDING TIME: 30 MINUTES

PRESSURE GAUGE S/N: LAT 174

CALIBRATION DUE DATE: 08/04/2017

TEST PERFORMED BY: _____ 03/01/17
Segundo Diaz, Supervisor — DATE

TEST CONFIRMED BY: _____ 3/1/17
Frank Loth, Quality Manager — DATE

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

AUXILIARY LUBE OIL PIPING

HYDROSTATIC PRESSURE TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS) MOUNTED ON COMMON SKID

THIS IS TO CERTIFY THAT **AUXILIARY LUBE OIL PIPING** PASSED THE HYDROSTATIC PRESSURE TEST PERFORMED AT THE INDICATED CONDITIONS OF THE ABOVE REFERENCED PURCHASE ORDER, HAS SUCCESSFULLY:

DESIGN PRESSURE: 650 PSIG

TEST PRESSURE: 975 PSIG

TEST MEDIUM: WATER

HOLDING TIME: 30 MINUTES

PRESSURE GAUGE S/N: LAT 060

CALIBRATION DUE DATE: 08/04/2017

TEST PERFORMED BY: _____ 03/01/17
Segundo Diaz, Supervisor — DATE

TEST CONFIRNED BY: _____ 3/1/17
Frank Loth, Quality Manager — DATE

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 15: VALVES & REGULATORS

- CERTIFICATE OF CONFORMANCE

Control Valves
Regulators

P.O. Box 6

Ellsworth, KS

67439-0006

CERTIFICATE OF CONFORMANCE
03-JAN-17

Order Number: AK9381-001

Customer PO Number: 23783

Product Code: 9S6-54S7-HBX32935C

Order Qty: 1

Description:
MODEL "123-1+6+S" DIFF BACK PRESS RELIEF REGULATOR,NON-NACE SERVICE 1" SIZE,3/4" FULL ORIFICE; WCB BODY & SPRING CHAMBER; S40S TRIM: 316SST METAL SEAT,FLUOROCARBON ELASTOMER (FKM) DIAPHRAGM; OPT-30: 600 LB RAISED FACE FLANGES; 65-160 PSID RANGE SPRING; PER SPQ/MA DRAWING NUMBER 32935 ;

Tag Numbers:
PDCV-101

This document certifies that the products supplied conform to the order requirements.

This is to certify that the regulators as listed are constructed of materials per our regulator terminology noted on the customer confirmation. The pressure containing castings will withstand hydrostatic test pressures at 1.5x the maximum rated pressure. The regulators have been tested per operating conditions for conformance and checked for no external leakage at the stated operating pressure (using concentrated leak detection solution) .

All phases of manufacturing, assembly and testing have been performed to qualified procedures and specifications, per Cashco's ISO management systems.

Quality Management System - ISO 9001:2008
Certificate No. 10002254 QM08

Environmental Management System – ISO 14001:2004
Certificate No. 10002254 UM

Occupational Health and Safety Management System – ISO 18001:2007
Certificate No. 10002165 BSOH

For and on behalf of Cashco, Inc.

Darrin Vanderbilt
Engineering Services Manager

Control Valves
Regulators

P.O. Box 6

Ellsworth, KS

67439-0006

CERTIFICATE OF CONFORMANCE

21-DEC-16

Order Number: AK9381-002

Customer PO Number: 23783

Product Code: 3B6-5367-81080000A

Order Qty: 1

Description:
MODEL "HP" PRESSURE REDUCING REGULATOR,GRAPHITE/NBR GASKETS 1" SIZE; WCB BODY & SPRING CHAMBER; S36 TRIM: 316SST WITH TFE SEAT,302SST DIAPHRAGM; OPT-30: 600 LB RAISED FACE FLANGES; 10-40 PSIG RANGE SPRING; OPT-1+6: DIFFERENTAL CONSTRUCTION WITH CLOSING CAP;

Tag Numbers:
PDCV-201

This document certifies that the products supplied conform to the order requirements.

This is to certify that the regulators as listed are constructed of materials per our regulator terminology noted on the customer confirmation. The pressure containing castings will withstand hydrostatic test pressures at 1.5x the maximum rated pressure. The regulators have been tested per operating conditions for conformance and checked for no external leakage at the stated operating pressure (using concentrated leak detection solution) .

All phases of manufacturing, assembly and testing have been performed to qualified procedures and specifications, per Cashco's ISO management systems.

Quality Management System - ISO 9001:2008
Certificate No. 10002254 QM08

Environmental Management System – ISO 14001:2004
Certificate No. 10002254 UM

Occupational Health and Safety Management System – ISO 18001:2007
Certificate No. 10002165 BSOH

For and on behalf of Cashco, Inc.

Darrin Vanderbilt
Engineering Services Manager

FROST ENGINEERING SERVICE
1260 LOGAN AVENUE SUITE A7 COSTA MESA, CA 92626 714.549.9222

CERTIFICATE OF CONFORMANCE

We certify the Quality and Quantity of your Purchase Order number 23745. We certify the Amot part number: 1 1/2" CFSK12001 Temperature Control Valve, TAG TCV-101 supplied to you are genuine parts and are in accordance with all specifications stated by the manufacturer. In addition, all materials and/or products comply with published descriptive literature, and/or drawings. Job number LAT573-SYSTEM

FROST ENGINEERING SERVICE

Tiffany Gecsey
Operations Supervisor
December 2016

EMERSON
Process Management

Inspection certificate
Certificat de Réception
Abnahmeprüfzeugnis
EN 10204 3.1

FISHER

Fisher Controls International, LLC
P.O. Box 1658
4725 Highway 75 South
Sherman, TX 75091-1658
75091 Sherman, TX
USA
(903) 868-3200
(903) 868-3280

Date/*Datum*: 8 Nov, 2016

Customer CALTROL INC Client *Auftraggeber*	**Order No** FIM INSTRUMENTS No commande *Bestell nr*	**Fisher Ref** 1462135 Réf. Fisher 3 *Fisher ref.*
Tag No No repère *Kenn Nr*	**Serial No** F001275047 No de série *Serien Nr*	
Type EZ Type - *Baureihe*	**Size** NPS 1 Dimension *Nennweite*	**Rating** CLASS 300 Classe *Druckstufe*

We hereby certify, that the material described above has been tested and complies with the terms of the contract.
Nous certifions que la livraison susnommée a été vérifiée et est conforme aux stipulations de l'acceptation de la commande.
Wir bestätigen, dass die obengenannte lieferung geprüft wurde und den vereinbarungen der Auftragsbestätigung entspricht.

Dimension & visual check Satisfactory / Satisfaisant / Zufriedenstellend
Contrôle visuel & dimensionnel
mass & Sichtprüfung

Function test Satisfactory / Satisfaisant / Zufriedenstellend
Essai de fonctionnement
Funktionsprüfung

This unit meets the metallurgical requirement of NACE as indicated below. Environmental restrictions may apply to wetted parts and/or boltings.
Cet appareil répond aux exigences métallurgiques de la norme NACE cochée ci-dessous. Les restrictions environnementales peuvent s'appliquer aux piéces en contact avec le fluide et/ou à la boulonnerie.
Dieses Gerät erfüllt die metallurgischen Anforderungen des angekreuzten NACE Standard. Umwelt-Einschränkungen können für Medium berührte Teile und/oder Verschraubungen gelten.

- ☐ NACE MR0175 / ISO 15156-2009 / Suivant NACE MR0175 / ISO 15156-2009 / Nach NACE MR0175 / ISO 15156-2009
- ☐ NACE MR0175-2002 / Suivant NACE MR0175-2002 / Nach NACE MR0175-2002
- ☐ MR0175-2003 / Suivant NACE MR0175-2003 / Nach NACE MR0175-2003
- ☐ MR0103-2012 / Suivant NACE MR0103-2012 / Nach NACE MR0103-2012

Pressure and leak tests /Epreuves de résistance et essais d'étanchéité / *Druck und Dichtheitsprüfung*

	Water/ Eau/ *Wasser* **Air**/Air/*Luft* **Nitrogen**/ Azote/*Stickstoff* Helium	**Pressure (gauges)**/ Pression/ *Druck*	**Test duration**/ Durée/ *Prüfdauer*	**Result conform to** / Résultat conforme *à*/ *Ergebnis*	**Allowable Leakage** / Fuite Tolérée / *Zulässige Leckage*	**Actual Leakage** / Fuite Relevée / *Gemessene Leckage*	**Customer Note**/ Note Client/ *Kunde Anmerkung*
Air Test	AIR	80 PSI	1 MIN	EN 12266-1 / FGS 4L1	NONE	CONFORM	
Hydrostatic Test	WATER	1125 PSI	1 MIN	ASME B16.34 / EN12266-1 / FGS4L1	NONE	CONFORM	
Seat Leak Test	AIR	50 PSI	1 MIN	Class IV, ANSI FCI-70-2-2006 / EN1349 / FGS4L5	3.21 SCFH	0.20 SCFH	

Material test certificates /Certificats matières / *Bescheinigungen über Werkstoffprüfungen* Certificat de reception 3.1

Description/Description/*Bezeichung*	**Material**/Matériaux/*Werkstoff*	**Heat No**/No Coulée/*Charge Nr*

External Inspection/ Inspection exterieur / *Externe Inspektion*

Works Inspection/ L'expert de l'usine/ *Werkssachverständiger*
Donald Siebert -- DOCUMENTATION TECH.

EMERSON
Donald A Siebert

EN 10204 3.1

SN F001275047

EMERSON
Process Management

Declaration of compliance
Attestation de conformité
Werkbescheinigung
EN 10204 2.1

FISHER

Fisher Controls International, LLC
P.O. Box 1658
4725 Highway 75 South
Sherman, TX 75091-1658
75091 Sherman, TX
USA
(903) 868-3200
(903) 868-3280

Date/*Datum*: 8 Nov, 2016

Customer Client *Auftraggeber* CALTROL INC	**Order No** No commande *Bestell nr* FIM INSTRUMENTS	**Fisher Ref** Réf. Fisher *Fisher ref.* 1462135 3
Tag No No repère *Kenn Nr*	**Serial No** No de série *Serien Nr* F001275047	
Type Type *Baureihe* EZ -	**Size** Dimension *Nennweite* NPS 1	**Rating** Classe *Druckstufe* CLASS 300

We hereby certify, that the material described above complies with the requirement of the order.
Nous certifions que la livraison susnommée a été verifiée et est conforme aux stipulations de l'acceptation de la commande.
Wir bestätigen, dass die obengenannte Lieferung den Vereinbarungen der Auftrag entspricht.

The following parts were made from materials complying ASTM, ASME, EN or other Standard specifications.
La matière des composants est conforme aux normes ASTM, ASME, EN ou autres normes.
Der Werskstoff der nachstehenden Bauteile entspricht den Anforderungen des ASTM, ASME, EN Norm oder anderen Normen.

Part/ Pièce / *Teil*	**Material /** Matériaux / *Werkstoff*
BONNET	ASME SA105 FMS20B102
PLUG,EQ%	TYPE 410/416 SST HT HRC 38 MIN, FMS20B64
SEAT RING RETAINER	ASTM A747 CB7CU-1, FMS20B18, H1150,NON-PRESS RETAI
SEAT RING	TYPE 410/416 SST HT HRC 38 MIN, FMS20B64
STEM,PLUG	ASTM A276 S31600 COND B, COLD FIN, GND & POL
VALVE BODY	ASME SA216 WCC

Works Inspection/ L'expert de l'usine/ *Werkssachverständiger*
Donald Siebert -- DOCUMENTATION TECH.

EMERSON
Donald Siebert

EMERSON
Process Management

Declaration of compliance
Attestation de conformité
Werkbescheinigung
EN 10204 2.1

FISHER

Fisher Controls International, LLC
P.O. Box 1658
4725 Highway 75 South
Sherman, TX 75091-1658
75091 Sherman, TX
USA
(903) 868-3200
(903) 868-3280

Date/*Datum*: 8 Nov, 2016

Customer Client *Auftraggeber* CALTROL INC	**Order No** No commande *Bestell nr* FIM INSTRUMENTS	**Fisher Ref** Réf. Fisher *Fisher ref.* 1462135 3
Tag No No repère *Kenn Nr*	**Serial No** No de série *Serien Nr* F001275047	
Type Type *Baureihe* EZ -	**Size** Dimension *Nennweite* NPS 1	**Rating** Classe *Druckstufe* CLASS 300

☑ Welders and welding procedures are qualified in accordance with ASME, Boiler and Pressure Vessel code section IX and all personnel performing nondestructive examinations are qualified to ASNT / SNT-TC-1A.

☐ This product is registered in Canada under CRN:.

Additional Statements:

Works Inspection/ L'expert de l'usine/ *Werkssachverständiger*
Donald Siebert -- DOCUMENTATION TECH.

EMERSON
Donald G Siebert



THE Fulflo SPECIALTIES CO.
459 EAST FANCY STREET
BLANCHESTER, OHIO 45107

PHONE 937-783-2411
FAX 937-783-4983
INFO@FULFLO.COM
WWW.FULFLO.COM

CERTIFICATE OF CONFORMANCE

DATE SHIPPED: 12/7/16 ORDER NO. 244765

CUSTOMER NAME: L A Turbine Corporation

CUSTOMER PURCHASE ORDER NO. 23870

LISTING OF ITEMS IN SUBJECT SHIPMENT:

VALVE / PART NO.	DESCRIPTION	QUANTITY
VSF-5-600AR/SS/YS	Relief Valve	2

WE HEREBY CERTIFY THAT ALL PARTS AND/OR MATERIALS INCLUDED IN THIS SHIPMENT HAVE BEEN MANUFACTURED AND/OR PROCESSED IN CONFORMANCE WITH ALL APPLICABLE DRAWINGS, INSTRUCTIONS, AND SPECIFICATIONS. MATERIAL SUPPLIED AGAINST YOUR PURCHASE ORDER IS FREE OF MERCURY, LEAD, AND ASBESTOS CONTAMINATION.

MADE AND ASSEMBLED IN THE U.S.A.

INSPECTION RECORDS ARE MAINTAINED ON FILE FOR A PERIOD OF FIVE YEARS, OR AS SPECIFIED BY THE CONTRACT.

THE FULFLO SPECIALTIES CO.

WILLIAM (BILL) MOORE SR
QUALITY CONTROL MANAGER

Bermingham Controls, Inc.
EST. 1961
STEAM & PROCESS SPECIALIST

Bermingham Controls, Inc.

11144 Business Circle, Cerritos CA 90703-5523 (562) 860-0463

Certified Test Report

329926 PSV-001

Test Date:	2016/12/14
Customer:	L.A. Turbine Corporation
Customer PO#:	23944
Serial #:	SD21086
Model #:	1910-00D-2-CC-MS-31-RF-GS-HP
Mfg / Size	Consolidated / 1 RF x 2 RF
Spring#/Range	0124CR / 649 - 722
Bermingham SO#:	329926
Set/Cap:	650 PSIG / 1464 SCFM
Test on:	Air

RECORD OF TEST		
Set	Blow down	Leakage
		NONE @ 90%
650	592	*
650	592	*
650	592	*

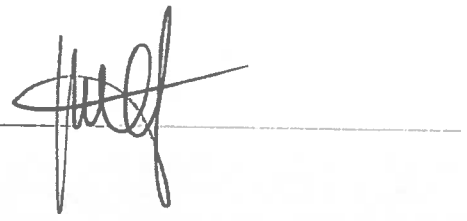
NB registration # UV# 28064

* Checked for visible/audible leakage at 90% or at the valve reseating pressure.
** WHEN APPLICABLE - Leakage test for air is no audible and/or soap bubble method for 30 seconds

* ASME SEC I PG-73.4.3 A seat test shall be conducted at maximum expected operating pressure, but at a pressure not exceeding the reseating pressure of the valve. When being tested, a valve exhibiting no visible signs of leakageshall be considered adequately tight.

** ASME SEC VIII UG 136 When testing with either water or steam, a valve exhibiting no visible signs of leakage shall be considered adequately tight. Leakage tests conducted with air shall be inaccordance with industry accepted standards.

I HEREBY CERTIFY THAT THE ABOVE REPRESENTS MY FINDINGS AND OBSERVATIONS WITH RESPECT TO THE RELIEF VALVE LISTED ABOVE:



Bermingham Controls, Inc.
EST. 1961
STEAM & PROCESS SPECIALIST

Bermingham Controls, Inc.

11144 Business Circle, Cerritos CA 90703-5523 (562) 860-0463

Certified Test Report

329926 PSV-001

Test Date:	2016/12/14
Customer:	L.A. Turbine Corporation
Customer PO#:	23944
Serial #:	SD21084
Model #:	1910-00D-2-CC-MS-31-RF-GS-HP
Mfg / Size	Consolidated / 1 RF x 2 RF
Spring#/Range	0124CR / 649 - 722
Bermingham SO#:	329926
Set/Cap:	650 PSIG / 1464 SCFM
Test on:	Air

RECORD OF TEST		
Set	Blow down	Leakage
		NONE @ 90%
650	593	*
650	593	*
650	593	*

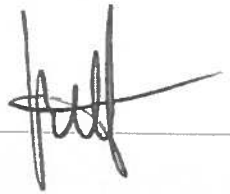
NB registration # UV# 28064

* Checked for visible/audible leakage at 90% or at the valve reseating pressure.
** WHEN APPLICABLE - Leakage test for air is no audible and/or soap bubble method for 30 seconds

* ASME SEC I PG-73.4.3 A seat test shall be conducted at maximum expected operating pressure, but at a pressure not exceeding the reseating pressure of the valve. When being tested, a valve exhibiting no visible signs of leakageshall be considered adequately tight.

