UOP RUSSELL LLC
Tulsa, Oklahoma

JOB NO: J-447 **DATE:** 7/14/11
CLIENT: UOP Russell **BY:** JRG
SUBJECT: 60 MMscfd Cryo Plant

AIR COOLED HEAT EXCHANGER

Service	Expander / Compressor Aftercooler			Tag No:	A-301
Combined with	A-302			P.O. No:	
Effective MTD (°F)	21.70	Total Heat Exchanged for this Service (Btu/Hr)			2,606,000
Finned Surface / Unit (Sq.Ft.)	33,480	Bare Surface/Unit (Sq.Ft.)	1,710	Qty of Bays	1
Finned Service Transfer Rate	3.94	Bare Service Transfer Rate	77.20	Heat Curve Attached	Yes

PROCESS DATA

Fluid Circulated		Residue Gas from EC-101	
		Inlet	Outlet
Liquid	Lbs/Hr	0	0
Density	Lb/CF		
Mol. Wt.			
Specific Heat	Btu/Lb °F		
Thermal Cond.	Btu/HrFt °F		
Viscosity	cP		
Vapor	Lbs/Hr	93,579	93,579
Density	Lb/CF	0.7787	0.8380
Mol. Wt.		16.22	16.22
Specific Heat	Btu/Lb °F	0.5839	0.5709
Thermal Cond.	Btu/HrFt °F	0.0247	0.0224
Viscosity	cP	0.0133	0.0124
Operating Temp.	°F	168.5	120

TUBESIDE

Inlet Pressure (psia)	315
Allow. Pressure Drop (psi)	5.00
Calc. Pressure Drop (psi)	3.870
Fouling Factor	0.001

AIR SIDE

Altitude (Ft)	3,000
Temperature In (°F)	110
Temperature Out (°F)	124.00
Air Quantity (Lb/Hr)	824,800
Face Velocity (sfm)	
Static Pressure (inH_2O)	

DESIGN

Code	ASME Section VIII		Wind	ASCE 7-10, 120 mph, Exp.C, Cat. III, Kd=0.9	
Stamp	Yes	Nat'l Board: Yes	Seismic	ASCE 7-10, Site D, I=1.25, S_S=100%, S_1=40%	
Design: Pressure @ Temperature	500	PSIG @	250	°F	
Minimum Design Metal Temperature	-20	°F@	500	PSIG	
Structure - Surface Prep. / Paint:	Metallized header, galvanized structure.				

MATERIALS

Tubes	SA-214
Headers	Carbon Steel
Fins	Aluminum
Plugs	Carbon Steel
Gaskets	Soft Iron

CONSTRUCTION

FINS

O.D.	2.5	inch
Type	L-Tension	
Thickness	0.016	inch
No. / Inch	10	

HEADER BOXES

Header Type	Fabbed Box, Grooved Tubesheet			API-661?:	No		
Plug Type	Shoulder			ANSI Class	300# RF		
Corrosion Allowance (inch)	0.0625	Inlet Nozzle:	Qty	2	Size	8	
Aux. Nozzles: Qty 2 Size 1"		Outlet Nozzle:	Qty	2	Size	8	

TUBES

O.D.	1.25	Inch	Pitch	2.563	Inch		
Min Thk.	16	Gage	Length	30.0	Feet		
Qty Bundles:	1	Tubes Per Bundle:	174	Rows / Passes:	4	2	

MISCELLANEOUS

Hailscreen	X	Auto Adj. Fans	
Bugscreen		Warm Air Recirc.	
Louvers		Auto Actuator	
Fail Open		Fail Shut	

MECHANICAL EQUIPMENT

FAN

Fans Per Bay	2	HP Per Fan	22.3
RPM	346	Diameter (ft)	10.0
No. Blades	5	Pitch (deg.)	7.2
Blade Mat'l	Aluminum		
Hub Mat'l	Aluminum		

DRIVER

Type	Induction motor				
HP Per Driver	30	RPM:	1750		
VFD:	No	Space Htr:	No		
Enclosure	TEFC	Service Factor	1.15		
Volts	480	Phase	3	Hz	60

SPEED REDUCER

Type	V-Belt
Model	(3) 5VX-1250
Ratio	5.06
AGMA HP Rating	47.1

Manufacturer:	Smithco Engineering, Inc.	Size & Type	1F30-119-2
O.A. Dimensions L x W x H (ft)	30 x 9.5 (3)	Shipping Weight	31,050

NOTES:
1) Add 10% duty and flow rates for design.
2) 3.382 GPM C2+ Recov.120°F.hsc
3) Combined unit plot area 30' x 11.9'.
4) Data report shall state that overpressure protection is provided by system design per UG-140(a)

Revision	3	▲ 4	1	2
Engineer / Date	TKF 07/08/13	TKF 08/28/15	BH 11/17/11	NR 05/14/12
Issued For	Added Note 4	Rev to Vib Transmitter	Revised	Revised

UOP RUSSELL LLC
Tulsa, Oklahoma

Job: J-447 **Date:** 7/14/11
Client: UOP Russell **By:** JRG

Scope Of Supply
Air Cooler

Tag No: A-301
Service: Expander / Compressor Aftercooler

Air cooler vendor shall include the following checked items for design and scope of supply.

▲ X	1) Provide one (1) vibration transmitter per fan. Metrix model ST5484E-122-120.
X	2) All carbon steel surfaces are to be hot dipped galvanized except for tube headers which shall be sandblasted and zinc metalized.
	3) **Provide Fisher or Durastroke Actuator with I / P Positioner with stainless steel tube fittings** stroked to check for smooth operation, witnessed by UOP Russell Rep.
	4) Provide 12 Ft. ladder and platform on header end of cooler as an added cost. Provide double bar self-closing saftey Gates on Platform (Note to UOPR - determine if ladder and platforms are required for off-skid coolers prior to issuing PO)
	5) Provide added cost for warm air recirculation with manual inlet louvers. Units shall be completely shop assembled including louvers. Assembled unit shall be witnessed by UOP Russell Representative.
	6) Provide two-speed motors on half the fans as an added cost. Motors above 50HP shall have space heaters.
	7) Provide variable frequency drive motors. (Motor starters by UOP Russell)
	8) Stress relieve header box on Amine Cooler, Amine Still Reflux Condenser, and Flash Gas Cooler Services.
	9) Amine Still Reflux Condenser, Flash Gas Cooler tubes and headers to be free draining with flush outlet nozzle.
	10) Amine Still Reflux Condenser: Provide SA-249T 316SS tubes as an added cost. No welding allowed on tubes after heat treatment by tube manufacturer.
X	11) Two (2) electronic copies "For Approval"; Two (2) electronic copie Certified AFC; Four (4) Final hard copies of As-Built Job Data Book Documentation and One (1) CD with all documents available in electronic format. One (1) set of field erection drawings and shipping list to be included in shipping package on truck. All ship loose pieces shall be tagged and identified on shipping list. Tag numbers shall be physically mounted on louvers.
	12) Rain shields are required if actuators must be mounted upside down and exposed to the atmosphere.
	13) Linkage between multiple louvers should be smooth. Torque tubes shall be of adequate strength.
	14) Vendor to flush Lube Oil Coolers and test per API 614 to remove contaminants.
X	15) Run test to be witnessed by UOP Russell Inspector.
X	16) Vendor to contact UOP Russell Inspector prior to start to fabrication to finalize inspection procedure.

When compliance with API-661 is indicated on the specification sheet, Vendor shall include the following:

A) All carbon steel exposed to the process will have 0.125" corrosion allowance (except tubes) per Paragraph 4.1.5.

B) The tube wall thickness shall comply with the requirements of Paragraph 4.1.11.3.

UOP RUSSELL LLC
Tulsa, Oklahoma

JOB NO: J-447 **DATE:** 7/14/11
CLIENT: UOP Russell **BY:** JRG
SUBJECT: 60 MMscfd Cryo Plant

AIR COOLED HEAT EXCHANGER

Service	NGL Product Cooler			Tag No:	A-302
Combined with	A-301			P.O. No:	
Effective MTD (°F)	18.70	Total Heat Exchanged for this Service (Btu/Hr)			600,420
Finned Surface / Unit (Sq.Ft.)	6,989.0	Bare Surface/Unit (Sq.Ft.)	330	Qty of Bays	1
Finned Service Transfer Rate	5.070	Bare Service Transfer Rate	107.270	Heat Curve Attached	Yes

PROCESS DATA

Fluid Circulated		NGL		TUBESIDE	
		Inlet	Outlet	Inlet Pressure (psia)	745
Liquid	Lbs/Hr	25,000	25,000	Allow. Pressure Drop (psi)	5.00
Density	Lb/CF	29.35	31.48	Calc. Pressure Drop (psi)	3.71
Mol. Wt.		49.41	49.41	Fouling Factor	0.001
Specific Heat	Btu/Lb °F	0.7183	0.6580		
Thermal Cond.	Btu/HrFt °F	0.0417	0.0461	**AIR SIDE**	
Viscosity	cP	0.0858	0.0999	Altitude (Ft)	3,000
Vapor	Lbs/Hr	0	0	Temperature In (°F)	110
Density	Lb/CF			Temperature Out (°F)	123.00
Mol. Wt.				Air Quantity (Lb/Hr)	206,400
Specific Heat	Btu/Lb °F			Face Velocity (sfm)	
Thermal Cond.	Btu/HrFt °F			Static Pressure (inH_2O)	
Viscosity	cP				
Operating Temp.	°F	155	120		

DESIGN

Code	ASME Section VIII			Wind	ASCE 7-10, 120 mph, Exp.C, Cat. III, Kd=0.9		
Stamp	Yes	Nat'l Board	Yes	Seismic	ASCE 7-10, Site D, I=1.25, S_S=100%, S_1=40%		
Design: Pressure @ Temperature	1,440	PSIG @	200	°F			
Minimum Design Metal Temperature	-20	°F@	1,440	PSIG			
Structure - Surface Prep. / Paint:	Metallized header, galvanized structure.						

MATERIALS

Tubes	SA-214
Headers	Carbon Steel
Fins	Aluminum
Plugs	Carbon Steel
Gaskets	Soft Iron

CONSTRUCTION

FINS

O.D.	2.25	inch
Type	L-Tension	
Thickness	0.016	inch
No. / Inch	10	

HEADER BOXES

Header Type	Fabbed Box, Grooved Tubesheet				API-661?:	No	
Plug Type	Shoulder				ANSI Class	900# RTJ	
Corrosion Allowance (inch)	0.0625			Inlet Nozzle:	Qty	1	Size 3
Aux. Nozzles:	Qty	2	Size 1"	Outlet Nozzle:	Qty	1	Size 3

TUBES

O.D.	1.00 Inch	Pitch	2.3125	Inch	
Min Thk.	14 Gage	Length	30.0	Feet	
Qty Bundles:	1	Tubes Per Bundle:	42	Rows / Passes:	4 4

MISCELLANEOUS

Hailscreen	X	Auto Adj. Fans	
Bugscreen		Warm Air Recirc.	
Louvers		Auto Actuator	
Fail Open		Fail Shut	

MECHANICAL EQUIPMENT

FAN

Fans Per Bay	2	HP Per Fan	22.3
RPM	346	Diameter (ft)	10
No. Blades	5	Pitch (deg.)	7.2
Blade Mat'l	Aluminum		
Hub Mat'l	Aluminum		

DRIVER

Type	Induction motor				
HP Per Driver	30	RPM:	1750		
VFD:	No	Space Htr:	No		
Enclosure	TEFC	Service Factor	1.15		
Volts	480	Phase	3	Hz	60

SPEED REDUCER

Type	V-Belt
Model	(3) 5VX-1250
Ratio	5.06
AGMA HP Rating	47.1

Manufacturer:	Smithco Engineering, Inc.	Size & Type	1F30-119-2
O.A. Dimensions L x W x H (ft)	30 x 2.2 (3)	Shipping Weight	31,050

NOTES:
1) Add 10% duty and flow rates for design.
2) 4.385 GPM C2+ Reject.80°F.Rev1.hsc
3) Combined unit plot area 30' x 11.7'.

Revision	3	0	1	2
Engineer / Date	TKF 08/28/15	JRG 10/18/11	BH 11/17/11	NR 05/14/12
Issued For	Rev to Vib Transmitter	Purchase	Revised	Revised

UOP RUSSELL LLC
Tulsa, Oklahoma

Job: J-447 **Date:** 7/14/11
Client: UOP Russell **By:** JRG

Scope Of Supply
Air Cooler

Tag No: A-302
Service: NGL Product Cooler

Air cooler vendor shall include the following checked items for design and scope of supply.

▲ X	1) Provide one (1) vibration transmitter per fan. Metrix model ST5484E-122-120.
X	2) All carbon steel surfaces are to be hot dipped galvanized except for tube headers which shall be sandblasted and zinc metalized.
	3) **Provide Fisher or Durastroke Actuator with I / P Positioner with stainless steel tube fittings** stroked to check for smooth operation, witnessed by UOP Russell Rep.
	4) Provide 12 Ft. ladder and platform on header end of cooler as an added cost. Provide double bar self-closing saftey Gates on Platform (Note to UOPR - determine if ladder and platforms are required for off-skid coolers prior to issuing PO)
	5) Provide added cost for warm air recirculation with manual inlet louvers. Units shall be completely shop assembled including louvers. Assembled unit shall be witnessed by UOP Russell Representative.
	6) Provide two-speed motors on half the fans as an added cost. Motors above 50HP shall have space heaters.
	7) Provide variable frequency drive motors. (Motor starters by UOP Russell Co.)
	8) Stress relieve header box on Amine Cooler, Amine Still Reflux Condenser, and Flash Gas Cooler Services.
	9) Amine Still Reflux Condenser, Flash Gas Cooler tubes and headers to be free draining with flush outlet nozzle.
	10) Amine Still Reflux Condenser: Provide SA-249T 316SS tubes as an added cost. No welding allowed on tubes after heat treatment by tube manufacturer.
X	11) Two (2) electronic copies "For Approval"; Two (2) electronic copie Certified AFC; Four (4) Final hard copies of As-Built Job Data Book Documentation and One (1) CD with all documents available in electronic format. One (1) set of field erection drawings and shipping list to be included in shipping package on truck. All ship loose pieces shall be tagged and identified on shipping list. Tag numbers shall be physically mounted on louvers.
	12) Rain shields are required if actuators must be mounted upside down and exposed to the atmosphere.
	13) Linkage between multiple louvers should be smooth. Torque tubes shall be of adequate strength.
	14) Vendor to flush Lube Oil Coolers and test per API 614 to remove contaminants.
X	15) Run test to be witnessed by UOP Russell Inspector.
X	16) Vendor to contact UOP Russell Inspector prior to start to fabrication to finalize inspection procedure.

When compliance with API-661 is indicated on the specification sheet, Vendor shall include the following:

A) All carbon steel exposed to the process will have 0.125" corrosion allowance (except tubes) per Paragraph 4.1.5.

B) The tube wall thickness shall comply with the requirements of Paragraph 4.1.11.3.

FINAL DATA BOOK

SMITHCO JOB NUMBER: 2017B430

CUSTOMER: UOP RUSSELL
P.O. #: 4500753943
PROJECT #: S17430

ITEM #: A-301/302
SERVICE: EXPANDER/ COMPRESSOR AC, NGL PRODUCTION COOLER

DATE: 6-16-17

Smithco Engineering
6312 S. 39th West Ave., Tulsa, OK 74132
(918) 446-4406
www.smithco-eng.com

UOP RUSSELL LLC.
UNKNOWN
JOB NO. S17430
P.O # 4500753943
ITEM NO. A-301/302

TABLE OF CONTENTS

SECTION 1. CODE DATA

National Board Number: 31354

Mfr. Representative: JP Date: 5-11-17

Authorized Inspector: [signature] Date: 5/11/17

FORM U-1 MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by Hudson Products Corporation., 9660 Grunwald Road, Beasley, Texas 77417
(Name and address of Manufacturer)

2. Manufactured for UOP Russel LLC
(Name and address of Purchaser)

3. Location of installation Unknown
(Name and address)

4. Type Horizontal (Horizontal, vertical, or sphere) | Heat Exchangers (Tank, separator, jkt. vessel, heat exch., etc.) | S17430-11A-A-1 (Manufacturer's serial number)

N/A (CRN) | 2017B430-1, Rev.0 (Drawing number) | 31354 (National Board number) | 2017 (Year built)

5. ASME Code, Section VIII, Div. 1 2015 [Edition and Addenda, if applicable (date)] | N/A (Code Case number) | N/A [Special service per UG-120(d)]

Items 6–11 incl. to be completed for single wall vessels, jackets of jacketed vessels, shell of heat exchangers, or chamber of multichamber vessels.

6. Shell: (a) Number of course(s) 1 (b) Overall length 9-7/8"x1'8-1/2"x9'4-13/16"

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2													

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. Heads: (a) SA-516, 70N N/A N/A (Material spec. number, grade or type) (H.T. — time and temp.) (b) SA-516, 70N N/A N/A (Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	Top & Bottom	7/8"	0.0625"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(b)	Ends	1/2"	0.0625"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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)												

8. Type of jacket N/A Jacket closure N/A (Describe as ogee and weld, bar, etc.)

If bar, give dimensions N/A If bolted, describe or sketch.

9. MAWP 500 (Internal) N/A (External) at max. temp. 250 (Internal) N/A (External) Min. design metal temp. -20 at 500.

10. Impact test No,Charpy Impact Test Exempt Per UG-20 (f) [Indicate *yes* or *no* and the component(s) impact tested] at test temperature of N/A.

11. Hydro., pneu., or comb. test pressure Hydrostatic 650 Proof test N/A

Items 12 and 13 to be completed for tube sections.

12. Tubesheet SA-516, 70N [Stationary (material spec. no.)] | 1'8-1/2"x9'4-13/16" [Diameter (subject to press.)] | 1-1/8" (Nominal thickness) | 0.0625"" (Corr. allow.) | Welded [Attachment (welded or bolted)]

N/A [Floating (material spec. no.)] | N/A (Diameter) | N/A (Nominal thickness) | N/A (Corr. allow.) | N/A (Attachment)

13. Tubes SA-214 (Material spec. no., grade or type) | 1-1/4" OD (O.D.) | .060" MW (Nominal thickness) | 174 (Number) | Straight [Type (straight or U)]

National Board Number: 31354

Mfr. Representative: _____ Date: 5-11-17

Authorized Inspector: _____ Date: 5/11/17

FORM U-1 (Cont'd)

Items 14–18 incl. to be completed for inner chambers of jacketed vessels or channels of heat exchangers.

14. Shell: (a) No. of course(s) N/A (b) Overall length _____

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time

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

15. Heads: (a) N/A (b) _____

(Material spec. number, grade, or type) (H.T. — time and temp.) (Material spec. number, grade, or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)														
(b)														

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)												

16. MAWP N/A (Internal) _____ (External) at max. temp. _____ (Internal) _____ (External) Min. design metal temp. _____ at _____.

17. Impact test N/A at test temperature of _____.

[Indicate *yes* or *no* and the component(s) impact tested]

18. Hydro., pneu., or comb. test pressure N/A Proof test _____

19. 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	4	8"300#	RFWN		SA-105	Sch.XS	0.0625"	None		UW-12	
Inlet & Outlet	4	8"	PIPE	SA-106,B		Sch.XS	0.0625"	None	UW-16.1		
Vents & Drains	2	1"6000#	COUP	SA-105		-----	0.0625"	None	UW-16.1		

20. Supports: Skirt No (Yes or no) Lugs _____ (Number) Legs _____ (Number) Others _____ (Describe) Attached _____ (Where and how)

21. Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report (list the name of part, item number, Manufacturer's name, and identifying number):

2-Header Boxes Manufactured by: Manufactured by: Ken's Welding LLC., 6440 S 57th W Ave., Tulsa, OK 74131 Serial No's KW108H-B FR, BK

22. Remarks

Two Rect. Headers: Inlet - Outlet Header: 9-7/8"x1'8-1/2"x9'4-13/16" & Return Header: 5-7/8"x1'7"x9'4-13/16". Service: Expander / Compressor A/C Item No. A-301

OVERALL DIMENSION: 1'8-1/2"x9'4-13/16"x31'1-1/4 Long

** Designed In Accordance With Appendix 13, Para. 13-5

National Board Number: 31354

Mfr. Representative: _____ Date: 5-11-17

Authorized Inspector: _____ Date: 5/11/17

FORM U-1 (Cont'd)

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements 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 8728 Expires Dec.31, 2018

Date 5-11-17 Name Hudson Products Corporation (Manufacturer) Signed _____ (Representative)

CERTIFICATE OF SHOP INSPECTION

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 Hartford, CT.

have inspected the pressure vessel described in this Manufacturer's Data Report on May 11, 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 5/11/17 Signed _____ (Authorized Inspector) Commissions Nat'l. Bd. # 12056 AI/IS TX # 1622 [National Board (incl. endorsements)]

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the statements in this report are correct and that the field assembly construction of all parts of this vessel conforms with the requirements of ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. U Certificate of Authorization Number _____ Expires _____.

Date _____ Name _____ (Assembler) Signed _____ (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by _____

of _____, have compared the statements in this Manufacturer's Data Report with the described pressure vessel and state that parts referred to as data items _____, not included in the certificate of shop inspection, have been inspected by me and to the best of my knowledge and belief, the Manufacturer has constructed and assembled this pressure vessel in accordance with the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. The described vessel was inspected and subjected to a hydrostatic test of _____. 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 _____ Signed _____ (Authorized Inspector) Commissions _____ [National Board (incl. endorsements)]

National Board Number: 31355

Mfr. Representative: _____ Date: 5-11-17

Authorized Inspector: _____ Date: 5/11/17

FORM U-1 MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by Hudson Products Corporation., 9660 Grunwald Road, Beasley, Texas 77417
(Name and address of Manufacturer)

2. Manufactured for UOP Russel LLC
(Name and address of Purchaser)

3. Location of installation Unknown
(Name and address)

4. Type Horizontal (Horizontal, vertical, or sphere) | Heat Exchangers (Tank, separator, jkt. vessel, heat exch., etc.) | S17430-11A-A-2 (Manufacturer's serial number)

N/A (CRN) | 2017B430-2, Rev.0 (Drawing number) | 31355 (National Board number) | 2017 (Year built)

5. ASME Code, Section VIII, Div. 1 2015 [Edition and Addenda, if applicable (date)] | N/A (Code Case number) | N/A [Special service per UG-120(d)]

Items 6–11 incl. to be completed for single wall vessels, jackets of jacketed vessels, shell of heat exchangers, or chamber of multichamber vessels.

6. Shell: (a) Number of course(s) 1 (b) Overall length 4-7/8"x1'5-3/4"x2'1-3/4"

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2													

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. Heads: (a) SA-516, 70N N/A N/A (Material spec. number, grade or type) (H.T. — time and temp.) (b) SA-516, 70N N/A N/A (Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	Top & Bottom	5/8"	0.0625"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(b)	Ends	1/2"	0.0625"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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)												

8. Type of jacket N/A Jacket closure N/A (Describe as ogee and weld, bar, etc.)

If bar, give dimensions N/A If bolted, describe or sketch.

9. MAWP 1440 (Internal) N/A (External) at max. temp. 200 (Internal) N/A (External) Min. design metal temp. -20 at 1440.

10. Impact test No,Charpy Impact Test Exempt Per UG-20 (f) [Indicate *yes* or *no* and the component(s) impact tested] at test temperature of N/A.

11. Hydro., pneu., or comb. test pressure Hydrostatic 1872 Proof test N/A

Items 12 and 13 to be completed for tube sections.

12. Tubesheet SA-516, 70N [Stationary (material spec. no.)] | 1'5-3/4"x2'1-3/4" [Diameter (subject to press.)] | 1" (Nominal thickness) | 0.0625"" (Corr. allow.) | Welded [Attachment (welded or bolted)]

N/A [Floating (material spec. no.)] | N/A (Diameter) | N/A (Nominal thickness) | N/A (Corr. allow.) | N/A (Attachment)

13. Tubes SA-214 (Material spec. no., grade or type) | 1" OD (O.D.) | .083" MW (Nominal thickness) | 42 (Number) | Straight [Type (straight or U)]

National Board Number: 31355

Mfr. Representative: _____ Date: 5-11-17

Authorized Inspector: _____ Date: 5/11/17

FORM U-1 (Cont'd)

Items 14–18 incl. to be completed for inner chambers of jacketed vessels or channels of heat exchangers.

14. Shell: (a) No. of course(s) N/A (b) Overall length _____

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time

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

15. Heads: (a) N/A (b) _____

(Material spec. number, grade, or type) (H.T. — time and temp.) (Material spec. number, grade, or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)														
(b)														

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)												

16. MAWP N/A (Internal) _____ (External) at max. temp. _____ (Internal) _____ (External) Min. design metal temp. _____ at _____.

17. Impact test N/A [Indicate *yes* or *no* and the component(s) impact tested] at test temperature of _____.

18. Hydro., pneu., or comb. test pressure N/A Proof test _____

19. 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	2	3"900#	RTJWN		SA-105	Sch.XS	0.0625"	None		UW-12	
Inlet & Outlet	2	3"	PIPE	SA-106,B		Sch.XS	0.0625"	None	UW-16.1		
Vents & Drains	2	1"6000#	COUP	SA-105		----	0.0625"	None	UW-16.1		

20. Supports: Skirt No (Yes or no) Lugs _____ (Number) Legs _____ (Number) Others _____ (Describe) Attached _____ (Where and how)

21. Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report (list the name of part, item number, Manufacturer's name, and identifying number):

2-Header Boxes Manufactured by: Manufactured by: Ken's Welding LLC., 6440 S 57th W Ave., Tulsa, OK 74131 Serial No's KW108H-A FR, BK

22. Remarks

Two Rect. Headers: Inlet - Outlet & Return Header: 4-7/8"x1'5-3/4"x2'1-3/4" Each". Service: NGL Prod Cooler
Item No. A-302
OVERALL DIMENSION: 1'5-3/4"x2'1-3/4"x30'7-1/2" Long
** Designed In Accordance With Appendix 13, Para. 13-5

National Board Number: 31355

Mfr. Representative: _____ Date: 5-11-17

Authorized Inspector: _____ Date: 5/11/17

FORM U-1 (Cont'd)

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements 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 8728 Expires Dec.31, 2018

Date 5-11-17 Name Hudson Products Corporation (Manufacturer) Signed _____ (Representative)

CERTIFICATE OF SHOP INSPECTION

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 Hartford, CT.

have inspected the pressure vessel described in this Manufacturer's Data Report on May 11, 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 5/11/17 Signed _____ (Authorized Inspector) Commissions Nat'l. Bd. # 12056 AI/IS TX # 1622 [National Board (incl. endorsements)]

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the statements in this report are correct and that the field assembly construction of all parts of this vessel conforms with the requirements of ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. U Certificate of Authorization Number _____ Expires _____.

Date _____ Name _____ (Assembler) Signed _____ (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by _____

of _____, have compared the statements in this Manufacturer's Data Report with the described pressure vessel and state that parts referred to as data items _____, not included in the certificate of shop inspection, have been inspected by me and to the best of my knowledge and belief, the Manufacturer has constructed and assembled this pressure vessel in accordance with the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. The described vessel was inspected and subjected to a hydrostatic test of _____. 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 _____ Signed _____ (Authorized Inspector) Commissions _____ [National Board (incl. endorsements)]

(04/14)

FORM U-2A MANUFACTURER'S PARTIAL DATA REPORT (ALTERNATIVE FORM)

A Part of a Pressure Vessel Fabricated by One Manufacturer for Another Manufacturer

As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by KEN'S WELDING LLC. 6440 S 57th W Ave. Tulsa,OK. 74131
(Name and address of Manufacturer)

2. Manufactured for HUDSON PRODUCTS CORPORATION 9660 GRUNWALD RD BEASLEY, TX 77417-8600
(Name and address of Purchaser)

3. Location of installation UNKNOWN
(Name and address)

4. Type HORIZ(NON-CIR) (Description of vessel part (shell, two-piece head, tube bundle)) KW108H-B FR,BK (Manufacturer's serial number) (CRN)

(National Board number) 2017B430-1 REV 0 (Drawing number) J CHAPMAN (Drawing prepared by) 2017 (Year built)

5. ASME Code, Section VIII, Div. 1 2015 (Edition and Addenda, if applicable (date)) (Code Case number) (Special service per UG-120(d))

6. Shell: (a) Number of course(s) SEE U-4 FORM (b) Overall length SEE U-4 FORM

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
2													

Body Flanges on Shells

No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Bolting			
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material

7. Heads: (a) (Material spec. number, grade or type) (H.T. — time and temp.) (b) (Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)														
(b)														

Body Flanges on Heads

	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Bolting			
									Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
(a)												
(b)												

8. MAWP 500 (Internal) (External) at max. temp. 250 (Internal) (External). Min. design metal temp. -20 at 500.

9. Impact test (Indicate *yes* or *no* and the component(s) impact tested) at test temperature of

10. Hydro., pneu., or comb. test pressure NONE Proof test

11. 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	4	8" 300#	RFWN	SA-106B	SA-105	XH	.0625	INTEGRAL	UW16.1(a)	TYPE 1	INLET/HDR
VENT/DRAIN	2	1" 6000#	CPLG		SA-105		.0625	INTEGRAL	UW16.1(a)	TYPE 1	IN/RET HDR

12. Identification of part(s)

Name of Part	Quantity	Line No.	Mfr's. Identification No.	Mfr's. Drawing No.	CRN	National Board No.	Year Built
N/A							
N/A							

13. Supports: Skirt NO (Yes or no) Lugs (Number) Legs (Number) Other SCALLOPED CHANNEL (Describe) Attached BOTTOM ENDS/WELD (Where and how)

14. Remarks

FORM U-2A (Back)

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of material, construction, and workmanship of this pressure vessel part conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

U Certificate of Authorization No. 35,987 Expires AUGUST 25 2018

Date 4/13/17 Name KEN'S WELDING LLC (Manufacturer) Signed (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by ONECIS/VERATAS INSURANCE COMPANY of LYNN, MA.

have inspected the pressure vessel part described in this Manufacturer's Data Report on 4/13/17, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part 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 part 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 4/13/17 Signed (Authorized Inspector) Commissions NB 7935 [National Board (incl. endorsements)]

(08/14)

FORM U-2A MANUFACTURER'S PARTIAL DATA REPORT (ALTERNATIVE FORM)

A Part of a Pressure Vessel Fabricated by One Manufacturer for Another Manufacturer

As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by KEN'S WELDING LLC. 4404 W. 51st ST. TULSA OK 74107
(Name and address of Manufacturer)

2. Manufactured for HUDSON PRODUCTS CORPORATION 9660 GRUNWALD,TX 77417-8600
(Name and address of Purchaser)

3. Location of installation UNKNOWN
(Name and address)

4. Type HORIZ(NON-CIR) (Description of vessel part (shell, two-piece head, tube bundle)) KW108H-A FR,BK (Manufacturer's serial number) (CRN)

(National Board number) 2017B430-2 REV 0 (Drawing number) J CHAPMAN (Drawing prepared by) 2017 (Year built)

5. ASME Code, Section VIII, Div. 1 2015 (Edition and Addenda, if applicable (date)) (Code Case number) (Special service per UG-120(d))

6. Shell: (a) Number of course(s) SEE U-4 FORM (b) Overall length SEE U-4 FORM

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time

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. Heads: (a) (Material spec. number, grade or type) (H.T. — time and temp.) (b) (Material spec. number, grade or type) (H.T. — time and temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemis. Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)														
(b)														

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)												

8. MAWP 1440 (Internal) (External) at max. temp. 200 (Internal) (External). Min. design metal temp. -20 at 1440.

9. Impact test (Indicate *yes* or *no* and the component(s) impact tested) at test temperature of

10. Hydro., pneu., or comb. test pressure NONE Proof test

11. 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	2	3" 900#	RTJWN	SA-106B	SA-105	XS	.0625"	INTEGRAL	UW16.1(a)	TYPE 1	INLET/HDR
VENT/DRAIN	2	1"6000#	CPLG		SA-105		.0625	INTEGRAL	UW16.1(a)	TYPE 1	IN/RET HDR

12. Identification of part(s)

Name of Part	Quantity	Line No.	Mfr's. Identification No.	Mfr's. Drawing No.	CRN	National Board No.	Year Built
N/A							
N/A							

13. Supports: Skirt NO (Yes or no) Lugs (Number) Legs (Number) Other SCALLOPED CHANNEL (Describe) Attached BOTTOM CORNERS/WELD (Where and how)

14. Remarks

FORM U-2A (Back)

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of material, construction, and workmanship of this pressure vessel part conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

U Certificate of Authorization No. 35,987 Expires AUGUST 25 2018

Date 4/13/17 Name KEN'S WELDING LLC (Manufacturer) Signed (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by ONECIS/VERATAS INSURANCE COMPANY of LYNN, MA.

have inspected the pressure vessel part described in this Manufacturer's Data Report on 4/13/17, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part 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 part 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 4/13/17 Signed (Authorized Inspector) Commissions NB 7935 [National Board (incl. endorsements)]

(08/14)

FORM U-4 MANUFACTURER'S DATA REPORT SUPPLEMENTARY SHEET
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by KEN'S WELDING LLC 6440 S. 57th W. Ave Tulsa, Ok. 74131
(Name and address of Manufacturer)

2. Manufactured for HUDSON PRODUCTS CORPORATION 9660 GRUNWALD, TX 77417-8600
(Name and address of Purchaser)

3. Location of installation UNKNOWN
(Name and address)

4. Type HORIZONTAL (NON-CIR) (Horizontal, vertical, or sphere) | HEADER (Tank, separator, heat exch., etc.) | KW108H-B FR,BK (Manufacturer's serial number)

(CRN) | 2017B430-1 REV 0 (Drawing number) | (National Board number) | 2017 (Year built)

Data Report Item Number	Remarks
Line 6(a) (b)	FRONT HEAD - 1.125" THICK, 112.8125" X 10.250"X 7.3125", WRAP .8750"THK., END .500" THK SA 516-70N
	BACK HEAD - 1.375" THICK, 112.8125"X 9.500" X 8.1875", WRAP .500" THK, END .500" SA516-70N
	CHARPY EXEMPT PER UCS-66 AND UG-20 (f) WPS QUALIFIED IN PWHT&NO PWHT CONDITIONS IN ACCORDANCEWITHAPP.28
	NSP.OPEN.(174) 1.250" X UNF. PLUG SHEET NO HYDRO TEST PERFORMED ON PARTS FABRICATION BY: KEN'S WELDING
	DESIGN BY: OTHERS

Certificate of Authorization: Type U No. 35,987 Expires AUGUST,25th 2018

Date 4/13/17 Name KEN'S WELDING LLC (Manufacturer) Signed (Representative)

Date 4/13/17 Name Mark Faught (Authorized Inspector) Commissions NB 7935 (National Board (incl. endorsements))

(08/14)

FORM U-4 MANUFACTURER'S DATA REPORT SUPPLEMENTARY SHEET
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by KEN'S WELDING LLC 6440 S. 57th W. Ave Tulsa, Ok. 74131
(Name and address of Manufacturer)

2. Manufactured for HUDSON PRODUCTS CORPORATION 9660 GRUNWALD RD BEASLEY, TX 77417-8600
(Name and address of Purchaser)

3. Location of installation UNKNOWN
(Name and address)

4. Type HORIZONTAL (NON-CIR) (Horizontal, vertical, or sphere) | HEADER (Tank, separator, heat exch., etc.) | KW108H-A FR BK (Manufacturer's serial number)

(CRN) | 2017B430-2 REV0 (Drawing number) | (National Board number) | 2017 (Year built)

Data Report Item Number	Remarks
Line 6(a) (b)	FRONT HEAD - 1" THICK, 25.750" X8.8750"X 7.3125", WRAP .625"THK., END ..500" THK SA 516-70N
	BACK HEAD - 1.0" THICK, 25.750"X 8.8750" X 7.3125", WRAP .625" THK, END ..5" SA516-70N
	CHARPY EXEMPT PER UCS-66 AND UG-20 (f) WPS QUALIFIED IN PWHT&NO PWHT CONDITIONS IN ACCORDANCEWITHAPP.28
	INSP.OPEN.(42) 1.00" X UNF. PLUG SHEET NO HYDRO TEST PERFORMED ON PARTS FABRICATION BY: KEN'S WELDING
	DESIGN BY: OTHERS

Certificate of Authorization: Type U No. 35,987 Expires AUGUST,25th 2018

Date 4/13/17 Name KEN'S WELDING LLC (Manufacturer) Signed (Representative)

Date 4/13/17 Name (Authorized Inspector) Commissions NB 7935 (National Board (incl. endorsements))

(08/14)

31354

CERTIFIED BY: **HUDSON PRODUCTS CORPORATION**

HOUSTON, TEXAS

U
W

MAWP	500 PSI	@	250 °F	**PASSES**	2
	( )	@	(°C)		
MDMT	-20 °F	@	500 PSI	**HYDRO**	650 PSIG
	(°C)	@	( )		( )

MFG. NO. S17430-11A-A-1

SERVICE EXPANDER/COMPRESSOR A/C

YEAR 2017

P.O. NO. 4500753943 **ITEM NO.** A-301

Manufactured in accordance with Extruded Fintubes U.S.Patent No. 2,562,785; Serrated Fintubes 3,355,788; Plate Fintubes-3,482,299. Plate Fins covered by one of the following U.S. Patent No. 3,397,741 , 3,438,433.