** ASME SEC VIII UG 136 When testing with either water or steam, a valve exhibiting no visible signs of leakage shall be considered adequately tight. Leakage tests conducted with air shall be inaccordance with industry accepted standards.

I HEREBY CERTIFY THAT THE ABOVE REPRESENTS MY FINDINGS AND OBSERVATIONS WITH RESPECT TO THE RELIEF VALVE LISTED ABOVE:



'Apollo' Valves

Apollo Valves
Division of Conbraco Industries
Conway, SC 29526
Fax: 843/347-1773
Phone: 843/347-4666

ISO 9001:2008

We certify that the below listed components were manufactured, tested, and inspected in accordance with the requirements of the procurement documents as stated.

Customer Name: Distribuition Now	Size: 1/2"
Customer Order Number:	Quantity: 6
Valve Part Number: 76-103-01A	User Tag Number: Ball Valve
Model Number: 76	Material Type: ASTM A 351-15 TYPE CF8M

HEAT_CODE	C	MN	P	S	SI	CR	NI	MO	CU	V	CB	TENSILE PSI	YIELD PSI	%ELO	% RA	HARDNESS (RB unless noted)
GU	0.014	1.340	0.033	0.007	1.036	19.200	10.532	2.231	0.271	0.000	0.0	75964.0	36126.0	51.0	N/A	78
HU	0.029	1.415	0.033	0.006	1.070	19.197	10.716	2.219	0.317	0.000	0.0	83340.0	40783.0	51.0	N/A	77

TESTING PROCEDURE: 100% of all Apollo Ball Valves produced are tested in accordance with their standard of construction: threaded and socket weld ball valves per MSS-SP110; flanged and butt weld ball valves per ASME/ANSI B16.34, MSS-SP72 and MSS-SP61

We certify that the above listed components meet the requirements of the procurement documents as stated.

This material certificate complies with EN 10204-2004 Type 3.1 (formerly Type F3.1.B).

The above listed information is certified to be true and accurate to the best of my knowledge and belief.

Date: 01/23/17

Signed

Steve Causey

Steve Causey
Quality Assurance Manager

CUST NAME: CA TURBINE
CUST PO#: 24214
SO#: 16397222 LINE#: 2
HEAT#: HU QUANTITY: 1
DEL#: 81552723 DATE: 1-23-17

CERTIFIED MILL TEST REPORT

The Best Value - *Price, Quality, Service* All The Time.

LOG NO. V00000000053512 Page 1 of 4

BONNEY FORGE CORPORATION
P.O. BOX 330 • 14496 CROGHAN PIKE • MOUNT UNION, PA 17066-0330
(814) 542-2545 • (800) 345-7546 • FAX (814) 542-4906
www.bonneyforge.com

CUSTOMER: DNOW L.P.

DATE 01/27/2017

CUSTOMER ORDER NO.: 659121601

BONNEY ORDER NO. B000216639

PO 24214

SHIP TO: L.A. TURBINE CORPORATION
28557 INDUSTRY DRIVE
PO: 24214
VALENCIA CA 91355
United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO. CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:
10	3	AACC	1 1/2" HL-41-SW PISTON SL SA/A105N
		BODY	C 0.190 Co 0.000 Cr 0.150 Cu 0.250 Mn 0.830 Mo 0.020 Nb 0.002 Ni 0.090 P 0.010 S 0.008 Si 0.240 Ti 0.019 V 0.011
			CE(Long Formula) = 0.39
			T/S(PSI) 70,778 Y/S(PSI) 46,702 EL(%) 34.80 RA(%) 66.30
			Brinell 141 BHN 141 BHN
SS TAG: CV1.5-SW			
		AACE	1 1/2" HL-41-SW PISTON SL SA/A105N
		BONNET	Al 0.024 C 0.190 Co 0.000 Cr 0.100 Cu 0.190 Mn 0.900 Mo 0.010 Nb 0.002 Ni 0.050 P 0.009 S 0.010 Si 0.210 Ti 0.018 V 0.016
			CE(Long Formula) = 0.38
			T/S(PSI) 70,488 Y/S(PSI) 48,007 EL(%) 33.90 RA(%) 62.30
			Brinell 137 BHN 139 BHN
20	1	AAAV	3/4" HL-11-SW TFE VRING PKG SA/A105N
		BODY	Al 0.024 C 0.180 Co 0.000 Cr 0.070 Cu 0.140 Mn 0.820 Mo 0.010 Nb 0.001 Ni 0.060 P 0.010 S 0.009 Si 0.210 Ti 0.018 V 0.011
			CE(Long Formula) = 0.35
			T/S(PSI) 70,343 Y/S(PSI) 36,259 EL(%) 22.00 RA(%) 30.00
			Brinell 138 BHN 138 BHN
SS TAG: V.75-SW			
		AACE	3/4" HL-11-SW TFE VRING PKG SA/A105N
		BONNET	Al 0.024 C 0.190 Co 0.000 Cr 0.100 Cu 0.190 Mn 0.900 Mo 0.010 Nb 0.002 Ni 0.050 P 0.009 S 0.010 Si 0.210 Ti 0.018 V 0.016
			CE(Long Formula) = 0.38
			T/S(PSI) 70,488 Y/S(PSI) 48,007 EL(%) 33.90 RA(%) 62.30
			Brinell 137 BHN 139 BHN

We certify that the data on this sheet is a true copy taken from our records of material furnished us by the production mill, or as obtained by additional laboratory checks.

by Brenda Garlock

BRENDA GARLOCK
QUALITY PROCESS MANAGER

CMTR: REV2

CERTIFIED MILL TEST REPORT

The Best Value - *Price, Quality, Service* All The Time.

LOG NO. V00000000053512

BONNEY FORGE CORPORATION
P.O. BOX 330 • 14496 CROGHAN PIKE • MOUNT UNION, PA 17066-0330
(814) 542-2545 • (800) 345-7546 • FAX (814) 542-4906
www.bonneyforge.com

CUSTOMER: DNOW L.P.

DATE 01/27/2017

CUSTOMER ORDER NO.: 659121601

BONNEY ORDER NO. B000216639
PO 24214

SHIP TO: L.A. TURBINE CORPORATION
28557 INDUSTRY DRIVE
PO: 24214
VALENCIA CA 91355
United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO. CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:
30	4	AACC	1 1/2" HL-11-SW TFE VRING PKG SA/A105N
		BODY	C 0.190 Co 0.000 Cr 0.150 Cu 0.250 Mn 0.830 Mo 0.020 Nb 0.002 Ni 0.090 P 0.010 S 0.008 Si 0.240 Ti 0.019 V 0.011 CE(Long Formula) = 0.39 T/S(PSI) 70,778 Y/S(PSI) 46,702 EL(%) 34.80 RA(%) 66.30 Brinell 141 BHN 141 BHN
SS TAG: V1.5-SW			
		AACE	1 1/2" HL-11-SW TFE VRING PKG SA/A105N
		BONNET	Al 0.024 C 0.190 Co 0.000 Cr 0.100 Cu 0.190 Mn 0.900 Mo 0.010 Nb 0.002 Ni 0.050 P 0.009 S 0.010 Si 0.210 Ti 0.018 V 0.016 CE(Long Formula) = 0.38 T/S(PSI) 70,488 Y/S(PSI) 48,007 EL(%) 33.90 RA(%) 62.30 Brinell 137 BHN 139 BHN
40	4	AACC	3/4" L3-11-RF TFE V PKG SA/A105N
		BODY	C 0.190 Co 0.000 Cr 0.150 Cu 0.250 Mn 0.830 Mo 0.020 Nb 0.002 Ni 0.090 P 0.010 S 0.008 Si 0.240 Ti 0.019 V 0.011 CE(Long Formula) = 0.39 T/S(PSI) 70,778 Y/S(PSI) 46,702 EL(%) 34.80 RA(%) 66.30 Brinell 141 BHN 141 BHN
SS TAG: V.75-F3			
		AACE	3/4" L3-11-RF TFE V PKG SA/A105N
		BONNET	Al 0.024 C 0.190 Co 0.000 Cr 0.100 Cu 0.190 Mn 0.900 Mo 0.010 Nb 0.002 Ni 0.050 P 0.009 S 0.010 Si 0.210 Ti 0.018 V 0.016 CE(Long Formula) = 0.38 T/S(PSI) 70,488 Y/S(PSI) 48,007 EL(%) 33.90 RA(%) 62.30 Brinell 137 BHN 139 BHN

We certify that the data on this sheet is a true copy taken from our records of material furnished us by the production mill, or as obtained by additional laboratory checks.

by Brenda Garlock
BRENDA GARLOCK
QUALITY PROCESS MANAGER

CMTR: REV2

CERTIFIED MILL TEST REPORT

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LOG NO. V00000000053512

BONNEY FORGE CORPORATION
P.O. BOX 330 • 14496 CROGHAN PIKE • MOUNT UNION, PA 17066-0330
(814) 542-2545 • (800) 345-7546 • FAX (814) 542-4906
www.bonneyforge.com

CUSTOMER: DNOW L.P.

DATE 01/27/2017

CUSTOMER ORDER NO.: 659121601

BONNEY ORDER NO. B000216639

PO 24214

SHIP TO: L.A. TURBINE CORPORATION
28557 INDUSTRY DRIVE
PO: 24214
VALENCIA CA 91355
United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO. CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:
60	1	AACH	3/4" HL-31-SW/T TFE VRING PKG SA/A105N
		BODY	Al 0.024 C 0.200 Co 0.000 Cr 0.090 Cu 0.190 Mn 0.820 Mo 0.010 Nb 0.002 Ni 0.060 P 0.008 S 0.009 Si 0.150 Ti 0.015 V 0.013
			CE(Long Formula) = 0.38
			T/S(PSI) 72,954 Y/S(PSI) 44,091 EL(%) 35.10 RA(%) 77.50
			Brinell 157 BHN 155 BHN
SS TAG: VGL.75-ST			
		AACE	3/4" HL-31-SW/T TFE VRING PKG SA/A105N
		BONNET	Al 0.024 C 0.190 Co 0.000 Cr 0.100 Cu 0.190 Mn 0.900 Mo 0.010 Nb 0.002 Ni 0.050 P 0.009 S 0.010 Si 0.210 Ti 0.018 V 0.016
			CE(Long Formula) = 0.38
			T/S(PSI) 70,488 Y/S(PSI) 48,007 EL(%) 33.90 RA(%) 62.30
			Brinell 137 BHN 139 BHN
70	2	AACC	1" HL-31-SW TFE VRING PKG SA/A105N
		BODY	C 0.190 Co 0.000 Cr 0.150 Cu 0.250 Mn 0.830 Mo 0.020 Nb 0.002 Ni 0.090 P 0.010 S 0.008 Si 0.240 Ti 0.019 V 0.011
			CE(Long Formula) = 0.39
			T/S(PSI) 70,778 Y/S(PSI) 46,702 EL(%) 34.80 RA(%) 66.30
			Brinell 141 BHN 141 BHN
SS TAG: VGL1-SW			
		AAAV	1" HL-31-SW TFE VRING PKG SA/A105N
		BONNET	Al 0.024 C 0.180 Co 0.000 Cr 0.070 Cu 0.140 Mn 0.820 Mo 0.010 Nb 0.001 Ni 0.060 P 0.010 S 0.009 Si 0.210 Ti 0.018 V 0.011
			CE(Long Formula) = 0.35
			T/S(PSI) 70,343 Y/S(PSI) 36,259 EL(%) 22.00 RA(%) 30.00
			Brinell 138 BHN 138 BHN

We certify that the data on this sheet is a true copy taken from our records of material furnished us by the production mill, or as obtained by additional laboratory checks.

by Brenda Garlock

BRENDA GARLOCK
QUALITY PROCESS MANAGER

CMTR: REV2

CERTIFIED MILL TEST REPORT

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LOG NO. V00000000053512

BONNEY FORGE CORPORATION
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(814) 542-2545 • (800) 345-7546 • FAX (814) 542-4906
www.bonneyforge.com

CUSTOMER: DNOW L.P.

DATE 01/27/2017

CUSTOMER ORDER NO.: 659121601

BONNEY ORDER NO. B000216639

PO 24214

SHIP TO: L.A. TURBINE CORPORATION
28557 INDUSTRY DRIVE
PO: 24214
VALENCIA CA 91355
United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO. CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:

1. TESTING AND ACCEPTANCE CRITERIA FOR THESE VALVES ARE IN ACCORDANCE WITH THE REQUIREMENTS OF API 598 (NINTH EDITION, SEPTEMBER 2009).
2. TRIM COMPONENTS AND BOLTING ARE IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND MATERIAL SPECIFICATIONS.
3. THE MATERIAL SUPPLIED IDENTIFIED AS A105N WAS NORMALIZED IN ACCORDANCE WITH ASTM A105 HEAT TREATING REQUIREMENTS.
4. CERTIFYING ASTM A105-14 / ASME SA105-15 EDITION.
5. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)
6. ITEM - 10, 60, 70 -THE SUPPLIED GLOBE, CHECK, AND GATE VALVES 2500# AND ABOVE WERE CONSTRUCTED IN ACCORDANCE WITH ASME B16.34.
7. ITEM - 20, 30, 40 -THE GATE VALVES SUPPLIED WERE CONSTRUCTED IN ACCORDANCE WITH API 602 AND ASME B16.34

We certify that the data on this sheet is a true copy taken from our records of material furnished us by the production mill, or as obtained by additional laboratory checks.

by Brenda Garlock

BRENDA GARLOCK
QUALITY PROCESS MANAGER

CMTR: REV2

CERTIFIED MILL TEST REPORT

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LOG NO. V00000000053511 Page 1 of 1

BONNEY FORGE CORPORATION
P.O. BOX 330 • 14496 CROGHAN PIKE • MOUNT UNION, PA 17066-0330
(814) 542-2545 • (800) 345-7546 • FAX (814) 542-4906
www.bonneyforge.com

CUSTOMER: DNOW L.P.

DATE 01/27/2017

CUSTOMER ORDER NO.: 659121601

BONNEY ORDER NO. B000216639

PO 24214

SHIP TO: L.A. TURBINE CORPORATION
28557 INDUSTRY DRIVE
PO: 24214
VALENCIA CA 91355
United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO. CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:
50	2	AACA	2" L3-11-RF TFE VRING PKG SA/A105N
		BODY	C 0.185 Co 0.000 Cr 0.130 Cu 0.170 Mn 0.820 Mo 0.010 Nb 0.002 Ni 0.060 P 0.010 S 0.009 Si 0.240 Ti 0.018 V 0.020
			CE(Long Formula) = 0.37
			T/S(PSI) 73,824 Y/S(PSI) 43,221 EL(%) 29.00 RA(%) 62.30
			Brinell 149 BHN 150 BHN
SS TAG: V2-F3			
		AACE	2" L3-11-RF TFE VRING PKG SA/A105N
		BONNET	Al 0.024 C 0.190 Co 0.000 Cr 0.100 Cu 0.190 Mn 0.900 Mo 0.010 Nb 0.002 Ni 0.050 P 0.009 S 0.010 Si 0.210 Ti 0.018 V 0.016
			CE(Long Formula) = 0.38
			T/S(PSI) 70,488 Y/S(PSI) 48,007 EL(%) 33.90 RA(%) 62.30
			Brinell 137 BHN 139 BHN

1. TESTING AND ACCEPTANCE CRITERIA FOR THESE VALVES ARE IN ACCORDANCE WITH THE REQUIREMENTS OF API 598 (NINTH EDITION, SEPTEMBER 2009).
2. TRIM COMPONENTS AND BOLTING ARE IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND MATERIAL SPECIFICATIONS.
3. THE MATERIAL SUPPLIED IDENTIFIED AS A105N WAS NORMALIZED IN ACCORDANCE WITH ASTM A105 HEAT TREATING REQUIREMENTS.
4. CERTIFYING ASTM A105-14 / ASME SA105-15 EDITION.
5. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)
6. THE GATE VALVES SUPPLIED WERE CONSTRUCTED IN ACCORDANCE WITH API 602 AND ASME B16.34

We certify that the data on this sheet is a true copy taken from our records of material furnished us by the production mill, or as obtained by additional laboratory checks.

by Brenda Garlock

BRENDA GARLOCK
QUALITY PROCESS MANAGER

CMTR: REV2

CERTIFIED MILL TEST REPORT

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LOG NO. V00000000053510 Page 1 of 4

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(814) 542-2545 • (800) 345-7546 • FAX (814) 542-4906
www.bonneyforge.com

CUSTOMER: DNOW L.P.

DATE 01/27/2017

CUSTOMER ORDER NO.: 659121476

BONNEY ORDER NO. B000216638

PO 24214

SHIP TO: LA TURBINE
28557 INDUSTRY DRIVE
VALENCIA CA 91355
United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO. CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:
10	3	AACC	1" HL-41-SW PISTON SA/A105N
179908		BODY	C 0.190 Co 0.000 Cr 0.150 Cu 0.250 Mn 0.830 Mo 0.020 Nb 0.002 Ni 0.090 P 0.010 S 0.008 Si 0.240 Ti 0.019 V 0.011
			CE(Long Formula) = 0.39
			T/S(PSI) 70,778 Y/S(PSI) 46,702 EL(%) 34.80 RA(%) 66.30
			Brinell 141 BHN 141 BHN
SS TAG: CV1.0-SW			
		AACE	1" HL-41-SW PISTON SA/A105N
179908		BONNET	Al 0.024 C 0.190 Co 0.000 Cr 0.100 Cu 0.190 Mn 0.900 Mo 0.010 Nb 0.002 Ni 0.050 P 0.009 S 0.010 Si 0.210 Ti 0.018 V 0.016
			CE(Long Formula) = 0.38
			T/S(PSI) 70,488 Y/S(PSI) 48,007 EL(%) 33.90 RA(%) 62.30
			Brinell 137 BHN 139 BHN
20	1	AAAV	3/4" HL-11-SW TFE VRING PKG SA/A105N
		BODY	Al 0.024 C 0.180 Co 0.000 Cr 0.070 Cu 0.140 Mn 0.820 Mo 0.010 Nb 0.001 Ni 0.060 P 0.010 S 0.009 Si 0.210 Ti 0.018 V 0.011
			CE(Long Formula) = 0.35
			T/S(PSI) 70,343 Y/S(PSI) 36,259 EL(%) 22.00 RA(%) 30.00
			Brinell 138 BHN 138 BHN
SS TAG: V.75-SW			
		AACE	3/4" HL-11-SW TFE VRING PKG SA/A105N
		BONNET	Al 0.024 C 0.190 Co 0.000 Cr 0.100 Cu 0.190 Mn 0.900 Mo 0.010 Nb 0.002 Ni 0.050 P 0.009 S 0.010 Si 0.210 Ti 0.018 V 0.016
			CE(Long Formula) = 0.38
			T/S(PSI) 70,488 Y/S(PSI) 48,007 EL(%) 33.90 RA(%) 62.30
			Brinell 137 BHN 139 BHN

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by Brenda Garlock

BRENDA GARLOCK
QUALITY PROCESS MANAGER

CMTR: REV2

CERTIFIED MILL TEST REPORT

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LOG NO. V00000000053510

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www.bonneyforge.com

CUSTOMER: DNOW L.P.

DATE 01/27/2017

CUSTOMER ORDER NO.: 659121476

BONNEY ORDER NO. B000216638

PO 24214

SHIP TO: LA TURBINE
28557 INDUSTRY DRIVE
VALENCIA CA 91355
United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO. CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:
30	3	AACC	1" HL-11-SW TFE VRING PKG SA/A105N
		BODY	C 0.190 Co 0.000 Cr 0.150 Cu 0.250 Mn 0.830 Mo 0.020 Nb 0.002 Ni 0.090 P 0.010 S 0.008 Si 0.240 Ti 0.019 V 0.011
			CE(Long Formula) = 0.39
			T/S(PSI) 70,778 Y/S(PSI) 46,702 EL(%) 34.80 RA(%) 66.30
			Brinell 141 BHN 141 BHN
SS TAG: V1-SW			
		AACH	1" HL-11-SW TFE VRING PKG SA/A105N
		BONNET	Al 0.024 C 0.200 Co 0.000 Cr 0.090 Cu 0.190 Mn 0.820 Mo 0.010 Nb 0.002 Ni 0.060 P 0.008 S 0.009 Si 0.150 Ti 0.015 V 0.013
			CE(Long Formula) = 0.38
			T/S(PSI) 72,954 Y/S(PSI) 44,091 EL(%) 35.10 RA(%) 77.50
			Brinell 157 BHN 155 BHN
40	1	AACC	1 1/2" HL-11-SW TFE VRING PKG SA/A105N
		BODY	C 0.190 Co 0.000 Cr 0.150 Cu 0.250 Mn 0.830 Mo 0.020 Nb 0.002 Ni 0.090 P 0.010 S 0.008 Si 0.240 Ti 0.019 V 0.011
			CE(Long Formula) = 0.39
			T/S(PSI) 70,778 Y/S(PSI) 46,702 EL(%) 34.80 RA(%) 66.30
			Brinell 141 BHN 141 BHN
SS TAG: V1.5-SW			
		AACE	1 1/2" HL-11-SW TFE VRING PKG SA/A105N
		BONNET	Al 0.024 C 0.190 Co 0.000 Cr 0.100 Cu 0.190 Mn 0.900 Mo 0.010 Nb 0.002 Ni 0.050 P 0.009 S 0.010 Si 0.210 Ti 0.018 V 0.016
			CE(Long Formula) = 0.38
			T/S(PSI) 70,488 Y/S(PSI) 48,007 EL(%) 33.90 RA(%) 62.30
			Brinell 137 BHN 139 BHN

We certify that the data on this sheet is a true copy taken from our records of material furnished us by the production mill, or as obtained by additional laboratory checks.

by Brenda Garlock

BRENDA GARLOCK
QUALITY PROCESS MANAGER

CMTR: REV2

CERTIFIED MILL TEST REPORT

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www.bonneyforge.com

CUSTOMER: DNOW L.P.

DATE 01/27/2017

CUSTOMER ORDER NO.: 659121476

BONNEY ORDER NO. B000216638

PO 24214

SHIP TO: LA TURBINE
28557 INDUSTRY DRIVE
VALENCIA CA 91355
United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO. CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:
50	4	AACC	3/4" L3-11-RF TFE V PKG SA/A105N
		BODY	C 0.190 Co 0.000 Cr 0.150 Cu 0.250 Mn 0.830 Mo 0.020 Nb 0.002 Ni 0.090 P 0.010 S 0.008 Si 0.240 Ti 0.019 V 0.011
			CE(Long Formula) = 0.39
			T/S(PSI) 70,778 Y/S(PSI) 46,702 EL(%) 34.80 RA(%) 66.30
			Brinell 141 BHN 141 BHN
SS TAG: V.75-F3			
		AACE	3/4" L3-11-RF TFE V PKG SA/A105N
		BONNET	Al 0.024 C 0.190 Co 0.000 Cr 0.100 Cu 0.190 Mn 0.900 Mo 0.010 Nb 0.002 Ni 0.050 P 0.009 S 0.010 Si 0.210 Ti 0.018 V 0.016
			CE(Long Formula) = 0.38
			T/S(PSI) 70,488 Y/S(PSI) 48,007 EL(%) 33.90 RA(%) 62.30
			Brinell 137 BHN 139 BHN
70	1	AACH	3/4" HL-31-SW/T TFE VRING PKG SA/A105N
		BODY	Al 0.024 C 0.200 Co 0.000 Cr 0.090 Cu 0.190 Mn 0.820 Mo 0.010 Nb 0.002 Ni 0.060 P 0.008 S 0.009 Si 0.150 Ti 0.015 V 0.013
			CE(Long Formula) = 0.38
			T/S(PSI) 72,954 Y/S(PSI) 44,091 EL(%) 35.10 RA(%) 77.50
			Brinell 157 BHN 155 BHN
SS TAG: VGL.75-ST			
		AACE	3/4" HL-31-SW/T TFE VRING PKG SA/A105N
		BONNET	Al 0.024 C 0.190 Co 0.000 Cr 0.100 Cu 0.190 Mn 0.900 Mo 0.010 Nb 0.002 Ni 0.050 P 0.009 S 0.010 Si 0.210 Ti 0.018 V 0.016
			CE(Long Formula) = 0.38
			T/S(PSI) 70,488 Y/S(PSI) 48,007 EL(%) 33.90 RA(%) 62.30
			Brinell 137 BHN 139 BHN

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by Brenda Garlock

BRENDA GARLOCK
QUALITY PROCESS MANAGER

CMTR: REV2

CERTIFIED MILL TEST REPORT

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LOG NO. V00000000053510

BONNEY FORGE CORPORATION
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www.bonneyforge.com

CUSTOMER: DNOW L.P.

DATE 01/27/2017

CUSTOMER ORDER NO.: 659121476

BONNEY ORDER NO. B000216638

PO 24214

SHIP TO: LA TURBINE
28557 INDUSTRY DRIVE
VALENCIA CA 91355
United States

ITEM	QUANTITY	LOT NO.	GRADE OR SPECIFICATION NO. CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS:
80	2	AACC	1" HL-31-SW TFE VRING PKG SA/A105N
		BODY	C 0.190 Co 0.000 Cr 0.150 Cu 0.250 Mn 0.830 Mo 0.020 Nb 0.002 Ni 0.090 P 0.010 S 0.008 Si 0.240 Ti 0.019 V 0.011
			CE(Long Formula) = 0.39
			T/S(PSI) 70,778 Y/S(PSI) 46,702 EL(%) 34.80 RA(%) 66.30
			Brinell 141 BHN 141 BHN
		SS TAG: VGL1-SW	
		AAAV	1" HL-31-SW TFE VRING PKG SA/A105N
		BONNET	Al 0.024 C 0.180 Co 0.000 Cr 0.070 Cu 0.140 Mn 0.820 Mo 0.010 Nb 0.001 Ni 0.060 P 0.010 S 0.009 Si 0.210 Ti 0.018 V 0.011
			CE(Long Formula) = 0.35
			T/S(PSI) 70,343 Y/S(PSI) 36,259 EL(%) 22.00 RA(%) 30.00
			Brinell 138 BHN 138 BHN

1. TESTING AND ACCEPTANCE CRITERIA FOR THESE VALVES ARE IN ACCORDANCE WITH THE REQUIREMENTS OF API 598 (NINTH EDITION, SEPTEMBER 2009).
2. TRIM COMPONENTS AND BOLTING ARE IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND MATERIAL SPECIFICATIONS.
3. THE MATERIAL SUPPLIED IDENTIFIED AS A105N WAS NORMALIZED IN ACCORDANCE WITH ASTM A105 HEAT TREATING REQUIREMENTS.
4. CERTIFYING ASTM A105-14 / ASME SA105-15 EDITION.
5. THE PRODUCT SUPPLIED WAS INSPECTED IN ACCORDANCE WITH EN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT. (EUROPEAN STANDARD)
6. ITEM - 20, 30, 40, 50 -THE GATE VALVES SUPPLIED WERE CONSTRUCTED IN ACCORDANCE WITH API 602 AND ASME B16.34
7. ITEM - 10, 70, 80 -THE SUPPLIED GLOBE, CHECK, AND GATE VALVES 2500# AND ABOVE WERE CONSTRUCTED IN ACCORDANCE WITH ASME B16.34.

We certify that the data on this sheet is a true copy taken from our records of material furnished us by the production mill, or as obtained by additional laboratory checks.

by Brenda Garlock

BRENDA GARLOCK
QUALITY PROCESS MANAGER

CMTR: REV2

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 16: ELECTRICAL COMPONENTS

- CERTIFICATE OF CONFORMANCE

BONCA TECHNOLOGIES INC.

1301 S.Beach Blvd Suite A
LA HABRA
California 90631 USA

Certificate of Conformance

Date	
1/18/2017	BTINC170118

Bill To	Ship To
L.A. Turbine 28557 Industry Drive Valencia, CA 91355 USA	BONCA TECHNOLOGIES INC. 1301 S. Beach Blvd. Suite A La Habra, CA 90631 USA

P.O. Number	Terms	Rep	Ship	Via	F.O.B.	Project
24040	Net-50		1/18/2017	E-mail		LAT574EC

Quantity	Item Code	Description
1	1	Electrical and mechanical assembly as per National Electric Code NEC,NFPA 70 and the Underwriters Laboratory (BTINC UL-CSA file# E215188) Product Standards UL508A and Rittal Product Standards, FOR: LAT574EC PROJECT ROHS compliant WE HEREBY CERTIFY THAT THE FOLLOWING PARTS CONFORM TO ALL DRAWING REQUIREMENTS, APPLICABLE SPECIFICATION, OR CODES, PURCHASE ORDER MANDATES, AND QUALITY CONTROL REQUIREMENTS. 1-18-2017 President John Bonca Jr. 

Thank you for your business.

Phone #	Fax #	E-mail	Web Site
1.562.947.5060		bt.inc@live.com	

BONCA TECHNOLOGIES INC.

1301 S.Beach Blvd Suite A
LA HABRA
California 90631 USA

Certificate of Conformance

Date	
1/18/2017	BTINC170118

Bill To	Ship To
L.A. Turbine 28557 Industry Drive Valencia, CA 91355 USA	BONCA TECHNOLOGIES INC. 1301 S. Beach Blvd. Suite A La Habra, CA 90631 USA

P.O. Number	Terms	Rep	Ship	Via	F.O.B.	Project
24040	Net-50		1/18/2017	E-mail		LAT574EC

Quantity	Item Code	Description
1	1	Electrical and mechanical assembly as per National Electric Code NEC,NFPA 70 and the Underwriters Laboratory (BTINC UL-CSA file# E215188) Product Standards UL508A and Rittal Product Standards, FOR: LAT574EC PROJECT ROHS compliant WE HEREBY CERTIFY THAT THE FOLLOWING PARTS CONFORM TO ALL DRAWING REQUIREMENTS, APPLICABLE SPECIFICATION, OR CODES, PURCHASE ORDER MANDATES, AND QUALITY CONTROL REQUIREMENTS. 1-18-2017 President John Bonca Jr.

Thank you for your business.

Phone #	Fax #	E-mail	Web Site
1.562.947.5060		bt.inc@live.com	

GE Oil & Gas

Certificate Of Conformance

CUSTOMER ORDER NO.	
24132	
SELLER ORDER NO.	SHIP DATE
850866	01.FEB.2017
PACKING LIST NO.	CERTIFICATE NO.
81017231	81017231

Ship To
L.A. TURBINE CORPORATION
28557 INDUSTRY DRIVE
VALENCIA, California 91355-3445
USA
Phone: 6612948290

Questions? Contact Global Technical Support team at ittechsupport@ge.com

BENTLY NEVADA, INC.

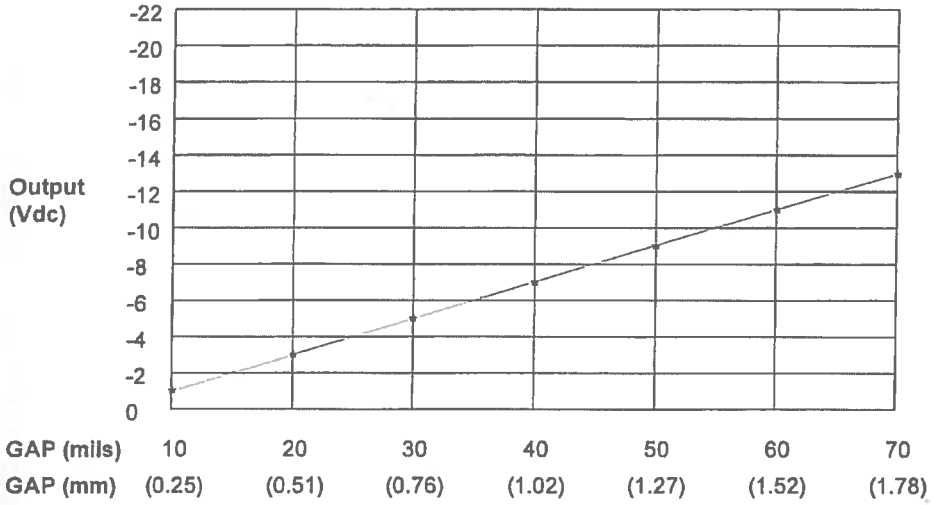
1631 BENTLY PARKWAY SOUTH
MINDEN Nevada 89423-4119 USA

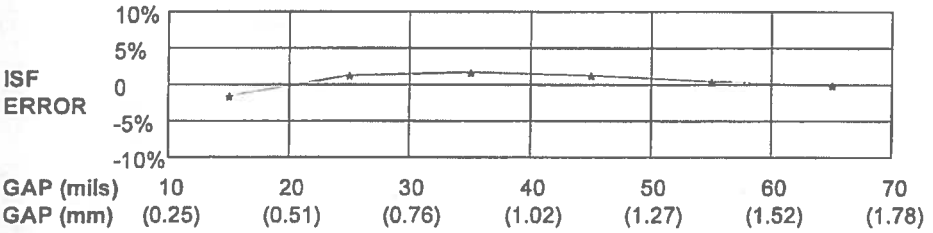
ITEM NO.	QTY.	U/M	DESCRIPTION
			CERTIFICATE OF CONFORMANCE The products included for shipment in the above customer order have been verified for conformance as follows: Products manufactured by Bently Nevada INC. have been verified in accordance with the applicable Bently Nevada INC. specifications, procedures, and the Integrated Manufacturing and Quality Plan. Products not manufactured by Bently Nevada have been verified for conformance to the specified order requirements. If you have any questions about our products, please contact our global Technical Support team at bntechsupport@ge.com. You can also visit our Technical Support portal at www.bntechsupport.com where local phone numbers and contact information are available. The portal is accessible by all customers with a registered GE Single On(SSO) account. If you do not have an SSO account, you will be prompted to register when accessing the portal for the first time. BENTLY NEVADA Karl Cyrd Customer Quality Representative **01.FEB.2017** **Date**
1000	2	EA	330930-040-05-05 3300 NSV EXTENSION CABLE Reference Order: 850866 / 001000 Customer PO Number: 24132
2000	1	EA	TEST_DATA_STD Standard Test Data Reference Order: 850866 / 001501 Customer PO Number: 24132
3000	2	EA	330909-10-60-10-11-05 PROBE 3300 NSV PROXIMITY 3/8-24 ARM Reference Order: 850866 / 002000 Customer PO Number: 24132

ITEM NO.	QTY.	U/M	DESCRIPTION
4000	1	EA	TEST_DATA_283638 ATEX DoC 283638 Reference Order: 850866 / 002001 Customer PO Number: 24132
5000	1	EA	TEST_DATA_STD Standard Test Data Reference Order: 850866 / 002003 Customer PO Number: 24132
6000	2	EA	990-05-50-01-05 990 VIBRATION TRANSMITTER Reference Order: 850866 / 003000 Customer PO Number: 24132
7000	1	EA	TEST_DATA_283649 ATEX DoC 283649 Reference Order: 850866 / 003001 Customer PO Number: 24132
8000	1	EA	TEST_DATA_STD Standard Test Data Reference Order: 850866 / 003002 Customer PO Number: 24132