31355

CERTIFIED BY: **HUDSON PRODUCTS CORPORATION**

HOUSTON, TEXAS

U
W

MAWP	1,440 PSI	@	200 °F	**PASSES**	4
	( )	@	(°C)		
MDMT	-20 °F	@	1,440 PSI	**HYDRO**	1,872 PSIG
	(°C)	@	( )		( )

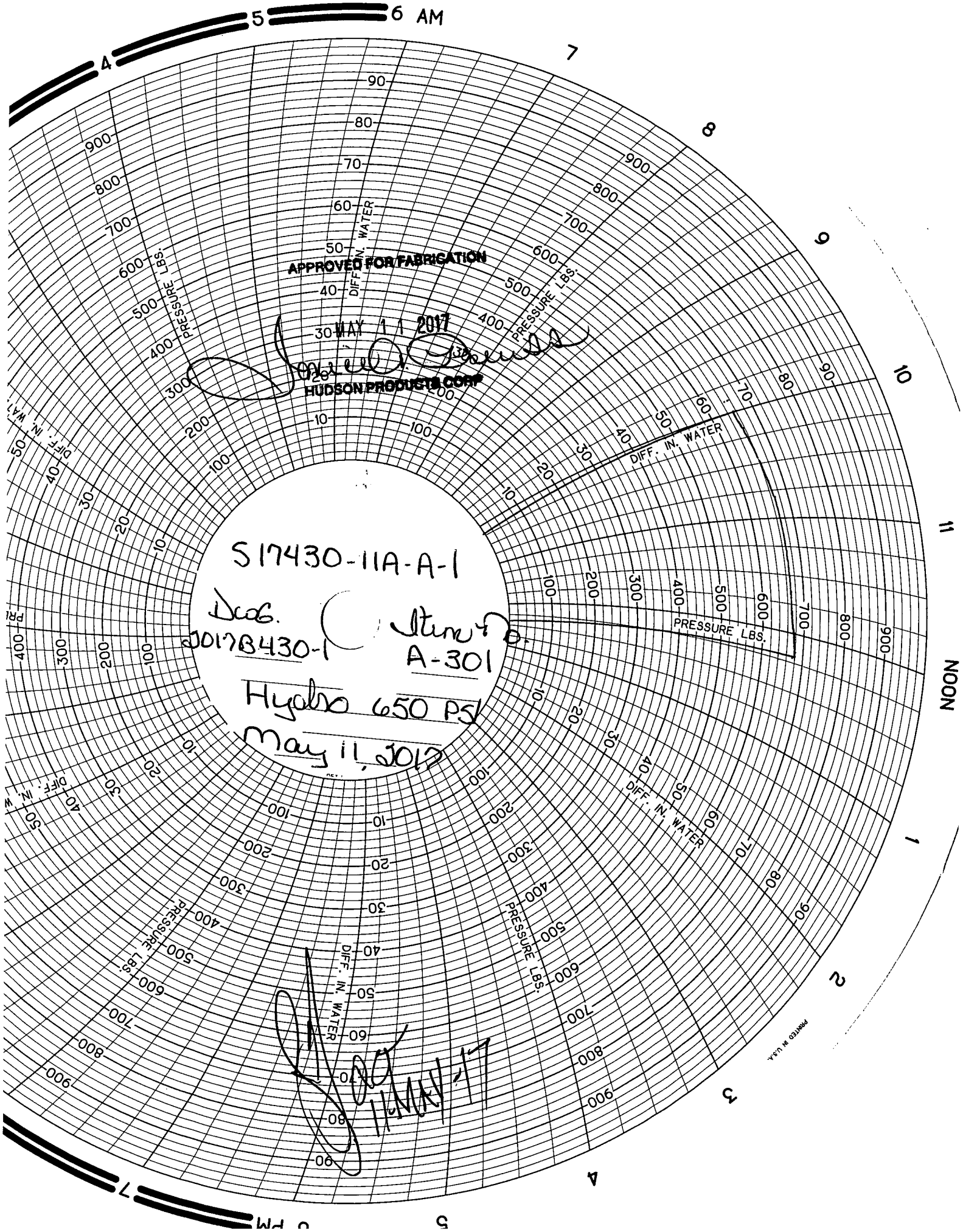
MFG. NO. S17430-11A-A-2

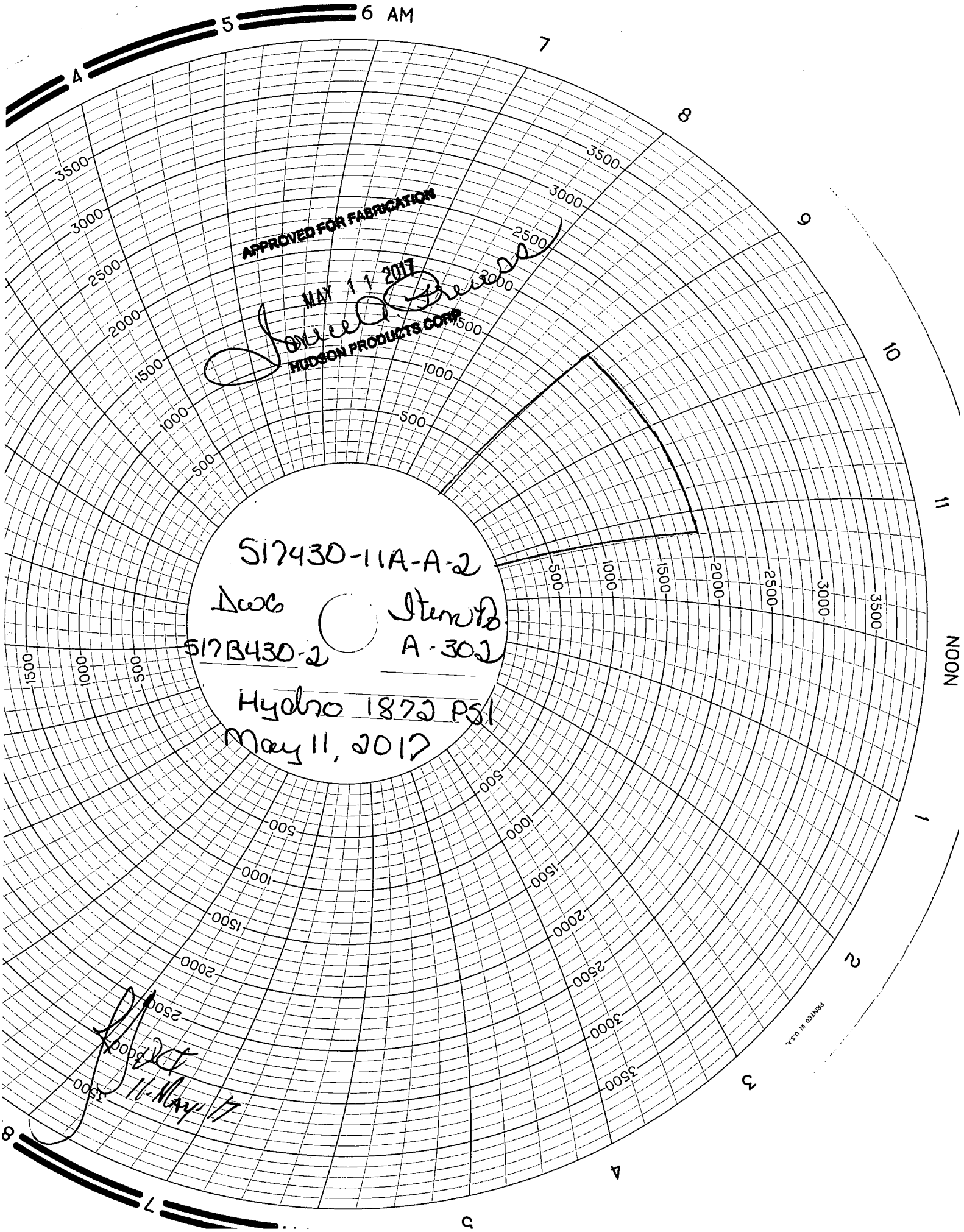
SERVICE NGL PROD COOLER

YEAR 2017

P.O. NO. 4500753943 **ITEM NO.** A-302

Manufactured in accordance with Extruded Fintubes U.S.Patent No. 2,562,785; Serrated Fintubes 3,355,788; Plate Fintubes-3,482,299. Plate Fins covered by one of the following U.S. Patent No. 3,397,741 , 3,438,433.


APPROVED FOR FABRICATION
MAY 11 2017
HUDSON PRODUCTS CORP
S17430-11A-A-1
Dwg.
J017B430-1
Item
A-301
Hydro 650 PSI
May 11, 2017
PRESSURE LBS.
DIFF. IN. WATER
NOON
6 AM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2500
3000
3500
APPROVED FOR FABRICATION
MAY 11 2017
HUDSON PRODUCTS CORP
517430-11A-A-2
Does
Item 2
517B430-2
A-302
Hydro 1872 PSI
May 11, 2017
11-May-17
PRINTED IN U.S.A.

SECTION 2. MATERIALS

A04 Manufacturer's mark

TŘINECKÉ ŽELEZÁRNY
MORAVIA STEEL

A03 Document No.:
A 2014/08/002782-JAN

A01, A05
Manufacturer: TŘINECKÉ ŽELEZÁRNY a.s. /Průmyslová 1000 /Staré Město /739 61 Třinec /Czech Republic
Production mill : VT – VÁLCOVNA TRUB / Vystavní 1132 / 708 02 Ostrava – Vítkovice / Czech Republic

B97.1 Heat No.	B97.2 Specimen No.	C40 Impact test KV J/Lb	C44 Lateral expansion mm	C45 Shear fracture area %
		C41: 0.394in x 0.394in		
		C42 Specimen direction: L	C43 Test temperature(°F): -4	C46 Test method: ASTM A370

		C42 Individual values	C43 Mean value	C44.1 Individual values	C44.2 Mean value	C45.1 Individual values	C45.2 Mean value
T15177	30923/P	~196 ~215 ~201	~204				

B97.1 Heat No.	B97.2 Specimen No.	C30 Hardness HBW NACE MR0103-2012/NACE MR0175-2009		
		max 237		
		C33 Test method: ISO 6508-1		

		C31 Individual values	C32 Mean value
T15177	30923/P	158 154 157	156

C70 Steelmaking process:
Basic oxygen furnace
Vacuum degassed.

C71-C82
Heat chemical analysis in %:
Ceq max.: 0.43

B97.1 Heat No.	C	Mn	Si	P	S	Cu	Ni	Cr	Mo	V	Ti	Al	Nb	B	Ceq		
T15177	0.17	1.18	0.18	0.016	0.007	0.03	0.02	0.19	0.007	0.038	0.001	0.026	0.001	0.0004	0.42		

Product chemical analysis in %:
Ceq max.: 0.43

B97.1 Heat No.	B97.2 Specimen No.	C	Mn	Si	P	S	Cu	Ni	Cr	Mo	V	Ti	Al	Nb	B	Ceq
T15177	30923/P	0.17	1.18	0.19	0.015	0.006	0.03	0.02	0.19	0.005	0.035	0.001	0.027	0.001	0.0004	0.42
T15177	30924/P	0.17	1.19	0.19	0.015	0.006	0.03	0.02	0.19	0.005	0.036	0.001	0.026	0.001	0.0004	0.42

C80, D01, D02, D31
Other requirements:

Visual and dimensional inspection		- satisfactory
Flattening test	ASTM A 630	- satisfactory
Hydrostatic test - test pressure	2970 psi/Sa	- satisfactory
Residual magnetism	API 5L	- satisfactory

Z02 Confirmed: Marta Uhrová, Ing.,
Head of Attestation, Releasing and External Inspection VT, independent authorized agent

TŘINECKÉ ŽELEZÁRNY, a.s.
Průmyslová 1000, Staré Město
739 61 Třinec 131

Z03 Independent authorized agent

Z02

Ostrava-Vítkovice :
12.08.2014

tel.: 00420/596/602150
fax: 00420/596/602144

A04 Manufacturer's mark

TŘINECKÉ ŽELEZÁRNY
MORAVIA STEEL

A03 Document No.:
A 2014/06/002782-JAN

A01, A05
Manufacturer: TŘINECKÉ ŽELEZÁRNY,a.s. /Průmyslová 1000 /Staré Město /739 61 Třinec /Czech Republic
Production mill : VT – VÁLCOVNA TRUB / Výstavní 1132 / 706 02 Ostrava – Vítkovice / Czech Republic

B15 Supplementary information:
Heat No.: T15177 - 22 pcs, 914.08 ft, 16805 kgs
Tube No.: 30982,30968,30990,30991,30988,30989,30925,30934,30923,30929,30924,30927,30930,30931, 30928,30933,31014,31016,31012,31018,30997,30998

80 % of capacity of the Charpy Impact Machine was exceeded at the Impact Test Values (see values marked with " ~ ").

The tubes are free of mercury contamination and no weld repair was performed.

The hardness test values in HBW conform to the request max. 22 HRC (max. 237 HBW).

Width of gauge length of the tension test specimen at a room temperature - 1.5 in.

Data mentioned in USC Units were converted from SI Units.

Appendix: Heat treatment report.

Z02 Confirmed. Marta Uhrová, Ing.,
Head of Attestation, Releasing and External Inspection VT, Independent authorized agent

TŘINECKÉ ŽELEZÁRNY, a.s.
Průmyslová 1000, Staré Město
739 61 Třinec 131

Z02

Ostrava-Vítkovice :
12.06.2014

tel.: 00420/[illegible]
fax: 00420/[illegible]

Z03 Independent authorized agent

02/17/2017 From: AMERICAN ALLOY STEEL, INC. To: PORT CITY METAL SERVICES
P.O.#: 102077 S.O.#: 564720 AA PL#: 5170788
Item: 2 (1 PC) 3/8" X 95" X 480" EXISTING

TEST CERTIFICATE

ARCELORMITTAL PLATE LLC

PAGE NO: 01 OF 02
FILE NO: 0284-01-43
MILL ORDER NO: 55864-001
MELT NO: U6453
SLAB NO: 39BA
DATE: 12/28/15

SHIP TO:
AMERICAN ALLOY STEEL
C/O SKOL TRACK 21
6350 N ERIE AVE
OWASSO OK 00000

SOLD TO:
AMERICAN ALLOY STEEL, INC
P. O. BOX 40469
HOUSTON TX 77240-0469

SEND TO:

01-C

STEEL PLATE DIMENSIONS / DESCRIPTION

TOTAL QTY	GAUGE	WIDTH	LENGTH	DESCRIPTION	PIECE WEIGHT
1	.375"	96"	480"	RECTANGLE	4901#

CUSTOMER INFORMATION

CUSTOMER PO: 106416-OK

PART NO. 1

SPECIFICATION(S)

THIS MATERIAL HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND SPECIFICATION(S).

ASME SA516 REV ED YR 13 GR 70
ASME SA516 REV ED YR 13 GR 65
ASME SA516 REV ED YR 13 ~~GR 60~~ JK
ASTM A516 2010 GR.70
ASTM A516 2010 GR.65
ASTM A516 2010 ~~GR.60~~ JK
THE MANAGEMENT SYSTEMS FOR MANUFACTURE OF THIS PRODUCT ARE CERTIFIED TO ISO 9001:2008 (CERTIFICATE NO. 30130) AND ISO 14001:2004 (CERTIFICATE NO. 49009).

CHEMICAL COMPOSITION (WT%) FOR ALL ELEMENTS EXCEPT H (PPM)

	C	MN	P	S	CU	SI	NI	CR	MO
MELT:U6453	.22	.96	.008	.007	.22	.20	.21	.11	.07

	V	TI	B	AL	CB
MELT:U6453	.002	.002	.0002	.022	.002

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL, INC.
Reviewed By:
JK 1/22/2016

MANUFACTURE

VACUUM DEGASSED

HEAT TREAT CONDITION

MATL OR TEST	HEAT TREAT DESCRIPTION	NOM TEMP	HOLD MINS	COOL MTHD
PL/TEST	NORMALIZE	1660F	18	AIR COOL

AMERICAN ALLOY PLATE # 5170788

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT:

ARCELORMITTAL PLATE LLC
QUALITY ASSURANCE LABORATORY
139 MODENA ROAD
COATESVILLE, PA 19320

Elinore Zaplitny
SUPERVISOR – TEST REPORTING
ELINORE ZAPLITNY

Q.A. APPROVED
By [signature] Date 2/17/2017

03/28/2016 From: AMERICAN ALLOY STEEL, INC. To: PORT CITY METAL SERVICES
P.O.#: 99127 S.O.#: 541935 AA PL#: 5167881
Item: 1 (1 PC) 5/8" X 120" X 480"
TAG: PO-99127

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANAYLSES

US HWY 12 Burns Harbor, Indiana

SHIPMENT NO.	DATE SHIPPED	CAR OR VEHICLE NO.		PAGE
803-08493	06-23-15	CSS-CHGO-BNSF	CSS 019081	5

SOLD TO:
AMERICAN ALLOY STEEL INC
PO BOX 40469
HOUSTON TX 77240-0469

SHIP TO:
AMERICAN ALLOY STEEL INC
C/O SKOL TRACK #21
6350 N ERIE AVE
OWASSO OK

NOTE	SERIAL NUMBER	PAT NO.	HEAT NUMBER	NO. PCS.	SIZE AND QUANTITY: THICKNESS	WIDTH OR DIA.	LENGTH	WEIGHT	YIELD POINT	TENSILE STRENGTH	ELONG.	RED.
					INCHES	INCHES	INCHES	POUNDS	PSI	PSI	IN	% %

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.
PLATES - ASTM A516-06 GR 70 PVQ, ASTM A516-06 GR 65 PVQ, ASTM A516-06 GR 60 PVQ, ASME SA516 GR 70 PVQ 2013 EDITION, ASME SA516 GR 65 PVQ 2013 EDITION, ASME SA516 GR 60 PVQ 2013 EDITION, CH-V SA20S5 PLT L 15/12 FTLBS AT -50F, VACUUM DEGASSED --- PLT NORMALIZED & COOLED IN STILL AIR --- TEST CERTS ARE PREPARED IN ACCORDANCE WITH PROCEDURES OUTLINED IN EN 10204:2004 TYPE 3.1
NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL, INC.
Reviewed By:

CO# 103847-OK GH 354-4573A
PLATES HEAT TREATED - TEST SPECIMENS ATTACHED & YIELD STRENGTH @ .5% EUL

X031314	822M33760	1	.625	120	480	10210	51900	76000	8	26
			N 1650 DEG F - 30 MIN							

(M55)MFST REF#:7

Q-QUENCH TEMPERATURE T-TEMPER TEMPERATURE N-NORMALIZE TEMPERATURE

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HARD BHN	BEND	THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP F	CHARPY IMPACT ENERGY FT LBS 1	2	3	SHEAR(%) 1	2	3	LAT. EXP MILS 1	2	3
X031314		822M33760			.625	V	FULL L		-50	38	44	53						

HEAT NUMBER	CHEMICAL ANALYSIS C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	MOLD GRAIN SIZE
822M33760	.17	1.06	.017	.007	.31	2.23	.17	.05	.010	.003	.002	.034	.0002	.002	.005	.001	

AMERICAN ALLOY PLATE # 5167881

I certify that the above results are a true and correct copy of actual results contained in records maintained by ArcelorMittal Burns Harbor and are in full compliance with the requirements of the specification cited above. This test report cannot be altered and must be transmitted intact with any subsequent third party test reports, if required.

D. W. ELWOOD PER WNK

BHPLTRPT.TIF SUPV. QUALITY ASSURANCE

Q.A. APPROVED
By _____ Date 3/28/2016

mill line 44725

A04 Manufacturer's mark
TŘINECKÉ ŽELEZÁRNY
MORAVIA STEEL

A03 Document No.:
A 2014/06/002782-JAN

Sheet : 1/3

1409443

A01, A05
Manufacturer: TŘINECKÉ ŽELEZÁRNY,a.s. /Průmyslová 1000 /Staré Město /739 61 Třinec /Czech Republic
Production mill : VT – VÁLCOVNA TRUB / Výstavní 1132 / 706 02 Ostrava – Vítkovice / Czech Republic

A07 Purchaser's order No.:	A06 Works order No./ Contract No.:	A06 Consignee:
011813-A	9700226943 0041300299 / 176	

A10 Advice-Note No.:
14/06/001039/04 05.06.2014

USA

A02 Type of inspection document:
Inspection certificate 3.1, EN 10204:2004

B01, B09-B11 Product, product dimensions, specification	B08, B13 Quantity	B02.1 Steel designation	B02.2 Product / Dimensional standard
Seamless Steel Line Pipes Hot Rolled 8.625 in x 0.500 in	22 pcs 914.08 ft 18905 kgs	X52/PSL1 X42/B/PSL1 Gr.B Gr.C Gr.B Gr.B	API SPEC 5L 45. EDITION API SPEC 5L 45. EDITION ASTM A106/A106M 11/2011 ASTM A106/A106M 11/2011 ASTM A53/A53M 03/2012 ASME SA106/SA106M 07/2011 ASME B36.10 10/2004

B04 Product delivery condition:
normalized

B03 Supplementary requirements:
ASME SA53/SA53M 2010 EDITION/2011 ADDENDA, ASME SA106/SA106M 2010 EDITION/2011 ADDENDA, API MONOGRAM
Bevelled ends 30-35°, root facet 1,6mm +-0,8mm

Requirements :

B07.1 Heat No.	B07.2 Specimen No.	C10* Specimen shape	C11 Yield Strength Rt0.5 psi	C12 Tensile Strength Rm psi	C13 Elongation 2" %	C14 Reduction of area Z %
			min 52200	min 70000	min 30	
		C02 Specimen direction: L		C03 Test temperature(°F): 70	C15 Test method:	ASTM A370
T15177	30923/P	P	59320	79916	42.6	-

* P - Flat specimen
K - Round specimen

Z01
ALL PRODUCTS MEET REQUIREMENTS OF ABOVE MENTIONED STANDARDS AND REQUIREMENTS SPECIFIED IN ORDER
THE DECLARATION IS ISSUED UNDER THE SOLE RESPONSIBILITY OF THE SUPPLIER

Z02 Confirmed: Mario Uhrsch, Ing.,
Head of Attestation, Releasing and External inspection VT, independent authorized agent

TŘINECKÉ ŽELEZÁRNY, a.s.
Průmyslová 1000, Staré Město
739 61 Třinec 131

Z02
Ostrava-Vítkovice :
12.06.2014

tel. 00420/59/660/2100
fax: 00420/59/660/2184

Z03 Independent authorized agent

[| 430-2 | | | YGR] | [LN: 1] | T0387797-1 | D390RJWNXH |

COFFER®
an AFGlobal Company

Material Test Report

Heat Code: YGR

ISO 9001:2008 Certified

Coffer Corp.
An AFGlobal Company
13770 Industrial Rd. Houston, TX 77015
Sales: (713) 868-4421 Fax: (713) 455-8366

Industrial Piping IPS0003	PO: HP195608	Sales Order: 138229	Line: 35
P. O. Box 581270	Item Code: 0901300402-0021F	Qty Shipped: 20	
Tulsa, OK 74158	Item Desc: FLG 03.00 0900 WN RJ XH A105 NRM COFFR		
	Supplier: ASW STEEL	Supplier Heat: 77143	

Spec: ASTM A105/A105N-(13)/ASME SA 105/SA 105N-(13)Section II Part A - Normalized

Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.19			
Mn	Manganese	1.07		✓	7439-96-5
P	Phosphorous	0.009			
S	Sulphur	0.002			
Si	Silicon	0.23			
Cu	Copper	0.19		✓	7440-50-8
Ni	Nickel	0.07		✓	7440-02-0
Cr	Chromium	0.07		✓	7440-47-3
Mo	Molybdenum	0.03			
V	Vanadium	0.003			
Cb	Columbium	0.003			
C.E.		0.41			
CuNiCrMoV		0.363			
CrMo		0.10			

Mechanical Testing	
Test Lab	AFG
Test Bar Size	SACRIFICIAL PIECE
HBW	146 - 146
Elg (%)	34
RA (%)	70
Tensile Specimen Size (in)	.492
Tensile (ksi)	77.4
Yield (ksi)	49.7
Gauge Length	2

Heat Treat	
Norm. Temp. (F)	1675
Norm. (Hrs)	4
Norm. Cooling Type	AIR
Norm. Location	AFG

Other	
Country of Melt	CANADA
EF	Y
Fully Killed	Y

Product compliant with NACE MR0175 / ISO 15156 and NACE MR0103 latest edition and flange dimensions to ASME B16.5 - 2013.

* No Weld repair performed.
* Ladle Chemical Analysis results are reported from the raw material suppliers MTR.
* Forgings are capable of passing hydrostatic test compatible with the appropriate rating.
* Elongation taken from a round specimen.
* Yield strength was determined using the .2% offset method.
* All material supplied under this order is certified to be free of mercury contamination and no mercury bearing equipment was used in manufacturing, fabrication or testing.
* When reported on MTR: Tensile Testing Per ASTM E8; Brinell Hardness Per ASTM E10; Charpy Testing Per ASTM E23
* AF Global manufactures materials according to a certified Quality Management System conforming to ISO 9001:2008 and PED 97/23/EC, Annex 1, Section 4.3

Certification No.: 1132008
Certification Date: 9/3/2014
Issued By: Juan Diaz

Rina Sane - Metallurgical Lab Manager

This report is issued in compliance with the requirements of EN10204 3.1 / ISO 10474 3.1.b

[| 430-2 | | | BEB] | [LN: 1] | T0387797-1 | D390RJWNXH |

COFFER®
an AFGlobal Company

Material Test Report

Heat Code: BEB

ISO 9001:2008 Certified

Coffer Corp.
An AFGlobal Company
13770 Industrial Rd. Houston, TX 77015
Sales: (713) 868-4421 Fax: (713) 455-8366

Industrial Piping IPS0003	PO: TP535871	Sales Order: 158710	Line: 80
P. O. Box 581270	Item Code: 0901300402-0021F	Qty Shipped: 8	
Tulsa, OK 74158	Item Desc: FLG 03.00 0900 WN RJ XH A105 NRM COFFR		
	Supplier: CMC	Supplier Heat: 3066701	

Spec: ASTM A105/A105N-(14)/ASME SA 105/SA 105N-(15) Section II Part A - Normalized

Element	(%wt)	Ladle	Product	EPCRA	CAS#	Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.19				Mo	Molybdenum	0.016			
Mn	Manganese	1.02		✓	7439-96-5	V	Vanadium	0.00			
P	Phosphorous	0.011				Cb	Columbium	0.001			
S	Sulphur	0.012				B	Boron	0.0001			
Si	Silicon	0.21				C.E.		0.40			
Cu	Copper	0.22		✓	7440-50-8	CuNiCrMoV		0.377			
Ni	Nickel	0.07		✓	7440-02-0	CrMo		0.09			
Cr	Chromium	0.07		✓	7440-47-3						

Mechanical Testing		Heat Treat	
Test Lab	AFG	Norm. Temp. (F)	1675
Test Bar Size	Sacrificial Piece	Norm. (Hrs)	4
HBW	156 - 159	Norm. Cooling Type	AIR
Elg (%)	28	Norm. Location	AFG
RA (%)	49		
Tensile Specimen Size (in)	.492	Other	
Tensile (ksi)	80.9	Country of Melt	USA
Yield (ksi)	50.1	EF	Y
Gauge Length (in)	2	Fully Killed	Y

Product compliant with NACE MR0175/ISO 15156-2:2009 Annex A (A.2.1.2, A2.1.3).
Product compliant with NACE MR0103-2012, Section 2.1.2 and 2.1.4.

* No Weld repair performed.
* Ladle Chemical Analysis results are reported from the raw material suppliers MTR.
* Tensile taken from a round specimen. Measurement of elongation after fracture.
* Yield strength was determined using the .2% offset method, unless otherwise specified.
* All material supplied under this order is certified to be free of mercury contamination and no mercury bearing equipment was used in manufacturing, fabrication or testing.
* When reported on MTR: Tensile Testing Per ASTM E8; Brinell Hardness Per ASTM E10; Charpy Testing Per ASTM E23
* AF Global manufactures materials according to a certified Quality Management System conforming to ISO 9001:2008 and PED 2014/68/EU, Annex 1, Section 4.3

Unless otherwise noted on PO, Dimensions of all standard pipe flanges and flange fittings (NPS 1/2 to NPS 24) per ASME B16.5-2013 , large diameter steel flanges (NPS 26 to 60) per ASME B16.47-2011, Orifice flanges per ASME B16.36-2015.