BENTLY NEVADA

Minden USA
CABLE Final Test Results





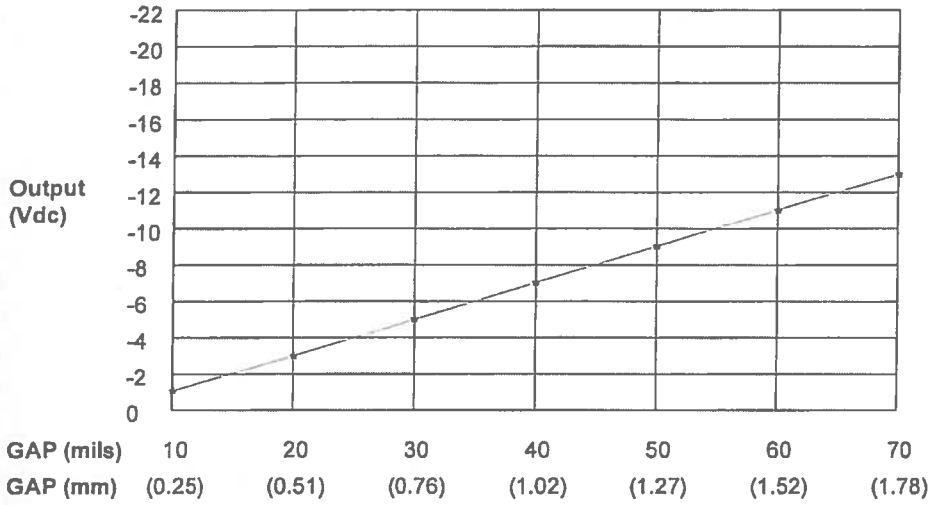
Customer:
L.A. TURBINE CORPORATION

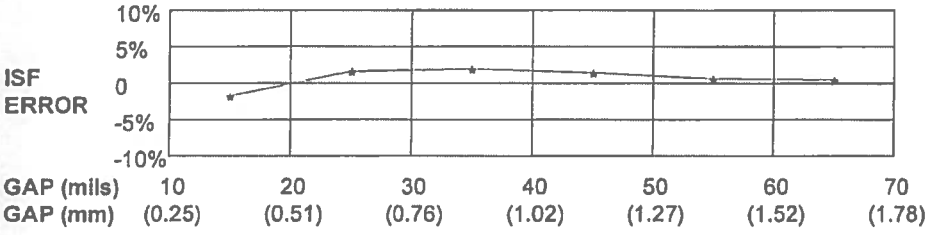
Customer PO #	: 24132
Serial Number	: 17A01P2R
Part Number	: 330930-040-05-05
Sales Order	: 0000850866
Test Date	: 30/Jan/2017 05:14 AM
Tester ID #	: 2362
Target Matl.	: AISI 4140
Standard ASF	: 198.47 mV/mil
	: (7.81 V/mm)
Device ASF	: 198.82 mV/mil
	: (7.83 V/mm)
Max DSL	: 0.17 mils (4.24 um)
Customer Tag	: VXC-501,502

Output Voltage (Vdc)	Gap mils : (mm)	Incremental Scale Factor mV/mil : (V/mm)
-1.053 @	10 : (0.25)	194.7 : (7.67)
-3.000 @	20 : (0.51)	200.3 : (7.89)
-5.003 @	30 : (0.76)	201.2 : (7.92)
-7.015 @	40 : (1.02)	200.3 : (7.89)
-9.018 @	50 : (1.27)	198.7 : (7.82)
-11.005@	60 : (1.52)	197.7 : (7.78)
-12.982@	70 : (1.78)	

BENTLY NEVADA

Minden USA
CABLE Final Test Results





Customer:
L.A. TURBINE CORPORATION

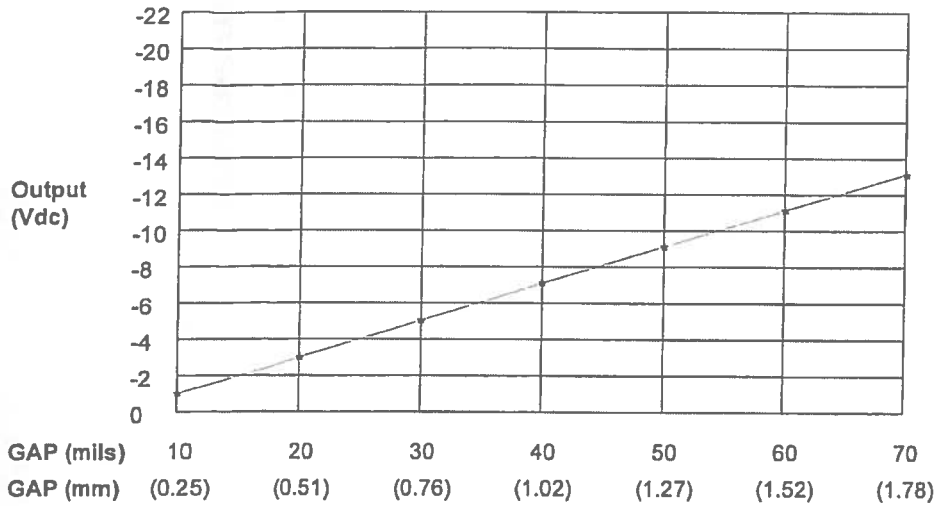
Customer PO #	: 24132
Serial Number	: 17A01P2T
Part Number	: 330930-040-05-05
Sales Order	: 0000850866
Test Date	: 30/Jan/2017 05:13 AM
Tester ID #	: 2362
Target Matl.	: AISI 4140
Standard ASF	: 198.47 mV/mil
	: (7.81 V/mm)
Device ASF	: 199.22 mV/mil
	: (7.84 V/mm)
Max DSL	: 0.22 mils (5.53 um)
Customer Tag	: VXC-501,502

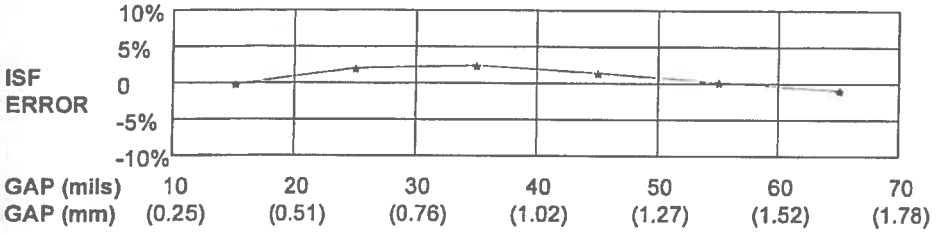
Output Voltage (Vdc)	Gap mils : (mm)	Incremental Scale Factor mV/mil : (V/mm)
-1.057 @	10 : (0.25)	194.3 : (7.65)
-3.000 @	20 : (0.51)	201.0 : (7.91)
-5.010 @	30 : (0.76)	201.7 : (7.94)
-7.027 @	40 : (1.02)	200.7 : (7.90)
-9.034 @	50 : (1.27)	199.0 : (7.83)
-11.024@	60 : (1.52)	198.6 : (7.82)
-13.010@	70 : (1.78)	

BENTLY NEVADA

Minden USA

PROBE Final Test Results





Customer:
L.A. TURBINE CORPORATION

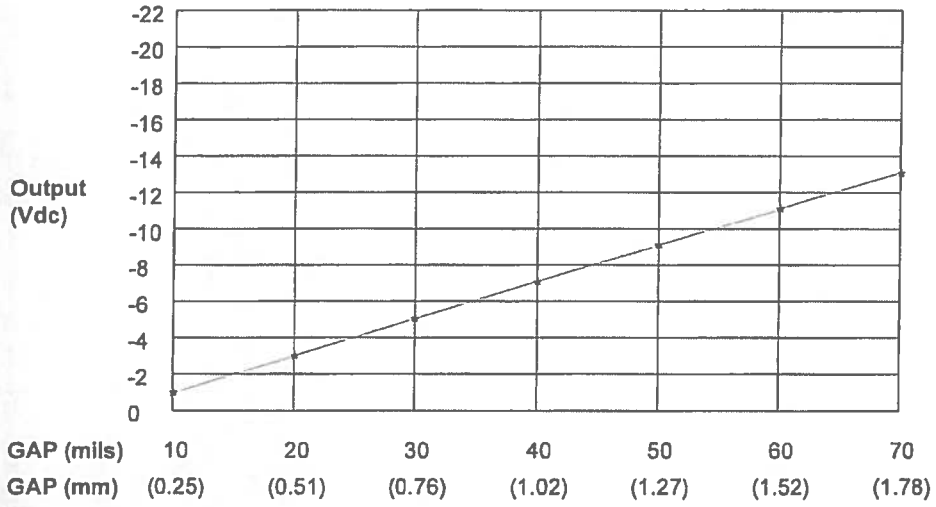
Customer PO #	: 24132
Serial Number	: 17A01KZ7
Part Number	: 330909-10-60-10-11-05
Sales Order	: 0000850866
Test Date	: 27/Jan/2017 09:26 AM
Tester ID #	: 7809
Target Matl.	: AISI 4140
Standard ASF	: 200.93 mV/mil
	: (7.91 V/mm)
Device ASF	: 201.97 mV/mil
	: (7.95 V/mm)
Max DSL	: 0.25 mils (6.23 um)
Customer Tag	: VXE-501, 502

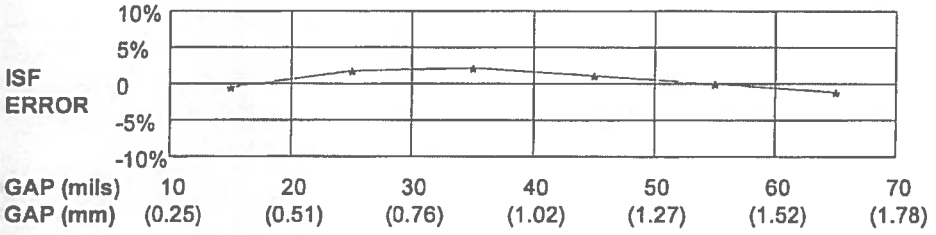
Output Voltage (Vdc)	Gap mils : (mm)	Incremental Scale Factor mV/mil : (V/mm)
-1.000 @	10 : (0.25)	199.9 : (7.87)
-2.999 @	20 : (0.51)	204.4 : (8.05)
-5.043 @	30 : (0.76)	205.2 : (8.08)
-7.095 @	40 : (1.02)	203.1 : (8.00)
-9.126 @	50 : (1.27)	200.7 : (7.90)
-11.133@	60 : (1.52)	198.5 : (7.81)
-13.118@	70 : (1.78)	

BENTLY NEVADA

Minden USA

PROBE Final Test Results





Customer:
L.A. TURBINE CORPORATION

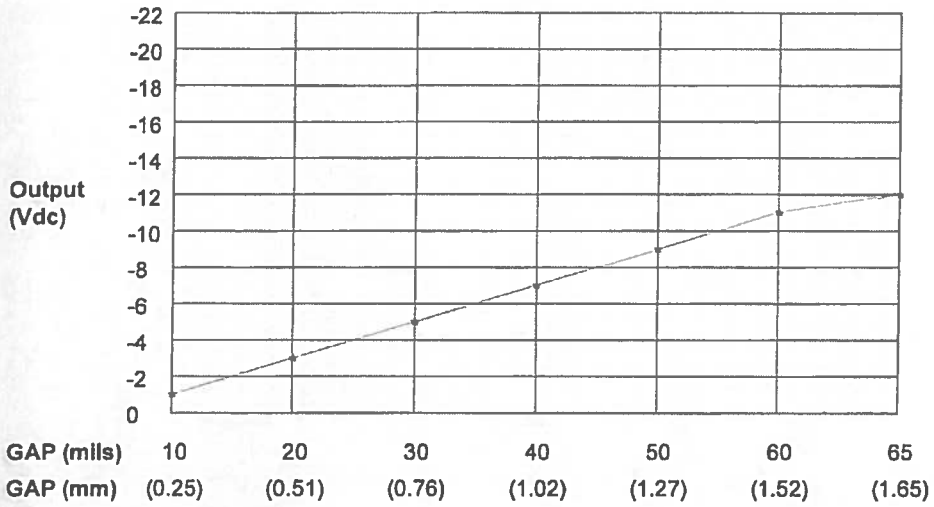
Customer PO #	: 24132
Serial Number	: 17A01KZ8
Part Number	: 330909-10-60-10-11-05
Sales Order	: 0000850866
Test Date	: 27/Jan/2017 09:26 AM
Tester ID #	: 7809
Target Matl.	: AISI 4140
Standard ASF	: 200.93 mV/mil
	: (7.91 V/mm)
Device ASF	: 201.43 mV/mil
	: (7.93 V/mm)
Max DSL	: 0.21 mils (5.23 um)
Customer Tag	: VXE-501, 502

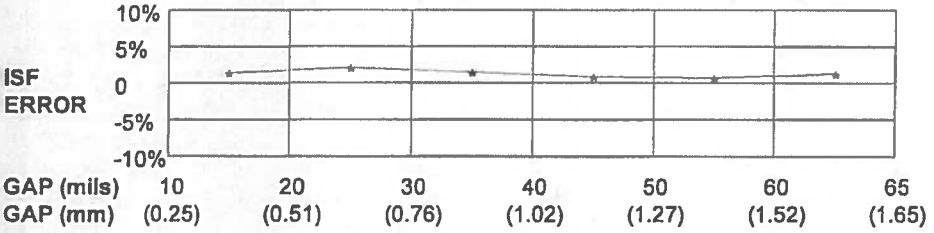
Output Voltage (Vdc)	Gap mils : (mm)	Incremental Scale Factor mV/mil : (V/mm)
-1.008 @	10 : (0.25)	199.3 : (7.85)
-3.001 @	20 : (0.51)	203.9 : (8.03)
-5.040 @	30 : (0.76)	204.7 : (8.06)
-7.087 @	40 : (1.02)	202.5 : (7.97)
-9.112 @	50 : (1.27)	200.3 : (7.89)
-11.115@	60 : (1.52)	197.9 : (7.79)
-13.094@	70 : (1.78)	

BENTLY NEVADA

Minden USA

PROX Final Test Results





Customer:
L.A. TURBINE CORPORATION

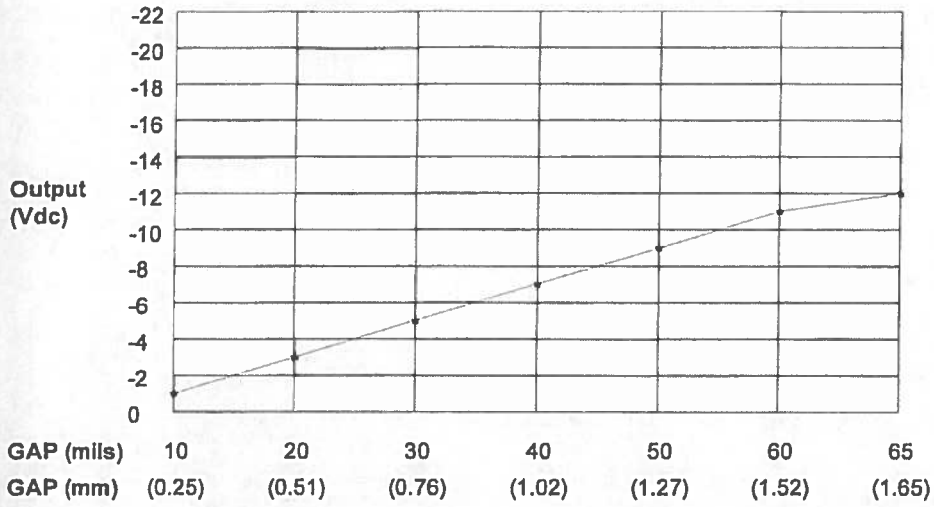
Customer PO #	: 24132
Serial Number	: 17A01KH5
Part Number	: 990-05-50-01-05
Sales Order	: 0000850866
Test Date	: 26/Jan/2017 08:58 AM
Tester ID #	: 4208
Target Matl.	: AISI 4140
Standard ASF	: 198.25 mV/mil
	: (7.81 V/mm)
Device ASF	: 200.22 mV/mil
	: (7.88 V/mm)
Max DSL	: 0.27 mils (6.87 um)
Customer Tag	: VXT-501,502

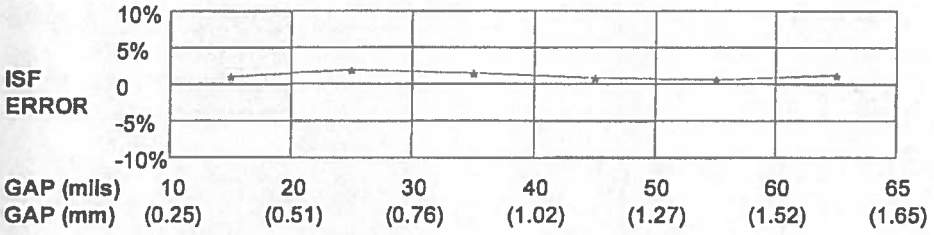
Output Voltage (Vdc)	Gap mils : (mm)	Incremental Scale Factor mV/mil : (V/mm)
-0.990 @	10 : (0.25)	200.4 : (7.89)
-2.994 @	20 : (0.51)	201.8 : (7.94)
-5.012 @	30 : (0.76)	200.6 : (7.90)
-7.018 @	40 : (1.02)	199.3 : (7.85)
-9.011 @	50 : (1.27)	199.0 : (7.83)
-11.001@	60 : (1.52)	200.2 : (7.88)
-12.002@	65 : (1.65)	

BENTLY NEVADA

Minden USA

PROX Final Test Results





Customer:
L.A. TURBINE CORPORATION

Customer PO #	: 24132
Serial Number	: 17A01KH6
Part Number	: 990-05-50-01-05
Sales Order	: 0000850866
Test Date	: 26/Jan/2017 08:55 AM
Tester ID #	: 4208
Target Matl.	: AISI 4140
Standard ASF	: 198.25 mV/mil
	: (7.81 V/mm)
Device ASF	: 200.00 mV/mil
	: (7.87 V/mm)
Max DSL	: 0.24 mils (6.11 um)
Customer Tag	: VXT-501,502

Output Voltage (Vdc)	Gap mils : (mm)	Incremental Scale Factor mV/mil : (V/mm)
-1.001 @	10 : (0.25)	199.8 : (7.87)
-2.999 @	20 : (0.51)	201.5 : (7.93)
-5.014 @	30 : (0.76)	200.6 : (7.90)
-7.020 @	40 : (1.02)	199.3 : (7.85)
-9.013 @	50 : (1.27)	198.8 : (7.83)
-11.001@	60 : (1.52)	200.0 : (7.87)
-12.001@	65 : (1.65)	

Revision	Name	Approved	Description
G	I.Gilstrap	T. Woods	ECM 500000219682
H	J. Drake	T. Woods	ECM: 500000229086

GE INTERNAL
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EC Declaration of Conformity – EMC/ATEX Declaration

We: Bently Nevada Inc.
1631 Bently Parkway South
Minden, NV 89423 U.S.A.