Certification No.: 1278399
Certification Date: 3/31/2017
Issued By: John Sauceda

Rina Sane - Metallurgical Lab Manager

This report is issued in compliance with the requirements of EN10204 3.1 / ISO 10474 3.1.b

Bonney Forge
14496 Croghan Pike
Mt. Union, PA 17066

CERTIFIED MILL TEST REPORT

H.G. Flake Co 3/22/2017

LOT NO.
4515

CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, REMARKS

1" 6M A105 Coupling Threaded

C	0.200	MN	0.980	P	0.007	S	0.022	SI	0.230
NI	0.030	CR	0.030	MO	0.010	CU	0.140	CO	0.003
V	0.004	Nb	0.015						

CE(LONG FORMULA) = 0.383

T/S(PSI) 79300 Y/S(PSI) 51200 EL(%) 30.000 RA(%) 45.000

BRINELL HARDNESS 156, 159

Click here for Original Steel Mill Certification

1. CERTIFYING ASTM A105-14 / ASME SA105-15 EDITION.
2. THE MATERIAL SUPPLIED MEETS THE REQUIREMENTS OF NACE MR0175/ISO 15156-2.
3. THE MATERIAL SUPPLIED WAS INSPECTED AND MANUFACTURED IN ACCORDANCE WITH EN DIN 10204:2004 EDITION TYPE 3.1 INSPECTION DOCUMENT.
4. THE ELONGATION TEST RESULTS ARE OBTAINED USING STANDARD ROUND SPECIMEN, 2 INCH OR 50 MM GAGE LENGTH.

THIS DOCUMENT HAS BEEN ELECTRONICALLY SUBMITTED.

Cancel | Logout

F1 00255

03/07/2008 16:02 FAX

1

BEBITZ FLANGES WORKS PVT. LTD.

Survey No.140/2,Sarawali,Boisar,Taluka-Palghar,Thane-401501
Tel.(91)-(0)-2525-274170/274444 Fax Off:(91)-(0)-2525-274266

F-QAC-09-00

MATERIAL TEST CERTIFICATE-EN 10204 3.1

CUSTOMER : USA	MANUFACTURE'S BRAND: B	DATE	07.02.2008
		MATERIAL SPECIFICATION	ASTM A105-05
		GRADE	A/SA105N
	STAMP OF THE TESTING ENGINEER: TKO 7	ORDER NO.	2521010
		FF P.O. NO.	165098
		ADDITIONAL SPECIFICATION	MRO 175
		DELIVERY NO/INVOICE NO.	BFW/00582

CHEMICAL ANALYSIS.

ITEM No.	ITEM DISCRIPTION	HEAT NO.	QTY.	%C	%Mn	%SI	%S	%P	%Cr	%NI	%Mo	%Ti	%Al	%Cu	%V	%Nb
5	8"WNRF150#STD	07AL032	360	0.190	0.830	0.200	0.025	0.012	0.210	0.009	0.002	-	0.023	0.006	0.001	0.001
28	2"BLRF150#	D4507	150	0.22	0.9	0.24	0.024	0.024	0.19	0.07	0.08	-	0.029	0.01	0.002	0.002
47	8"WNRF300#XS	C5997	28	0.19	0.86	0.22	0.008	0.011	0.02	0.009	0.001	-	0.030	0.009	0.003	0.0071
47	8"WNRF300#XS	07AL030	72	0.200	0.870	0.240	0.016	0.021	0.210	0.009	0.003	-	0.023	0.008	0.002	0.001
57	2"BLRF300#	D4506	100	0.22	0.9	0.19	0.027	0.026	0.18	0.046	0.028	-	0.027	0.09	0.001	0.002

MECHANICAL PROPERTIES.

TEST NO	ITEM DISCRIPTION	TENSILE STRENGTH N/mm²	YIELD STRESS RP=0.2% N/mm²	YIELD STRESS RP=1.0% N/mm²	ELONGATION (EL. %) L0=4D	REDUCTION OF AREA (RA %)	IMPACT TEST AT 20°C CHARPY 'V' NOTCH (J) 1	2	3	AVG.	HARDNESS (Avg. of Two) BHN
07AL032/1	8"WNRF150#STD	506.76	272.12	-	31.02	57.00	56	68	64	56.00	153
D4507/1	2"BLRF150#	505.64	280.71	-	30.76	57.00	60	60	58	59.33	154
C5997/1	8"WNRF300#XS	498.27	274.64	-	30.07	56.00	56	54	56	55.33	155
07AL030/1	8"WNRF300#XS	501.02	276.39	-	30.07	56.00	52	54	50	52.00	149
D4506/1	2"BLRF300#	496.12	274.94	-	34.20	66.00	58	62	60	60.00	152

MELTING PROCESS : INDUCTION/LRF/CONCAST
HEAT TREATMENT : ALL MATERIALS ARE NORMALISED AT 930°C FOR 1.5HRS.
DIMENSIONAL INSPECTION : CONFIRM WITH THE SPECIFICATION (B16.5)
SURFACE INSPECTION : SATISFACTORY

REMARKS : WE CERTIFY THAT THE MATERIAL DESCRIBED ABOVE HAS BEEN TESTED AND COMPLIES WITH THE GIVEN PURCHASE ORDER.

FOR BEBITZ FLANGES WORKS PVT.LTD.,INDIA

Q.A. Manager.

Aug-05

F1 00255

005/010

Ord# 675143-81; PO# 0552092; Ht# 83M; 1 6000 TH COUPL A105N 53324

I.M.L. - INDUSTRIA MECCANICA LIGURE S.P.A.
Via Giancarlo Farina, 25 - 16030 Casarza Ligure - GE - ITALY
Tel. +39 0185 467661 - Fax +39 0185 466510 - E-mail quality.iml@farinagroup.com
MATERIAL TEST DEPARTMENT

COMPANY WITH QUALITY SYSTEM ISO 9001: 2008 CERTIFIED BY RINA CERT. N°23/91/S

INSPECTION CERTIFICATE EN 10204:2004 / 3.1 — Nr 24045 Dated 30.04.2013

Purchase Order Nr	4022
Item Nr	050
Packing List Nr	536
Invoice Nr	491

Heat Code	Heat Nr	Quantity	Description
83M	12/71843	1.260,00	FITTING COUPLING THRD NPT 6M 1" A105N

Element	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu
ASTM A105 (LADLE)	0,200	0,200	0,960	0,010	0,014	0,130	0,060	0,020	0,020	0,180

Element	V	Nb	N	AL	C.E.	PRE
ASTM A105 (LADLE)	0,003	0,003	--	0,026	0,407	--

Test specimen Sect. mm2	Test specimen Lenght mm	Shape 1=O - 2=□	Tensile N/mm2	Yeld Strenght > 0,2% N/mm2	Yeld Strenght >1% N/mm2	Elongation %	Reduction of area %
122,65	50,00	1	520,0	331,0	--	33,0	57,0

HARDNESS HBW	IMPACT TEST TYPE	Test specimen	°C	1-Joule	2-Joule	3-Joule
154,0 - 160,0	KV	10x10mm	-10	63	68	60

Heat treatment	Normalized at 880°-920°C / Air Cool				ELECTRIC FURNACE
Dimension in accordance	ASME B16.11 Ed.2011 - ANSI/ASME B1.20.1 Ed.1992 - MSS SP25 Ed.2008 - NACE MR 0175 ISO 15156 Ed.2009- NACE MR 0103 Ed. 2012 - SUPPLIED MATERIAL MEETS SPECIFICATIONS AND P.O. REQUIREMENTS				
Material in accordance	ASME SA ASTM A105-11a				
Visual & Dimensional	SATISFACTORY	Origin	EUROPEAN UNION	Our Ref.	2013-2E201-0000222-0050

Notes --

QUALITY CONTROL DEPT.	INSPECTION AUTHORITY	MANUFACTURER'S SYMBOL
Boris Fizzotti		IML or

6503472 04 ID#0808

09/27/2016 From:AMERICAN ALLOY STEEL, INC. To:PORT CITY METAL SERVICES
P.O.#: 100581 S.O.#: 554505 AA PL#: 5175851
Item: 1 (1 PC) 1/2" X 96" X 480"

AMERICAN ALLOY PLATE #5175851

NUCOR PLATE MILL

P.O.Box 279
Winton, NC 27986
(252) 356-3700

Mill Test Report

Page 1

1505 River Rd
Cofield, NC 27922
(252) 356-3700

NUCOR It's Our Nature

Issuing Date : 09/09/2016 **B/L No. :** 440116 **Load No. :** 454043 **Our Order No. :** 137698/3 **Cust. Order No. :** 106333-OK

Vehicle No: NOKL 725113

Specification: 0.5000" x 96.000" x 480.000"
ASTM A516 70/65/60-16(2015)/ASME SA516-70/65/60 PVQ 2013/2015
Normalized Plate NACE MR0175 Annex 2.1.2, MR0103 (2010) Section 2.1.2 Compliant (2016) 13.1.1, 13.1.2)Vacuum Degassed

Marking : 106333-OK

Sold To: AMERICAN ALLOY STEEL INC
6230 N HOUSTON ROSSLYN RD
PO BOX 40460
NORTH HOUSTON,TX 77091

Ship To: AMERICAN ALLOY STEEL
6350 N ERIE AVE
C/O SKOL TRACK #21
OWASSO,OK 74055

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm
6503472	0.19	0.89	0.007	0.002	0.18	0.19	0.07	0.09	0.01	0.031	0.005	0.001	0.002	0.0060	0.0023	0.0002	0.009	0.37	0.25
6503515	0.20	0.84	0.008	0.001	0.20	0.24	0.10	0.10	0.02	0.028	0.005	0.001	0.002	0.0063	0.0027	0.0002	0.013	0.40	0.27

Plate Serial No	Pieces	Tons	Tensile Test Dir.	Yield (psi)	Tensile (psi)	Elong. % in 2"	Elong. % in 8"	Heat Treat Norm °F	Time (min)	Temper °F	Time (min)	Charpy Impacts Dir.	Absorbed Energy (ft-lbs) 1	2	3	Ave	Min	Shear (%) 1	2	3	Ave	Min	Temp °F	Size
6503472-04	8	19.60	T	47,100	73,400	46.2		1650	23			H-L	110.5	103.1	99.5	105.4	15						-50	10mm
6503472-05	4	18.00	T	47,400	72,500	53.2		1660	23			H-L	106.4	103.8	91.6	101.6	15						-50	10mm
6503515-07	1	3.26	T	48,100	73,800	44.6		1650	23			H-L	69.0	77.0	75.4	69.6	15						-50	10mm

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL, INC.
Reviewed By:
7/18/2016

HOT ROLLED CARBON STEEL PLATE
Piece frequency charpy;

Manufactured to fully killed fine grain 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, unless otherwise noted in Specification. For Mexico shipments: nhc-SalesHX@Nucor.com
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 9001:2008 certified (#010040) by SRI Quality System Registrar (#0005-09). 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 14-MMPQA-723

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. Dapratis

T. A. Dapratis, Metallurgist

8/2/2016 9:41:01 AM

Q.A. APPROVED
By [signature] Date 9/28/2016

03/29/2017 From:AMERICAN ALLOY STEEL, INC. To: PORT CITY METAL SERVICES
P.O.#: 102166 S.O.#: 567331 AA PL#: 5175193
Item: 2 (1 PC) 1" X 96" X 480"

AMERICAN ALLOY
PLATE #5179193

SSAB

12400 Highway 43 North, Axis, Alabama 36505, US

Test Certificate

Form TC1: Revision 2: Date 23 Apr 2014

Customer:
AMERICAN ALLOY STEEL, INC.
P.O. BOX 40489

HOUSTON
TX 77240 0469

Customer P.O.No.: 109792-OK | **Mill Order No.** 41-462652-05 | **Shipping Manifest:** AR233912

Product Description: ASME SA516-70/SA516-65/SA516-60(15)
ASTM A516-70/A516-65/A516-60(10/15)
LCVN 16 FT.LBS@-50F/A673-P;VACUUM DEGAS
NORMALIZED

Ship Date: 11 Nov 16 | **Cert No:** 081581764
Cert Date: 11 Nov 16 | (Page 1 of 1)

Size: 1.000 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	Elong % 8in	Tst Dir	Hardness	Abs. Energy(FTLB) 1	2	3	Avg	% Shear 1	2	3	Avg	Tst Tmp	Tst Dir	Tst Siz	BDWTT Tmp %Shr
W6J658	B06	1.008 (DISCRT)	C	60	74			28	T		102	106	68	92					-50F	L	10.	
W6J658	B07	1.007 (DISCRT)	C	49	74			29	T		49	74	78	67					-50F	L	10.	
W6J727	D06	1.007 (DISCRT)	C	49	73			29	T		92	76	70	79					-50F	L	10.	

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	HW	
W6J658	.18	1.04	.011	.001	.24	.026	.025	.26	.14	.13	.04	.002	.005	.010	.0003	.42	ORGN
W6J727	.19	1.01	.010	.001	.24	.028	.027	.27	.15	.11	.05	.001	.004	.011	.0001	.42	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.
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.
WELD REPAIRING HAS NOT BEEN PERFORMED
NORMALIZED PLATES. HEATED AT 1665F FOR 44 MINUTES.
TEST COUPONS TAKEN FROM HEAT TREATED PLATE.
PRODUCTS SHIPPED:

W6J727	D06	6690556	PCES:	1,	LBS:	13068	W6J658	B07	6690493	PCES:	1, LBS: 13068
W6J658	B06	6690492	PCES:	1,	LBS:	13068	W6J727	D06	6690490	PCES:	1, LBS: 13068
W6J658	B06	6690485	PCES:	1,	LBS:	13068	W6J658	B07	6690489	PCES:	1, LBS: 13068
W6J658	B06	6690486	PCES:	1,	LBS:	13068	W6J658	B07	6690488	PCES:	1, LBS: 13068
W6J658	B06	6690484	PCES:	1,	LBS:	13068	W6J658	B07	6690487	PCES:	1, LBS: 13068

KENS WELDING HT#W6J658
PO#KWTP SL#B07
SO#324327 ITEM#1 10PCS

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL, INC.
Reviewed By:
12.1.2016

(F) 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

Q.A. APPROVED
By: Date: 3/20/2017

03/28/2016 From: AMERICAN ALLOY STEEL, INC. To: PORT CITY METAL SERVICES
P.O.#: 99127 S.O.#: 541935 AA PL#: 5167881
Item: 1 (1 PC) 5/8" X 120" X 480"
TAG: PO-99127

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANALYSES

US HWY 12 Burns Harbor, Indiana

SHIPMENT NO. 803-08493 | DATE SHIPPED 05-23-15 | CAR OR VEHICLE NO. CSS-CHGO-BNSF CSS 019081 | PAGE 5

SOLD TO: AMERICAN ALLOY STEEL INC
PO BOX 40469
HOUSTON TX 77240-0469

SHIP TO: AMERICAN ALLOY STEEL INC
C/O SKOL TRACK #21
6350 N ERIE AVE
OWASSO OK

NOTE	SERIAL NUMBER	PAT NO.	HEAT NUMBER	NO. PCS.	SIZE AND QUANTITY: THICKNESS	WIDTH OR DIA.	LENGTH	WEIGHT	YIELD POINT	TENSILE STRENGTH	ELONG.	RED.
					INCHES	INCHES	INCHES	POUNDS	PSI	PSI	IN	% %

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.
PLATES - ASTM A516-06 GR 70 PVQ, ASTM A516-06 GR 65 PVQ, ASTM A516-06 GR 60 PVQ, ASME SA516 GR 70 PVQ 2013 EDITION, ASME SA516 GR 65 PVQ 2013 EDITION, ASME SA516 GR 60 PVQ 2013 EDITION, CH-V SA20S5 PLT L 15/12 FTLBS AT -50F, VACUUM DEGASSED --- PLT NORMALIZED & COOLED IN STILL AIR --- TEST CERTS ARE PREPARED IN ACCORDANCE WITH PROCEDURES OUTLINED IN EN 10204:2004 TYPE 3.1
NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)
CO# 103847-OK GH 354-4573A
PLATES HEAT TREATED - TEST SPECIMENS ATTACHED & YIELD STRENGTH @ .5% EUL

X031314	822M33760	1	.625	120	480	10210	51900	76000	8	26	

N 1650 DEG F - 30 MIN
(M55)MPST REF#:7

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL, INC.
Reviewed By:

Q-QUENCH TEMPERATURE T-TEMPER TEMPERATURE N-NORMALIZE TEMPERATURE

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HARD SPEC	COND	THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP F	CHARPY IMPACT ENERGY FT LBS 1	2	3	SHEAR(%) 1	2	3	LAT. EXP MILS 1	2	3
X031314		822M33760			.625	V	FULL	L	-50	38	42	53						

HEAT NUMBER	CHEMICAL ANALYSES C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	GRAIN SIZE
822M33760	.17	1.06	.017	.007	.312	.223	.17	.05	.010	.003	.002	.034	.0002	.002	.005	.001	

I certify that the above results are a true and correct copy of select results contained in records maintained by ArcelorMittal Burns Harbor and are in full compliance with the requirements of the specification cited above. This test report cannot be altered and must be transmitted intact with any subsequent third party test results, if required.

D. W. ELWOOD FOR WWK

ENPLTRPT.TIF SUPV. QUALITY ASSURANCE

AMERICAN ALLOY PLATE # 5167881

Q.A. APPROVED
By _____ Date 3/28/2016

Ord# 675143-81; PO# 0552092; Ht# 83M; 1 6000 TH COUPL A105N 53324

I.M.I.L. - INDUSTRIA MECCANICA LIGURE S.P.A.
Via Giancarlo Parina, 25 - 16030 Casarza Ligure - GE - ITALY
Tel. +39 0185 467831 - Fax +39 0185 466510 - E-mail quality.imil@forlaogroup.com
MATERIAL TEST DEPARTMENT

COMPANY WITH QUALITY SYSTEM ISO 9001: 2008 CERTIFIED BY RINA CERT. N°23/91/S

INSPECTION CERTIFICATE EN 10204:2004 / 3.1

Nr 24045 Dated 30.04.2013

Purchase Order Nr	4022
Item Nr	050
Packing List Nr	536
Invoice Nr	491

Heat Code	Heat Nr	Quantity	Description
83M	12/71843	1.230,00	FITTING COUPLING THRD NPT 6M 1" A105N

Element	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu
ASTM A105 (LADLE)	0,200	0,200	0,950	0,010	0,014	0,130	0,050	0,020	0,020	0,180

Element	V	Nb	N	AL	C.E.	PRE
ASTM A105 (LADLE)	0,003	0,003	--	0,026	0,407	--

Test specimen Sect. mm2	Lenght mm	Shape 1=○ - 2=□	Tonello N/mm2	Yield Strenght > 0,2% N/mm2	Yield Strenght >1% N/mm2	Elongation %	Reduction of area %
122,65	50,00	1	520,0	331,0	--	33,0	57,0

HARDNESS HBW	TYPE	IMPACT TEST Test specimen	°C	1-Joule	2-Joule	3-Joule
154,0 - 160,0	KV	10x10mm	-10	63	68	60

Heat treatment	Normalized at 880°-920°C / Air Cool	ELECTRIC FURNACE
Dimension in accordance	ASME B16.11 Ed.2011 - ANSI/ASME B1.20.1 Ed.1992 - MSS SP25 Ed.2008 - NACE MR 0175 ISO 15156 Ed.2009- NACE MR 0103 Ed. 2012 - SUPPLIED MATERIAL MEETS SPECIFICATIONS AND P.O. REQUIREMENTS	
Material in accordance	ASME SA ASTM A105-11a	

Visual & Dimensional	SATISFACTORY	Origin	EUROPEAN UNION	Our Ref.	2013-2E201-0000222-0050

Notes --

QUALITY CONTROL DEPT.	INSPECTION AUTHORITY	MANUFACTURER'S SYMBOL
Boris Fizzotti		IML or

Tenaris

MILL TEST CERTIFICATE
CERTIFICADO DE PRUEBAS EN FABRICA
EN 10204 3.1: 2004-API 5L 8.13.2

Number / Número:	Page / Página:
14041291	1 / 8
Date / Día: July 31, 2014	

Tubos de Acero de México, S.A.
Carret. México Veracruz KM 433.7 SN
Delimo Valenzuela Tejeda, 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:
	139506-00 ITEM 3	N/A	217672/03

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 A106/11, ASME SA106/2010, ASTM A53/12, ASME SA53/2010	BR-L245R/X42R-L290R/C PSL2	NORMAL BEVEL BISELADO NORMAL

Dimensions / Dimensiones:	Schedule / Cédula:	Length / Longitud.	Quantity / Cantidad: 373 Pcs/Pz		Nominal Weight / Peso Nominal:
8.625 X 0.5 INCH 219.1 X 12.7 MM	SCH 080 / W.C XS	37.99 / 41.99 FT 11.58 / 12.80 MTS	15364.469 FT 4683.090 MTS	668951.392 LB 303431.000 KG	43.43 LB/FT 64.64 KG/M

TENSILE TEST / ENSAYO DE TENSION

Heat N° / Colada N°	Sample N° / Muestra N°	Zone / Zona	Specimen condition / Condición de la probeta				Specimen dimensions / Dimensiones de la probeta		Test temp / Temp. ensayo	Y.S. Eut 0.50 %. Min. 42 100 Max. 65 300	U.T.S. Req. Min: 70 000 Max: 95 000	Y.S./U.T.S Req. Max. 0.93	Elongation / Alargamiento		
			Ls	Sc	Type / Tipo	Ori	Size / Tamaño	Area / Sección					Lo	Min.	Obt.
							mm	mm2	°C	psi	psi		In	%	%
72631	52274	E2	B	AM	Ss	L	38.13 X 12.30	471.71	RT	47 163	73 789	0.64	2	25.6	40.0
72632	52256	E2	B	AM	Ss	L	38.12 X 12.24	469.28	RT	46 708	74 799	0.62	2	25.6	39.0
72632	52255	E2	B	AM	Ss	L	38.14 X 12.61	483.73	RT	47 021	74 884	0.63	2	25.7	40.0
72633	52257	E2	B	AM	Ss	L	38.48 X 12.47	482.67	RT	44 774	74 315	0.60	2	25.7	42.0
72633	52258	E2	B	AM	Ss	L	38.12 X 12.63	484.25	RT	46 566	74 102	0.63	2	25.7	39.0
72634	52263	E2	B	AM	Ss	L	38.15 X 13.15	504.60	RT	46 239	73 689	0.63	2	25.9	40.0

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 temparature / 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

020297

ArcelorMittal South Africa Limited
Tubular Products
Genl. Hertzog rd.
P O Box 48 Vereeniging 1930
South Africa

Telephone +27 (0)16 450 4220
Fax +27 (0)16 423 4906

MATERIAL TEST CERTIFICATE
SEAMLESS TUBE

Licensed under API Spec 5L and 5CT
5L - 0319
5CT - 0419

ISO 9001: 2008
DE-395997 QM

Test Certificate EN 10204:2004 TYPE 3.1

ArcelorMittal

Customer:		Customer Order/Contract No:	SUS6 140066
Order No:	4000014824	Material No:	1000000696
Certificate Reference No:	040060688188	Cast/Heat No:	98B6959
Product:	FULLY KILLED HOT FINISHED CARBON STEEL SEAMLESS TUBES		Page 1 of 1
Specification:	ISO3183:2007/API 5L:2007 L245/L290/B/X42 PSL1 ASTM A106.08B/A53B.07/ A530.04 ASME SA106.08B/SA53B.07/SA530.04		
Product Marking:	ARCELORMITTAL SA ISO3183/Spec 5L-0319 MONOGRAM 05-12 ASTM/ASME A/SA106B A/SA53B 88.900 (3.500) 7.620 (0.300) 12.200 (40.000) L245/B L290/X42 PSL1 SMLS TESTED 20.7 MPa (3000 psi) CAST NO:98B6959 PROD/O NO: H8741482410 MADE IN RSA		

General Information

Quantity	Mass	Dimensions			Total Length
		Tube OD	Thickness	Length	
76	14,161.080(kg)	88.900(mm)	7.620(mm)	12.200(m)	927.200(m)
	31,219.517(lb)	3.500(")	0.300(")	40.000 (ft)	3,040.000(ft)

Steel making process	Final Rolling Operation
Electric Arc	Final hot rolling operation finished above 860°C and cooled in still air.

Chemical Composition

R22-(V+Nb+Ti) R24-(Nb+V)

Element(%)	C	Si	Mn	S	P	Cr	Ni	Mo	Cu	V	Al	Ti	Sn	Ca	N	B	Nb	CE	R22	R24
Minimum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maximum	0.260	-	1.30	0.030	0.030	0.50	0.50	0.150	0.500	-	-	-	-	-	-	-	-	0.41	0.15	0.060
Heat	0.170	0.30	0.84	0.004	0.011	0.05	0.07	0.018	0.090	0.001	0.029	0.001	0.007	0.0029	0.0093	0.0003	0.0010	0.34	0.00	0.002
Product	0.170	0.300	0.840	0.004	0.011	0.060	0.070	0.018	0.090	0.001	0.029	0.001	0.007	0.003	0.009	0.000	0.001	0.336	0.003	0.002
Product (ADD)	0.170	0.300	0.840	0.004	0.011	0.060	0.070	0.018	0.090	0.001	0.029	0.001	0.007	0.003	0.009	0.000	0.001	0.336	0.003	0.002

Mechanical Properties

Specification Limits	UTS (Rm) MPa	UTS (Rm) psi	Yield (0.5%) MPa	Yield (0.5%) psi	% El 50mm
Minimum	415	60000	290	42000	30.0
Maximum	-	-	-	-	-
(1) Actual	468	67877	320	46412	42.0
(2) Actual	471	68312	324	46992	44.0
(3) Actual					
(4) Actual					

	UTS (Rm) MPa	UTS (Rm) psi	Yield (0.5%) MPa	Yield (0.5%) psi	% El 50mm
(5) Actual					
(6) Actual					
(7) Actual					
Orientation & type of tensile test			Longitudinal, Strip		
Width of tensile place (mm)			19mm		
Orientation of impact test place					

OTHER TESTS	
Category	Result
Flattening	Passed
Hydrostatic	20700 kPa (3000 psi) - 5 sec
NDI: EMI	PASS - ASTM E570 - 12.5% NOTCH
NDI: UT	UT not required
HV 10 Kg	137 138 140
Shear Fracture (%)	Ave.

Remarks:

Material in accordance with NACE MR0175:2003/ISO15156-2:2003, MR0103:2010. Dimensions to ANSI B36.10M-2004
The material conform to the hot yield strength requirements as per ASME, Sect II, Pt D, Table Y-1, 2010
All the material conform to the visual and dimensional requirements and is made to a suitable fine grain practice

Quality Assurance Manager: *R. Bester* *Date of Issue:* *2012.06.18* *Certified by:*

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.

MANUFACTURING TEST CERTIFICATE

CERTIFICATION AS PER EN 10204: 3.1

TC NO. BF/04395 DT. 26.01.2014

CUSTOMER NAME :- M/S. 1106 Dt: 26.01.2014

P.O. No.	1032022	P.O. DT.	27.11.2013							
Sr. No.	DESCRIPTION	P.O. SR NO.	INV. SR NO.	QTY	MATERIAL	MILL HEAT NO.	H.L. NO.	DIMENSION STD		
1	4" X 3-1/2"NB X 150# RED SO RF	7	7	50	ASTM-A105-13	1056	1056	ASME B16.5-13		
2	4" X 2-1/2"NB X 150# RED THRD RF	10	10	20	ASTM-A105-13	06/03/05	06/03/05	ASME B16.5-13		
3	6" X 2"NB X 150# RED THRD RF	11	11	7	ASTM-A105-13	837	837	ASME B16.5-13		
4	6" X 3"NB X 150# RED THRD RF	12	12	15	ASTM-A105-13	837	837	ASME B16.5-13		
5	4" NB X 150# SW RF STD	18	13	10	ASTM-A105-13	13AG262	13AG262	ASME B16.5-13		
6	8"NB X 300# WN RF STD	39	22	75	ASTM-A105-13	724	724	ASME B16.5-13		
7	8"NB X 300# WN RF XH	40	23	10	ASTM-A105-13	724	724	ASME B16.5-13		

Chemical Composition			C%	Mn%	P%	S%	Si%	Cu%	Ni%	Cr%	Mo%	V%	Nb%	N%	CE.
Std. Reqmnt.		MIN.		0.60			0.10								
		MAX	0.25	1.05	0.035	0.040	0.35	0.40	0.40	0.30	0.12	0.08	0.02		0.43
Check Analysis	1056		0.180	0.990	0.022	0.017	0.190	0.047	0.030	0.047	0.009	0.002	0.001	-	0.362
	06/03/05		0.215	0.880	0.028	0.011	0.244	0.051	0.033	0.107	0.003	0.003	<0.001	--	0.389
	837		0.199	0.928	0.024	0.012	0.198	0.027	0.033	0.049	0.010	0.015	0.003	-	0.372
	13AG262		0.207	0.948	0.022	0.021	0.229	0.009	0.019	0.002	0.002	<0.001	0.001	-	0.369
	724		0.201	0.923	0.028	0.025	0.225	0.059	0.041	0.087	0.006	0.002	0.001	-	0.381

MECHANICAL PROPERTIES		U.T.S. N/mm2	Y.S.(0.2% Offset) N/mm2	ELONGATION%	REDUCTION IN AREA%	HARDNESS (BHN)	HEAT TREATMENT DETAILS	IMPACT ENERGY ABSORBED AT 'C				
								Specimen (J)				
								1	2	3		Avg.(J)
Std. Requirement		485 MIN.	250 MIN.	22% MIN.	30% MIN.	137 TO 187						
Result	1056	510.82	357.77	34.00	65.80	143-149	AS FORGED	-	-	-		-
	06/03/05	540.86	328.95	34.00	65.00	146-153	AS FORGED	-	-	-		-
	837	506.03	331.67	35.20	67.00	143-149	AS FORGED	-	-	-		-
	13AG262	524.30	307.30	29.30	45.70	143-159	AS FORGED	-	-	-		-
	724	529.40	297.10	35.00	59.40	143-149	AS FORGED	-	-	-		-

Identification Size,Pressure Rating,Type,Nominal Bore,SA/A105, B-16, Heat Lot No., INDIA

Remark:-

- Materials Was manufactured,sampled,Tested and Inspected in accordance with specification(s) solely by the manufacturer listed herein and was found to meet the requirments.
- No weld repair was performed.
- Materials is free of mercury and radioactive contamination.

We hereby certify that the above mentioned items confirm to requirements of - ASTM A-105-13 / ASME SA 105 & NACE MR0175-09

(Metallurgist)

QA HEAD

F:LB:10 REV.00, Dt.-15.05.2013

12/19/2016 From: AMERICAN ALLOY STEEL, INC. To: PORT CITY METAL SERVICES
P.O.#: 101436 S.O.#: 560454 AA PL#: 5174338
Item: 5 (1 PC) 7/8" X 119" X 480"

6502641 03 ID#1465

AMERICAN ALLOY
PLATE #5174338

NUCOR PLATE MILL
P.O.Box 279
Winton, NC 27986
(252) 356-3700

Mill Test Report

Page 4

1505 River Rd
Cofield, NC 27922
(252) 356-3700

NUCOR It's Our Nature.