Declare in sole responsibility that the equipment to which this declaration applies, complies with

EMC Directive 2014/30/EU

and, where the applicable dash option has been ordered, also complies with

ATEX directive 2014/34/EU

when installed in accordance with the installation instructions in the Installation and Maintenance Manuals.

Equipment

3300 Series			7200 Series		3000 Series		
24134	146056	330194	810	43330	3389	20102	30001
87741	147038-01	330195	21500	43331	4452	20240	30002
100630	148239	330196	21501	84441	6609	20241	30003
102044	162380	330197	21502	84842-01	7736	20395	30004
102047	162381	330198	21504	84856	8425-01	20423	30005
102048	162625	330232	21505	85743	8444	20432	30006
105971	164710	330701	21506	86691	8837	20438	30008
106763	164711	330702	21508	100354	CA8837	20468	30009

3300 Series			7200 Series		3000 Series		
109548-01	164712	330703	21509		9004	24547	104495
109549-01	167063	330704	22810		9722	27604	133021
109550-01	168209	330705	22811		9761-01	28400	133775
123616-01	173687	330706	22812		10169	28407	135334
123617	173688	330707	22813		19000	28408	135395
128093	177112	330708	24134		CA19000	28411	
128164	177451-01	330709	24721		19001	28450	
128685	330101	330710	26017		CA19001	28454	
129715	330102	330851	28194		19004	28607	
129716	330103	330875	28277		CA19004	28701	
129764	330104	330876	28418		19006	30000	
130368	330105	330901	43329		19007	30011	
130938	330106	330902	BA100386		BA19007	30012	
134340	330140	330903	101395		CA19007	38777	
134387	330141	330904	102018		19008	80627	
137383	330145	330905	105839		20080	81063-01	
137479	330171	330906	130528		20101	82832	
137504	330172	330907	131908		20539	82981	
141912-01	330173	330908	134713-01		20578	82983	
143493-01	330174	330909	136077		20638	83860	
143497-01	330191	330910	158569-01		20643	83897	
146054	330192	1x35667			20800	84821-01	
146055	330193				20805	84838	

Environmental and Use Conditions: Industrial Applications

EMC

Standards	Accredited Test Lab	Test Reports	Technical File
EN 61000-6-2:2005 EN 61000-6-4:2007 +A1:2011	CKC Laboratories, Inc. 5046 Sierra Pines Drive Mariposa, CA 95338	CE09-082	284760 104M3190

ATEX (Where the applicable dash option has been ordered)

Standards	Notified Body	Test Report	Certificate No.
EN 60079-0:2012 +A11:2013 EN 60079-11:2012 EN 60079-15:2010	SGS Baseefa Limited Rockhead Business Park, Staden Lane Buxton, Derbyshire SK17 9RZ, England Registration No. 1180 (formerly 0600)	GB/BAS/ExTR 12.0152 GB/BAS/ExTR 16.0185	BAS99ATEX1099 BAS99ATEX3098

Marking	
	II 1 G Ex ia IIC T1...T5 Ga
	II 3 G Ex nA IIC T1...T5 Gc

Temperature Ratings	
Temperature Class	**Temperature Range**
T1	-55°C to +232°C
T2	-55°C to +177°C
T3	-55°C to +120°C
T4	-55°C to +80°C
T5	-55°C to +40°C

Entity Parameters

Intrinsically Safe Parameters (Ex ia)

Probe Type	U_i (V)	I_i (mA)	P_i (W)	C_i (nF)	L_i (µH)
All Probes (excluding 3300XL 50mm)	-28	140	0.91	1.5	210
3300 XL 50mm (330875/330876)					610

Input Parameters (Ex nA)

Max rated Input: -28V

Signatory

9/30/16

Luis Blasini Date
Executive Engineering Manager
Bently Nevada Inc.
1631 Bently Parkway South
Minden, NV 89423, US

Revision	Name	Approved	Description
E	J. Drake	T. Woods	RE-INSTATED WAS OBSOLETE SEE ECM: 500000215616
F	J. DRAKE	T. WOODS	ECM: 500000229086

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EC Declaration of Conformity – EMC/ATEX Declaration

We: Bently Nevada Inc.
1631 Bently Parkway South
Minden, NV 89423 U.S.A.

Declare in sole responsibility that the equipment to which this declaration applies; complies with

EMC Directive 2014/30/EU

and, where the applicable dash option has been ordered, also complies with

ATEX directive 2014/34/EU

when installed in accordance with the installation instructions in the Installation and Maintenance Manuals.

Equipment

Model Number	Model Name
990	990 Vibration Transmitter
991	991 Thrust Transmitter

Environmental and Use Conditions: Industrial Applications

EMC

Standards	Accredited Test Lab	Test Reports	Technical File
EN 61000-6-2 (2005) EN 61000-6-4 (2007)+A1:2011	CKC Laboratories, Inc. 5046 Sierra Pines Drive Mariposa, CA 95338	CE08-156	286506 286507

Where the applicable dash option has been ordered:

ATEX

Standards	Notified Body	Test Report	Certificate No.
EN 60079-0 : 2012 EN 60079-11 : 2012 EN 60079-15 : 2010	LCIE Avenue du Général Leclerc, 33 92266 Fontenay-aux-Roses, France Registration Number: 0081	60056862/557600/1 60056862/557600/2 324100 – Technical File Summary 1122516-645256	LCIE 06 ATEX 6052 X LCIE 06 ATEX 6055 X

Marking	Temperature Ratings
II 1 G Ex ia IIC T4 Ga	T4 @ Ta = -35°C to +85°C
II 3 G Ex nA IIC T4 Gc	

Entity Parameters

Zone 0/1

Terminal blocks E1-E2 "power supply 4-20 mA"	Terminal blocks E3-E4 and connector J2 "Proximitor"	Connector J3 "Probe"
Ui ≤ 28 V	Uo ≤ 28 V	Uo ≤ 28 V
Ii ≤ 120 mA	Io ≤ 6 mA	Io ≤ 100 mA
Pi ≤ 0.84 W	Po ≤ 0.17 W	Po ≤ 0.8 W
Ci ≤ 20 nF	Co ≤ 80 nF	Co ≤ 27.3 nF
Li ≤ 10 µH	Lo ≤ 1 H	Lo ≤ 5.3 mH

Zone 2

Power Supply : 28 V

ATEX Special Conditions of Safe Use

Zone	Special Conditions for Safe Use
Zone 0/1	• The terminal blocks and connectors can be only connected to intrinsically safe certified equipments. • These combinations must be compatible as regard the intrinsic safety rules (see Entity Parameters). • Operating ambient temperature: -35°C to +85°C
Zone 2	• The apparatus shall be installed in a metallic enclosure with a minimum degree of protection IP 54. • Operating ambient temperature: -35°C to +85°C

Signatory



9/30/16

Luis Blasini Date
Executive Engineering Manager
Bently Nevada Inc.
1631 Bently Parkway South
Minden, NV 89423, US

EXHEAT Electric Heaters and Control Systems

EXHEAT Industrial Ltd

Certificate of Conformity

WO024265N / N/A

Customer Name Exheat Industrial Ltd	Customer ID: N/A
Customer Reference : WO024265N	Order Date: 17/02/2016

Item/Group	Qty	Description
S0370201000111	15.00	(S0370201000111) HEF100 100W 110V 1Ph HAZARDOUS AREA ENCLOSURE HEATER ATEX / IECEx Certified Ex II 2 G Ex e IIC T4 Gb Zone 1 & 2 DWG 3030.02.01

TESTS

1. Resistance check within 7.5% of rated value.
2. High voltage flash test (cold) @ 2000 volts for 1 minute.
3. Insulation resistance (cold) > 999 @ 500 volts D.C.
4. Earth continuity check.
5. Visual and Dimensional Check.
6. Hydrostatic Test Pressure @ - Bar G for - minutes
7. Heater Pneumatic Pressure Test @ - PSI for - minutes
8. Vessel Pressure Test @ - Bar G for - minutes
9. Serial Number: 161892N TO 161906N
10. Tag Number: -

"Certified that the equipment / Services detailed hereon have been inspected and tested in accordance with the contract or purchase order and unless noted hereon, conform in all respect to the specifications and drawings relevent thereto."

QC 11

Name : Chris Green Signed: _____ Date: 17/03/2016

For and On behalf of Exheat Industrial Ltd

Exheat Industrial Ltd
Threxton House, Threxton Road Industrial Estate, Watton, Norfolk, IP25 6NG
Tel: +44 (0)1953 886210, Fax: +44 (0) 1953 883853, email: accounts@exheat.com, web: www.exheat-industrial.com

EXHEAT Electric Heaters and Control Systems

EX HEAT Industrial Ltd

Electrical Test Record

Test Ref No: WI/09/114

WO024265N / N/A

Customer Name :	Customer ID:
Customer Reference :	Order Date: 17/02/2016

Item/Group	Qty	Description
S0370201000111	15.00	(S0370201000111) HEF100 100W 110V 1Ph HAZARDOUS AREA ENCLOSURE HEATER ATEX / IECEx Certified Ex II 2 G Ex e IIC T4 Gb Zone 1 & 2 DWG 3030.02.01

Element assembly resistance: Phase to Neutral **Stage 1:** 71.9 TO 75.1 Ohms **Stage 3:** - Ohms

Stage 2: - Ohms **Stage 4:** - Ohms

Insulation resistance (cold): 999 M Ohms
(500V dc test between all live points and earth)

High voltage flash test **Elements:** 2000 Volts **Thermostat & ACH Circuit:** - Volts
(HV applied for 1 minute between all live points and earth)

Insulation resistance (after HV test): 999 M Ohms
(500V dc test between all live points and earth)

Insulation resistance between stages: - M Ohms
(500V dc test between all live points and earth)

Earth bonding resistance: - Ohms **Thermostat and cutout continuity:** N/A

ACH circuit resistance: - Ohms

Temperature sensor readings (RTD/TC/Temperature Transmitter)

Hydrostatic Test Pressure carried out @: - **Bar G for:** - **minutes**

Vessel Hydrostatic test carried out @: - **Bar G for:** - **minutes**

Comments

Tag Number: -

Serial Number: 161892N TO 161906N

Name : Chris Green
For and On behalf of Exheat Industrial Ltd

Signed: _____ Date: 17/03/2016

Exheat Industrial Ltd
Tel: Tel: +44 (0)1953 886210, Fax: +44 (0) 1953 883853, email: accounts@exheat.com, web: www.exheat-industrial.com

HEAT Electric Heaters and Control Systems

LA514 23989

HEAT Industrial Ltd

ectrical Test Record Test Ref No: WI/09/114

WO024265N / N/A

Customer Name :

Customer ID:

Customer Reference :

Order Date: 17/02/2016

Item/Group	Qty	Description
S0370201000111	15.00	(S0370201000111) HEF100 100W 110V 1Ph HAZARDOUS AREA ENCLOSURE HEATER ATEX / IECEx Certified Ex II 2 G Ex e IIC T4 Gb Zone 1 & 2 DWG 3030.02.01

Element assembly resistance: Phase to Neutral **Stage 1:** 71.9 TO 75.1 Ohms **Stage 3:** - Ohms

Stage 2: - Ohms **Stage 4:** - Ohms

Insulation resistance (cold): 999 M Ohms
(500V dc test between all live points and earth)

High voltage flash test **Elements:** 2000 Volts **Thermostat & ACH Circuit:** - Volts
(HV applied for 1 minute between all live points and earth)

Insulation resistance (after HV test): 999 M Ohms
(500V dc test between all live points and earth)

Insulation resistance between stages: - M Ohms
(500V dc test between all live points and earth)

Earth bonding resistance: - Ohms **Thermostat and cutout continuity:** N/A

ACH circuit resistance: - Ohms

Temperature sensor readings (RTD/TC/Temperature Transmitter)

Hydrostatic Test Pressure carried out @: - **Bar G for:** - **minutes**

Vessel Hydrostatic test carried out @: - **Bar G for:** - **minutes**

Comments

Tag Number: -

Serial Number: 161892N TO 161906N

Name . Chris Green
For and On behalf of Exheat Industrial Ltd

Signed: _____ Date: 17/03/2016

Certificate of Conformity

WO024265N / N/A

Customer Name Exheat Industrial Ltd

Customer ID: N/A

Customer Reference : WO024265N

Order Date: 17/02/2016

Item/Group	Qty	Description
S0370201000111	15.00	(S0370201000111) HEF100 100W 110V 1Ph HAZARDOUS AREA ENCLOSURE HEATER ATEX / IECEx Certified Ex II 2 G Ex e IIC T4 Gb Zone 1 & 2 DWG 3030.02.01

TESTS

1. Resistance check within 7.5% of rated value.
2. High voltage flash test (cold) @ 2000 volts for 1 minute.
3. Insulation resistance (cold) > 999 @ 500 volts D.C.
4. Earth continuity check.
5. Visual and Dimensional Check.
6. Hydrostatic Test Pressure @ - Bar G for - minutes
7. Heater Pneumatic Pressure Test @ - PSI for - minutes
8. Vessel Pressure Test @ - Bar G for - minutes
9. Serial Number: 161892N TO 161906N
10. Tag Number: -

"Certified that the equipment / Services detailed hereon have been inspected and tested in accordance with the contract or purchase order and unless noted hereon, conform in all respect to the specifications and drawings relevent thereto."

Name : Chris Green Signed: Date: 17/03/2016

For and On behalf of Exheat Industrial Ltd

Exheat Industrial Ltd
Threxton House, Threxton Road Industrial Estate, Watton, Norfolk, IP25 6NG
Tel: +44 (0)1953 886210, Fax: +44 (0) 1953 883853, email: accounts@exheat.com, web: www.exheat-industrial.com

GE Oil & Gas

Certificate Of Conformance

CUSTOMER ORDER NO.	
24835	
SELLER ORDER NO.	SHIP DATE
873640	04.APR.2017
PACKING LIST NO.	CERTIFICATE NO.
81043455	81043455

BENTLY NEVADA, INC.

1631 BENTLY PARKWAY SOUTH
MINDEN Nevada 89423-4119 USA

Ship To
L.A. TURBINE CORPORATION
PO: 24835
28557 INDUSTRY DRIVE
VALENCIA, California 91355-3445
USA
Phone: 6612948290

Questions? Contact Global Technical Support team at ittechsupport@ge.com

ITEM NO.	QTY.	U/M	DESCRIPTION
			CERTIFICATE OF CONFORMANCE The products included for shipment in the above customer order have been verified for conformance as follows: Products manufactured by Bently Nevada INC. have been verified in accordance with the applicable Bently Nevada INC. specifications, procedures, and the Integrated Manufacturing and Quality Plan. Products not manufactured by Bently Nevada have been verified for conformance to the specified order requirements. If you have any questions about our products, please contact our global Technical Support team at bntechsupport@ge.com. You can also visit our Technical Support portal at www.bntechsupport.com where local phone numbers and contact information are available. The portal is accessible by all customers with a registered GE Single On(SSO) account. If you do not have an SSO account, you will be prompted to register when accessing the portal for the first time. BENTLY NEVADA Karl Cyrd Customer Quality Representative **04.APR.2017** **Date**
1000	2	EA	330909-10-60-10-11-05 PROBE 3300 NSV PROXIMITY 3/8-24 ARM Reference Order: 873640 / 001000 Customer PO Number: 24835
2000	1	EA	TEST_DATA_283638 ATEX DoC 283638 Reference Order: 873640 / 001001 Customer PO Number: 24835
3000	2	EA	330909-10-60-10-11-05 PROBE 3300 NSV PROXIMITY 3/8-24 ARM Reference Order: 873640 / 002000 Customer PO Number: 24835

ITEM NO.	QTY.	U/M	DESCRIPTION
4000	1	EA	TEST_DATA_283638 ATEX DoC 283638 Reference Order: 873640 / 002001 Customer PO Number: 24835

Revision	Name	Approved	Description
G	I.Gilstrap	T. Woods	ECM 500000219682
H	J. Drake	T. Woods	ECM: 500000229086

GE INTERNAL
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© 2002 GENERAL ELECTRIC COMPANY & BENTLY NEVADA , INC. MINDEN, NEVADA USA

EC Declaration of Conformity – EMC/ATEX Declaration

We: Bently Nevada Inc.
1631 Bently Parkway South
Minden, NV 89423 U.S.A.