Issuing Date : 05/10/2016 B/L No. : 444111 Load No. : 451844 Our Order No. : 137326/8 Cust. Order No. : 108026-OK

Vehicle No: TTPX 81008

Sold To: AMERICAN ALLOY STEEL INC
6230 N HOUSTON ROSSLYN RD
PO BOX 40469
NORTH HOUSTON,TX 77001

Ship To: AMERICAN ALLOY STEEL
6350 N ERIE AVE
C/O SKOL TRACK #21
OWASSO,OK 74055

Specification: 0.8750" x 120.000" x 480.000"
ASTM A516 70/65/60-10(2016)/ASME SA516-70/65/60 PVQ 2013/2015
Normalized Plate NACE MR0175 Annex 2.1.2, MR0103 Section 2.1.2
Compliant Vacuum Degassed

Marking : 108026-OK

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm
6502641	0.10	1.03	0.005	0.001	0.20	0.25	0.12	0.00	0.03	0.030	0.000	0.003	0.003	0.0053	0.0008	0.0003	0.012	0.40	0.28
6502644	0.10	0.07	0.000	0.002	0.10	0.24	0.11	0.00	0.03	0.029	0.005	0.002	0.002	0.0056	0.0016	0.0002	0.010	0.39	0.28

Plate Serial No	Pieces	Tons	Tensile Test Dir.	Yield (psi)	Tensile (psi)	Elong. % In 2"	Elong. % In 8"	Heat Treat Norm °F	Time (min)	Temper °F	Time (min)	Charpy Impacts Dir.	Absorbed Energy (Ft-lbs) 1	2	3	Avg	Min	Shear (%) 1	2	3	Avg	Min	Temp °F	Size
6502641-03	4	28.68	T	46,100	72,300	54.7		1650	36			H-L	115.1	95.8	75.8	95.6	15						-50	10mm
6502644-01	1	7.14	T	46,300	73,200	48.1		1650	36			H-L	84.8	78.4	82.0	81.7	15						-50	10mm

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL, INC.
Reviewed By:
JK 12/22/2016

HOT ROLLED CARBON STEEL PLATE
Piece frequency charpy;

Manufactured to fully killed fine grain 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, unless otherwise noted in Specification. For Mexico shipments: nho-SalesMX@Nucor.com
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 9001:2008 certified (8010940) by SRI Quality System Registrar (#0996-08). 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 14-MMPQA-723

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, Metallurgist

6/17/2016 11:16:31 AM

Q.A. APPROVED
By [signature] Date 12/20/2016

02/03/2017 From: AMERICAN ALLOY STEEL, INC. To: PORT CITY METAL SERVICES
P.O.#: 101515 S.O.#: 563830 AA PL#: 5176012
Item: 1 (1 PC) 1-1/8" X 96" X 480"

AMERICAN ALLOY
PLATE # 5176012

NUCOR PLATE MILL
P.O.Box 279
Winton, NC 27986
(252) 356-3700

Mill Test Report

Page 6

2695 River Rd
Cofield, NC 27922
(252) 356-3700

NUCOR It's Our Nature

Issuing Date : 03/12/2016 B/L No. : 446445 Load No. : 464174 Our Order No. : 137000/13 Cust. Order No. : 168333-OK

Vehicle No: LW 62139

Specification: 1.1250" x 96.000" x 480.000"
ASTM A516 70/65/60-16(2015)/ASME SA516-70/65/60 PVQ 2013/2016
Normalized Plate NACE MR0175 Annex 2.1.2, MR0103 (2010) Section
2.1.2 Compliant (2015) 13.1.1, 13.1.2)Vacuum Degassed

Sold To: AMERICAN ALLOY STEEL INC
6230 N HOUSTON ROSSLYN RD
PO BOX 40469
NORTH HOUSTON,TX 77091

Ship To: AMERICAN ALLOY STEEL
6350 N ERIE AVE
C/O SKOL TRACK 521
OWASSO,OK 74055

Marking : 168333-OK

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(sol)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm
6503521	0.10	0.98	0.003	0.001	0.23	0.23	0.03	0.08	0.02	0.030	0.036	0.001	0.003	0.0033	0.0016	0.0001	0.012	0.40	0.27

Plate Serial No	Pieces	Tons	Tensile Test: Dir.	Yield (psi)	Tensile (psi)	Elong. % in 2"	Elong. % in 8"	Heat Treat: Norm °F	Time (min)	Temper °F	Time (min)	Charpy Impacts: Dir.	Absorbed Energy (Ft-lbs) 1	2	3	Avg	Min	Shear (%) 1	2	3	Avg	Min	Temp °F	Size
6503521-09	1	7.35	T	44,800	71,600	54.7		1680	45			H-L	89.3	97.8	105.7	97.6	15						-50	10mm

Certified a true copy of the
original, retained in our file.
AMERICAN ALLOY STEEL, INC.
Reviewed By:
JK 7/12/2016

HOT ROLLED CARBON STEEL PLATE
Piece frequency charpy;

Manufactured to fully killed fine grain 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, unless otherwise noted in Specification. For Mexico shipments: nhc-SalesMX@Nucor.com
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 9001:2008 certified (#010040) by SRI Quality System Registrar (#8606-09). 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 14-MWQA-725

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. Deprelis
T. A. Deprelis, Metallurgist

6/13/2016 6:08:34 AM

Q.A. APPROVED
By ________ Date 2/3/2017

AMERICAN ALLOY
PLATE # 501944

NUCOR
PLATE MILL

P.O.Box 279
Winton, NC 27986
(252) 356-3700

Mill Test Report

Page 3

1505 River Rd
Cofield, NC 27922
(252) 356-3700

NUCOR
It's Our Nature

Issuing Date :	07/07/2010	B/L No. : 440884	Load No. : 438849
Vehicle No:	NOKO. 723103	Our Order No. : 1322223	Cust. Order No. : 103428-OK

Specification: 0.5000" x 96.000" x 480.000"
ASTM A516 70/35/30-10(2015)/ASME SA516-70/05/09 PVQ 2012/2015
Normalized Plate NACE MR0175 Annex 2.1.2, MR0103 (2010) Section
2.1.2 Compliant (2015) 13.1.1, 13.1.2)Vacuum Degassed

Marking : 103428-OK

Sold To: AMERICAN ALLOY STEEL INC
6230 N HOUSTON ROSSLYN RD
PO BOX 40489
NORTH HOUSTON,TX 77001

Ship To: AMERICAN ALLOY STEEL
6350 N ERIE AVE
C/O SKOL TRACK #21
OWASSO,OK 74055

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm
6504310	0.20	1.00	0.003	0.002	0.24	0.21	0.03	0.03	0.01	0.035	0.005	0.004	0.003	0.0070	0.0019	0.0003	0.011	0.40	0.27

Plate Serial No	Pieces	Tons	Tensile Test Dir.	Yield (psi)	Tensile (psi)	Elong. % in 2"	Elong. % in 8"	Heat Treat Norm °F	Time (min)	Temper °F	Time (min)	Charpy Impacts Dir.	Absorbed Energy (Ft-lbs) 1	2	3	Avg	Min	Shear (%) 1	2	3	Avg	Min	Temp °F	Size
6504310-07	8	10.60	T	51,900	76,000	45.5		1650	23			H-L	95.1	70.2	116.5	93.9	15						-50	10/mm

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL, INC.
Reviewed By: [signature]

HOT ROLLED CARBON STEEL PLATE
Piece frequency charpy:

Manufactured to fully killed fine grain 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, unless otherwise noted in Specification. For Mexico shipments: nhc-SalesMX@Nucor.com
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 9001:2008 certified (#010840) by SRI Quality System Registrar (#0055-09), 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 14-MMPQA-729

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, Metallurgist

7/7/2010 8:10:26 AM

Q.A. APPROVED
By: [signature] Date 3/15/2017

03/15/2017 From: AMERICAN ALLOY STEEL, INC. To: PORT CITY METAL SERVICES
P.O.#: 102134 S.O.#: 566751 AA PL#: 5176944
Item: 3 (1 PC) 1/2" X 96" X 480"

MATERIAL TEST REPORT

Sold To: 6070000	Ship To: 6070000
HUDSON PRODUCTS CORP.	HUDSON PRODUCTS CORP.
9660 GRUNWALD ROAD	9660 GRUNWALD ROAD
BEASLEY TX 77417	BEASLEY TX 77417

517430
118037

Purchase Order: 118037
Sales Order: 214698
Material: A13010000830 A/SA 214 ERW 1000D 083M
Delivery / File Nbr: 80366839

CHECKED AND RELEASED
Date 4-13-17
Signed

Description: ASTM A214-96(12) ASME SA214 2015 ERW CARBON STEEL TUBING.

Test: FLATTENING TEST PASSED. REVERSE FLATTENING TEST PASSED. FLANGE TEST PASSED. NDT ELECTRIC TESTED TO ASTM A450 OR A1016 & APPLICABLE TEST METHOD E309 OR E426.

Heat Number: WA617923

		%
CARBON	LDL	0.070
MANGANESE	LDL	0.360
PHOSPHORUS	LDL	0.010
SULFUR	LDL	0.005

Ultimate (PSI)	
Yield (PSI)	
Elongation (%)	
Hardness (RB)	51 / 51
Manufactured in	USA

Webco Industries, Inc. certifies that the material described was manufactured and tested and/or inspected in accordance with the specification and fulfills requirements in such respect.
This document conforms to the requirements of Specification EN 10204 Inspection Document Type 3.1.
This document was prepared by means of electronic processing and is valid without signature.

Date: 04/11/2017

Tony Stubblefield
Quality Manager
TSTUBBLE@WEBCOTUBE.COM

201 S. Woodland Dr.
Sand Springs OK 74063

45 Pcs 1"OD X .083 MW X 30' SA-214 TUBES

MATERIAL TEST REPORT

Sold To: 6070000	Ship To: 6070000
HUDSON PRODUCTS CORP.	HUDSON PRODUCTS CORP.
9660 GRUNWALD ROAD	9660 GRUNWALD ROAD
BEASLEY TX 77417	BEASLEY TX 77417

517430
118037

Purchase Order: 118037
Sales Order: 214698
Material: A13012500600 A/SA 214 ERW 1250OD 060M
Delivery / File Nbr: 80364840

CHECKED AND RELEASED
Date 4-6-17
Signed

Description: ASTM A214-96(12) ASME SA214 2015 ERW CARBON STEEL TUBING.

Test: FLATTENING TEST PASSED. REVERSE FLATTENING TEST PASSED. FLANGE TEST PASSED. NDT ELECTRIC TESTED TO ASTM A450 OR A1016 & APPLICABLE TEST METHOD E309 OR E426.

Heat Number: WA701866

		%
CARBON	LDL	0.060
MANGANESE	LDL	0.350
PHOSPHORUS	LDL	0.007
SULFUR	LDL	0.003

Ultimate (PSI)	
Yield (PSI)	
Elongation (%)	
Hardness (RB)	50 / 52
Manufactured in	USA

Webco Industries, Inc. certifies that the material described was manufactured and tested and/or inspected in accordance with the specification and fulfills requirements in such respect.
This document conforms to the requirements of Specification EN 10204 Inspection Document Type 3.1.
This document was prepared by means of electronic processing and is valid without signature.

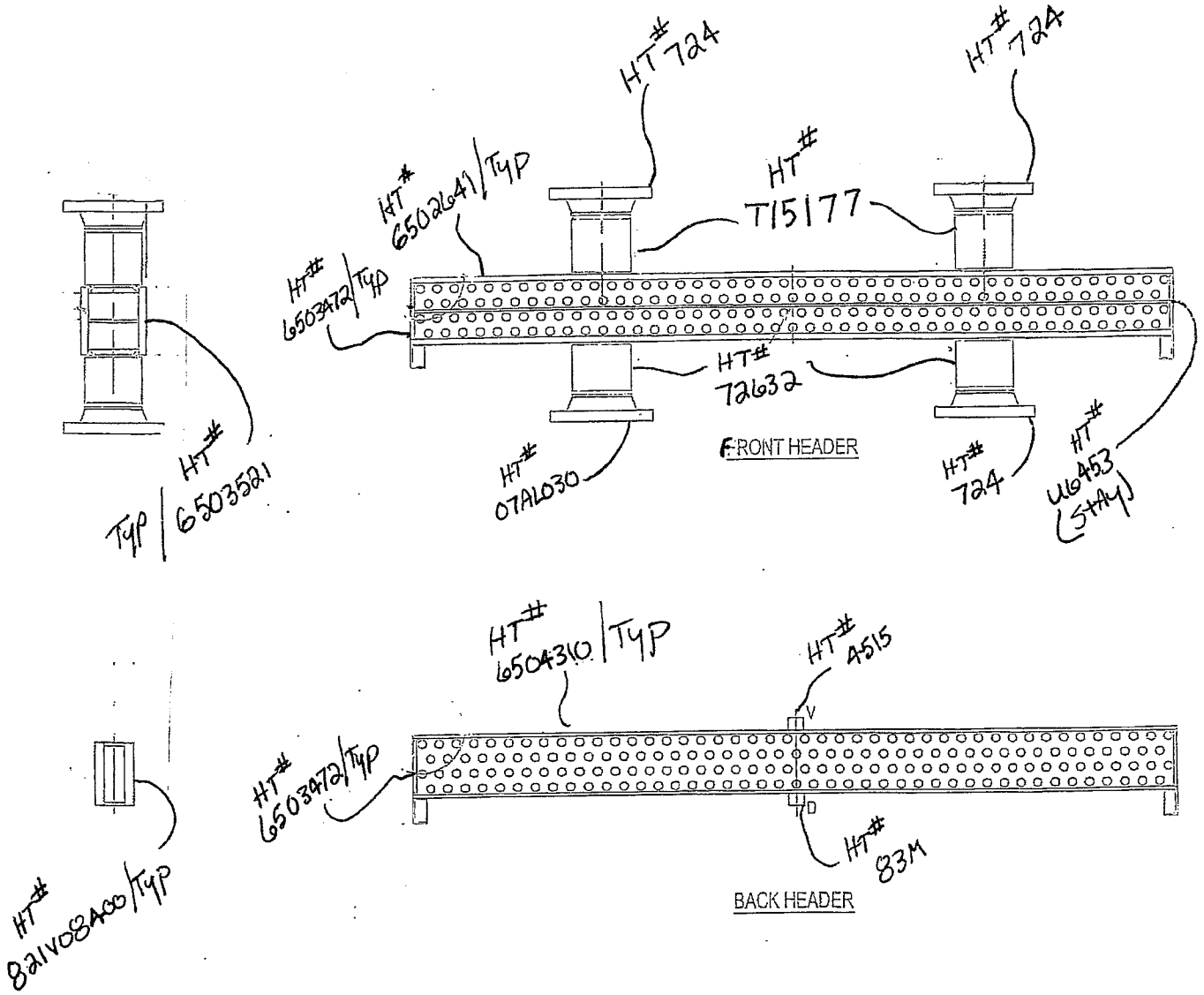
Date: 03/27/2017

Tony Stubblefield
Quality Manager
tstubble@webcotube.com

201 S. Woodland Dr.
Sand Springs OK 74063

177 Pcs 1/4" OD X .060MW X 30' SA-214 TUBES

430-1 Heat #'s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HT# 83M
HT# 831V08A00/Typ
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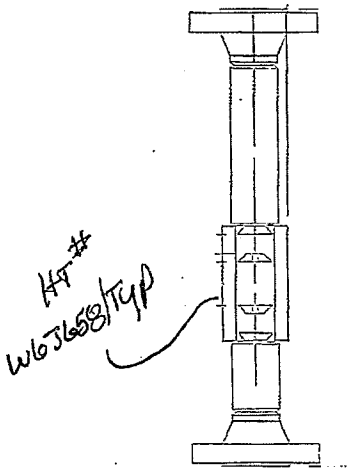

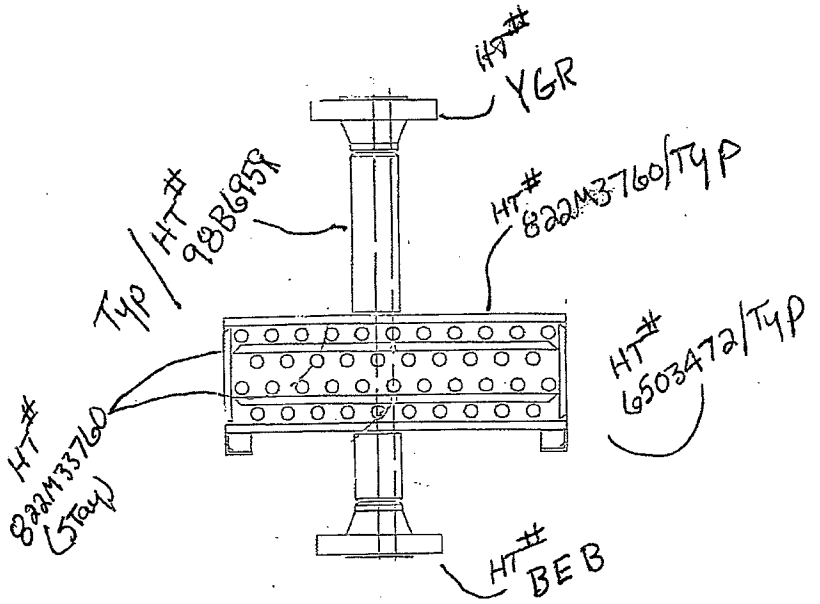

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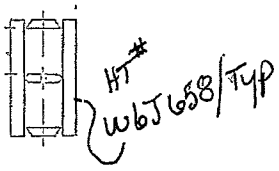
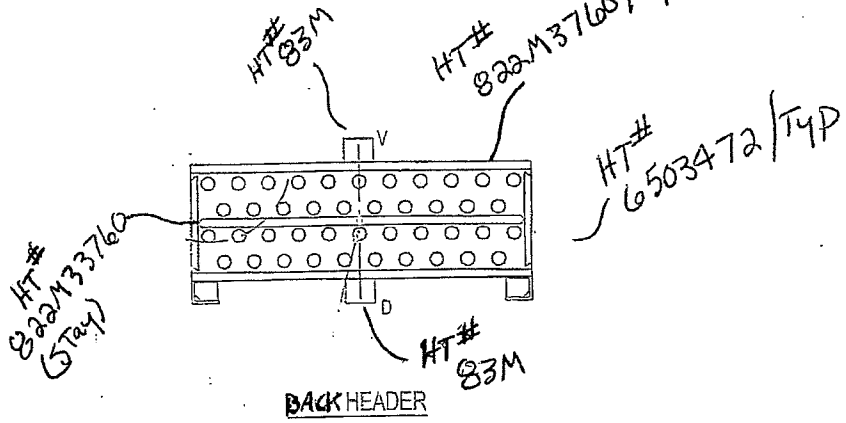




BACK HEADER

430-2 Heat #S

SECTION 3. NON-DESTRUCTIVE EXAMINATIONS

K.W.L.L.C.

Ken's Welding, LLC

Visible Liquid Penetrant Report Form

Technician Larry Owens

Date 3/27/17

Level II

Time

Penetrant 57-L2

Customer

Remover Water

Customer P.O. 430-[redacted]2

Developer Batch# 610-06

K.W.L.L.C. W.O. KW-1083H-A

Material type and thickness SA-516706N All plate edges Before welding.

Reject

Sketch

Accept ✓

K.W.L.L.C.

Ken's Welding, LLC

Visible Liquid Penetrant Report Form

Technician Larry Owens

Date 3/27/17

Level II

Time

Penetrant 57-L2

Customer

Remover WATER

Customer P.O. 430 - [illegible]

Developer Batch# 610-06

K.W.L.L.C. W.O. KW-108 H-A

Material type and thickness SA-516 70N All plate edges Before welding.

Reject

Sketch

Accept ✓

K.W.L.L.C.

Ken's Welding, LLC

Visible Liquid Penetrant Report Form

Technician Larry Owens

Date 4/12/17

Level II

Time

Penetrant 57-L2

Customer

Remover Water

Customer P.O. 430-1

Developer Batch# 610-06

K.W.L.L.C. W.O. KW-108H-B

Material type and thickness SA-516 70 N All plate edges & Attachments Post weld.

Reject

Accept ✓

K.W.L.L.C.

Ken's Welding, LLC

Visible Liquid Penetrant Report Form

Technician Larry Owens

Date 4/12/17

Level II

Time

Penetrant 57-L2

Customer

Remover Water

Customer P.O. 430-2

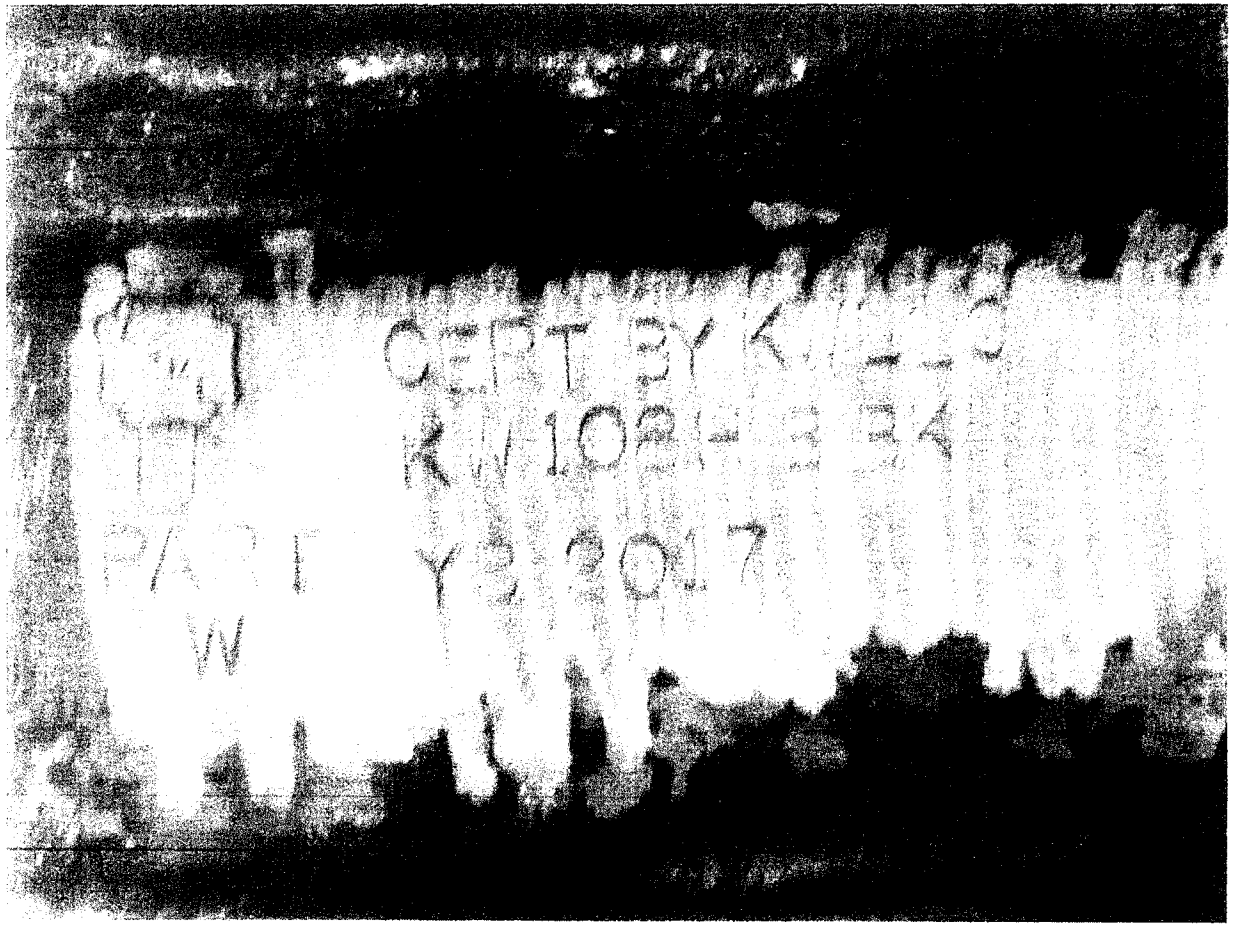
Developer Batch# 610-06

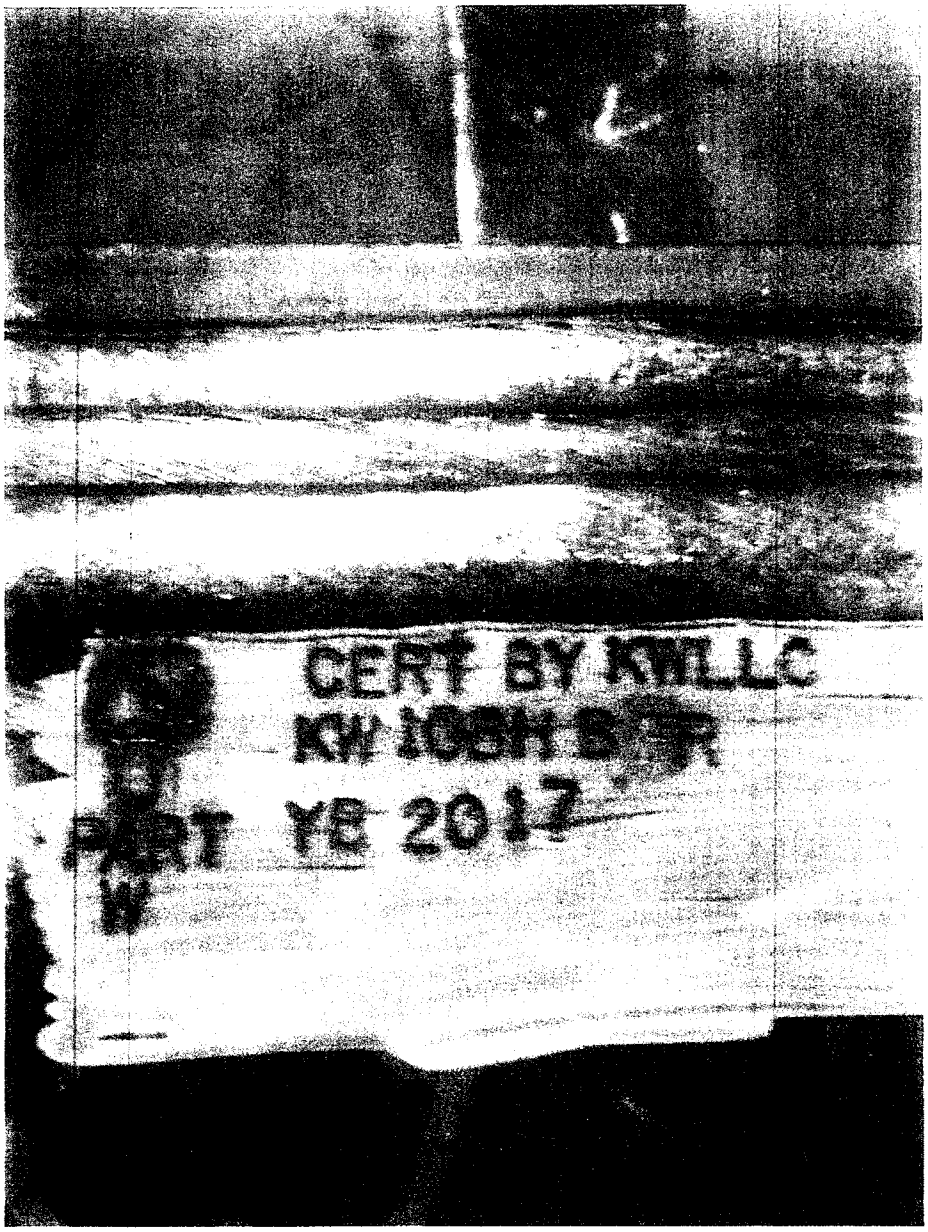
K.W.L.L.C. W.O. KW-1083H-A

Material type and thickness 511670 N All plate edges & Attachments Post weld.

Reject

Accept ✓


CERT BY
YR 2017


CERT BY KWLLC
PART YE 2017


BY KWLLC
KW 108H A FR
PART
W
YB 2017


YB 2017

SECTION 4. CALCULATIONS

Smithco Engineering

V2.1

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
Item: A-301
Page: 1 of 5

Doc. No.: H 1 **Plug Header Calculations**

TUBES 2015 ASME VIII, Div. 1, App. 1, Eq. (1)
SA-214,WLD

P	Design Pressure	500	psig
Ro	Outside Radius	0.625	in
Sd	Allowable Stress at 250 F	11400	psi
Sa	Allowable Stress at 70 F	11400	psi
E	Longitudinal Weld Eff	1	~
CA	Tube Corrosion Allowance	0	in
t	Tube Thickness	0.06	in
EMB	Embedded Groove Depth	0	in
t(min)	=P*Ro / (Sd*E+0.4*P)+CA	**0.0269**	in
MAWP(hot & corr)	=(t-CA)*Sd*E / (Ro-0.4*(t-CA))	**1138.10**	psig
MAP(new & cold)	=t*Sa*E / (Ro-0.4*t)	**1138.10**	psig

NOZZLES App. 1, Eq. (1)

Ri	Inlet Outside Radius	4.3125	in
ti	Inlet Nozzle Wall (0.5 * 0.875)	0.4375	in
Ro	Outlet Outside Radius	4.3125	in
to	Outlet Nozzle Wall (0.5 * 0.875)	0.4375	in
Sd	Allowable Stress at 250 F	17100	psi
Sa	Allowable Stress at 70 F	17100	psi
E	Longitudinal Weld Eff	1	~
CA	Nozzle Corrosion Allowance	0.0625	in
Inlet Pipe	SA-106,B,SMLS		
t(min)	=P*Ri / (Sd*E+0.4*P)+CA	**0.1871**	in
MAWP(hot & corr)	=(ti-CA)*Sd*E / (Ri-0.4*(ti-CA))	**1540.54**	psig
MAP(new & cold)	=ti*Sa*E / (Ri-0.4*ti)	**1808.16**	psig
Outlet Pipe	SA-106,B,SMLS		
t(min)	=P*Ro / (Sd*E+0.4*P)+CA	**0.1871**	in
MAWP(hot & corr)	=(to-CA)*Sd*E / (Ro-0.4*(to-CA))	**1540.54**	psig
MAP(new & cold)	=to*Sa*E / (Ro-0.4*to)	**1808.16**	psig
Flanges	SA-105		
MAWP(hot & corr)	ASME B16.5 at 250 F	**667.50**	psig
MAP(new & cold)	ASME B16.5 at 70 F	**740.00**	psig

Designer:	ME	Date:	1/18/2017	Chkd By:		Date:	

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
Item: A-301
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Doc. No.: H 1 **NOZZLE Plug Header Calculations** **Box 1**

TUBE, PLUG, AND COVER PLATE App. 13, Figure 13-2(a), Sketch (7) & 13-9(b)
SA-516,70,N

		new & cold	hot & corr	
P	Design Pressure		500	psig
CA	Header Corrosion Allowance		0.0625	in
h	Maximum Vertical Span	4.0625	4.1875	in
H	Horizontal Span	7.625	7.75	in
a	=H/h	1.8769	1.8507	~
t1	Cover Plate	0.875	0.8125	in
t2	Tubesheet	1.125	1.0625	in
t22	Plugsheet	1.125	1.0625	in
I1	=t1^3/12	0.0558	0.0447	in^3
I2	=t2^3/12	0.1187	0.1000	in^3
I22	=t22^3/12	0.1187	0.1000	in^3
K	=(I2/I1)a	3.9891	4.1387	~
k1	=I22/I2	1.0000	1.0000	~
k2	=(I22/I1)a	3.9891	4.1387	~
K1	=2k2+3	10.9783	11.2774	~
K2	=3k1+2k2	10.9783	11.2774	~
N	=K1K2-k2^2	104.6096	110.0508	~
S	Allowable Stress at 70 F & 250 F	20000	20000	psi
d	Plug Thread Pitch Dia at 1.375 Thread	1.3209	1.3209	in
p	Horizontal Tube Pitch	2.5625	2.5625	in
e	Ligament Efficiency of Tube/Plugsheet =1-d/p	0.4845	0.4845	~

COVER PLATE

		new & cold	hot & corr	
Sm	=Ph/4t1(act)*{4-[2+K(5-a^2)]/(1+2K)}	1811	1985	psi
(Sb)N	=P(t1/2)/24I1*[-3H^2+2h^2*(1+2a^2K)/(1+2K)]	-11007	-13109	psi
(Sb)Q	=Ph^2(t1/2)/12I1*(1+2a^2K)/(1+2K)	17470	21010	psi
(Sm+Sb)N	Membrane + Bending at Midpoint	12818	15094	psi
(Sm+Sb)Q	Membrane + Bending at Corner	19282	22995	psi

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
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Doc. No.: H 1 **NOZZLE Plug Header Calculations** **Box 1**

TUBE/PLUG

		new & cold	hot & corr	
Sm	=PH/2t2(act)/e	3497	3764	psi
(Sb)M	=Ph^2(t2/2)/12l2*{[1+K(3-a^2)]/(1+2K)}/e	-814	-657	psi
(Sb)Q	=Ph^2(t2/2)/12l2*(1+2a^2K)/(1+2K)	10569	12286	psi
(Sm+Sb)M	Membrane + Bending at Midpoint	4311	4420	psi
(Sm+Sb)Q	Membrane + Bending at Corner	12263	14109	psi

STAY PLATE

		new & cold	hot & corr	
t4	Stay Thickness	0.375	0.25	in
ep	Stay Ligament & Weld Eff	0.7	0.7	~
t(min)	=Ph/2S*[2+K(5-a^2)]/(1+2K)/ep+2CA		**0.1937**	in

END PLATE

Figure UG-34(g) & Eq. (3)

		new & cold	hot & corr	
d	Minimum Span	4.0625	4.1875	in
D	Maximum Span	7.625	7.75	in
Z	=3.4-2.4d/D (Max 2.5)	2.121	2.103	~
C	[Per 13-4(f)]	0.2	0.2	~
P	Design Pressure		500	psig
S	Allowable Stress at 70 F & 250 F	20000	20000	psi
E	[Per 13-5, Endnote 99]	1	1	~
t	End Plate Thickness	0.5	0.4375	in
CA	Header Corrosion Allowance		0.0625	in
t(min)	=d*sqrt(ZCP/SE)+CA		**0.4919**	in

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
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PO No: J-447 P.O. 4500753943

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Doc. No.: H 1 **RETURN Plug Header Calculations** Box 2