Declare in sole responsibility that the equipment to which this declaration applies, complies with

EMC Directive 2014/30/EU

and, where the applicable dash option has been ordered, also complies with

ATEX directive 2014/34/EU

when installed in accordance with the installation instructions in the Installation and Maintenance Manuals.

Equipment

3300 Series			7200 Series		3000 Series		
24134	146056	330194	810	43330	3389	20102	30001
87741	147038-01	330195	21500	43331	4452	20240	30002
100630	148239	330196	21501	84441	6609	20241	30003
102044	162380	330197	21502	84842-01	7736	20395	30004
102047	162381	330198	21504	84856	8425-01	20423	30005
102048	162625	330232	21505	85743	8444	20432	30006
105971	164710	330701	21506	86691	8837	20438	30008
106763	164711	330702	21508	100354	CA8837	20468	30009

3300 Series			7200 Series		3000 Series		
109548-01	164712	330703	21509		9004	24547	104495
109549-01	167063	330704	22810		9722	27604	133021
109550-01	168209	330705	22811		9761-01	28400	133775
123616-01	173687	330706	22812		10169	28407	135334
123617	173688	330707	22813		19000	28408	135395
128093	177112	330708	24134		CA19000	28411	
128164	177451-01	330709	24721		19001	28450	
128685	330101	330710	26017		CA19001	28454	
129715	330102	330851	28194		19004	28607	
129716	330103	330875	28277		CA19004	28701	
129764	330104	330876	28418		19006	30000	
130368	330105	330901	43329		19007	30011	
130938	330106	330902	BA100386		BA19007	30012	
134340	330140	330903	101395		CA19007	38777	
134387	330141	330904	102018		19008	80627	
137383	330145	330905	105839		20080	81063-01	
137479	330171	330906	130528		20101	82832	
137504	330172	330907	131908		20539	82981	
141912-01	330173	330908	134713-01		20578	82983	
143493-01	330174	330909	136077		20638	83860	
143497-01	330191	330910	158569-01		20643	83897	
146054	330192	1x35667			20800	84821-01	
146055	330193				20805	84838	

Environmental and Use Conditions: Industrial Applications

EMC

Standards	Accredited Test Lab	Test Reports	Technical File
EN 61000-6-2:2005 EN 61000-6-4:2007 +A1:2011	CKC Laboratories, Inc. 5046 Sierra Pines Drive Mariposa, CA 95338	CE09-082	284760 104M3190

ATEX (Where the applicable dash option has been ordered)

Standards	Notified Body	Test Report	Certificate No.
EN 60079-0:2012 +A11:2013 EN 60079-11:2012 EN 60079-15:2010	SGS Baseefa Limited Rockhead Business Park, Staden Lane Buxton, Derbyshire SK17 9RZ, England Registration No. 1180 (formerly 0600)	GB/BAS/ExTR 12.0152 GB/BAS/ExTR 16.0185	BAS99ATEX1099 BAS99ATEX3098

Marking	
	II 1 G Ex ia IIC T1...T5 Ga
	II 3 G Ex nA IIC T1...T5 Gc

Temperature Ratings	
Temperature Class	**Temperature Range**
T1	-55°C to +232°C
T2	-55°C to +177°C
T3	-55°C to +120°C
T4	-55°C to +80°C
T5	-55°C to +40°C

Entity Parameters

Intrinsically Safe Parameters (Ex ia)

Probe Type	U_i (V)	I_i (mA)	P_i (W)	C_i (nF)	L_i (µH)
All Probes (excluding 3300XL 50mm)	-28	140	0.91	1.5	210
3300 XL 50mm (330875/330876)					610

Input Parameters (Ex nA)

Max rated Input: -28V

Signatory



9/30/16

Luis Blasini Date
Executive Engineering Manager
Bently Nevada Inc.
1631 Bently Parkway South
Minden, NV 89423, US

L.A.Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 17: INSTRUMENTS AND GAUGES

- CERTIFICATE OF CONFORMANCE

ASHCROFT

CERTIFIED CALIBRATION CHART

For Customer Use Only:	DATE CALIBRATION CYCLE BEGINS	CALIBRATION DUE DATE

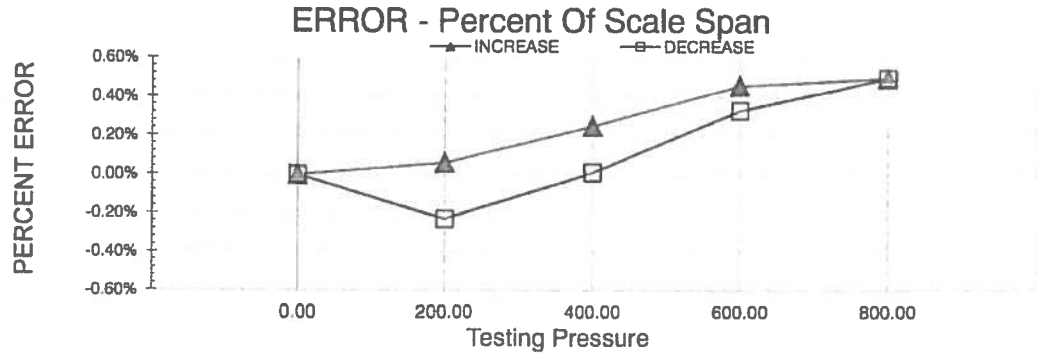
JENSEN INSTRUMENT COMPANY	6192	2
CUSTOMER NAME	CUSTOMER ORDER No	ITEM No

10463171	2	45 1279SS 04B XC4LLNHOSSG 800#
ORDER No.	LINE No.	DESCRIPTION

0.	800.	psi	0.50%	PI-102	E449718
MIN. RANGE	MAX. RANGE	UNITS	ACCURACY	TAG No. / PRODUCT INFO	SERIAL No.

Gauge Indication	INCREASE		DECREASE	
	Applied Pressure	% ERROR	Applied Pressure	% ERROR
0.00	0.0	0.00%	0.0	0.00%
200.00	200.5	0.06%	198.2	-0.23%
400.00	402.0	0.25%	400.1	0.01%
600.00	603.7	0.46%	602.6	0.33%
800.00	804.0	0.50%	804.0	0.50%

EQUIPMENT USED FOR INSPECTION	
Pressure Standard Used :	Ashcroft
Serial /ID Number :	1049
Range :	1500 psi
Accuracy :	0.025%
Date Calibrated :	06/02/2016
Due Date of Calibration:	06/02/2017
Tested in accordance with ASME B 40.100:2013	
Accuracy of Unit is traceable to N.I.S.T	



All standards used in this calibration are maintained in accordance with the latest revisions of ANSI/NCSL Z540-1 and ISO-10012

December 13, 2016	8024	Certified By: Agata Czaja
DATE OF CALIBRATION at ASHCROFT® INC.	TESTED BY	Agata Czaja

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250 East Main Street - Stratford, CT 06614-5145 - Phone: 203-378-8281 - www.ashcroftinc.com

ASHCROFT

CERTIFIED CALIBRATION CHART

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DATE CALIBRATION CYCLE BEGINS _____ CALIBRATION DUE DATE _____

JENSEN INSTRUMENT COMPANY	6192	3
CUSTOMER NAME	CUSTOMER ORDER No.	ITEM No.

10463171	3	45 1279SS 04B XC4NHOSSG 600#
ORDER No.	LINE No.	DESCRIPTION

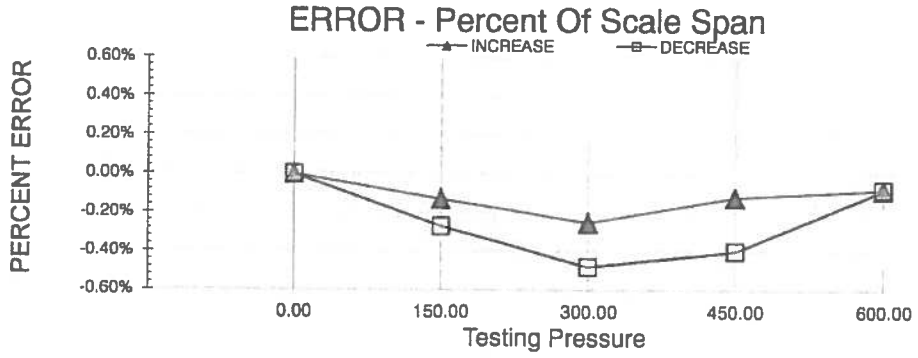
0.	600.	psi	0.50%	PI-504	E449714
MIN. RANGE	MAX. RANGE	UNITS	ACCURACY	TAG No. / PRODUCT INFO	SERIAL No.

Gauge Indication	INCREASE		DECREASE	
	Applied Pressure	% ERROR	Applied Pressure	% ERROR
0.00	0.0	0.00%	0.0	0.00%
150.00	149.2	-0.13%	148.4	-0.27%
300.00	298.5	-0.25%	297.1	-0.48%
450.00	449.3	-0.12%	447.6	-0.40%
600.00	599.5	-0.08%	599.5	-0.08%

EQUIPMENT USED FOR INSPECTION

Pressure Standard Used :	Ashcroft
Serial /ID Number :	1049
Range :	1500 psi
Accuracy :	0.025%
Date Calibrated :	06/02/2016
Due Date of Calibration:	06/02/2017

Tested in accordance with ASME B 40.100:2013
Accuracy of Unit is traceable to N.I.S.T



All standards used in this calibration are maintained in accordance with the latest revisions of ANSI/NCSL Z540-1 and ISO-10012

December 13, 2016	8024	Certified By: Agata Czaja
DATE OF CALIBRATION at ASHCROFT® INC.	TESTED BY	Agata Czaja

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CERTIFIED CALIBRATION CHART

For Customer Use Only:	DATE CALIBRATION CYCLE BEGINS	CALIBRATION DUE DATE

JENSEN INSTRUMENT COMPANY	6192	4
CUSTOMER NAME	CUSTOMER ORDER No.	ITEM No.

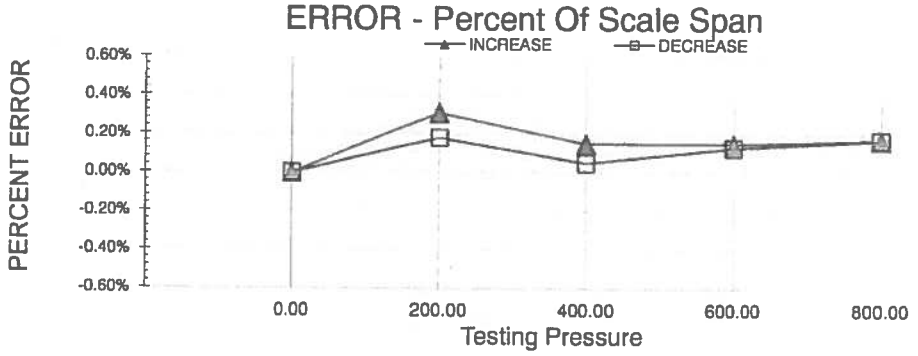
10463171	4	45 1279SS 04B XC4NHOSSG 800#
ORDER No.	LINE No.	DESCRIPTION

0.	800.	psi	0.50%	PI-501	E449715
MIN. RANGE	MAX. RANGE	UNITS	ACCURACY	TAG No. / PRODUCT INFO	SERIAL No.

Gauge Indication	INCREASE		DECREASE	
	Applied Pressure	% ERROR	Applied Pressure	% ERROR
0.00	0.0	0.00%	0.0	0.00%
200.00	202.5	0.31%	201.4	0.18%
400.00	401.2	0.15%	400.4	0.05%
600.00	601.2	0.15%	601.0	0.13%
800.00	801.4	0.17%	801.4	0.17%

EQUIPMENT USED FOR INSPECTION	
Pressure Standard Used :	Ashcroft
Serial /ID Number :	1049
Range :	1500 psi
Accuracy :	0.025%
Date Calibrated :	06/02/2016
Due Date of Calibration:	06/02/2017

Tested in accordance with ASME B 40.100:2013
Accuracy of Unit is traceable to N.I.S.T



All standards used in this calibration are maintained in accordance with the latest revisions of ANSI/NCSL Z540-1 and ISO-10012

December 13, 2016	8024	Certified By: Agata Czaja
DATE OF CALIBRATION at ASHCROFT® INC.	TESTED BY	Agata Czaja

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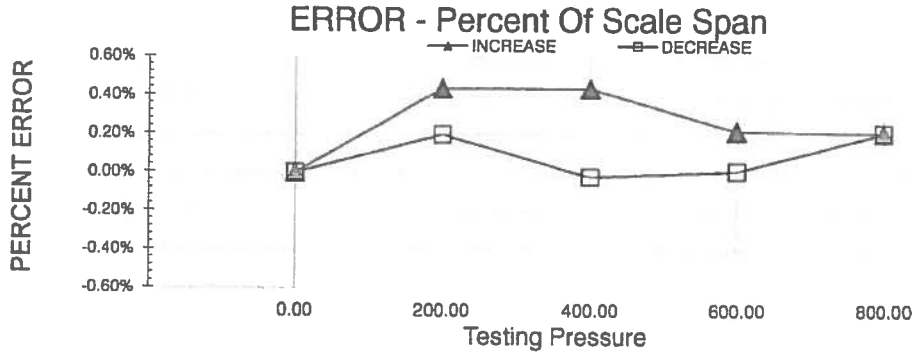
JENSEN INSTRUMENT COMPANY	6192	4
CUSTOMER NAME	CUSTOMER ORDER No.	ITEM No.

10463171	4	45 1279SS 04B XC4NHOSSG 800#
ORDER No.	LINE No.	DESCRIPTION

0.	800.	psi	0.50%	PI-502	E449716
MIN. RANGE	MAX. RANGE	UNITS	ACCURACY	TAG No. / PRODUCT INFO	SERIAL No

Gauge Indication	INCREASE		DECREASE	
	Applied Pressure	% ERROR	Applied Pressure	% ERROR
0.00	0.0	0.00%	0.0	0.00%
200.00	203.5	0.44%	201.6	0.20%
400.00	403.5	0.44%	399.8	-0.02%
600.00	601.8	0.22%	600.1	0.01%
800.00	801.7	0.21%	801.7	0.21%

EQUIPMENT USED FOR INSPECTION	
Pressure Standard Used :	Ashcroft
Serial /ID Number :	1049
Range :	1500 psi
Accuracy :	0.025%
Date Calibrated :	06/02/2016
Due Date of Calibration:	06/02/2017
Tested in accordance with ASME B 40.100:2013	
Accuracy of Unit is traceable to N.I.S.T	



All standards used in this calibration are maintained in accordance with the latest revisions of ANSI/NCSL Z540-1 and ISO-10012

December 13, 2016	8024	Certified By: Agata Czaja
DATE OF CALIBRATION at ASHCROFT® INC	TESTED BY	Agata Czaja

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CERTIFIED CALIBRATION CHART

For Customer Use Only:	DATE CALIBRATION CYCLE BEGINS	CALIBRATION DUE DATE

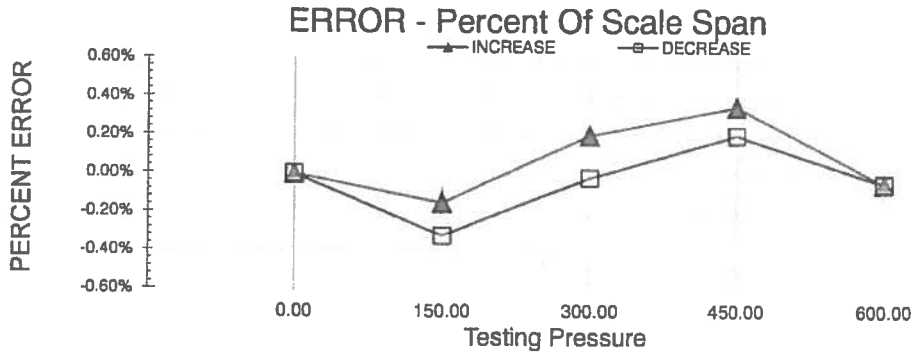
JENSEN INSTRUMENT COMPANY	6192	3
CUSTOMER NAME	CUSTOMER ORDER No.	ITEM No.

10463171	3	45 1279SS 04B XC4NHOSSG 600#
ORDER No.	LINE No.	DESCRIPTION

0.	600.	psi	0.50%	PI-201	E449712
MIN. RANGE	MAX. RANGE	UNITS	ACCURACY	TAG No. / PRODUCT INFO	SERIAL No.

Gauge Indication	INCREASE		DECREASE	
	Applied Pressure	% ERROR	Applied Pressure	% ERROR
0.00	0.0	0.00%	0.0	0.00%
150.00	149.1	-0.15%	148.1	-0.32%
300.00	301.2	0.20%	299.9	-0.02%
450.00	452.1	0.35%	451.2	0.20%
600.00	599.7	-0.05%	599.7	-0.05%

EQUIPMENT USED FOR INSPECTION	
Pressure Standard Used :	Ashcroft
Serial /ID Number :	1049
Range :	1500 psi
Accuracy :	0.025%
Date Calibrated :	06/02/2016
Due Date of Calibration:	06/02/2017
Tested in accordance with ASME B 40.100:2013	
Accuracy of Unit is traceable to N.I.S.T	



All standards used in this calibration are maintained in accordance with the latest revisions of ANSI/NCSL Z540-1 and ISO-10012

December 13, 2016	8024	Certified By: Agata Czaja
DATE OF CALIBRATION at ASHCROFT® INC.	TESTED BY	Agata Czaja

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CERTIFIED CALIBRATION CHART

For Customer Use Only:	DATE CALIBRATION CYCLE BEGINS	CALIBRATION DUE DATE

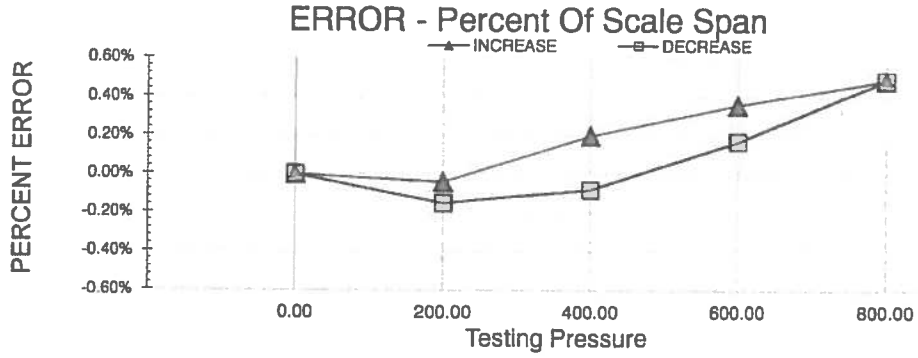
JENSEN INSTRUMENT COMPANY	6192	2
CUSTOMER NAME	CUSTOMER ORDER No.	ITEM No.