TUBE, PLUG, AND COVER PLATE App. 13, Figure 13-2(a), Sketch (1) & 13-7(a)

SA-516,70,N

		new & cold	hot & corr	
P	Design Pressure		500	psig
CA	Header Corrosion Allowance		0.0625	in
h	Maximum Vertical Span	8.5	8.625	in
H	Horizontal Span	3.125	3.25	in
a	=H/h	0.3676	0.3768	~
t1	Cover Plate	0.5	0.4375	in
t2	Tubesheet	1.375	1.3125	in
t22	Plugsheet	1.375	1.3125	in
I1	=t1^3/12	0.0104	0.0070	in^3
I2	=t2^3/12	0.2166	0.1884	in^3
I22	=t22^3/12	0.2166	0.1884	in^3
K	=(I2/I1)a	7.6459	10.1739	~
k1	=I22/I2	1.0000	1.0000	~
k2	=(I22/I1)a	7.6459	10.1739	~
K1	=2k2+3	18.2918	23.3478	~
K2	=3k1+2k2	18.2918	23.3478	~
N	=K1K2-k2^2	276.1307	441.6125	~
S	Allowable Stress at 70 F & 250 F	20000	20000	psi
d	Plug Thread Pitch Dia at 1.375 Thread	1.3209	1.3209	in
p	Horizontal Tube Pitch	2.5625	2.5625	in
e	Ligament Efficiency of Tube/Plugsheet =1-d/p	0.4845	0.4845	~

COVER PLATE

		new & cold	hot & corr	
Sm	=Ph/2t1(act)	4250	4929	psi
(Sb)N	=P(t1/2)/12I1*[-1.5H^2+h^2*(1+a^2K)/(1+K)]	2344	563	psi
(Sb)Q	=Ph^2(t1/2)/12I1*(1+a^2K)/(1+K)	16993	21257	psi
(Sm+Sb)N	Membrane + Bending at Midpoint	6594	5492	psi
(Sm+Sb)Q	Membrane + Bending at Corner	21243	26185	psi

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
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Doc. No.: H 1 **RETURN Plug Header Calculations** Box 2

TUBE/PLUG

		new & cold	hot & corr	
Sm	=PH/2t2(act)/e	1173	1278	psi
(Sb)M	=Ph^2(t2/2)/12l2*[-1.5+(1+a^2K)/(1+K)]/e	-24939	-28547	psi
(Sb)Q	=Ph^2(t2/2)/12l2*(1+a^2K)/(1+K)	2247	2362	psi
(Sm+Sb)M	Membrane + Bending at Midpoint	26112	29825	psi
(Sm+Sb)Q	Membrane + Bending at Corner	2815	2981	psi

STAY PLATE

		new & cold	hot & corr	
t4	Stay Thickness	0	0	in
ep	Stay Ligament & Weld Eff			~
t(min)			**0.0000**	in

END PLATE

Figure UG-34(g) & Eq. (3)

		new & cold	hot & corr	
d	Minimum Span	3.125	3.25	in
D	Maximum Span	8.5	8.625	in
Z	=3.4-2.4d/D (Max 2.5)	2.500	2.496	~
C	[Per 13-4(f)]	0.2	0.2	~
P	Design Pressure		500	psig
S	Allowable Stress at 70 F & 250 F	20000	20000	psi
E	[Per 13-5, Endnote 99]	1	1	~
t	End Plate Thickness	0.5	0.4375	in
CA	Header Corrosion Allowance		0.0625	in
t(min)	=d*sqrt(ZCP/SE)+CA		**0.4255**	in

Smithco Engineering

V2.1

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
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Doc. No.: H 2 **Plug Header Calculations**

TUBES 2015 ASME VIII, Div. 1, App. 1, Eq. (1)
SA-214,WLD

P	Design Pressure	1440	psig
Ro	Outside Radius	0.5	in
Sd	Allowable Stress at 200 F	11400	psi
Sa	Allowable Stress at 70 F	11400	psi
E	Longitudinal Weld Eff	1	~
CA	Tube Corrosion Allowance	0	in
t	Tube Thickness	0.083	in
EMB	Embedded Groove Depth	0	in
t(min)	=P*Ro / (Sd*E+0.4*P)+CA	**0.0601**	in
MAWP(hot & corr)	=(t-CA)*Sd*E / (Ro-0.4*(t-CA))	**2026.99**	psig
MAP(new & cold)	=t*Sa*E / (Ro-0.4*t)	**2026.99**	psig

NOZZLES App. 1, Eq. (1)

Ri	Inlet Outside Radius	1.75	in
ti	Inlet Nozzle Wall (0.3 * 0.875)	0.2625	in
Ro	Outlet Outside Radius	1.75	in
to	Outlet Nozzle Wall (0.3 * 0.875)	0.2625	in
Sd	Allowable Stress at 200 F	17100	psi
Sa	Allowable Stress at 70 F	17100	psi
E	Longitudinal Weld Eff	1	~
CA	Nozzle Corrosion Allowance	0.0625	in
Inlet Pipe	SA-106,B,SMLS		
t(min)	=P*Ri / (Sd*E+0.4*P)+CA	**0.2051**	in
MAWP(hot & corr)	=(ti-CA)*Sd*E / (Ri-0.4*(ti-CA))	**2047.90**	psig
MAP(new & cold)	=ti*Sa*E / (Ri-0.4*ti)	**2728.72**	psig
Outlet Pipe	SA-106,B,SMLS		
t(min)	=P*Ro / (Sd*E+0.4*P)+CA	**0.2051**	in
MAWP(hot & corr)	=(to-CA)*Sd*E / (Ro-0.4*(to-CA))	**2047.90**	psig
MAP(new & cold)	=to*Sa*E / (Ro-0.4*to)	**2728.72**	psig
Flanges	SA-105,N		
MAWP(hot & corr)	ASME B16.5 at 200 F	**2035.00**	psig
MAP(new & cold)	ASME B16.5 at 70 F	**2220.00**	psig

Designer:	ME	Date:	1/19/2017	Chkd By:		Date:	

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
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Job: 17B430
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Doc. No.: H 2 **NOZZLE Plug Header Calculations** **Box 1**

TUBE, PLUG, AND COVER PLATE App. 13, Figure 13-2(a), Sketch (8) & 13-9(c)
SA-516,70,N

		new & cold	hot & corr	
P	Design Pressure		1440	psig
CA	Header Corrosion Allowance		0.0625	in
h	Maximum Vertical Span	3.375	3.5	in
H	Horizontal Span	2.875	3	in
a	=H/h	0.8519	0.8571	~
t1	Cover Plate	0.625	0.5625	in
t2	Tubesheet	1	0.9375	in
t22	Plugsheet	1	0.9375	in
I1	=t1^3/12	0.0203	0.0148	in^3
I2	=t2^3/12	0.0833	0.0687	in^3
I22	=t22^3/12	0.0833	0.0687	in^3
K	=(I2/I1)a	3.4892	3.9683	~
k1	=I22/I2	1.0000	1.0000	~
k2	=(I22/I1)a	3.4892	3.9683	~
K1	=2k2+3	9.9784	10.9365	~
K2	=3k1+2k2	9.9784	10.9365	~
N	=K1K2-k2^2	87.3935	103.8602	~
S	Allowable Stress at 70 F & 200 F	20000	20000	psi
d	Plug Thread Pitch Dia at 1.125 Thread	1.0787	1.0787	in
p	Horizontal Tube Pitch	2.3125	2.3125	in
e	Ligament Efficiency of Tube/Plugsheet =1-d/p	0.5335	0.5335	~

COVER PLATE

		new & cold	hot & corr	
Sm	=Ph/2t1(act)*{3-[6+K(11-a^2)]/(3+5K)}	3706	4274	psi
(Sb)N	=P(t1/2)/24I1*[-3H^2+2h^2*(3+5a^2K)/(3+5K)]	-6772	-9269	psi
(Sb)Q	=Ph^2(t1/2)/12I1*(3+5a^2K)/(3+5K)	16080	21451	psi
(Sm+Sb)N	Membrane + Bending at Midpoint	10478	13542	psi
(Sm+Sb)Q	Membrane + Bending at Corner	19786	25725	psi

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
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Doc. No.: H 2 **NOZZLE Plug Header Calculations** **Box 1**

TUBE/PLUG

		new & cold	hot & corr	
Sm	=PH/2t2(act)/e	3880	4318	psi
(Sb)M	=Ph^2(t2/2)/12l2*{[3+K(6-a^2)]/(3+5K)}/e	16091	19676	psi
(Sb)Q	=Ph^2(t2/2)/12l2*(3+5a^2K)/(3+5K)	6281	7722	psi
(Sm+Sb)M	Membrane + Bending at Midpoint	19971	23994	psi
(Sm+Sb)Q	Membrane + Bending at Corner	8351	10026	psi

STAY PLATE

		new & cold	hot & corr	
t4	Stay Thickness	0.625	0.5	in
ep	Stay Ligament & Weld Eff	0.7	0.7	~
t(min)	=Ph/2S*[6+K(11-a^2)]/(3+5K)/ep+2CA		**0.4933**	in

END PLATE

Figure UG-34(g) & Eq. (3)

		new & cold	hot & corr	
d	Minimum Span	2.875	3	in
D	Maximum Span	3.375	3.5	in
Z	=3.4-2.4d/D (Max 2.5)	1.356	1.343	~
C	[Per 13-4(f)]	0.2	0.2	~
P	Design Pressure		1440	psig
S	Allowable Stress at 70 F & 200 F	20000	20000	psi
E	[Per 13-5, Endnote 99]	1	1	~
t	End Plate Thickness	0.5	0.4375	in
CA	Header Corrosion Allowance		0.0625	in
t(min)	=d*sqrt(ZCP/SE)+CA		**0.4797**	in

Smithco Engineering

Customer: UOP Russell
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Plant:
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Doc. No.: H 2 **RETURN Plug Header Calculations** **Box 2**

TUBE, PLUG, AND COVER PLATE App. 13, Figure 13-2(a), Sketch (7) & 13-9(b)
SA-516,70,N

		new & cold	hot & corr	
P	Design Pressure		1440	psig
CA	Header Corrosion Allowance		0.0625	in
h	Maximum Vertical Span	3.5	3.625	in
H	Horizontal Span	2.875	3	in
a	=H/h	0.8214	0.8276	~
t1	Cover Plate	0.625	0.5625	in
t2	Tubesheet	1	0.9375	in
t22	Plugsheet	1	0.9375	in
I1	=t1^3/12	0.0203	0.0148	in^3
I2	=t2^3/12	0.0833	0.0687	in^3
I22	=t22^3/12	0.0833	0.0687	in^3
K	=(I2/I1)a	3.3646	3.8314	~
k1	=I22/I2	1.0000	1.0000	~
k2	=(I22/I1)a	3.3646	3.8314	~
K1	=2k2+3	9.7291	10.6628	~
K2	=3k1+2k2	9.7291	10.6628	~
N	=K1K2-k2^2	83.3359	99.0163	~
S	Allowable Stress at 70 F & 200 F	20000	20000	psi
d	Plug Thread Pitch Dia at 1.125 Thread	1.0787	1.0787	in
p	Horizontal Tube Pitch	2.3125	2.3125	in
e	Ligament Efficiency of Tube/Plugsheet =1-d/p	0.5335	0.5335	~

COVER PLATE

		new & cold	hot & corr	
Sm	=Ph/4t1(act)*{4-[2+K(5-a^2)]/(1+2K)}	3747	4317	psi
(Sb)N	=P(t1/2)/24I1*[-3H^2+2h^2*(1+2a^2K)/(1+2K)]	-6667	-9152	psi
(Sb)Q	=Ph^2(t1/2)/12I1*(1+2a^2K)/(1+2K)	16185	21568	psi
(Sm+Sb)N	Membrane + Bending at Midpoint	10414	13469	psi
(Sm+Sb)Q	Membrane + Bending at Corner	19932	25884	psi

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
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Doc. No.: H 2 **RETURN Plug Header Calculations** **Box 2**

TUBE/PLUG

		new & cold	hot & corr	
Sm	=PH/2t2(act)/e	3880	4318	psi
(Sb)M	=Ph^2(t2/2)/12l2*{[1+K(3-a^2)]/(1+2K)}/e	18872	22988	psi
(Sb)Q	=Ph^2(t2/2)/12l2*(1+2a^2K)/(1+2K)	6322	7764	psi
(Sm+Sb)M	Membrane + Bending at Midpoint	22752	27307	psi
(Sm+Sb)Q	Membrane + Bending at Corner	8392	10068	psi

STAY PLATE

		new & cold	hot & corr	
t4	Stay Thickness	0.625	0.5	in
ep	Stay Ligament & Weld Eff	0.7	0.7	~
t(min)	=Ph/2S*[2+K(5-a^2)]/(1+2K)/ep+2CA		**0.5238**	in

END PLATE Figure UG-34(g) & Eq. (3)

		new & cold	hot & corr	
d	Minimum Span	2.875	3	in
D	Maximum Span	3.5	3.625	in
Z	=3.4-2.4d/D (Max 2.5)	1.429	1.414	~
C	[Per 13-4(f)]	0.2	0.2	~
P	Design Pressure		1440	psig
S	Allowable Stress at 70 F & 200 F	20000	20000	psi
E	[Per 13-5, Endnote 99]	1	1	~
t	End Plate Thickness	0.5	0.4375	in
CA	Header Corrosion Allowance		0.0625	in
t(min)	=d*sqrt(ZCP/SE)+CA		**0.4906**	in

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Product Information Packet

UNLAUB COMPANY, INC

M00CEXR3018286T

40HP,1775RPM,3PH,60HZ,324T,1260M,TEFC,F1

BALDOR · RELIANCE Product Information Packet: 12G305X277G1 - 40HP,1775RPM,3PH,60HZ,324T,1260M,TEFC,F1

Nameplate NP2613L

CAT NO	EXR4018324T						
SPEC.	12G305X277G1				ENCL	TEFC	
FRAME	324T	HP	40				
VOLTS	230/460						
MAG CUR	36.4/18.2			FLA	94/47		
RPM	1775			RPM MAX	2700		
HZ	60	PH	3	CLASS	H		
SER.F.	1.00	DES	A	SL HZ	0.83		
NEMA-NOM-EFF	94.1	WK2	7.99				
RATING	50C AMB-CONT						
DE BRG	6312			ODE BRG	6311		
INV.TYPE	PWM	C HP FR	60	C HP TO	90	T. CODE	T3
CT HZ FROM	30	CT HZ TO	60	VT HZ FROM	6	VT HZ TO	60
CC	010A	SER.NO					
	1.15 SF ON SINEWAVE						
	SUITABLE FOR VFD						

BALDOR · RELIANCE Product Information Packet: 12G305X277G1 - 40HP,1775RPM,3PH,60HZ,324T,1260M,TEFC,F1

Nameplate NP2141L

CAT NO	EXR4018324T						
SPEC.	12G305X277G1			ENCL	TEFC		
FRAME	324T	HP	30				
VOLTS	190/380-400-415						
MAG CUR	34/17	FLA	86/43				
RPM	1480	RPM MAX	2200				
HZ	50	PH	3	CLASS	H		
SER.F.	1.00	DES	A	SL HZ	0.67		
NEMA-NOM-EFF	93	WK2	7.99				
RATING	50C AMB-CONT						
DE BRG	6312	ODE BRG	6311				
INV.TYPE	PWM	C HP FR	50	C HP TO	75	T. CODE	T3
CT HZ FROM	25	CT HZ TO	50	VT HZ FROM	5	VT HZ TO	50
CC	010A	SER.NO					
	1.15 SF ON SINEWAVE						
	SUITABLE FOR VFD						

Parts List

Part Number	Description	Quantity
SA228930	SA 12G305X277G1	1.000 EA
RA215983	RA 12G305X277G1	1.000 EA
10CB1000A04SP	CONDUIT BOX, MACH	1.000 EA
09GS1010	GASKET, DWG, LEADWIRE SEPERATOR	1.000 EA
10XN3118K16	5/16-18 X 1' GRADE #5, STL, ZINC PLATE	4.000 EA
HW1001A31	LOCKWASHER 5/16, ZINC PLT.591 OD, .319 I	4.000 EA
WD1000B16	T&B CX70TN TERMINAL	1.000 EA
51XF2520A08	SCREW, HEX SER SLT HD, ZN 1/4-20 X .50 L	1.000 EA
12EP1107A132	FR ENDPLATE, MACH	1.000 EA
HA3400A13	STUD, 1/2-13 X 7" WELKER	4.000 EA
HW1001A50	LOCKWASHER 1/2, ZINC PLT,.879 OD, .509 I	4.000 EA
HA4017A01	1/8 X 4 GREASE EXT (F/S)	1.000 EA
HW4019A01	PIPE COUPLING 1/8 NPT,STEEL,ZINC COATING	1.000 EA
HA4017A02	.125X2.50 GREASER EXTENS.F/S	1.000 EA
HW4600B41	V-RING SLINGER 2.125 X 2.880 X 0.280	1.000 EA
10XN3118K36	5/16-18 X 2.25" HEX HD, GRADE 5	2.000 EA
HW1001A31	LOCKWASHER 5/16, ZINC PLT.591 OD, .319 I	2.000 EA
10XN3118K40	5/16-18 X 2.50" HEX HD, GRADE 5	4.000 EA
HW1001A31	LOCKWASHER 5/16, ZINC PLT.591 OD, .319 I	4.000 EA
12EP1106A61	PU ENDPLATE, MACH	1.000 EA
10XN5013K28	1/2-13 X 1.75 HEX HEAD MACH SCREW,GRAD	4.000 EA
HW1001A50	LOCKWASHER 1/2, ZINC PLT,.879 OD, .509 I	4.000 EA
HW5100A15	W4997-050 WVY WSHR (WB)	1.000 EA
12FH1002A13	FAN COVER, MACH	1.000 EA

Parts List (continued)

Part Number	Description	Quantity
HW1001A50	LOCKWASHER 1/2, ZINC PLT,.879 OD, .509 I	4.000 EA
XY5013A12	NUT,1/2-13,HEX,STEEL,ZINCPLATED	4.000 EA
10CB1500A01SP	CONDUIT BOX LID, MACH	1.000 EA
14GS1003	GASKET CONDUIT BOX LID, NEOP	1.000 EA
10XN2520K16	1/4-20 X 1" HX HD SCRW GRADE 5, ZINC P	4.000 EA
HW1001A25	LOCKWASHER 1/4, ZINC PLT .493 OD, .255 I	4.000 EA
HW4600B41	V-RING SLINGER 2.125 X 2.880 X 0.280	1.000 EA
HW2501H33	KEY, 1/2 SQ X 3.875	1.000 EA
LB1115N	LABEL,LIFTING DEVICE (ON ROLLS)	1.000 EA
MN416A01	TAG-INSTAL-MAINT no wire (1000/bx) 11/14	1.000 EA
HW4500A21	1618BALEMITE FITTING 825 UNIVERSAL	1.000 EA
HW4500A17	317400 ALEMITE GREASE RELIEF	1.000 EA
HA4001A01SP	DRAIN PLUG, PLASTIC (MICRO PLAS)	1.000 EA
HA4051A00	PLASTIC CAP FOR GREASE FITTING	1.000 EA
MJ1000A02	GREASE, POLYREX EM EXXON (USe 4824-15A)	0.200 LB
HW4500A03	GREASE FITTING, .125 NPT 1610(ALEMITE) 8	1.000 EA
HW4500A17	317400 ALEMITE GREASE RELIEF	1.000 EA
HA4001A01SP	DRAIN PLUG, PLASTIC (MICRO PLAS)	3.000 EA
HA4051A00	PLASTIC CAP FOR GREASE FITTING	1.000 EA
09FN3001B03SP	EXTERNAL FAN, PLASTIC	1.000 EA
HW2500A25	WOODRUFF KEY USA #1008 #BLOW CARBON STEE	1.000 EA
51XB1214A20	12-14X1.25 HXWSSLD SERTYB	1.000 EA
MG1000G27	MED CHARCOAL METALLIC GREY 400-0096	0.080 GA
85XU0407S04	4X1/4 U DRIVE PIN STAINLESS	4.000 EA

Product Information Packet: 12G305X277G1 - 40HP,1775RPM,3PH,60HZ,324T,1260M,TEFC,F1

LB1119N	WARNING LABEL	1.000 EA
LC0181	CONNECTION LABEL	1.000 EA
NP2613L	ALUM INV DIV-2 UL CSA-C US EEV PREM	1.000 EA
NP2141L	ALUM INV DIV-2 UL CSA-C US CC	1.000 EA
12PA1000	PACKAGING GROUP PRINT PK1024A06	1.000 EA
LB1449	DIV-2/NEC WARNING LABEL	1.000 EA
LB1417	LABEL CARTON 6X4 PERFORATED BLANK ROLLS	1.000 EA

AC Induction Motor Performance Data

Record # 55875 - Typical performance - not guaranteed values

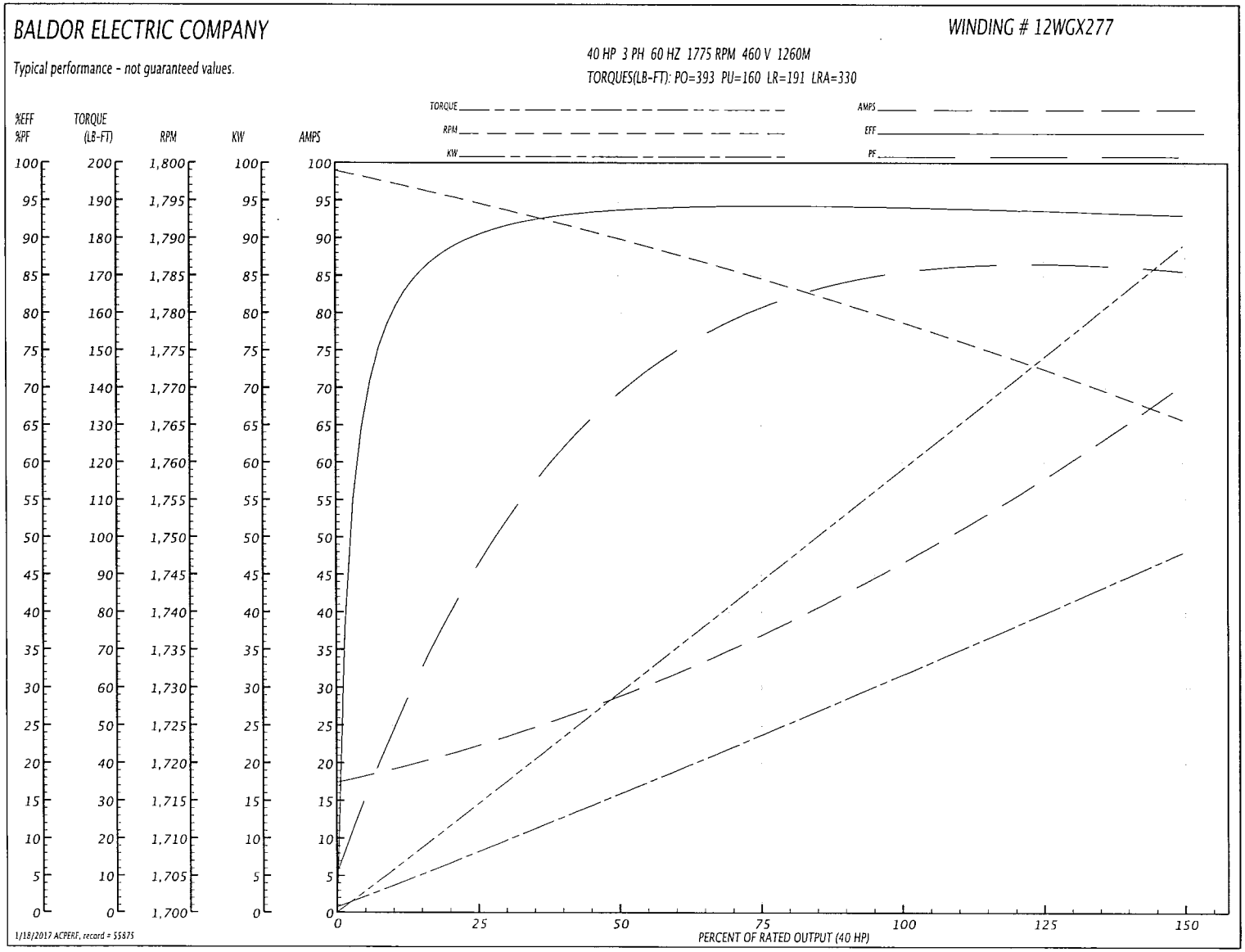
Winding: 12WGX277-R039	**Type:** 1260M	**Enclosure:** TEFC

Nameplate Data				460 V, 60 Hz: High Voltage Connection	
Rated Output (HP)	40			Full Load Torque	117 LB-FT
Volts	230/460			Start Configuration	direct on line
Full Load Amps	94/47			Breakdown Torque	393 LB-FT
R.P.M.	1775			Pull-up Torque	160 LB-FT
Hz	60	Phase	3	Locked-rotor Torque	191 LB-FT
NEMA Design Code	A	KVA Code	H	Starting Current	330 A
Service Factor (S.F.)	1			No-load Current	18.2 A
NEMA Nom. Eff.	94.1	Power Factor	81	Line-line Res. @ 25°C	0.14537 Ω
Rating - Duty	50C AMB-CONT			Temp. Rise @ Rated Load	55°C
				Locked-rotor Power Factor	26.8

Load Characteristics 460 V, 60 Hz, 40 HP

% of Rated Load	25	50	75	100	125	150
Power Factor	48	70	80	84	86	86
Efficiency	90.3	93.7	94.3	94.1	93.6	92.8
Speed	1794.9	1789.9	1784.9	1778.8	1772.8	1765.6
Line amperes	21.3	28	36.9	46.9	58.1	69.9

Performance Graph at 460V, 60Hz, 40.0HP Typical performance - Not guaranteed values



AC Induction Motor Performance Data

Record # 55876 - Typical performance - not guaranteed values

Winding: 12WGX277-R040	**Type:** 1260M	**Enclosure:** TEFC

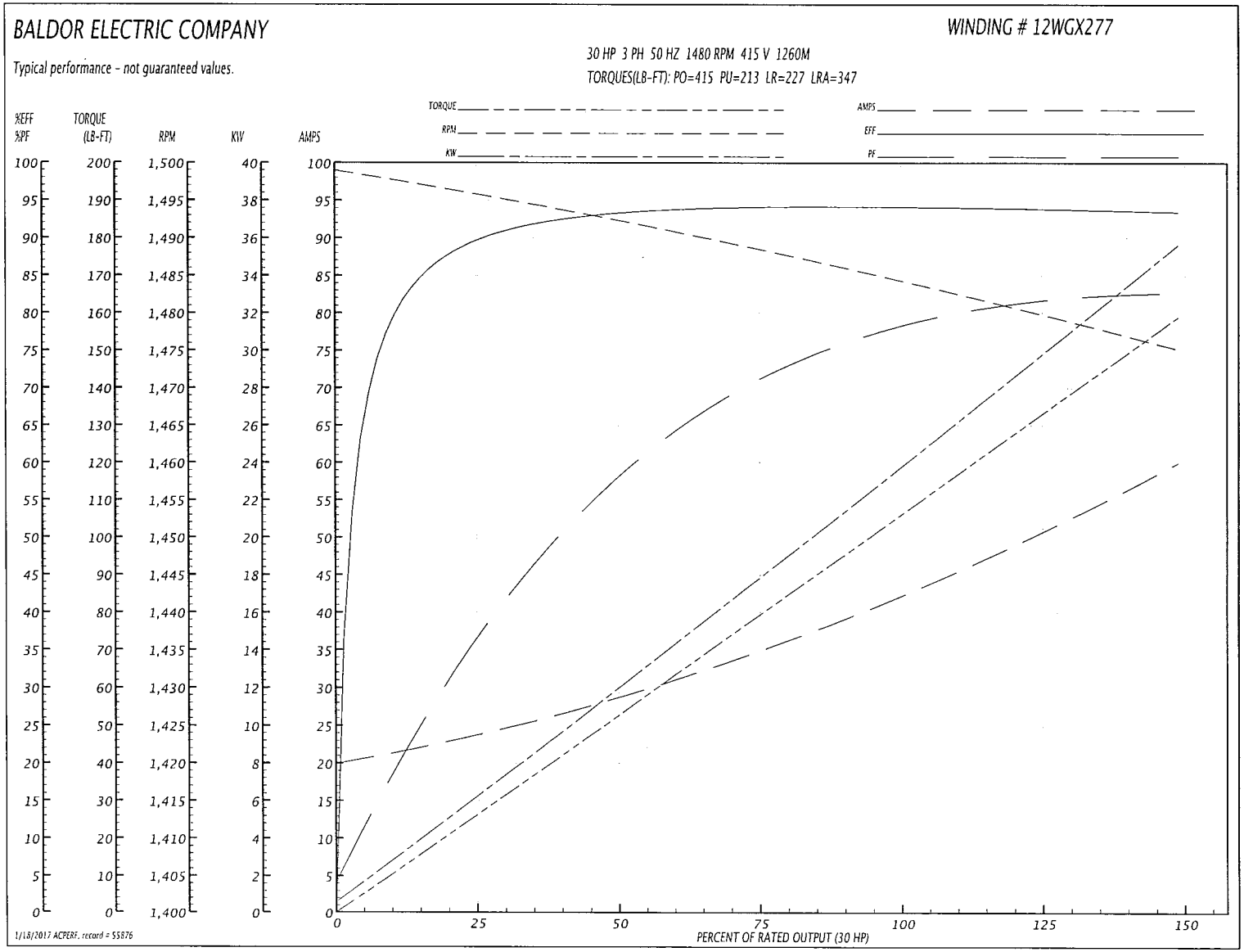
Nameplate Data			
Rated Output (HP)	30		
Volts	190/380-400-415		
Full Load Amps	86/43		
R.P.M.	1480		
Hz	50	Phase	3
NEMA Design Code	A	KVA Code	K
Service Factor (S.F.)	1		
NEMA Nom. Eff.	93	Power Factor	78
Rating - Duty	50C AMB-CONT		

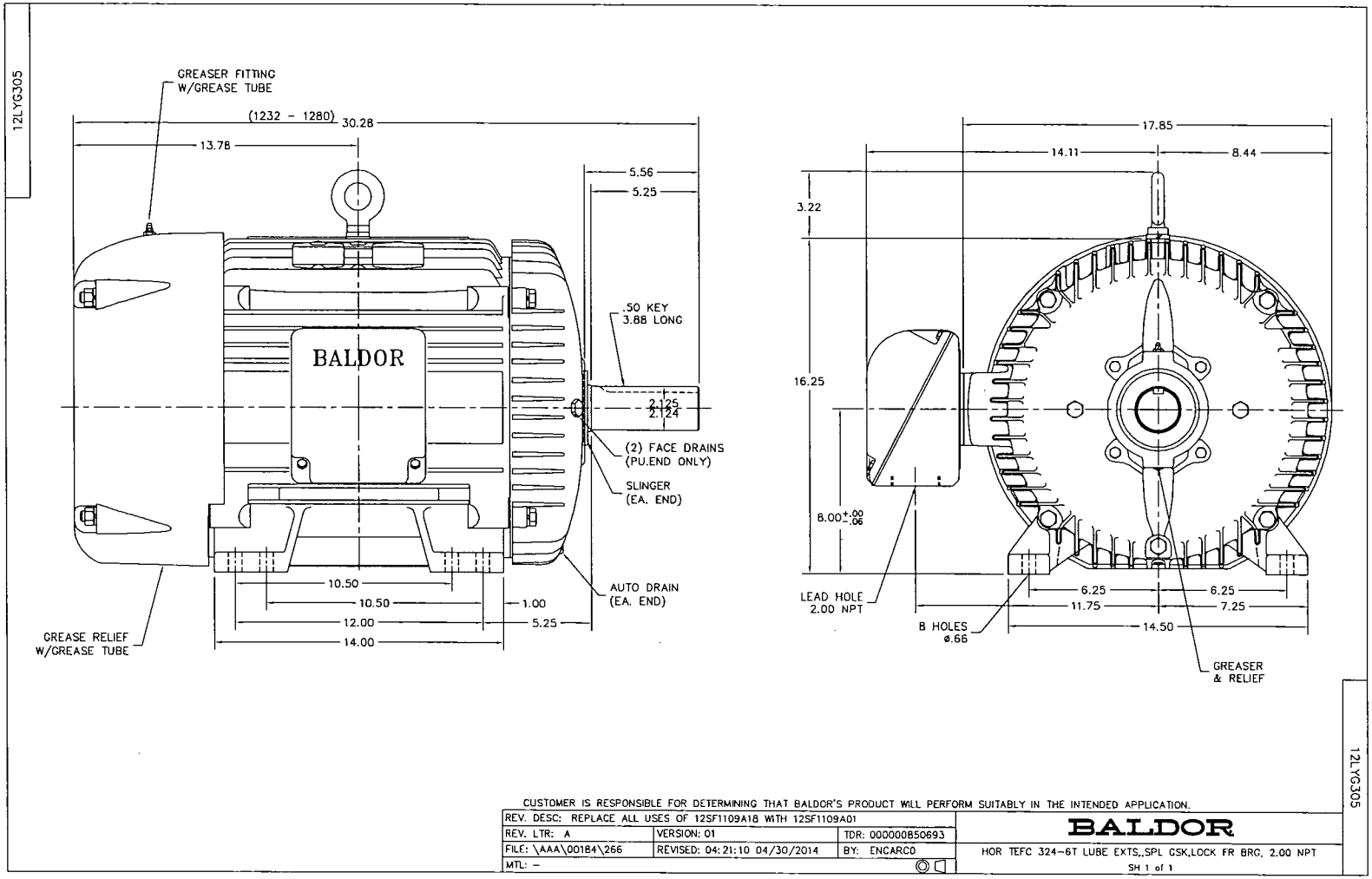
415 V, 50 Hz: High Voltage Connection	
Full Load Torque	106 LB-FT
Start Configuration	direct on line
Breakdown Torque	415 LB-FT
Pull-up Torque	213 LB-FT
Locked-rotor Torque	227 LB-FT
Starting Current	347 A
No-load Current	20.5 A
Line-line Res. @ 25ºC	0.142 Ω
Temp. Rise @ Rated Load	45°C
Locked-rotor Power Factor	30.1
Rotor inertia	7.99 LB-FT2

Load Characteristics 415 V, 50 Hz, 30 HP

% of Rated Load	25	50	75	100	125	150
Power Factor	38	59	71	78	81	83
Efficiency	89.4	93.3	94.2	94.4	93.7	93.6
Speed	1496	1492	1488	1485	1480	1475
Line amperes	23.1	28.5	35.1	42.4	51	59.5

Performance Graph at 415V, 50Hz, 30.0HP Typical performance - Not guaranteed values





CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT BALDOR'S PRODUCT WILL PERFORM SUITABLY IN THE INTENDED APPLICATION.