10463171	2	45 1279SS 04B XC4LLNHOSSG 800#
ORDER No.	LINE No.	DESCRIPTION

0.	800.	psi	0.50%	PI-101	E449717
MIN. RANGE	MAX. RANGE	UNITS	ACCURACY	TAG No. / PRODUCT INFO	SERIAL No.

Gauge Indication	INCREASE		DECREASE	
	Applied Pressure	% ERROR	Applied Pressure	% ERROR
0.00	0.0	0.00%	0.0	0.00%
200.00	199.7	-0.04%	198.8	-0.15%
400.00	401.6	0.20%	399.4	-0.08%
600.00	602.9	0.36%	601.4	0.17%
800.00	803.9	0.49%	803.9	0.49%

EQUIPMENT USED FOR INSPECTION	
Pressure Standard Used :	Ashcroft
Serial /ID Number :	1049
Range :	1500 psi
Accuracy :	0.025%
Date Calibrated :	06/02/2016
Due Date of Calibration:	06/02/2017
Tested in accordance with ASME B 40.100:2013	
Accuracy of Unit is traceable to N.I.S.T	



All standards used in this calibration are maintained in accordance with the latest revisions of ANSI/NCSL Z540-1 and ISO-10012

December 13, 2016	8024	Certified By: Agata Czaja
DATE OF CALIBRATION at ASHCROFT® INC	TESTED BY	Agata Czaja

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ASHCROFT

CERTIFIED CALIBRATION CHART

For Customer Use Only:	DATE CALIBRATION CYCLE BEGINS	CALIBRATION DUE DATE

JENSEN INSTRUMENT COMPANY	6192	3
CUSTOMER NAME	CUSTOMER ORDER No.	ITEM No

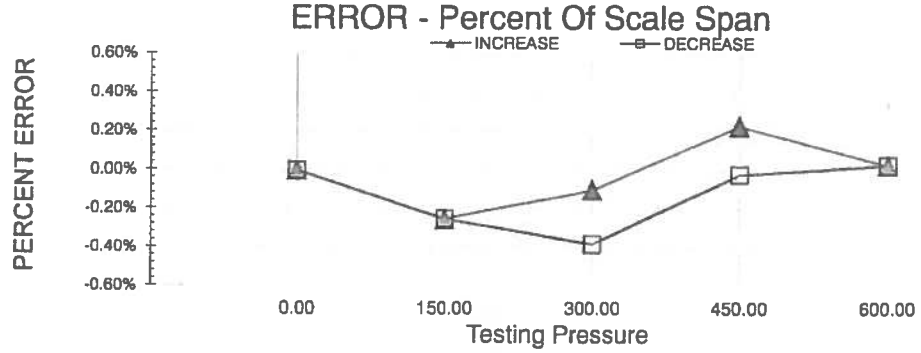
10463171	3	45 1279SS 04B XC4NHOSSG 600#
ORDER No.	LINE No.	DESCRIPTION

0.	600.	psi	0.50%	PI-503	E449713
MIN. RANGE	MAX. RANGE	UNITS	ACCURACY	TAG No. / PRODUCT INFO	SERIAL No.

Gauge Indication	INCREASE		DECREASE	
	Applied Pressure	% ERROR	Applied Pressure	% ERROR
0.00	0.0	0.00%	0.0	0.00%
150.00	148.5	-0.25%	148.5	-0.25%
300.00	299.4	-0.10%	297.7	-0.38%
450.00	451.4	0.23%	449.9	-0.02%
600.00	600.2	0.03%	600.2	0.03%

EQUIPMENT USED FOR INSPECTION	
Pressure Standard Used :	Ashcroft
Serial /ID Number :	1049
Range :	1500 psi
Accuracy :	0.025%
Date Calibrated :	06/02/2016
Due Date of Calibration:	06/02/2017

Tested in accordance with ASME B 40.100:2013
Accuracy of Unit is traceable to N.I.S.T



All standards used in this calibration are maintained in accordance with the latest revisions of ANSI/NCSL Z540-1 and ISO-10012

December 13, 2016	8024	Certified By: Agata Czaja
DATE OF CALIBRATION at ASHCROFT® INC.	TESTED BY	Agata Czaja

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ASHCROFT HEISE WILLY WEKSLER
250 East Main Street - Stratford, CT 06614-5145 - Phone: 203-378-8281 - www.ashcroftinc.com

Quality, First Choice, Always

CERTIFICATE OF CONFORMANCE

CUSTOMER: L.A. TURBINE CORPORATION

CUSTOMER ORDER NO: 23962

THERMO ELECTRIC REFERENCE: SOA16-4525

This is to certify that all the materials and services furnished on the subject purchase order comply with the terms and specifications contained therein. Records and Test records are on file for review.

LINE	PART NO.	QTY (Ea)	DESCRIPTION	TAG NOS.
1	SF044-006	2	RTD-14-LT-6-72-2A	
2	SF044-006	2	RTD-14-LT-6-72-2A	
3	SF047-649	1	RTD-14-LT-15-72-2A	
4	SF042-902	2	D-RTD-14-LT-7-72-2A	

BY: _____
QUALITY CONTROL DEPT.

DATE: Tuesday, January 31, 2017

Thermo Electric Company Inc.
1193 McDermott Drive, West Chester, PA 19380

Quality, First Choice, Always

CERTIFICATE OF CONFORMANCE

CUSTOMER: L.A. TURBINE CORPORATION
CUSTOMER PO NO.: 23962
THERMO ELECTRIC ORDER NO.: SOA16-4453

This is to certify that all the materials and services furnished on the subject purchase order comply with the terms and specifications contained therein. Records and Test records are on file for review.

LINE	TE PART NO.	QTY	DESCRIPTION/TAG NOS.
1	SF042-902	1 EA	D-RTD-14-LT-7-72-2A TAG:
2	SF044-006	2 EA	RTD-14-LT-6-72-2A TAG:
3	SF042-902	2 EA	D-RTD-14-LT-7-72-2A TAG:

BY: _____
QUALITY CONTROL DEPT.

DATE: December 28, 2016

ASHCROFT

CERTIFIED CALIBRATION CHART

For Customer Use Only:

DATE CALIBRATION CYCLE BEGINS _____ CALIBRATION DUE DATE _____

JENSEN INSTRUMENT COMPANY	6200	6
CUSTOMER NAME	CUSTOMER ORDER No.	ITEM No.

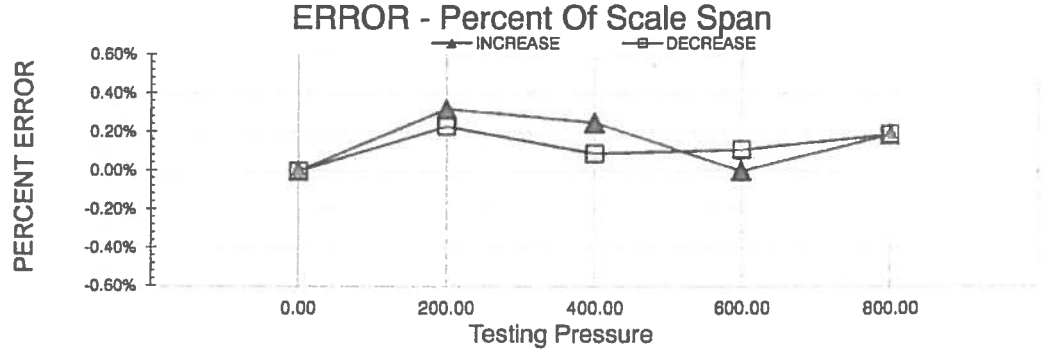
10463209	6	45 1279SS 04B XC4NHOSSG 800#
ORDER No.	LINE No.	DESCRIPTION

0.	800.	psi	0.50%	PI-502	E452607
MIN. RANGE	MAX. RANGE	UNITS	ACCURACY	TAG No. / PRODUCT INFO	SERIAL No.

Gauge Indication	INCREASE		DECREASE	
	Applied Pressure	% ERROR	Applied Pressure	% ERROR
0.00	0.0	0.00%	0.0	0.00%
200.00	202.6	0.32%	201.8	0.23%
400.00	402.0	0.25%	400.7	0.09%
600.00	600.0	0.00%	600.9	0.11%
800.00	801.5	0.19%	801.5	0.19%

EQUIPMENT USED FOR INSPECTION	
Pressure Standard Used :	Ashcroft
Serial /ID Number :	1049
Range :	1500 psi
Accuracy :	0.025%
Date Calibrated :	06/02/2016
Due Date of Calibration:	06/02/2017

Tested in accordance with ASME B 40.100:2013
Accuracy of Unit is traceable to N.I.S.T



All standards used in this calibration are maintained in accordance with the latest revisions of ANSI/NCSL Z540-1 and ISO-10012

January 27, 2017	8024	Certified By: Agata Czaja
DATE OF CALIBRATION at ASHCROFT® INC.	TESTED BY	Agata Czaja

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ASHCROFT HEISE WILLY WEKSLER
250 East Main Street - Stratford, CT 06614-5145 - Phone: 203-378-8281 - www.ashcroftinc.com

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

QC DATA BOOK LAT574

SECTION NO. 18: MACHINE TEST

- SYSTEM CLEANLINESS CHECK CERTIFICATE
- EXPANDER PERFORMANCE TEST CERTIFICATE
- COMPRESSOR PERFORMANCE TEST CERTIFICATE
- MECHANICAL RUN TEST CERTIFICATE
- TEARDOWN / DISASSEMBLY INSPECTION CERTIFICATE

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

PIPING SYSTEM CLEANLINESS CHECK

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS) MOUNTED ON COMMON SKID

THIS IS TO CERTIFY THAT **ENTIRE SYSTEM,** OF THE ABOVE REFERENCED EXPANDER-COMPRESSOR UNITS, HAS BEEN CLEANED AND FLUSHED, PER LAT STANDARD PROCEDURE NO. QMS-WI-709, PRIOR TO MACHINE TESTING, AND THE RESULT WAS FOUND TO BE SATISFACTORY.

INSP. PERFORMED BY: _____ 04/05/17
Segundo Diaz, Supervisor — DATE

CERTIFIED BY: _____ 4/5/17
Frank Loth, Quality Manager — DATE

L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate
EXPANDER PERFORMANCE TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS)

THIS IS TO CERTIFY THAT **PERFORMANCE TEST** HAS BEEN SUCCESSFULLY CONDUCTED ON THE **EXPANDER** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER. THE TEST RECORDS ARE SHOWN IN THE ATTACHED TEST REPORT AND THEY INDICATE THAT EXPANDER'S PERFORMANCE MET THE CONTRACTUAL REQUIREMENTS.

TEST PERFORMED BY: _____ 4-6-17
BRIAN PARRELLI, LAT TEST ENGINEER — DATE

CERTIFIED BY: _____ 4/6/17
FRANK LOTH, QA MANAGER — DATE

L.A. Turbine Corp.

Expander Performance Test

Test No.: 1 Test Date: 04/06/17 Test Engr: B. PARRELLI Job No.: LAT574EC

Time Start: 01:30 PM Witness: Approval: T. AVETIAN Unit No.: MAIN

Design Conditions:

Shaft Speed (RPM): 40,000
ΔH,s (BTU/lb): 41.91
Flow Rate (ACFM): 637
Wheel Diameter (in): 5.500
Isentropic Efficiency (%): 84
U/C0: 0.663

Test Conditions:

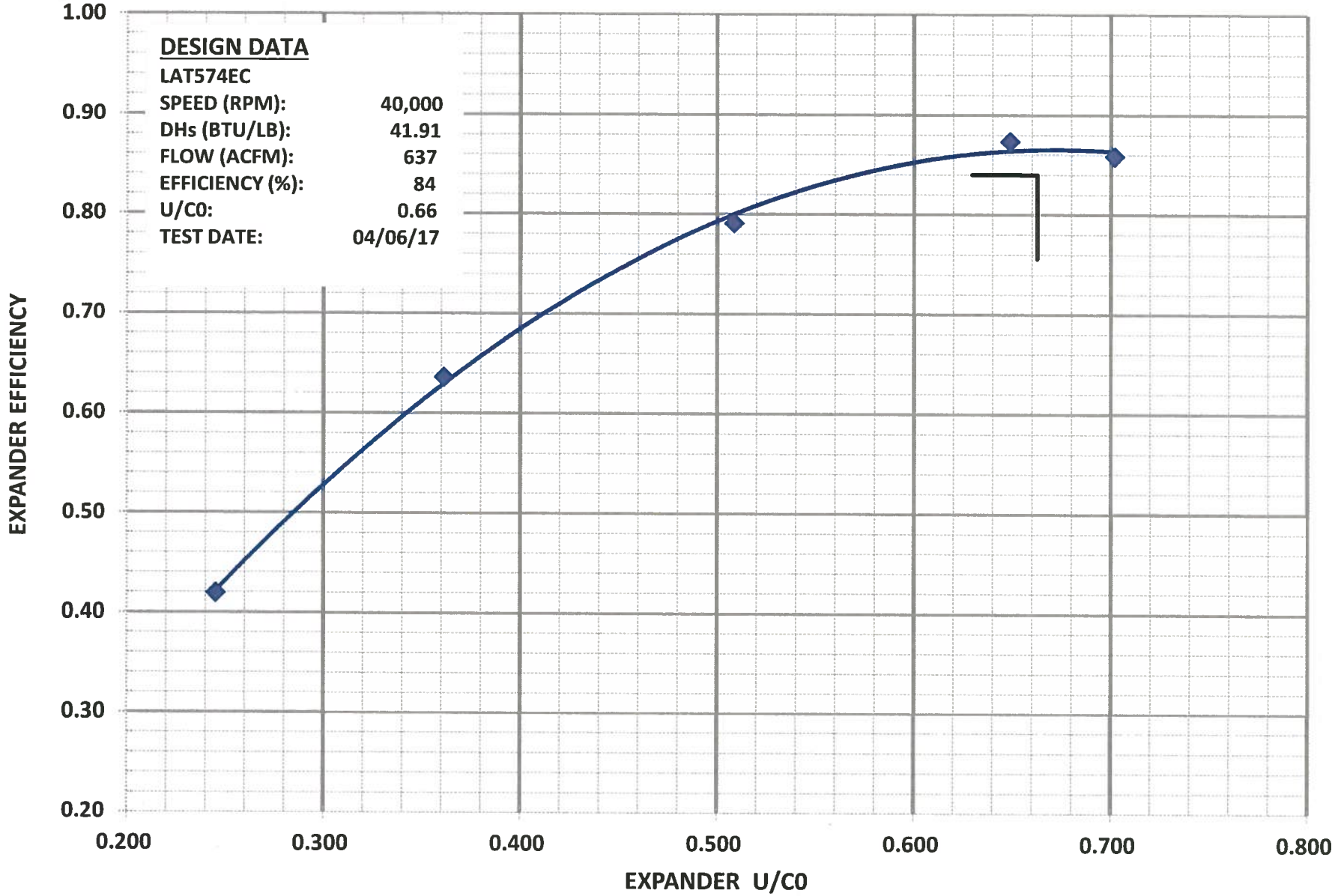
Test Gas: Air
Pipe Diameter (in): 6.000
Orifice Diameter (in): 4.000
Ambient Pressure (in Hg): 30.06
Ambient Temperature (F): 70
Relative Humidity (%): 32%

Test Data:		Point #1	Point #2	Point #3	Point #4	Point #5	
Shaft Speed (RPM)		26,796	24,184	21,365	18,129	15,461	
Inlet Pressure (psig)		67.15	66.20	44.50	33.80	53.40	
Discharge Pressure (psig)		37.60	38.20	19.80	7.30	3.40	
Inlet Temperature (F)		122.15	123.10	132.45	138.05	145.70	
Discharge Temperature (F)		62.20	64.95	65.60	61.35	65.85	
Orifice ΔP (in H2O)		7.60	7.60	4.45	2.00	0.70	
Orifice Pressure (psig)		67.20	66.25	44.45	33.65	53.30	
Orifice Temperature (F)		123.55	124.45	134.25	140.85	149.50	
Nozzle Opening (%)		100%	100%	80%	55%	25%	
ΔH,s (BTU/lb)		16.76	15.98	20.29	28.95	45.71	
Isentropic Efficiency		0.858	0.874	0.791	0.636	0.419	
U/C0		0.702	0.649	0.509	0.361	0.245	

As-tested, the expander meets the minimum required efficiency and produces 101% of the predicted power at the guaranteed design case. This satisfies the API-617 performance test requirement.