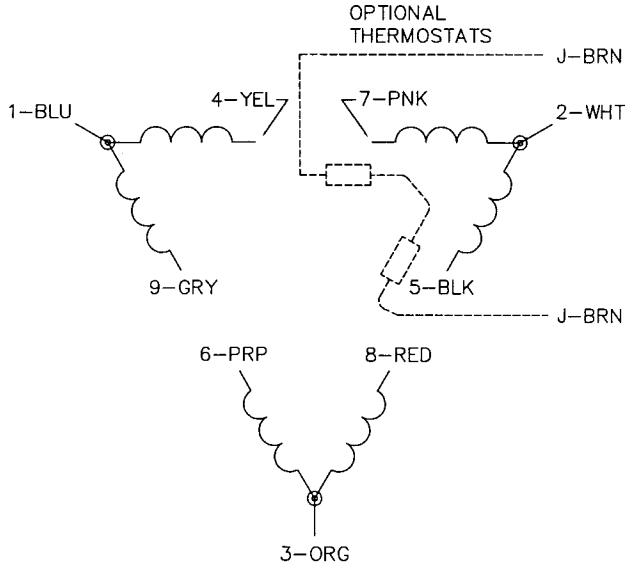
REV. DESC: REPLACE ALL USES OF 12SF1109A18 WITH 12SF1109A01		
REV. LTR: A	VERSION: 01	TDR: 000000850693
FILE: \AAA\00184\266	REVISED: 04:21:10 04/30/2014	BY: ENCARCO
MTL: –		

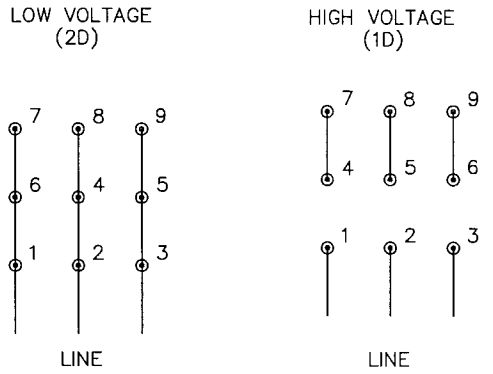
BALDOR

HOR TEFC 324-6T LUBE EXTS,,SPL GSK,LOCK FR BRG, 2.00 NPT

SH 1 of 1

CD0180





NOTES:

1. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.
4. LEAD COLORS ARE OPTIONAL. LEADS MUST ALWAYS BE NUMBERED AS SHOWN.

REV. DESC: REVISE TO SHOW OPTIONAL COLORS			
REV. LTR: C	BY: JLP	REVISED: 01/21/99 2:28	TDR: 0171435
CD0180		FILE: AAA00005148	MDL: –
		MTL: –	

BALDOR ELECTRIC Co.

3PH, DV, 9 LEADS, DELTA CONNECTION

CD0180

BALDOR

Marketing maintained PDF of MN416:

http://www.baldor.com/support/Literature/Load.ashx/MN416?ManNumber=MN416

Marketing maintained PDF of MN408:

http://www.baldor.com/support/Literature/Load.ashx/MN408?ManNumber=MN408

SECTION 5. FIN-FAN SPECIFICATIONS

SMITHCO Engineering Inc.
P.O. Box 571330 Tulsa, OK 74157
Ph. (918) 446-4406 FAX (918) 445-2857

AIR COOLED EXCHANGER SPECIFICATION SHEET

Date	1/5/2015 REV_0
Proposal/Job No.	17B430-01
Reference	J-447 P.O. 4500753943
Item No.	A-301

Customer	UOP RUSSELL LLC					
Plant Location	UNKNOWN					
Service	EXPANDER/COMPRE AFTE					
Model	1 F30-119-2	Type	FORCED		No. of Bays	1
Surface per Unit-Finned Tube	33,480			Ft²	Bare Tubes	1,710 Ft²
Heat Exchanged	2,867,000			BTU/Hr	MTD (Eff.)	21.7 (Counter Flow)°F
Transfer Rate-Finned Tube	3.94	Bare Tube, Service	77.20			BTU/Hr. Ft2 °F

PERFORMANCE DATA-TUBE SIDE

Fluid Name	RESIDUE GAS			Lethal Service	Yes ☐ No ☒	IN	OUT
Total Fluid Entering	Lb/Hr 102,900			Density	Lb/Ft³	.777	.850
		IN	OUT	Specific Heat (Liq/Vap)	BTU/Lb°F	/ .584	/ .571
Temperature	°F	168.5	120.0	Cond. avg (Liq/Vap)	BTU/HrFt°F		.0236
Liquid	Lb/Hr			Pour/Freeze Point	°F		
Vapor	Lb/Hr (MW)	102,900 (16.2)	102,900 (16.2)	Bubble Point	°F		
Nocond	Lb/Hr (MW)			Latent Heat	BTU/Lb		
Steam	Lb/Hr			Pressure	Psia	315.00	
Water	Lb/Hr			Pressure Drop	Allow/Calc Psi	5.00 / 3.87	
Viscosity (Liq/Vap)	Cp	/.013	/.012	Fouling resist, Inside	ft² hr °F/BTU	0.00100	

PERFORMANCE DATA-AIR SIDE

Air Quantity	SCFM 183,300	Lb/Hr 824,800	Altitude	Ft	3,000
Air Quantity/Fan	ACFM 135,900		Temperature In	°F	110.0
			Temperature Out	°F	124.4

DESIGN - MATERIAL - CONSTRUCTION

Design Pressure	500 Psig	Test Pressure	650 Psig	Design Temperature	250 / MDMT -20 °F		
TUBE BUNDLE		**HEADER**, Type	PLUG BOX	**TUBE** Material	SA-214 WLD		
Size	9.5 x 30.0	Material	SA-516 GR-70				
No. 1	No. Tube Rows 4	No. Passes 2	Slope 0 In/Ft	OD 1.250 In	Min. Thick 0.0600 In		
Bays 1	In Parallel In Series	Plug	A1052222	No./Bundle 174	Length 30.0 Ft		
Bundles 1	In Parallel In Series	Gasket	CS2213	Pitch 2.5625	InΔ		
Pass Arrangement (Top to Bottom)		Corrosion Allowance	0.0625 In	FIN Type	L-TENSION		
Rows / Pass	4/ 2	Size In Nozzle	(2) 8.00 SCH XS SA-106B In	Material	ALUM		
Turbulators	NO	Size Out Nozzle	(2) 8.00 SCH XS SA-106B In	OD 2.500 In	Stock Thick 0.016 In		
Steam Coil	NO	Rating & Facing	300 -RF SA-105	No/In 10	Support Chan. / Staple		
Hailscreens	YES	Vent	(1) 1-6000 Drain (1) 1-6000	Code-ASME VIII,Div 1	YES Stamp NATL BD		
Louvers	NONE (0)	TI	PI	Radiograph N	Heat Treat N		
Frame Finish	HTC 1 Coat Galvanize	Header Finish	WMSB 1 Coat Metalize	Tube Hole Grooving	YES		

MECHANICAL EQUIPMENT

FAN Mfg & Model	COFIMCO 3048-5-24L/B3T	**DRIVER** Type	RELIANCE	**SPEED REDUCER** Type	V-BELT
No./Bay 2	RPM 346	S.F. 1.15	Insul/TR CLASS F / B286	BELTS (3) 5VX-1250.	SHEAVES 31.5/6.3
Dia. 10.0 Ft.	No. Blades 5	No./Bay 2	Frame T HP30.0	No./Bay 2	Test Run Fan
Pitch ADJUSTABLE	Angle° 7.3	RPM (2)1750	Duty CHEM	HP Rating 47.1	Ratio 5.06
Matl, Blade ALUMINUM	Hub EXT ALUM	Enclosure TEFC DIV II (P.E.)	V & D V&D	Support: SUSPENDED FROM STRUCTURE	
HP/Fan, Des. 22.3	DBA 85.	V/P/C 460/3/60	Space Heater NO	Vibration Switch	METRIX ST5484E-122-120

STRUCTURE

Mounting	GRADE		
Windload - PSF	43.0	Seismic	1
Finish	HTC 1 Coat Galvanize		

WALKWAYS

Inlet Header	in. None
Outlet/Return	in. None
Drive Access	in. None

NOTES

Items combined: A-301 A-302
Coil Volume (ft^3): 44.
Assembled Drive, Structure & Bundles (Within Shipping Restrictions)

Plot Area	11.9 x 30.0 ft	Weight Bundle	12,400 Lbs	Total Shipping	30,510 Lbs		

SMITHCO Engineering Inc.
P.O. Box 571330 Tulsa, OK 74157
Ph. (918) 446-4406 FAX (918) 445-2857

AIR COOLED EXCHANGER SPECIFICATION SHEET

Date	1/5/2015 REV_0
Proposal/Job No.	17B430-02
Reference	J-447 P.O. 4500753943
Item No.	A-302

Customer	UOP RUSSELL LLC					
Plant Location	UNKNOWN					
Service	NGL PROD COOLER					
Model		Type	FORCED		No. of Bays	1
Surface per Unit-Finned Tube	6,989			Ft²	Bare Tubes	330.1 Ft²
Heat Exchanged	660,500			BTU/Hr	MTD (Eff.)	18.6 (Counter Flow)°F
Transfer Rate-Finned Tube	5.07	Bare Tube, Service	107.32			BTU/Hr. Ft2 °F

PERFORMANCE DATA-TUBE SIDE

Fluid Name	NGL			Lethal Service	Yes ☐ No ☒	
Total Fluid Entering	Lb/Hr 27,500			Density	Lb/Ft³	IN 29.3 / OUT 31.5
	IN	OUT		Specific Heat (Liq/Vap)	BTU/Lb°F	.718 / .658 /
Temperature	°F 155.0	120.0		Cond. avg (Liq/Vap)	BTU/HrFt°F	.0439/
Liquid	Lb/Hr 27,500	27,500		Pour/Freeze Point	°F	
Vapor	Lb/Hr (MW)			Bubble Point	°F	
Nocond	Lb/Hr (MW)			Latent Heat	BTU/Lb	
Steam	Lb/Hr			Pressure	Psia	745.00
Water	Lb/Hr			Pressure Drop Allow/Calc	Psi	5.00 / 4.48
Viscosity (Liq/Vap)	Cp .08580 /	.09990 /		Fouling resist, Inside	ft² hr °F/BTU	0.00100

PERFORMANCE DATA-AIR SIDE

Air Quantity	SCFM 45,860	Lb/Hr 206,400	Altitude	Ft	3,000
Air Quantity/Fan ACFM	.0		Temperature In	°F	110.0
			Temperature Out	°F	123.3

DESIGN - MATERIAL - CONSTRUCTION

Design Pressure	1,440 Psig	Test Pressure	1,872 Psig	Design Temperature	200 / MDMT -20 °F		
TUBE BUNDLE		**HEADER**, Type	PLUG BOX	**TUBE** Material	SA-214 WLD		
Size	2.2 x 30.0	Material	SA-516 GR-70				
No. 1	No. Tube Rows 4	No. Passes 4	Slope 0 In/Ft	OD 1.000 In	Min. Thick 0.0830 In		
Bays 1	In Parallel In Series	Plug	A1051822	No./Bundle 42	Length 30.0 Ft		
Bundles 1	In Parallel In Series	Gasket	CS1813	Pitch 2.3125	InΔ		
Pass Arrangement (Top to Bottom)		Corrosion Allowance	0.0625 In	FIN Type L-TENSION			
Rows / Pass	4/4	Size In Nozzle	(1) 3.00 SCH XS SA-106B In	Material ALUM			
Turbulators	NO	Size Out Nozzle	(1) 3.00 SCH XS SA-106B In	OD 2.250 In	Stock Thick 0.016 In		
Steam Coil	NO	Rating & Facing	900 -RJ SA-105	No/In 10	Support Chan. / Staple		
Hailscreens	YES	Vent	(1) 1-6000 Drain (1) 1-6000	Code-ASME VIII,Div 1 YES	Stamp NATL BD		
Louvers	NONE (0)	TI	PI	Radiograph N	Heat Treat N		
Frame Finish	HTC 1 Coat Galvanize	Header Finish	WMSB 1 Coat Metalize	Tube Hole Grooving YES			

MECHANICAL EQUIPMENT

FAN Mfg & Model			**DRIVER** Type			**SPEED REDUCER** Type	
No./Bay		RPM	S.F.	Insul/TR			
Dia.	Ft.	No. Blades	No./Bay	Frame	HP	No./Bay	
Pitch		Angle°	RPM		Duty	HP Rating	Ratio
Matl, Blade		Hub	Enclosure		V & D	Support:	
HP/Fan, Des.		DBA	V/P/C		Space Heater	Vibration Switch	

STRUCTURE

Mounting	
Windload - PSF	Seismic
Finish	

WALKWAYS

Inlet Header	in.
Outlet/Return	in.
Drive Access	in.

NOTES

Coil Volume (ft^3): 6.

Plot Area	ft	Weight Bundle 3,626	Lbs	Total Shipping 30,510	Lbs

IMPERIAL 4/94

SECTION 6. FINAL INSPECTIONS

HUDSON PRODUCTS CORPOATION

QUALITY CONTROL DEPT.

FINAL INSPECTION REPORT AND UNIT RELEASE

JOB NO. : S17430 ITEM NO : A - 301 SmithCo : X DATE : 5/17/2017

MECHANICAL : _____ BUNDLE: _____ ASSEMBLED UNITS FIN - FAN : _____ SER # S17430 - 11A - A - 1

COMPRESSION COOLING UNITS : _____ SOLO - AIRE : _____ WINTERIZED ASSEMLED UNIT: _____

( ) STRUCTURAL :

	APP.
Touch Up Galv	( )
Touch Up Paint	( )
Straightness	( )
Color Coding	( )
Bolt - Up Surfaces	( )
Loose Mechanical	( )

( ) TUBES :

	APP.
Finned Tubes	( )
SurFace Finish	( )
Tube Coalting	( )

	APP.
Galvanlzing	( )
Paint	( )
Straightness	( )
Finned Tubes	( )
Bolts	( )
Greased Flanges	( )
Flange Covers	( )
Tape Flange Covers	( )
Tape End Protection	( )
Name Plate	( )
Purging	( )
Sheaves	( )
Plywood Covers	( )
Motors	( )
Vibration Switches	( )
Blades	( )
Tracking of Blades	( )
Shafts	( )
Louvers	( )
Trial Fit	( )

Tip Clearance :	1/4" to 5/8"
Blade Pitch :	7.3
Motor Hp.	30
No. of Blades:	5
Equipment Tags :	YES
Bundle:	#1
Nitrogen Purge:	N/A

Hemispherical Noise Test	( )
Post Weld Heat Treated	( )
P.O. # and Item # and Serial #	( )
GearBox	( )
C.G. Symbol center of gravity .	( )
Fan Performance	( )
Noise Test Performed	( )
Louvers Stroked and Adjusted:	( )
Hail Guards	( )
Header Guards	( )
Shipping Beams Installed	( )
Hail Screens built into Louvers	( )

REMARKS: _____

WITNESSED BY : _____ UNIT RELEASED BY : ROY GARZA DATE: 6/8/2017

INSPECTED AND RELEASED FOR SHIPMENT BY: _____

HUDSON PRODUCTS CORPORATION
STANDARD VIBRATION TEST

INSTRUMENT USED : BALMAC MODEL 211 # 0201001 JOB NO. S17430

CALIBRATION DATE: 10/17/2017 SERIAL NO. S17430 - 11A -A - 1

TEST SPECIFICATION: NO API - 661 ITEM NO. A - 301

TEST PERFORMED BY: ROY GARZA DATE : 5/17/2017

WITNESSED BY : MOTOR AMP RATING : 36

NOZZLE / INLET END		RETURN / OUTLET END	
# 1.	1.0 MILS.	# 6.	.6 MILS.
# 2.	1.8 MILS.	# 7.	.6 MILS.
# 3.	.4 MILS.	# 8.	.6 MILS.
# 4.	.4 MILS.	# 9.	1.2 MILS.
# 5.	.8 MILS.	#10.	1.4 MILS.

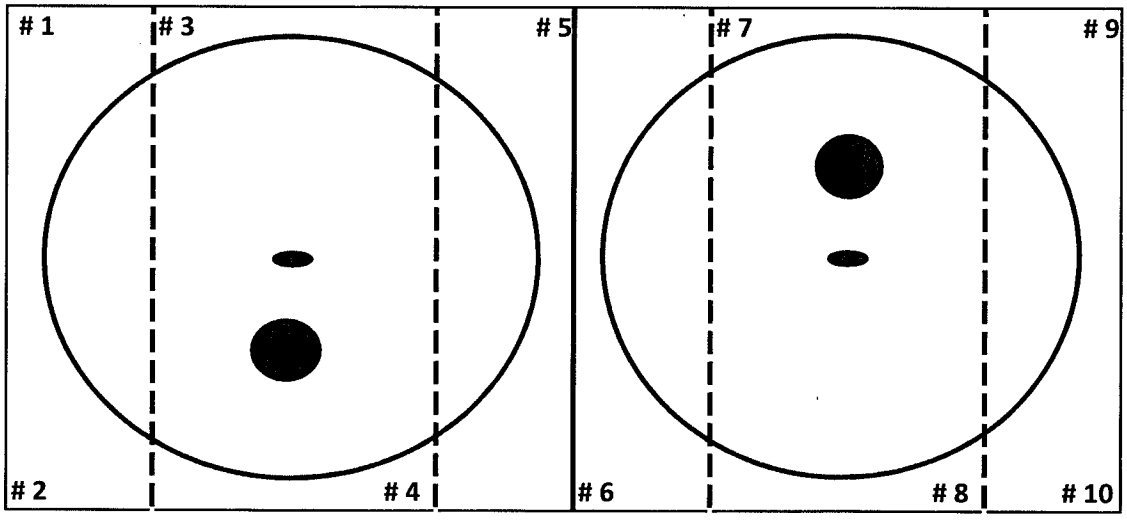
ACTUAL AMP READINGS

27.71 / 25.50 / 28.00

ACTUAL AMP READINGS

25.10 / 25.78 / 25.82

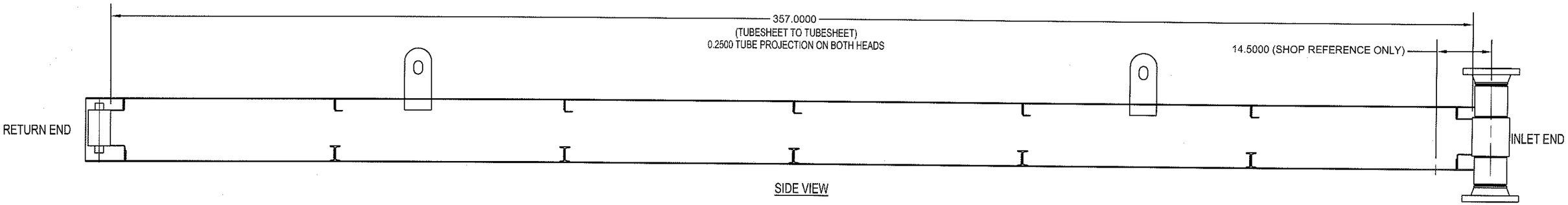
NOZZLE OR INLET END



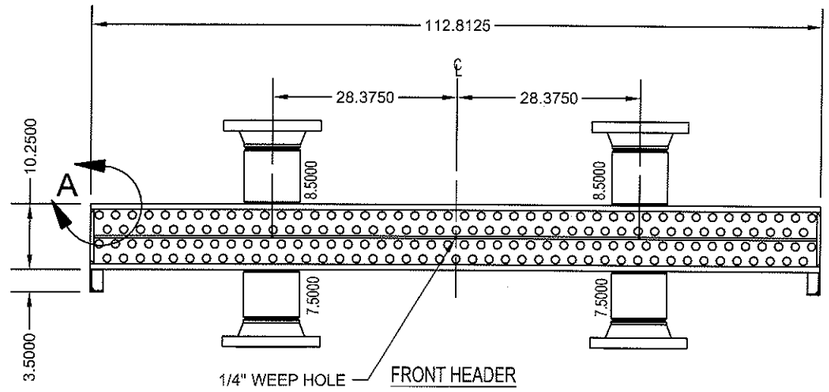
RETURN OR OUTLET END

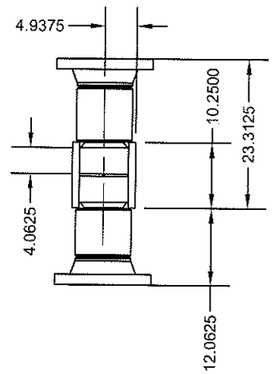
Nozzle or Inlet End db's	Back Ground db's	Return or Outlet End db's
N/A	N/A	N/A

SECTION 7. FABRICATION DRAWINGS

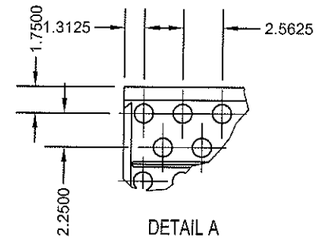


SIDE VIEW

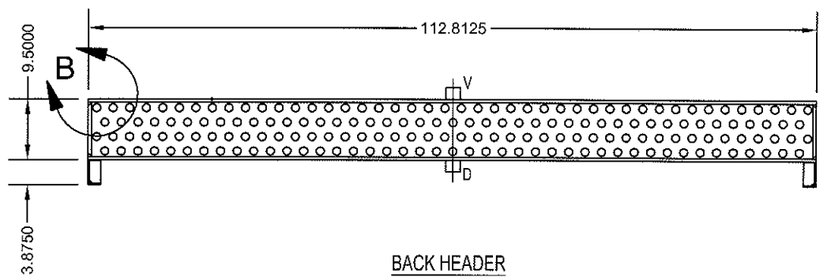




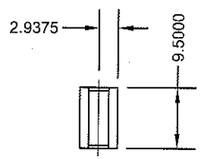
OUT TO OUT OF SIDEFRAMES = 113.6875 in



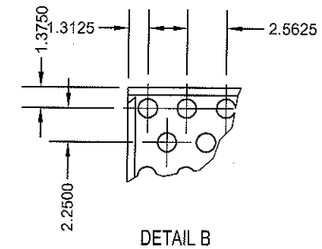
DETAIL A



BACK HEADER



TUBE SHEET SIDE



DETAIL B

PROJECT NETWORK: J447

REV 0: FINAL CERTIFIED JC 1-19-2017

MACHINING	DRILL	REAM	SPECIAL
TUBE HOLE:	1.1875	1.261 ± 0.003	DG
PLUG HOLE:	1.2812 SF	1.6250 TAP	1.3750

NOZZLE: IN (2) 8 - 300 # RF SCH XS
OUT (2) 8 - 300 # RF SCH XS
VENT: (1) 1-6000
DRAIN: (1) 1-6000

WEIGHT: 2500

	THICK	LENGTH	WIDTH	BEVELS
FRONT TUBE PLUG	1.1250	112.8125	10.2500	NONE
FRONT COVER	0.8750	112.8125	7.3125	LONG SIDES
FRONT END	0.5000	7.3125	8.1875	ALL SIDES
FRONT STAY	0.3750	111.8125	7.6250	DBAS
REAR TUBE PLUG	1.3750	112.8125	9.5000	NONE
REAR COVER	0.5000	112.8125	3.1250	NONE
REAR END	0.5000	2.8125	8.1875	ALL SIDES

MATERIAL SPECIFICATIONS
PLATE: SA-516 GR70 NORM
FLG: SA-105
PIPE: SA-106B
CPLG: SA-105

PLATE TOLERANCES: +.0000"/ -.1250

TUBES 174 TF 44 ROWS 4 PASS 2 LGTH 360 IN.
TUBE OD 1.2500 X 0.060 MATL SA-214 WLD
FIN TYPE L-TENSION 10 - 0.625 - ALUM
FRONT PLUG QTY: 174 TYPE A105-2222 GASKET: CS-2213
REAR PLUG QTY: 174 TYPE A105-2222
EXPANDER: 1.1300 LENGTH: 12.0000
FRAME THICK: 0.1875
LENGTH: 370.0000 IN. DEPTH: 16.7500 IN. X 3.0000 IN.
SUPPORT: 5 BINDER: 5 CLOSER: 4 112.4375
SUPPORT TYPE: SCALLOPED CHANNEL
F.FOOT: 6" X 3.5000 B.FOOT: 6" X 3.8750

TEST PRESSURE: 650 TIME: 60 MIN. W/ CHART
HEADS: WHITE METAL BLAST CLEAN
WITH 1 COAT METALIZE
FRAME: HAND TOOL CLEAN
WITH 1 COAT GALVANIZE
COIL VOLUME: 42 CUBIC FEET
DESIGN TEMP: 250 F
DESIGN PRESSURE: 500 Psig
MDMT: -20 F
CORROSION ALLOWANCE: 0.0625

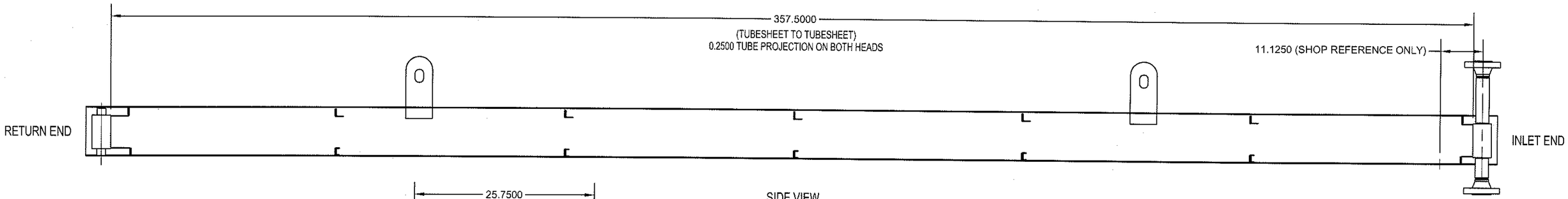
CERTIFIED FINAL: JCHAPMAN DATE: 1-19-2017

AIR COOLED DIVISION
BUNDLE DETAILS

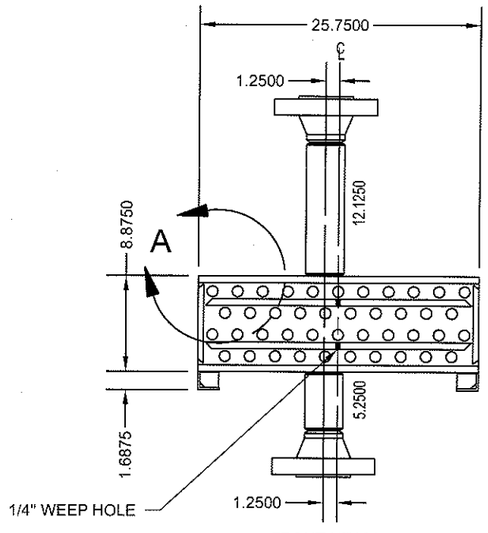
ENG: JC	REV: 0	1-19-2017

SERVICE: EXPANDER/COMPRESSOR A/C
ITEM: A-301
PO#: 4500753943

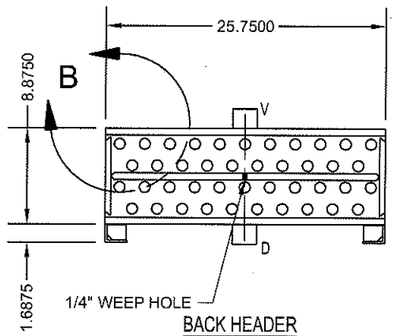
QTY: 1	WEIGHT: 12200	2017B430-1



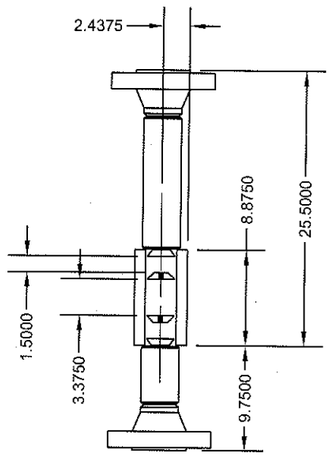
SIDE VIEW

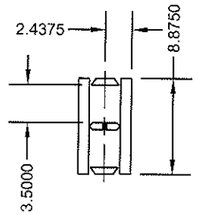


FRONT HEADER

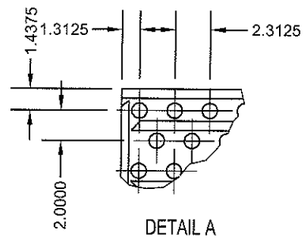


BACK HEADER

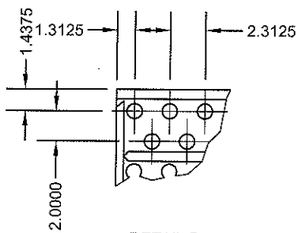




OUT TO OUT OF SIDEFRAMES = 26.6250 in



DETAIL A



DETAIL B

TUBE SHEET SIDE

PROJECT NETWORK: J447

REV 0: FINAL CERTIFIED JC 1-19-2017

MACHINING	DRILL	REAM	SPECIAL
TUBE HOLE:	0.9375	1.010 ± 0.002	DG
PLUG HOLE:	1.0312 SF	1.3750 TAP	1.3750

NOZZLE: IN (1) 3 - 900 # RJ SCH XS
OUT (1) 3 - 900 # RJ SCH XS
VENT: (1) 1-6000
DRAIN: (1) 1-6000

WEIGHT: 500

	THICK	LENGTH	WIDTH	BEVELS
FRONT TUBE PLUG	1.0000	25.7500	8.8750	NONE
FRONT COVER	0.6250	25.7500	2.5625	LONG SIDES
FRONT END	0.5000	2.5625	7.3125	ALL SIDES
FRONT STAY	0.6250	24.4375	2.5625	ALL SIDES
REAR TUBE PLUG	1.0000	25.7500	8.8750	NONE
REAR COVER	0.6250	25.7500	2.5625	LONG SIDES
REAR END	0.5000	2.5625	7.3125	ALL SIDES
REAR STAY	0.6250	24.7500	2.8750	DBAS

MATERIAL SPECIFICATIONS
PLATE: SA-516 GR70 NORM
FLG: SA-105
PIPE: SA-106B
CPLG: SA-105

PLATE TOLERANCES: +.0000"/ -.1250

TUBES 42 TF 11 ROWS 4 PASS 4 LGTH 360 IN.
TUBE OD 1.0000 X 0.083 MATL SA-214 WLD
FIN TYPE L-TENSION 10 - 0.625 - ALUM
FRONT PLUG QTY: 42 TYPE A105-1822
REAR PLUG QTY: 42 TYPE A105-1822 GASKET: CS-1813
EXPANDER: 0.8340 LENGTH: 8.0000
FRAME THICK: 0.1875
LENGTH: 370.5000 IN. DEPTH: 13.0000 IN. X 3.0000 IN.
SUPPORT: 5 BINDER: 5 CLOSER: 4 25.3750
SUPPORT TYPE: SCALLOPED CHANNEL
F.FOOT: 6" X 1.6875 B.FOOT: 6" X 1.6875