L.A.Turbine

EXPANDER PERFORMANCE



L.A. Turbine™
Rethinking Turboexpanders

28557 Industry Drive
Tel: 661-294-8290 Valencia, CA 91355 Fax: 888-674-6503

Certificate

COMPRESSOR PERFORMANCE TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS)

THIS IS TO CERTIFY THAT **PERFORMANCE TEST** HAS BEEN SUCCESSFULLY CONDUCTED ON THE **COMPRESSOR** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER. THE TEST RECORDS ARE SHOWN IN THE ATTACHED TEST REPORT AND THEY INDICATE THAT COMPRESSOR'S PERFORMANCE MET THE CONTRACTUAL REQUIREMENTS.

TEST PERFORMED BY: _____ 4-6-17
BRIAN PARRELLI, LAT TEST ENGINEER **DATE**

CERTIFIED BY: _____ 4/6/17
FRANK LOTH, QA MANAGER **DATE**

L.A. Turbine Corp.

Compressor Performance Test

Test No.:	1	Test Date:	04/06/17	Test Engr:	B. PARRELLI	Job No.:	LAT574EC
Time Start:	12:30 PM	Witness:		Approval:	T. AVETIAN	Unit No.:	MAIN

Design Conditions:

Shaft Speed (RPM):	40,000
Polytropic Head (BTU/lb):	17.18
Flow Rate (ACFM):	2,338
Wheel Diameter (in):	6.000
Polytropic Efficiency (%):	78.0

Test Conditions:

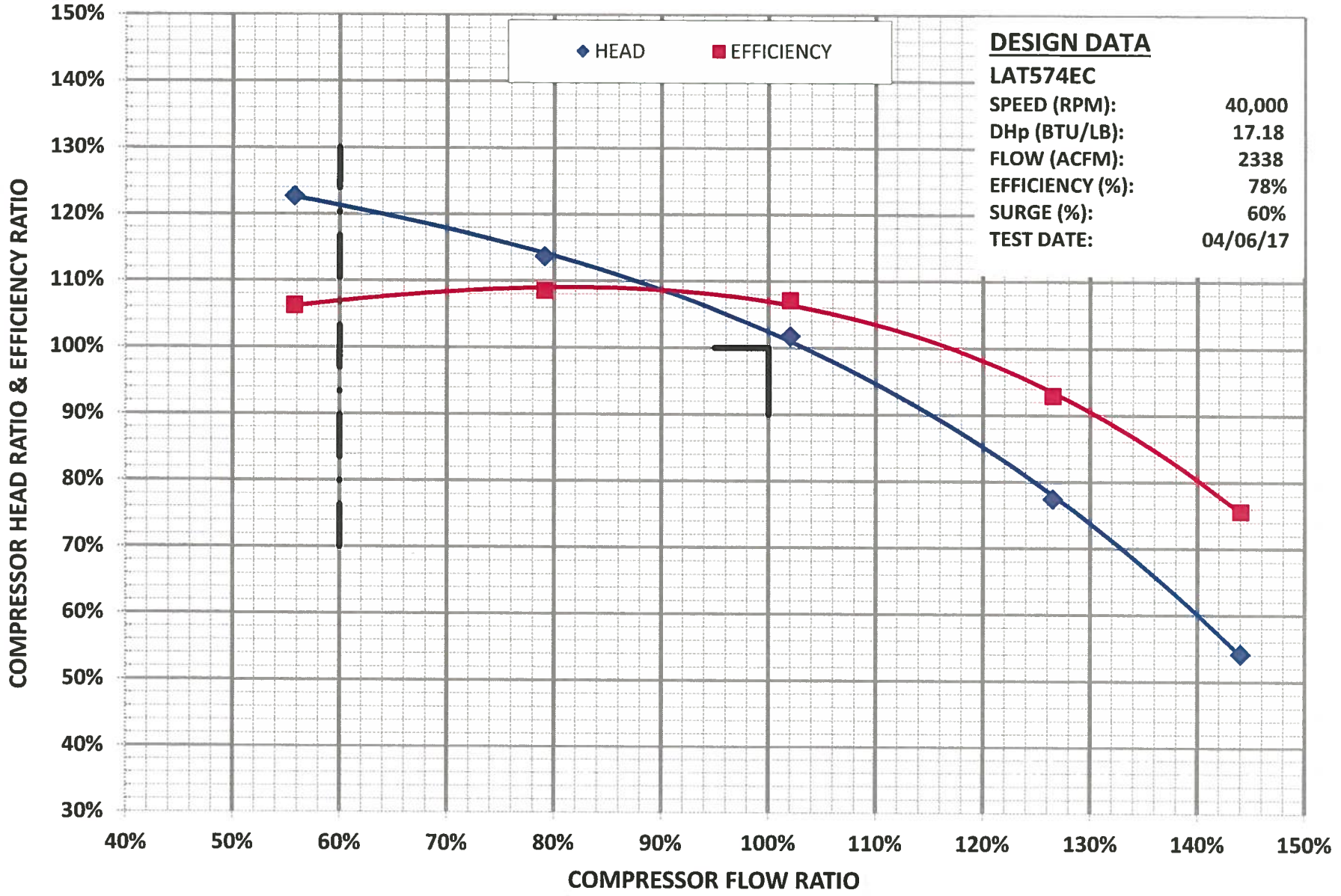
Test Gas:	Air
Pipe Diameter (in):	12.000
Orifice Diameter (in):	6.500
Ambient Pressure (in Hg):	30.06
Ambient Temperature (F):	70.00
Relative Humidity (%):	32%

Test Data:		Stonewall Point #1	Point #2	Design Point #3	Point #4	Surge Point #5	
Shaft Speed (RPM)		26,596	26,494	27,109	28,294	29,943	
Orifice Diameter (in)		6.500	6.500	6.500	6.500	6.500	
Orifice ΔP (in H2O)		15.50	12.00	8.25	5.45	3.05	
Inlet Pressure (in H2O)		11.30	8.70	6.00	3.95	2.20	
Discharge Pressure (psig)		1.25	2.10	3.20	4.10	5.15	
Inlet Temperature (F)		74.60	74.60	75.55	75.75	76.70	
Discharge Temperature (F)		103.65	108.15	115.60	123.85	136.10	
Flow Rate (ACFM)		2,239	1,959	1,617	1,309	976	
Polytropic Head (BTU/lb)		4.11	5.84	8.03	9.77	11.81	
Polytropic Efficiency		0.590	0.725	0.835	0.846	0.829	
% Design ACFM		144%	127%	102%	79%	56%	
% Design Head		54%	77%	102%	114%	123%	
% Design Efficiency		76%	93%	107%	108%	106%	

As-tested, the compressor meets the minimum required head and efficiency and consumes 99% of the predicted power at the guaranteed design case. This satisfies the API-617 performance test requirement.

L.A.Turbine

COMPRESSOR PERFORMANCE



L.A. Turbine™
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Certificate

EXPANDER-COMPRESSOR

MECHANICAL RUN TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC (MAIN)

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS)

THIS IS TO CERTIFY THAT MECHANICAL RUN TEST HAS BEEN SUCCESSFULLY CONDUCTED ON THE **EXPANDER-COMPRESSOR** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER. THE TEST RECORDS ARE SHOWN IN THE ATTACHED TEST REPORT. THE MECHANICAL OPERATION OF THE EQUIPMENT WAS FOUND TO BE SATISFACTORY.

TEST PERFORMED BY: (B. Parrell: signing for T. Avetian) 4-6-17
TADEH AVETIAN, LAT TEST ENGINEER — DATE

CERTIFIED BY: 4/6/17
FRANK LOTH, QA MANAGER — DATE

L.A. Turbine Corp.

Mechanical Running Test

Test No.: 1 Test Date: **04/06/17** Test Engr: CM Job No.: **LAT574EC - MAIN**

Time Start: 2:30 PM Witness: No Approval: TA Unit No.: **1203**

Design Data:

Speed (RPM): 40,000 Bearing Diameter (Inches): 1.625

Max. Continuous Speed (RPM): 42,000 Oil Viscosity: 150 SSU @ 100 °F

Test Data:			Expected Values	1 Hour Mechanical Run								Over Speed Trip
Time				2:40 PM	2:50 PM	3:00 PM	3:10 PM	3:20 PM	3:30 PM	3:40 PM	3:50 PM	4:00 PM
Shaft Speed		RPM	42000	30,000	38,520	42,031	42,008	41,989	42,077	42,004	42,018	42,090
Shaft Vibration	Expander X	mils	< 0.8	0.14	0.11	0.11	0.10	0.09	0.07	0.07	0.08	0.07
	Expander Y	mils	N/A	x	x	x	x	x	x	x	x	x
	Compressor X	mils	< 0.8	0.06	0.06	0.05	0.06	0.06	0.08	0.08	0.07	0.07
	Compressor Y	mils	N/A	x	x	x	x	x	x	x	x	x
Bearing Temperature	Expander Side	°F	<150 °F	125.0	133.1	136.0	137.8	139.9	140.7	141.1	141.0	141.1
	Compressor Side	°F	<150 °F	118.0	130.7	135.3	139.4	143.0	143.8	144.4	144.4	144.7
Reservoir Temperature		°F	135 - 150 °F	122.0	130.4	133.2	137.1	140.6	140.6	141.0	140.9	140.7
L.O. After Cooler Temperature		°F	120 °F	116.0	119.7	120.3	120.6	120.8	120.8	120.8	120.8	120.8
L.O. Drain Temperature		°F	<150 °F	128.6	139.3	144.1	144.9	145.2	145.3	145.3	145.2	145.3
Oil DT		°F	<30 °F	12.6	19.6	23.8	24.3	24.4	24.5	24.5	24.4	24.5
Oil Flow		GPM	13 - 15	12.00	11.50	11.06	11.00	10.98	10.96	10.96	10.96	10.96
Oil DP		PSI	100	105.0	106.7	106.7	106.2	105.4	105.4	105.4	105.8	106.0

Auxilliary System Testing (refer to LAT574EC-20-C16 for Alarm/Trip Setpoints):

1. Verified Duplex Lube Oil Filter changeover w/o dropping below oil DP alarm setting.
2. Verified Aux Lube Oil Pump start at low DP alarm setting.
3. Verified Overspeed Shutdown protection.

L.A. Turbine™
Rethinking Turboexpanders

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Certificate

EXPANDER-COMPRESSOR

MECHANICAL RUN TEST

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC (SPARE)

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS)

THIS IS TO CERTIFY THAT MECHANICAL RUN TEST HAS BEEN SUCCESSFULLY CONDUCTED ON THE **EXPANDER-COMPRESSOR** SUPPLIED FOR THE ABOVE REFERENCED PURCHASE ORDER. THE TEST RECORDS ARE SHOWN IN THE ATTACHED TEST REPORT. THE MECHANICAL OPERATION OF THE EQUIPMENT WAS FOUND TO BE SATISFACTORY.

TEST PERFORMED BY: (Signing for T. Avetian) 4-7-17
TADEH AVETIAN, LAT TEST ENGINEER DATE

CERTIFIED BY: 4/7/17
FRANK LOTH, QA MANAGER DATE

L.A. Turbine Corp.

Mechanical Running Test

Test No.: 1 Test Date: **04/07/17** Test Engr: CM Job No.: **LAT574EC - SPARE w/dummy wheel**

Time Start: 1:30 PM Witness: No Approval: TA Unit No.: **1204**

Design Data:

Speed (RPM): 40,000 Bearing Diameter (Inches): 1.625

Max. Continuous Speed (RPM): 42,000 Oil Viscosity: 150 SSU @ 100 °F

Test Data:			Expected Values	1 Hour Mechanical Run								Over Speed Trip
Time				1:50 PM	2:00 PM	2:10 PM	2:20 PM	2:30 PM	2:40 PM	2:50 PM	3:00 PM	3:10 PM
Shaft Speed		RPM	42000	35,000	40,000	42,032	41,984	41,975	41,953	41,961	42,120	42,025
Shaft Vibration	Expander X	mils	< 0.8	0.14	0.18	0.18	0.19	0.23	0.24	0.24	0.23	0.22
	Expander Y	mils	N/A	x	x	x	x	x	x	x	x	x
	Compressor X	mils	< 0.8	0.15	0.22	0.23	0.25	0.24	0.23	0.23	0.22	0.22
	Compressor Y	mils	N/A	x	x	x	x	x	x	x	x	x
Bearing Temperature	Expander Side	°F	<150 °F	116.0	122.5	129.9	131.4	132.7	133.6	134.2	134.1	134.6
	Compressor Side	°F	<150 °F	113.0	120.3	128.6	130.4	131.8	132.8	133.5	133.3	133.9
Reservoir Temperature		°F	135 - 150 °F	120.0	128.9	138.1	139.6	140.0	140.2	140.3	140.4	139.9
L.O. After Cooler Temperature		°F	120 °F	116.0	119.8	120.7	120.8	120.9	121.0	121.0	121.0	120.7
L.O. Drain Temperature		°F	<150 °F	131.0	136.4	139.8	140.0	140.2	140.2	140.3	140.2	140.1
Oil DT		°F	<30 °F	15.0	16.6	19.1	19.2	19.3	19.2	19.3	19.2	19.4
Oil Flow		GPM	13 - 15	14.98	14.55	14.29	14.25	14.23	14.23	14.23	14.29	14.25
Oil DP		PSI	100	99.0	99.3	99.8	99.6	99.9	99.8	99.9	100.7	100.8

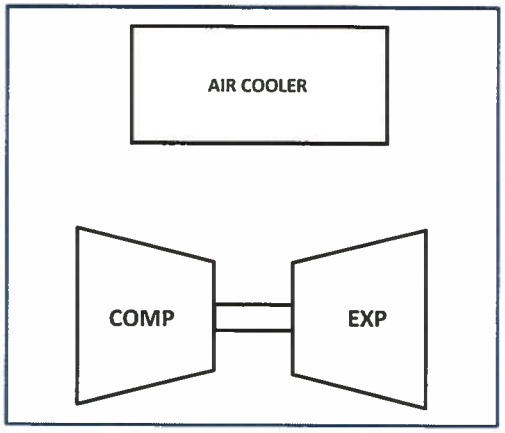
L.A. Turbine	EQUIPMENT NOISE MEASUREMENT (FOR INFORMATION ONLY)	PROJ NO. : LAT574 - S/N - 1203 DOC. NO. : LAT574EC-30-A95

MEASUREMENT LOCATION

113.9 dBA

115.1 dBA

115.4 dBA



113 dBA

117 dBA

RENTAL AIR COMPRESSORS

113.3 dBA

113.6 dBA

115.4 dBA

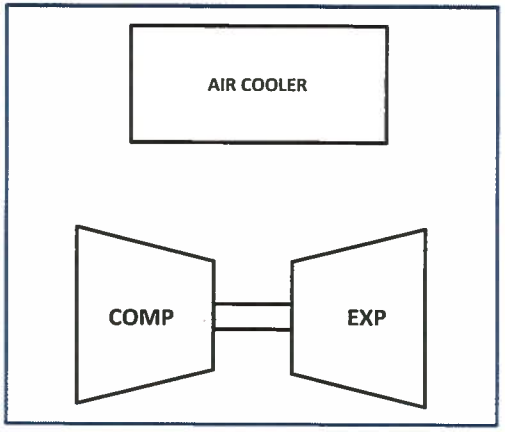
L.A. Turbine — The Turbocompander Company	EQUIPMENT NOISE MEASUREMENT (FOR INFORMATION ONLY) w/Dummy Compressor Wheel	PROJ NO. : LAT574 - S/N - 1204 DOC. NO. : LAT574EC-30-A95

MEASUREMENT LOCATION

91.3 dBA

93.9 dBA

93.3 dBA



87.7 dBA

98.7 dBA

RENTAL AIR COMPRESSORS

90.5 dBA

91.1 dBA

95.4 dBA

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Rethinking Turboexpanders

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Certificate

TEARDOWN/DISASSEMBLY INSPECTION

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS) MOUNTED ON COMMON SKID

THIS IS TO CERTIFY THAT TEARDOWN/DISASSEMBLY INSPECTION HAS BEEN PERFORMED ON THE MECHANICAL CENTER SECTION FOLLOWING THE MECHANICAL RUN TEST. ALL INTERNAL PARTS HAVE BEEN INSPECTED AND FOUND ACCEPTABLE.

INSP. PERFORMED BY: _____ 4/7/17
Chase Murphy, Lead Technician **DATE**

INSP. CONFIRMED BY: _____ 4/7/17
Frank Loth, Quality Manager **DATE**

L.A.Turbine™
Rethinking Turboexpanders

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QC DATA BOOK LAT574

SECTION NO. 19: FINAL INSPECTION

- FINAL INSPECTION CERTIFICATE

L.A. Turbine™
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Certificate

FINAL INSPECTION

CUSTOMER: UOP RUSSELL, LLC

CUSTOMER'S P.O. NUMBER: 4500743460

LA TURBINE JOB NO.: LAT574EC

EQUIPMENT DESCRIPTION: FRAME L2000 EXPANDER-COMPRESSOR UNIT (OIL BEARINGS) MOUNTED ON COMMON SKID

THIS IS TO CERTIFY THAT FOLLOWING INSPECTIONS HAVE BEEN PERFORMED ON THE MAIN EXPANDER-COMPRESSOR UNIT AND SPARE MCS BUILT FOR THE ABOVE REFERENCED PURCHASE ORDER:

- **CLEANING**
- **PAINT APPLICATION**
- **DIMENSIONAL**
- **NAMEPLATES AND TAGGING**

THE RESULTS OF THESE INSPECTIONS WERE FOUND TO BE SATISFACTORY.

INSP. PERFORMED BY: _____ 5/4/17
Frank Loth, Quality Manager **DATE**