TEST PRESSURE: 1872 TIME: 60 MIN. W/ CHART
HEADS: WHITE METAL BLAST CLEAN
WITH 1 COAT METALIZE
FRAME: HAND TOOL CLEAN
WITH 1 COAT GALVANIZE
COIL VOLUME: 5 CUBIC FEET
DESIGN TEMP: 200 F
DESIGN PRESSURE: 1440 Psig
MDMT: -20 F
CORROSION ALLOWANCE: 0.0625

CERTIFIED FINAL: JCHAPMAN DATE: 1-19-2017

AIR COOLED DIVISION
BUNDLE DETAILS
ENG: JC | REV: 0 | 1-9-2017

SERVICE: NGL PROD COOLER
ITEM: A-302
PO#: 4500753943

QTY: 1 | WEIGHT: 3500 | 2017B430-2

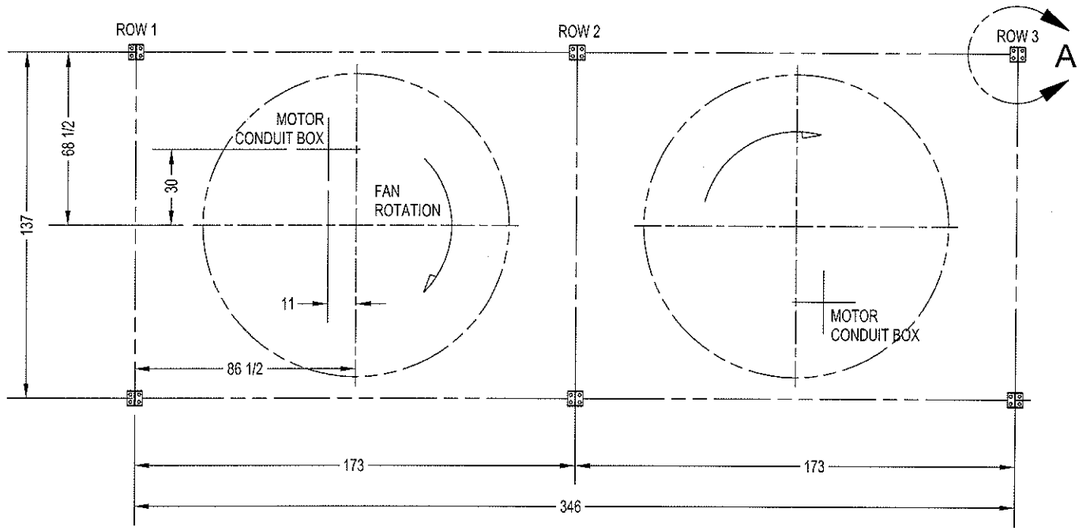
DRY WGHT 27200 WIND 43.0 PSF / 120 MPH SEISMIC 1 PLATFORM 50 LBS / SQ-FT LIVE

COLUMN LOAD KIPS	DRY DEAD	WET DEAD	WIND VERT	WIND HORIZ	SEIS VERT	SEIS HORIZ	SNOW	PLAT	NOZZ VERT	NOZZ HORIZ	TOTAL
ROW 1 / COLUMN	3.2	3.6	1.1	0.7	0.4	0.3	0.0	0.0	0.0	0.0	4.8
ROW 2 / COLUMN	6.4	7.3	2.2	1.5	0.5	0.5	0.0	0.0	0.0	0.0	9.5
ROW 3 / COLUMN	3.2	3.6	1.1	0.7	0.4	0.3	0.0	0.0	3.4	2.2	8.1

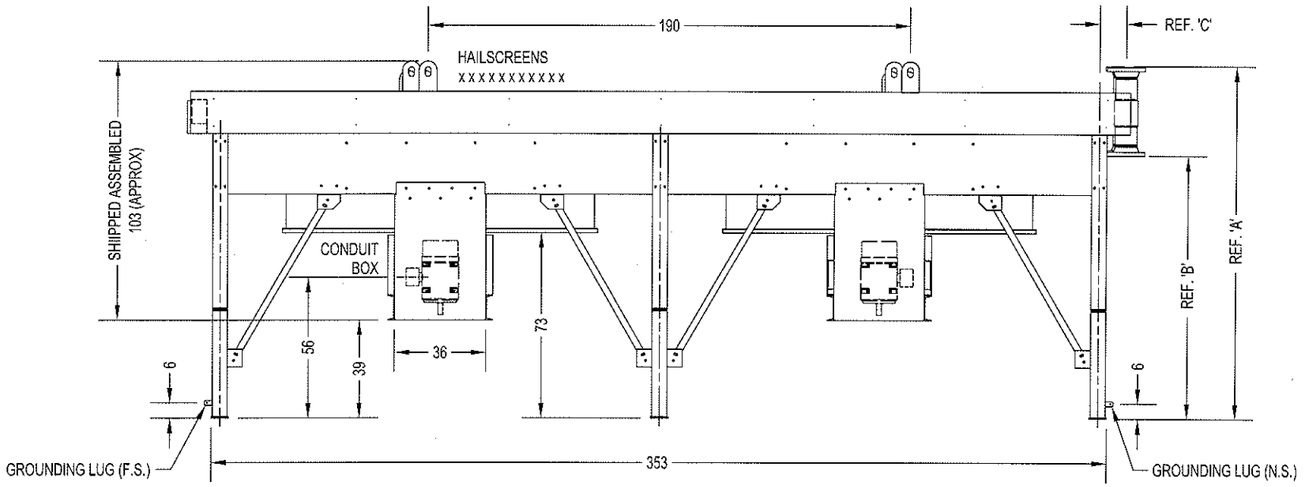
FAN COFIMCO 3048-5-24L/B3T
120 IN. DIAMETER 5 BLADE
135900 ACFM 7.3 DEG.
DRIVE REDUCER
BELTS (3) 5V - 1250
SHEAVES FAN 31.5 MOTOR 6.3
BEARINGS 2.4375 IN.
SHAFTS 2.4375 IN.

MOTOR HP 30.0 RPM 1750
286T TEFC
INSULATION CLASS F / B TEMP RISE
460 / 3 / 60 SINGLE WINDING VARIABLE TORQUE
AMPS (±10%) FLA 36 LRA 218
VIBRATION TRANS. METRIX ST5484E-122-120

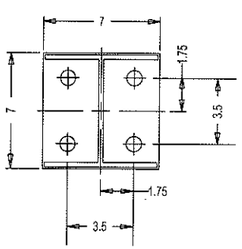
SHOP RUN IN TEST



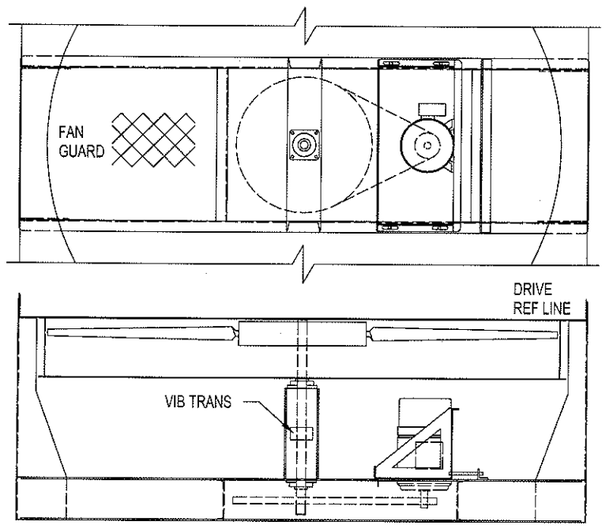
ANCHOR BOLT PLAN



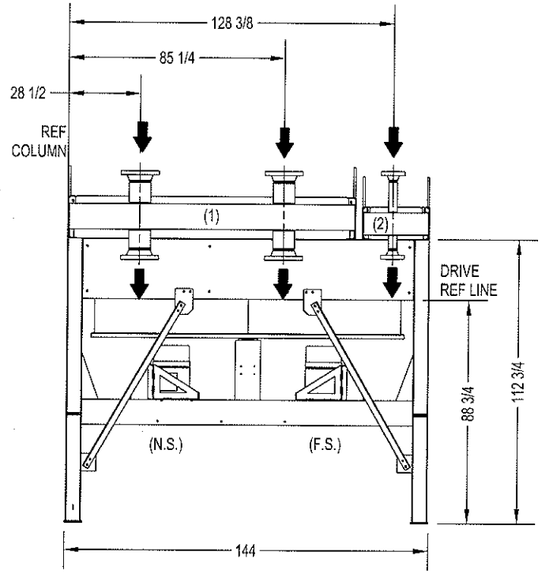
SIDE VIEW



DETAIL A



FAN & DRIVE DETAIL
ONE THUS & ONE REVERSE



END VIEW

PROJECT NETWORK: J447

	ITEM	SERVICE	NOZZLES INLET	OUTLET	REFERENCE DIMENSIONS A	B	C	D	BUNDLE WEIGHT	COUPLINGS V&D	TEMP	PRESS	SHUTTER OPERATOR	HAIL SCRN	CODE	DESIGN PRESS.
1	A-301	EXPANDER/COMPRESSOR AFTER-COOLER	(2) 8.00 - 300 # RF SCH XS	(2) 8.00 - 300 # RF SCH XS	139.750	104.375	10.500		12020	1-6000			NONE	YES	NATL	500
2	A-302	NGL PRODUCT COOLER	(1) 3.00 - 900 # RJ SCH XS	(1) 3.00 - 900 # RJ SCH XS	140.125	104.875	7.125		2967	1-6000			NONE	YES	NATL	1440

REV 0: CERTIFIED FINAL JC 1-19-2017

TOLERANCES: (ALL DIMENSIONS IN INCHES)
MECHANICAL EQUIPMENT: ± 1/8" PER 10'-0"
NOZZLE: ± 1/8"
STRUCTURAL - HAND TOOL CLEAN WITH 1 COAT GALVANIZE
FRAME - HAND TOOL CLEAN WITH 1 COAT GALVANIZE
HEADER - WHITE METAL BLAST CLEAN WITH 1 COAT METALIZE

CUSTOMER: UOP RUSSELL
LOCATION: UNKNOWN
REFERENCE: 4500753943

CERTIFIED BY: JCHAPMAN | CERT DATE: 1-19-2017

SMITHCO
AIR COOLED DIVISION
TULSA, OKLAHOMA

PIPING, EQUIPMENT OUTLINE & ANCHOR BOLT PLAN
MODEL 1 F 30 - 119 - 2 QUANTITY 1

DWN: JC | CKD: | DATE: 1-19-2017

REV: 0 | REF JOB: 2016B386 | JOB: 2017B430 - A

FINAL INSTALLATION, OPERATION, AND MAINTENANCE (I.O.M.) MANUAL

SMITHCO JOB NUMBER: 2017B430

CUSTOMER: UOP RUSSELL

PO#: 4500753943
UOP Russell Project: J447XX
Item#: A-301 / A302
NGL Prod Cooler / Expander Compressor Aftercooler

Date: 24-Jun-17
Project Doc#: S17430-IOM1

Smithco Engineering
6312 S. 39th West Ave., Tulsa, OK 74132
(918) 446-4406
www.smithco-eng.com

REV	REV DATE	DESCRIPTION
0	24-Jun-2017	Issued Final

SMITHCO ENGINEERING, INC.

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

VERSION 10/21/13

SMITHCO

TABLE OF CONTENTS

CERTIFICATE OF AUTHORIZATION

U

The named company is authorized by the American Society of Mechanical Engineers (ASME) for the scope of activity shown below in accordance with the applicable rules of the ASME Boiler and Pressure Vessel Code. The use of the certification mark and the authority granted by this Certificate of Authorization are subject to the provisions of the agreement set forth in the application. Any construction stamped with this certification mark shall have been built strictly in accordance with the provisions of the ASME Boiler and Pressure Vessel Code.

COMPANY:

Smithco Engineering, Inc.
6211 S. 39th W. Avenue
Tulsa, Oklahoma 74132

SCOPE:

Manufacture of pressure vessels at the above location only

AUTHORIZED:	**December 5, 2014**
EXPIRES:	**February 28, 2018**
CERTIFICATE NUMBER:	**4,175**

Vice President, Conformity Assessment

Director, Conformity Assessment

The American Society of Mechanical Engineers

THE NATIONAL BOARD

OF

BOILER & PRESSURE VESSEL INSPECTORS

Certificate of Authorization

This is to certify that

SMITHCO ENGINEERING, INC.
6211 S. 39TH W. AVE.
TULSA, OKLAHOMA 74132
UNITED STATES

is authorized to use the "R" SYMBOL in accordance with the provisions of the National Board.

The scope of Authorization is limited as follows:

METALLIC REPAIRS AND/OR ALTERATIONS AT THE ABOVE LOCATION AND EXTENDED FOR FIELD REPAIRS AND/OR ALTERATIONS CONTROLLED BY THIS LOCATION

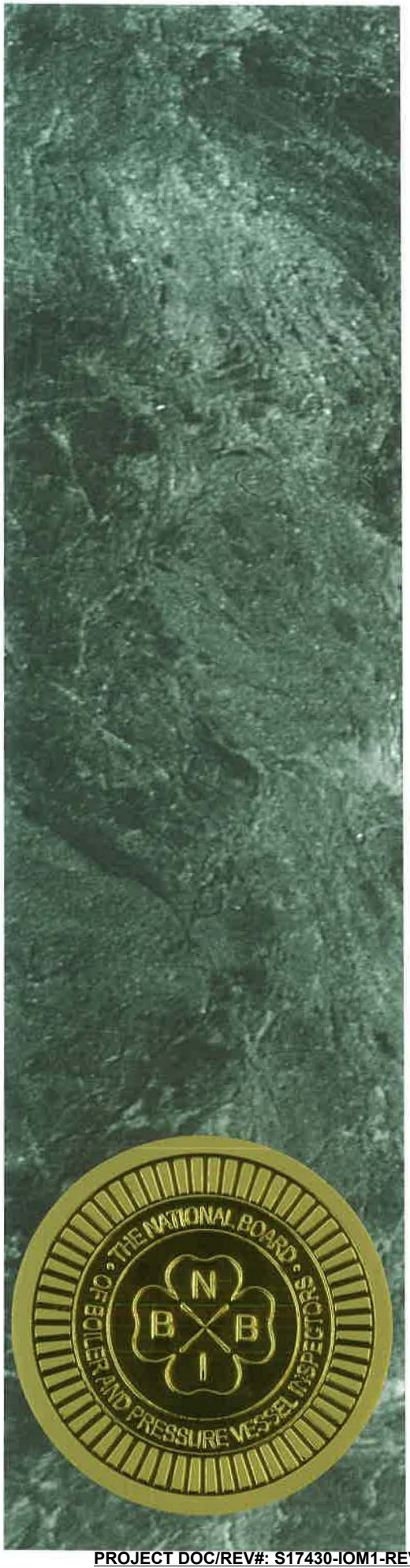
CERTIFICATE NUMBER: **R-2244**

ISSUE DATE: **JANUARY 26, 2015**

EXPIRATION DATE: **FEBRUARY 28, 2018**

Executive Director

NB 243 Rev. 4



THE NATIONAL BOARD
OF
BOILER & PRESSURE VESSEL INSPECTORS

Certificate of Authorization to Register

This is to certify that

SMITHCO ENGINEERING, INC.
6211 S. 39TH W. AVENUE
TULSA, OK 74132

is authorized to apply the "NB" mark and register boilers, pressure vessels or other pressure retaining items with the National Board.

The scope of Authorization is limited to items manufactured in accordance with:

ASME Designator(s): U

ISSUE DATE: January 28, 2015

This Certificate of Authorization to Register will remain in effect as long as the manufacturing organization holds a valid Certificate of Authorization issued by the American Society of Mechanical Engineers.

Executive Director

NB 137 Rev. 9

SECTION (1)

INTRODUCTION

SHIP LIST

CERTIFIED
APPROVED FOR FABRICATION
09-Mar-2017
SMITHCO ENGINEERING

Ship To:

UOP RUSSELL
5380 ARKANSAS ROAD
PORT OF CATOOSA, OK
ATTN:

Date: 4/25/2017
Job #: 2017B430
Cust. PO: 4500753943
Shipped Via:

Item #	Qty	Description	Weight(lbs)
1		SMITHCO Model 1 F30-119-2 Air Cooled Heat Exchanger	27,200

UNIT DESCRIPTION: Size(ft)(Length x Width x Height) 31.5 x 11.9 x 8.8 — Weight(lbs) 26,420

TIMBER: (3) 8 X 8 X 146

LOOSE STRUCTURE:
Note: Stubbed Columns

101	2	BOTTOM LEFT COLUMN	{ W 6.00 x 15 x 47}	140
106	2	BOTTOM RIGHT COLUMN	{ W 6.00 x 15 x 47}	140
111	2	BOTTOM CENTER COLUMN	{ W 6.00 x 15 x 47}	150
131	6	END COLUMN BRACE	{ L 2.50 x 0.25 x 75}	150
136	8	SIDE COLUMN BRACE	{ L 2.50 x 0.25 x 75}	200

LOOSE BOLTS:

292	62	BOLT, NUT, LOCK & (2) FLATS 5/8" X 2" A-325 GALV.
293	28	BOLT, NUT, LOCK & (2) FLATS 5/8" X 2 1/2" A-325 GALV.

LOOSE PARTS:
2) METRIX ST5484E-122-120 VIBE TRANSMITTER

REV 1: ADDED TRANSMITTERS JJ 3/9/17

REV 1: CHANGED COLUMN WEIGHTS JJ 1/23/17
REV 2: ADDED VIBE TRANSMITTER JJ 3/7/17

RECEIVING THE EQUIPMENT

The **SMITHCO** Air Cooled Heat Exchanger should be inspected thoroughly by receiving personnel. Check the columns, fan drive support, plenum panels, fan ring and guard, and cooling sections for damage. Any damage in transit must be noted on receiving documents presented by the carrier. Prompt claim filing will expedite compensation from the carrier.

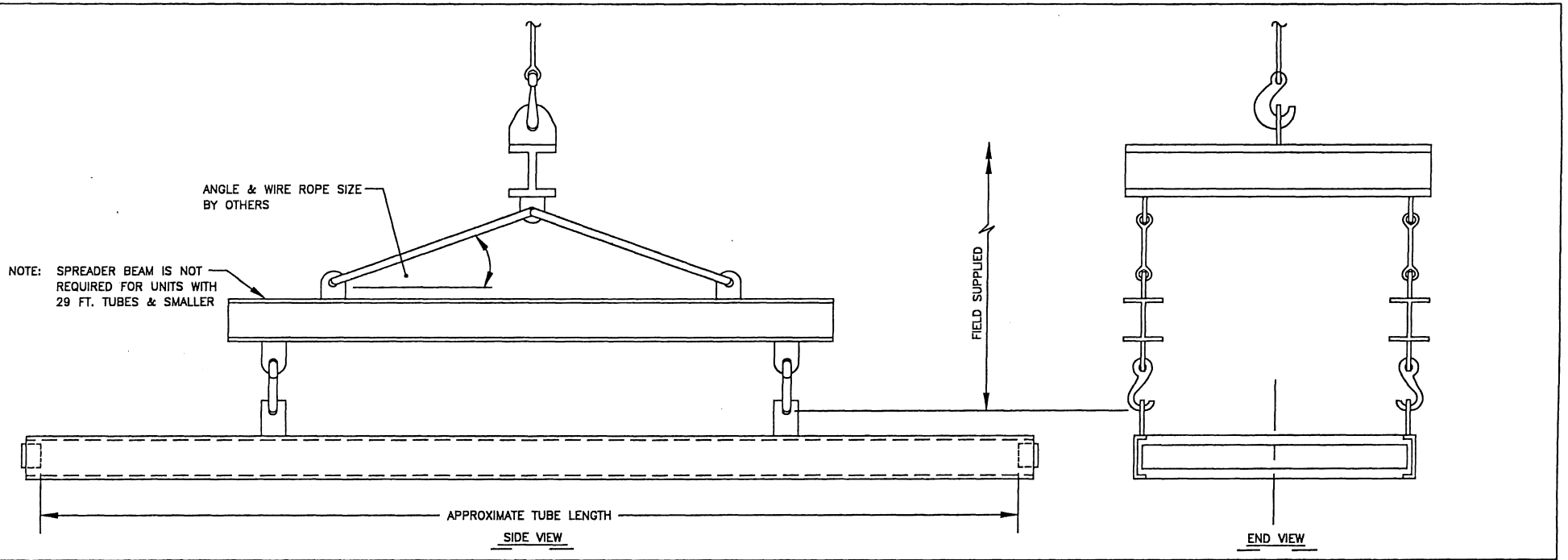
The base unit is a shop assembled cooling unit. The columns, braces, walkway supports, and walkways may be shipped disassembled due to shipping limitations. The ship loose parts will normally be secured on the trailer with the base unit or may require additional trailer(s), depending on the size and extent of these items.

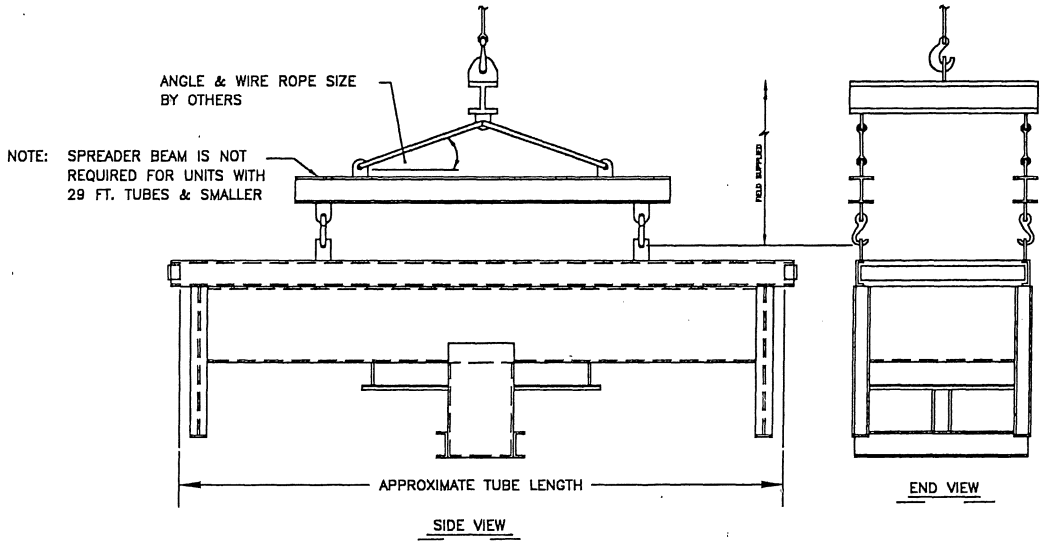
Included with the shipping documents is a Shipping List. This document lists all ship loose items with the part number or piece mark number shown as the Item #. Each ship loose item should be counted and marked as received.

To enable assembly of the components, the appropriate assembly instructions will accompany the shipment.

Attached:

1. Shipping List
2. General Storage Recommendations
3. Lifting Details





FOR INFORMATION ONLY
NOT FOR REVIEW

SMITHCO
ENGINEERING, INC.
Tulsa, Oklahoma

COIL SECTION & STRUCTURE
LIFTING DETAIL

DWN KIM	CKD -------	DATE 10/12/92
JOB NO. STD.		DWG NO. A-1000
REVISION 0		F

COIL SECTION & STRUCTURE LIFTING DETAIL

Serving the Industry Since 1952
Member of HTRI & ACHEMA

SMITHCO ENGINEERING, INC.

P.O. BOX 571330
TULSA, OK 74157
PHONE: (918) 446-4406
FAX: (918) 445-2857

SHORT TERM AND LONG TERM STANDBY RECOMMENDATIONS

Shut down periods of an air cooled heat exchanger for an extended period of time can cause serious damage to some components under almost any conditions. Shut down in a wet or humid atmosphere can cause condensate to damage the electric motors, bearings, and unprotected machined surfaces. Drive belts can be damaged by extended exposure to either wet or dry conditions. The terms of shut down as shown below are general and based on moderate conditions. If the shut down is on a coastal or tropical area, the conditions will require a higher level of protection for even a short storage period.

Shut Down Period — 1 Month or Less
If the unit will be idle for a period longer than one week, it will be necessary to run the unit for ten minutes every week it is idle. This short operation will keep the gears and bearings coated with oil and prevent rusting due to condensation of moisture resulting from temperature changes.

Shut Down Period — 1 to 6 Months (Moderate Conditions)

1. Nozzles covered and sealed with tape.
2. Drive belts relieved of tension.
3. Motors covered (shrink wrap and add desiccant bags) to protect against weather.
4. Plywood covers on fin tube bundle to avoid damage to the fins.
5. Coat all exposed machined surfaces with rust inhibiting preservative.
6. Rotate the fan and motor shafts by hand every 60 days (maximum) to circulate lubricant and avoid "brinelling" the bearings.
7. Parts such as vibration switches, louver actuators, and all other parts boxed separately should be properly marked and stored indoors in an area designated for the cooler.

Shut Down Period — 6 Months or longer (Moderate Conditions)

1. Nozzles — Install gaskets and seal with metal covers or blind flanges.
2. Nitrogen purge of bundle to retard corrosion. Check the purge pressure every week and recharge as necessary to maintain 5 to 15 psi pressure.
3. Remove motors and drives from unit and store inside a humidity controlled building.
4. If the electric motors have internal space heaters, they can be connected to power continuously to avoid condensate in the motors.
5. Plywood covers on fin tube bundle to avoid damage to the fins.
6. Coat all exposed machined surfaces with rust inhibiting preservative.
7. Rotate the fan and motor shafts by hand every 60 days (maximum) to circulate lubricant and avoid "brinelling" the bearings.
8. Parts such as vibration switches, louver actuators, and all other parts boxed separately should be properly marked and stored indoors in an area designated for the cooler.

The above are recommendations only. All or part of the recommendations may be selected depending on length of shut down and weather conditions at the site. You are advised to document all steps taken to protect the components during storage should a warranty issue arise at a later date. These recommendations are made with the understanding that Smithco assumes no responsibility for deterioration on any part of the equipment due to corrosion or erosion, when such deterioration occurs after leaving Smithco premises.

SECTION (2)

INSTALLATION

PREPARING FOR START UP

1. FIELD ASSEMBLED COMPONENTS

Structural components requiring field assembly are to be assembled per the drawing furnished. All parts are marked with a piece mark and the drawing shows the location of the part by piece mark number.

After Assembly:
Check all bolts (including shop assembled unit) to confirm they are tightened.
Remove any protective plywood panels from the top of the tube bundles.
Remove any restraint used to keep the fan from rotating during transport.

2. BEARINGS

Rotate the fan by hand to confirm that the shaft, bearings, speed reducer and driver turn freely.

Remote lubrication lines should be disconnected at the bearing, and then purged with grease from the fitting end. Reconnect the lube line at the bearing. This will ensure that the lube lines are full of grease and free of air and debris.

Check bearing flange bolts and set screws and tighten if necessary.

3. ELECTRIC MOTORS

Remove the condensate drain plug from each motor to drain any condensate that may have accumulated during storage. If space heaters are provided in the electric motors, activate them approximately 24 hours before starting the equipment.

4. V-BELT DRIVES

Check V-Belt tension in accordance with V-Belt tensioning in the Maintenance section of this manual.

5. GEAR BOX

Check gearbox for oil. Some gearboxes are shipped with no oil and must be filled and serviced per the Maintenance section of this manual.

6. LOUVERS

Check all louvers for ease of movement prior to operation. If they do not operate freely, loosen the frame mounting bolts and adjust the frame until the louvers move freely. Retighten the bolts.

Check all mounting brackets and bolts for tightness.

Check the operation of manually operated louvers by moving the manual operator from full open to full closed several times to confirm proper linkage adjustment. To check the operation of air motor operated (automatic) louvers, disconnect the actuator linkage and move the blades by hand. When operating correctly, retighten the bolts and reconnect the actuator. Check air supply line fittings for tightness and operate the air motor with air at the operating pressure to confirm proper linkage adjustment and the louvers operate freely with the specified air supply.

7. FLOATING HEADER BOLTS TO BE REMOVED PRIOR TO BEING PUT IN SERVICE.

If the bundle has an even number of passes, bolts attaching return header(s) to sideframes must be removed. If the bundle has an odd number of passes, the bolts attaching the outlet header to the sideframes must be removed. In either case, the bolts must be removed before the unit is put into service to allow thermal expansion of the tubes.

Failure to remove these bolts may result in serious damage to the bundle. See attached drawing.

8. FANS

The fan must be checked for adequate fan blade tip clearance. Move the blades around the inside of the fan ring and observe where blades have the least amount of clearance. The fan tip clearance should be approximately 1/2" for fans up to 9ft. Dia., 5/8" for fans 9 ft to 11 ft. Dia., 3/4" for fans 11 ft. Dia. and larger.

Confirm the fan blade pitch setting. Looking into the end of the fan blade, the leading edge of the blade should be down and to the left. See the maintenance section for vendor instructions to set the blade pitch.

9. HYDROSTATIC TEST

SMITHCO tube bundles are hydrostatically tested at 1.3 times the design pressure before being released for shipment. To ensure that no damage has occurred during shipment and/or erection, it is good practice to hydrostatically test the entire system, including piping, heat exchangers, pumps, etc., prior to start-up. Do not use water to hydrostatically test Oil Coolers. Movement during shipment and temperature fluctuations may cause minor seepage at the plug to plug-sheet joint. If this occurs, it will require tightening the plugs. Please contact the factory at the phone number below for advice on how to proceed.

After hydrostatic test, remove the test connections. Completely drain the bundle and, if required, dry it. Connect all process piping and auxiliary connections.

Inspect all process connections as well as vent, drain, temperature and pressure connections to confirm they are plugged or connected properly.

FLOATING HEADER BOLTS TO BE REMOVED PRIOR TO BEING PUT IN SERVICE

Bolts attaching return header to sideframe must be removed prior to this unit being put in service, to allow for thermal expansion of this bundle.

Failure to remove these bolts may result in serious damage to this bundle.

START UP

1. Complete wiring of all electrical components including the motor(s), vibration switch(s), controls, etc. **DO NOT START MOTORS.**

2. ***WARNING! Turn off and lock out or tag power source before proceeding.***

3. Remove all hand tools and debris from the cooler plenum, drive supports, and any area containing components that will be moving when the fan is turning. Any loose debris under or around the unit may be pulled into the fan and should be removed from the area of the unit.

4. **If the unit is equipped with a fan anti windmilling device, it must be disengaged prior to applying power to the electric motors or serious damage could occur.**

5. Install all equipment guards to protect personnel from possible injury.

6. Switch on the fan driver momentarily to check for proper direction of rotation and fan blade orientation. A forced draft horizontal cooler fan should rotate counter-clockwise (left hand rotation) when looking at the air intake of the fan. The fan in an induced draft cooler should rotate clockwise looking at the air discharge of the fan.

7. Re-engage the anti windmilling device if the unit is so equipped.

8. If the starting torque trips the vibration switch turn the adjusting screw located on the right hand side of the vibration switch to the right (clockwise) for a less sensitive setting.

9. When the above steps are completed, start the fans and let then run for several minutes to warm the motors, bearings, etc. The fan should run smoothly and evenly in the fan ring. If there is noticeable vibration in the unit, stop and lock out the motor(s) and check the drive bolting for tightness. If necessary, tighten the bolts. If the vibration persists, check the fan blades for proper pitch and possible damage.

   With the unit running smoothly, the next step is to start the process through the tube bundle(s). The following methods of introducing the process fluid into the bundle should be followed.
   The process start-up should minimize thermal shock to the tube bundle(s) and avoid overcooling critical services during conditions of low ambient temperature and low heat load.

10. Low pour point and low viscosity services should have the process fluid introduced at a low rate and gradually increased to the design flow rate with the fans off. Start the fan(s) one at a time as the process fluid starts to exceed the design operating temperature. Start the fans until all fans are on or the process temperature is at the design operating temperature.

11. High viscosity fluids and fluids with a pour point above the ambient air temperature should have the process fluid introduced rapidly to prevent over cooling the first process liquid to contact the tubes. When the design process flow is reached and the process temperature begins to exceed the design temperature, start the fan(s) one at a time until the process temperature is at the design temperature or all the fans are running.

SECTION (3)

OPERATION

OPERATION

This section of the manual contains drawings and documents specific to this air cooled heat exchanger. Please consult the Maintenance section of this manual for schedules of periodic maintenance.

LIST OF DOCUMENTS IN THIS SECTION (IF APPLICABLE)

1. Specification Sheet
2. Drawings
3. Header Calculations
4. Nozzle Loads
5. Weld Map
6. Vendor Specific Data
    a. Fan Rating, Curves, Noise Data
    b. Motor Data Sheet

OTHER REFERENCE SOURCES

VENDOR WEBSITES:

ELECTRIC MOTORS:	www.reliance.com
	www.sea.siemens.com/motors
FANS:	www.cofimco.com
	www.moorefans.com
FAN SHAFT BEARINGS:	www.dodge-pt.com
V-BELTS:	www.gates.com
	www.dayco.com
VIBRATION SWITCHES:	www.fwmurphy.com
	www.metrix1.com
	www.icca.invensys.com (Robert Shaw)
SPIRAL BEVEL GEAR BOXES:	www.amarillogear.com
	www.hubcityinc.com
LOUVER ACTUATORS AND CONTROLLERS:	www.airtechproducts.com
	www.emersonprocess.com (Fisher Actuators and Controls)
LOUVERS:	www.airtechproducts.com

SPECIFICATION SHEET(S)

SMITHCO Engineering Inc.

P.O. Box 571330 Tulsa, OK 74157
Ph. (918) 446-4406 FAX (918) 445-2857

AIR COOLED EXCHANGER SPECIFICATION SHEET

Date	1/5/2015 REV_0
Proposal/Job No.	17B430-01
Reference	J-447 P.O. 4500753943
Item No.	A-301

Customer	UOP RUSSELL LLC				
Plant Location	UNKNOWN				
Service	EXPANDER/COMPRE AFTE				
Model	1 F30-119-2	Type	FORCED	No. of Bays	1
Surface per Unit-Finned Tube	33,480		Ft^2	Bare Tubes	1,710 Ft^2
Heat Exchanged	2,867,000		BTU/Hr	MTD (Eff.)	21.7 (Counter Flow) °F
Transfer Rate-Finned Tube	3.94	Bare Tube, Service	77.20		BTU/Hr. Ft2 °F

PERFORMANCE DATA-TUBE SIDE

Fluid Name	RESIDUE GAS		Lethal Service Yes [ ] No [X]	IN	OUT
Total Fluid Entering Lb/Hr	102,900		Density Lb/Ft^3	.777	.850
	IN	OUT	Specific Heat (Liq/Vap) BTU/Lb°F	/ .584	/ .571
Temperature °F	168.5	120.0	Cond. avg (Liq/Vap) BTU/HrFt°F	.0236	
Liquid Lb/Hr			Pour/Freeze Point °F		
Vapor Lb/Hr (MW)	102,900 (16.2)	102,900 (16.2)	Bubble Point °F		
Nocond Lb/Hr (MW)			Latent Heat BTU/Lb		
Steam Lb/Hr			Pressure Psia	315.00	
Water Lb/Hr			Pressure Drop Allow/Calc Psi	5.00 / 3.87	
Viscosity (Liq/Vap) Cp	/.013	/.012	Fouling resist, Inside ft^2 hr °F/BTU	0.00100	

PERFORMANCE DATA-AIR SIDE

Air Quantity SCFM	183,300 Lb/Hr 824,800	Altitude Ft	3,000
Air Quantity/Fan ACFM	135,900	Temperature In °F	110.0
		Temperature Out °F	124.4

DESIGN - MATERIAL - CONSTRUCTION

Design Pressure 500 Psig		Test Pressure 650 Psig		Design Temperature 250 / MDMT -20 °F	
TUBE BUNDLE		**HEADER,** Type PLUG BOX		**TUBE** Material SA-214 WLD	
Size 9.5 x 30.0		Material SA-516 GR-70			
No. 1	No. Tube Rows 4	No. Passes 2	Slope 0 In/Ft	OD 1.250 In	Min. Thick 0.0600 In
Bays 1	In Parallel In Series	Plug A1052222		No./Bundle 174	Length 30.0 Ft
Bundles 1	In Parallel In Series	Gasket CS2213		Pitch 2.5625	InΔ
Pass Arrangement (Top to Bottom)		Corrosion Allowance 0.0625 In		FIN Type L-TENSION	
Rows / Pass 4/ 2		Size In Nozzle (2) 8.00 SCH XS SA-106B In		Material ALUM	
Turbulators NO		Size Out Nozzle (2) 8.00 SCH XS SA-106B In		OD 2.500 In	Stock Thick 0.016 In
Steam Coil NO		Rating & Facing 300 -RF SA-105		No/In 10	Support Chan. / Staple
Hailscreens YES		Vent (1) 1-6000	Drain (1) 1-6000	Code-ASME VIII,Div 1 YES	Stamp NATL BD
Louvers NONE (0)		TI	PI	Radiograph N	Heat Treat N
Frame Finish HTC 1 Coat Galvanize		Header Finish WMSB 1 Coat Metalize		Tube Hole Grooving YES	

MECHANICAL EQUIPMENT

FAN Mfg & Model COFIMCO 3048-5-24L/B3T		**DRIVER** Type RELIANCE		**SPEED REDUCER** Type V-BELT	
No./Bay 2	RPM 346	S.F. 1.15	Insul/TR CLASS F / B286	BELTS (3) 5VX -1250.	SHEAVES 31.5/6.3
Dia. 10.0 Ft.	No. Blades 5	No./Bay 2	Frame T HP 30.0	No./Bay 2 Test Run Fan	
Pitch ADJUSTABLE	Angle° 7.3	RPM (2)1750	Duty CHEM	HP Rating 47.1	Ratio 5.06
Matl, Blade ALUMINUM	Hub EXT ALUM	Enclosure TEFC DIV II (P.E.)	V & D V&D	Support: SUSPENDED FROM STRUCTURE	
HP/Fan, Des. 22.3	DBA 85.	V/P/C 460/3/60	Space Heater NO	Vibration Switch METRIX ST5484E-122-120	

STRUCTURE

Mounting GRADE	
Windload - PSF 43.0	Seismic 1
Finish HTC 1 Coat Galvanize	

WALKWAYS

Inlet Header in. None	
Outlet/Return in. None	
Drive Access in. None	

NOTES

Items combined: A-301 A-302

Coil Volume (ft^3): 44.

Assembled Drive, Structure & Bundles (Within Shipping Restrictions)

Plot Area 11.9 x 30.0 ft	Weight Bundle 12,400	Lbs	Total Shipping 30,510	Lbs	

IMPERIAL 4/94

SMITHCO Engineering Inc.

P.O. Box 571330 Tulsa, OK 74157
Ph. (918) 446-4406 FAX (918) 445-2857

AIR COOLED EXCHANGER SPECIFICATION SHEET

Date	1/5/2015 REV_0
Proposal/Job No.	17B430-02
Reference	J-447 P.O. 4500753943
Item No.	A-302

Customer	UOP RUSSELL LLC					
Plant Location	UNKNOWN					
Service	NGL PROD COOLER					
Model		Type	FORCED		No. of Bays	1
Surface per Unit-Finned Tube	6,989			Ft²	Bare Tubes	330.1 Ft²
Heat Exchanged	660,500			BTU/Hr	MTD (Eff.)	18.6 (Counter Flow) °F
Transfer Rate-Finned Tube	5.07	Bare Tube, Service	107.32			BTU/Hr. Ft2 °F

PERFORMANCE DATA-TUBE SIDE

Fluid Name	NGL			Lethal Service	Yes [ ] No [X]	
Total Fluid Entering	Lb/Hr 27,500			Density	Lb/Ft³	IN 29.3 / OUT 31.5
	IN	OUT		Specific Heat (Liq/Vap)	BTU/Lb°F	.718 / .658 /
Temperature	°F 155.0	120.0		Cond. avg (Liq/Vap)	BTU/HrFt°F	.0439/
Liquid	Lb/Hr 27,500	27,500		Pour/Freeze Point	°F	
Vapor	Lb/Hr (MW)			Bubble Point	°F	
Nocond	Lb/Hr (MW)			Latent Heat	BTU/Lb	
Steam	Lb/Hr			Pressure	Psia	745.00
Water	Lb/Hr			Pressure Drop Allow/Calc	Psi	5.00 / 4.48
Viscosity (Liq/Vap)	Cp .08580 /	.09990 /		Fouling resist, Inside	ft² hr °F/BTU	0.00100

PERFORMANCE DATA-AIR SIDE

Air Quantity	SCFM 45,860	Lb/Hr 206,400	Altitude	Ft	3,000
Air Quantity/Fan	ACFM .0		Temperature In	°F	110.0
			Temperature Out	°F	123.3

DESIGN - MATERIAL - CONSTRUCTION

Design Pressure	1,440 Psig	Test Pressure	1,872 Psig	Design Temperature	200 / MDMT -20 °F		
TUBE BUNDLE		**HEADER,** Type	PLUG BOX	**TUBE** Material	SA-214 WLD		
Size	2.2 x 30.0	Material	SA-516 GR-70				
No. 1	No. Tube Rows 4	No. Passes 4	Slope 0 In/Ft	OD	1.000 In	Min. Thick	0.0830 In
Bays 1	In Parallel In Series	Plug	A1051822	No./Bundle	42	Length	30.0 Ft
Bundles 1	In Parallel In Series	Gasket	CS1813	Pitch	2.3125		InΔ
Pass Arrangement (Top to Bottom)		Corrosion Allowance	0.0625 In	FIN Type	L-TENSION		
Rows / Pass	4/ 4	Size In Nozzle	(1) 3.00 SCH XS SA-106B In	Material	ALUM		
Turbulators	NO	Size Out Nozzle	(1) 3.00 SCH XS SA-106B In	OD	2.250 In	Stock Thick	0.016 In
Steam Coil	NO	Rating & Facing	900 -RJ SA-105	No/In	10	Support	Chan. / Staple
Hailscreens	YES	Vent	(1) 1-6000 Drain (1) 1-6000	Code-ASME VIII,Div 1	YES	Stamp	NATL BD
Louvers	NONE (0)	TI	PI	Radiograph	N	Heat Treat	N
Frame Finish	HTC 1 Coat Galvanize	Header Finish	WMSB 1 Coat Metalize	Tube Hole Grooving	YES		

MECHANICAL EQUIPMENT

FAN Mfg & Model			**DRIVER** Type			**SPEED REDUCER** Type	
No./Bay		RPM	S.F.	Insul/TR			
Dia.	Ft.	No. Blades	No./Bay	Frame	HP	No./Bay	
Pitch		Angle°	RPM		Duty	HP Rating	Ratio
Matl, Blade		Hub	Enclosure		V & D	Support:	
HP/Fan, Des.	DBA		V/P/C		Space Heater	Vibration Switch	

STRUCTURE

Mounting	
Windload - PSF	Seismic
Finish	

WALKWAYS

Inlet Header	in.
Outlet/Return	in.
Drive Access	in.

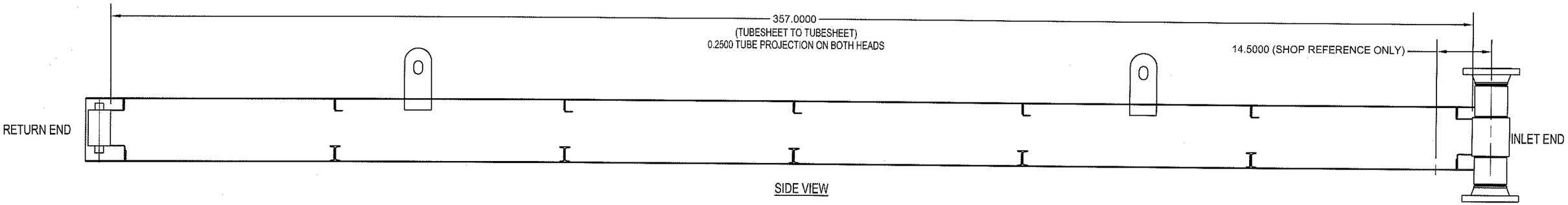
NOTES

Coil Volume (ft^3): 6.

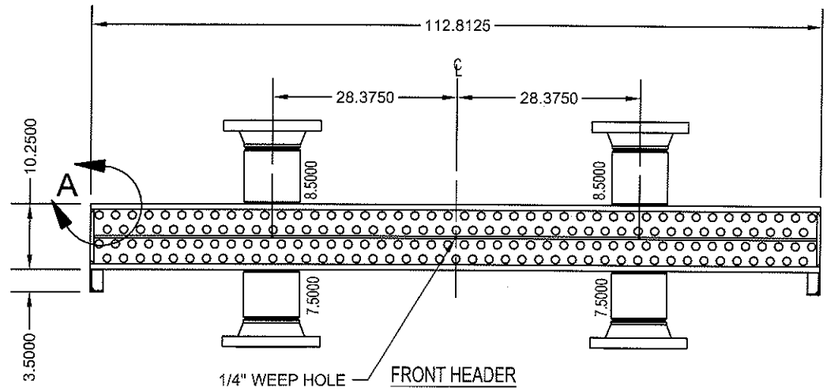
Plot Area	ft	Weight Bundle 3,626	Lbs	Total Shipping 30,510	Lbs

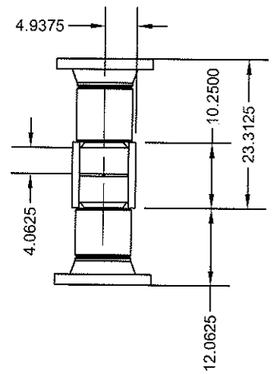
IMPERIAL 4/94

DRAWINGS



SIDE VIEW





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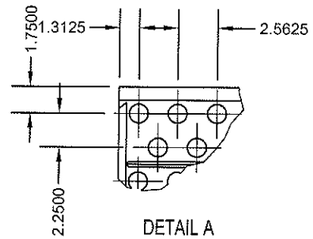
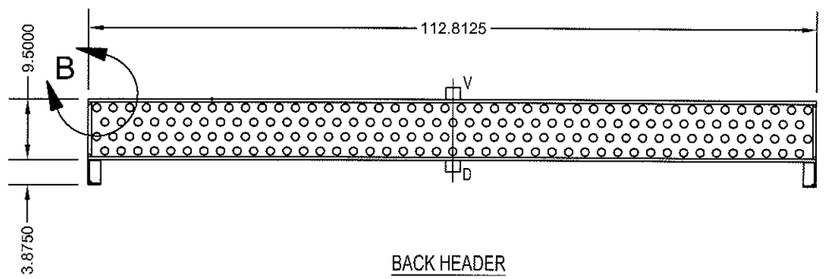
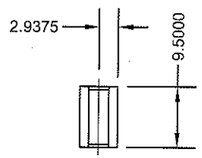


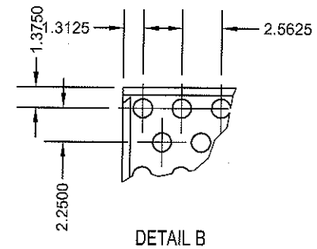
DETAIL A



BACK HEADER



TUBE SHEET SIDE



DETAIL B

PROJECT NETWORK: J447

REV 0: FINAL CERTIFIED JC 1-19-2017

MACHINING	DRILL	REAM	SPECIAL
TUBE HOLE:	1.1875	1.261 ± 0.003	DG
PLUG HOLE:	1.2812 SF	1.6250 TAP	1.3750

NOZZLE: IN (2) 8 - 300 # RF SCH XS
OUT (2) 8 - 300 # RF SCH XS
VENT: (1) 1-6000
DRAIN: (1) 1-6000

WEIGHT: 2500

	THICK	LENGTH	WIDTH	BEVELS
FRONT TUBE PLUG	1.1250	112.8125	10.2500	NONE
FRONT COVER	0.8750	112.8125	7.3125	LONG SIDES
FRONT END	0.5000	7.3125	8.1875	ALL SIDES
FRONT STAY	0.3750	111.8125	7.6250	DBAS
REAR TUBE PLUG	1.3750	112.8125	9.5000	NONE
REAR COVER	0.5000	112.8125	3.1250	NONE
REAR END	0.5000	2.8125	8.1875	ALL SIDES

MATERIAL SPECIFICATIONS
PLATE: SA-516 GR70 NORM
FLG: SA-105
PIPE: SA-106B
CPLG: SA-105

PLATE TOLERANCES: +.0000"/ -.1250

TUBES 174 TF 44 ROWS 4 PASS 2 LGTH 360 IN.
TUBE OD 1.2500 X 0.060 MATL SA-214 WLD
FIN TYPE L-TENSION 10 - 0.625 - ALUM
FRONT PLUG QTY: 174 TYPE A105-2222 GASKET: CS-2213
REAR PLUG QTY: 174 TYPE A105-2222
EXPANDER: 1.1300 LENGTH: 12.0000
FRAME THICK: 0.1875
LENGTH: 370.0000 IN. DEPTH: 16.7500 IN. X 3.0000 IN.
SUPPORT: 5 BINDER: 5 CLOSER: 4 112.4375
SUPPORT TYPE: SCALLOPED CHANNEL
F.FOOT: 6" X 3.5000 B.FOOT: 6" X 3.8750

TEST PRESSURE: 650 TIME: 60 MIN. W/ CHART
HEADS: WHITE METAL BLAST CLEAN
WITH 1 COAT METALIZE
FRAME: HAND TOOL CLEAN
WITH 1 COAT GALVANIZE
COIL VOLUME: 42 CUBIC FEET
DESIGN TEMP: 250 F
DESIGN PRESSURE: 500 Psig
MDMT: -20 F
CORROSION ALLOWANCE: 0.0625

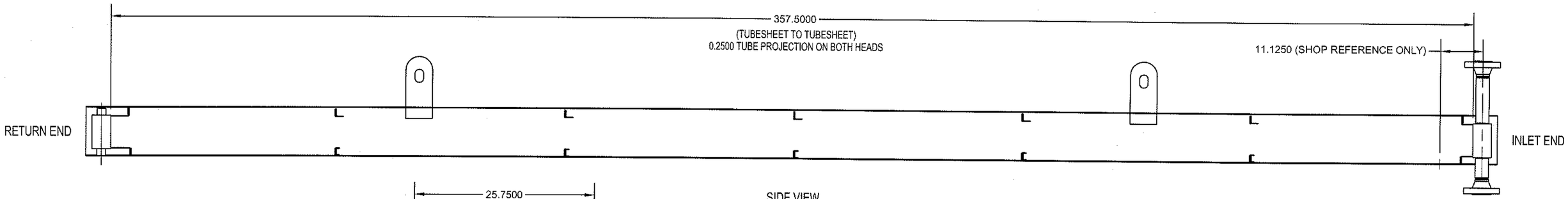
CERTIFIED FINAL: JCHAPMAN DATE: 1-19-2017

AIR COOLED DIVISION
BUNDLE DETAILS
ENG: JC | REV: 0 | 1-19-2017

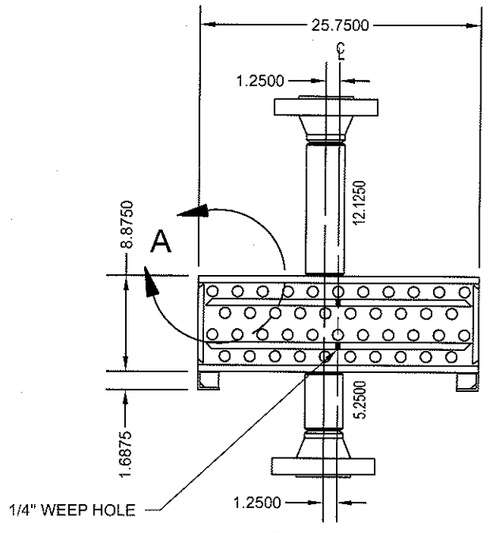
SERVICE: EXPANDER/COMPRESSOR A/C
ITEM: A-301
PO#: 4500753943

QTY: 1 | WEIGHT: 12200 | 20178430-1

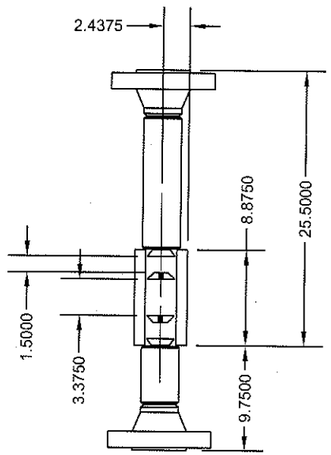
PROJECT DOC/REV#: S17430-IOM1-REV.0



SIDE VIEW



FRONT HEADER



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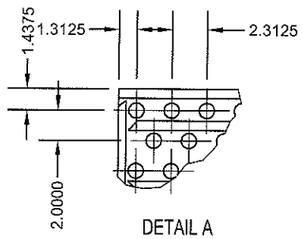
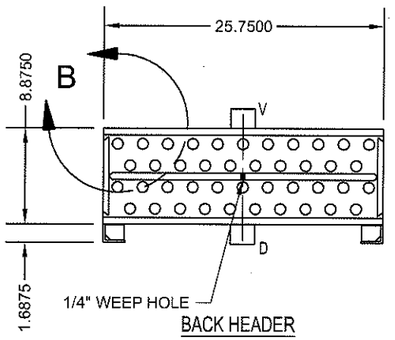


DETAIL A



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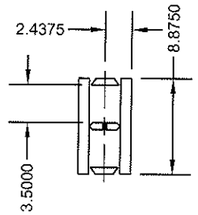
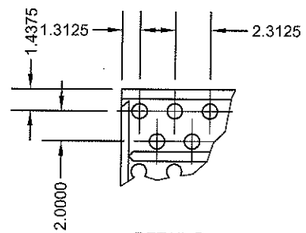


TUBE SHEET SIDE



DETAIL B

PROJECT NETWORK: J447

REV 0: FINAL CERTIFIED JC 1-19-2017

MACHINING	DRILL	REAM	SPECIAL
TUBE HOLE:	0.9375	1.010 ± 0.002	DG
PLUG HOLE:	1.0312 SF	1.3750 TAP	1.3750
NOZZLE: IN	(1) 3 - 900 # RJ SCH XS		
OUT	(1) 3 - 900 # RJ SCH XS		
VENT:	(1) 1-6000		
DRAIN:	(1) 1-6000		

WEIGHT: 500

	THICK	LENGTH	WIDTH	BEVELS
FRONT TUBE PLUG	1.0000	25.7500	8.8750	NONE
FRONT COVER	0.6250	25.7500	2.5625	LONG SIDES
FRONT END	0.5000	2.5625	7.3125	ALL SIDES
FRONT STAY	0.6250	24.4375	2.5625	ALL SIDES
REAR TUBE PLUG	1.0000	25.7500	8.8750	NONE
REAR COVER	0.6250	25.7500	2.5625	LONG SIDES
REAR END	0.5000	2.5625	7.3125	ALL SIDES
REAR STAY	0.6250	24.7500	2.8750	DBAS

MATERIAL SPECIFICATIONS
PLATE: SA-516 GR70 NORM
FLG: SA-105
PIPE: SA-106B
CPLG: SA-105

PLATE TOLERANCES: +.0000"/ -.1250

TUBES 42 TF 11 ROWS 4 PASS 4 LGTH 360 IN.
TUBE OD 1.0000 X 0.083 MATL SA-214 WLD
FIN TYPE L-TENSION 10 - 0.625 - ALUM
FRONT PLUG QTY: 42 TYPE A105-1822 GASKET: CS-1813
REAR PLUG QTY: 42 TYPE A105-1822
EXPANDER: 0.8340 LENGTH: 8.0000
FRAME THICK: 0.1875
LENGTH: 370.5000 IN. DEPTH: 13.0000 IN. X 3.0000 IN.
SUPPORT: 5 BINDER: 5 CLOSER: 4 25.3750
SUPPORT TYPE: SCALLOPED CHANNEL
F.FOOT: 6" X 1.6875 B.FOOT: 6" X 1.6875

TEST PRESSURE: 1872 TIME: 60 MIN. W/ CHART
HEADS: WHITE METAL BLAST CLEAN
WITH 1 COAT METALIZE
FRAME: HAND TOOL CLEAN
WITH 1 COAT GALVANIZE
COIL VOLUME: 5 CUBIC FEET
DESIGN TEMP: 200 F
DESIGN PRESSURE: 1440 Psig
MDMT: -20 F
CORROSION ALLOWANCE: 0.0625

CERTIFIED FINAL: JCHAPMAN DATE: 1-19-2017

AIR COOLED DIVISION
BUNDLE DETAILS
ENG: JC | REV: 0 | 1-9-2017

SERVICE: NGL PROD COOLER
ITEM: A-302
PO#: 4500753943

QTY: 1 | WEIGHT: 3500 | 2017S430-2

PROJECT DOC/REV#: S17430-IOM1-REV.0

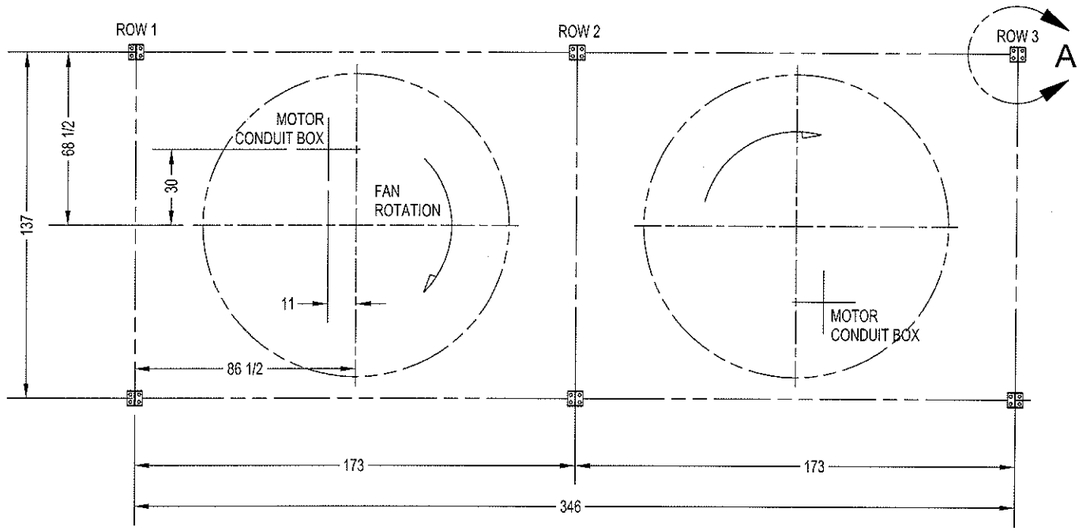
DRY WGHT 27200 WIND 43.0 PSF / 120 MPH SEISMIC 1 PLATFORM 50 LBS / SQ-FT LIVE

COLUMN LOAD KIPS	DRY DEAD	WET DEAD	WIND VERT	WIND HORIZ	SEIS VERT	SEIS HORIZ	SNOW	PLAT	NOZZ VERT	NOZZ HORIZ	TOTAL
ROW 1 / COLUMN	3.2	3.6	1.1	0.7	0.4	0.3	0.0	0.0	0.0	0.0	4.8
ROW 2 / COLUMN	6.4	7.3	2.2	1.5	0.5	0.5	0.0	0.0	0.0	0.0	9.5
ROW 3 / COLUMN	3.2	3.6	1.1	0.7	0.4	0.3	0.0	0.0	3.4	2.2	8.1

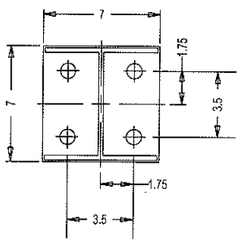
FAN COFIMCO 3048-5-24L/B3T
120 IN. DIAMETER 5 BLADE
135900 ACFM 7.3 DEG.
DRIVE REDUCER
BELTS (3) 5V - 1250
SHEAVES FAN 31.5 MOTOR 6.3
BEARINGS 2.4375 IN.
SHAFTS 2.4375 IN.

MOTOR HP 30.0 RPM 1750
286T TEFC
INSULATION CLASS F / B TEMP RISE
460 / 3 / 60 SINGLE WINDING VARIABLE TORQUE
AMPS (±10%) FLA 36 LRA 218
VIBRATION TRANS. METRIX ST5484E-122-120

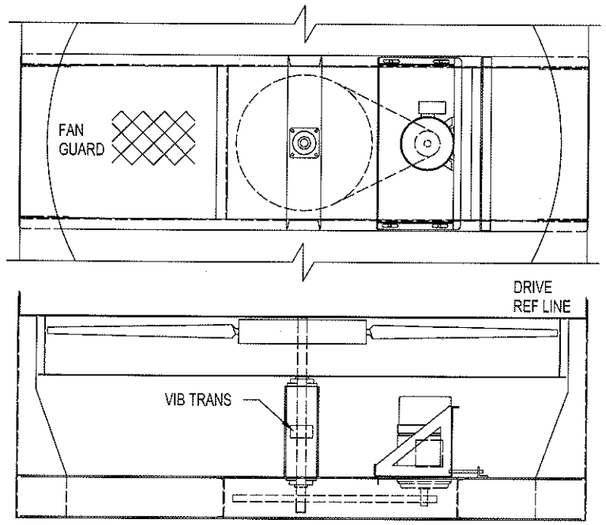
SHOP RUN IN TEST



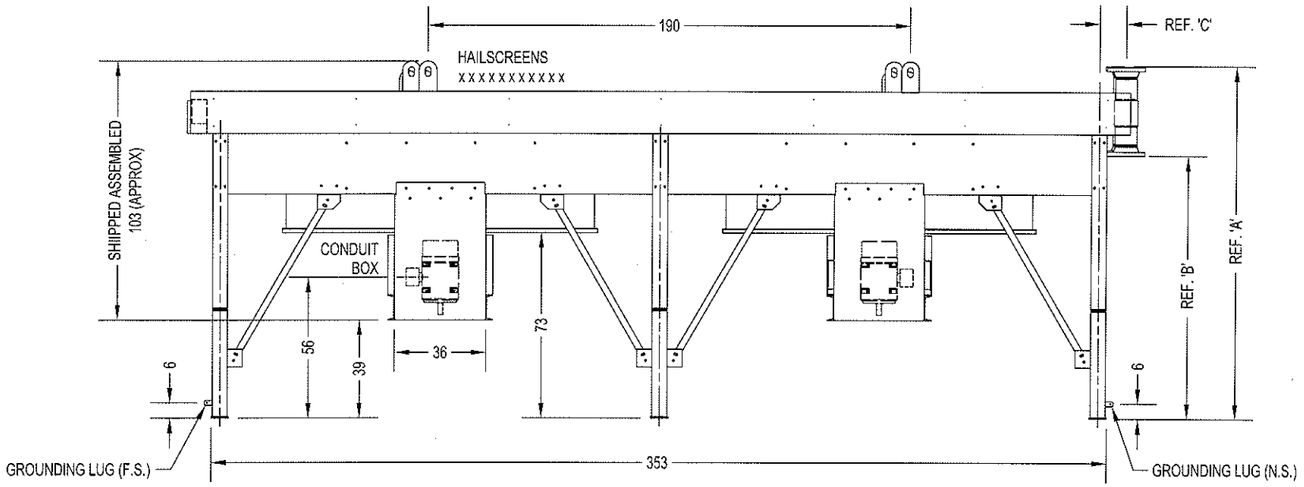
ANCHOR BOLT PLAN



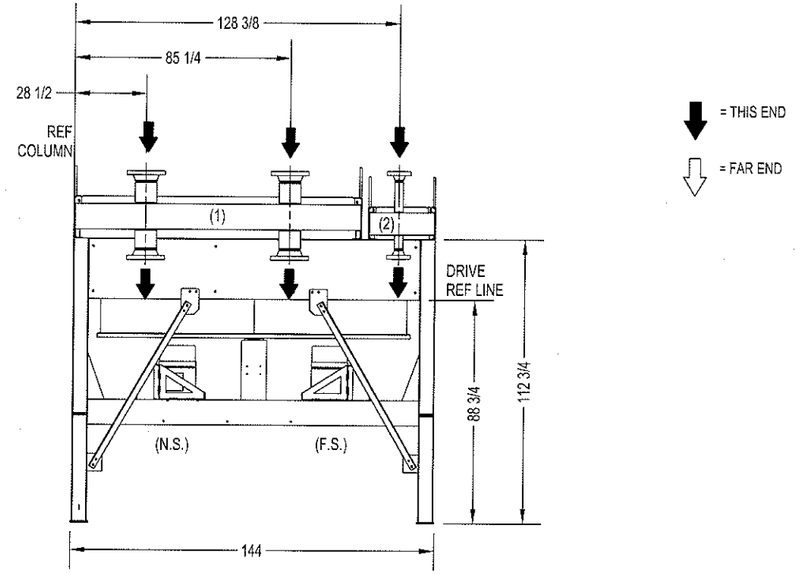
DETAIL A



FAN & DRIVE DETAIL
ONE THUS & ONE REVERSE



SIDE VIEW



END VIEW

PROJECT NETWORK: J447

	ITEM	SERVICE	NOZZLES INLET	OUTLET	REFERENCE DIMENSIONS A	B	C	D	BUNDLE WEIGHT	COUPLINGS V&D	TEMP	PRESS	SHUTTER OPERATOR	HAIL SCRN	CODE	DESIGN PRESS.
1	A-301	EXPANDER/COMPRESSOR AFTER-COOLER	(2) 8.00 - 300 # RF SCH XS	(2) 8.00 - 300 # RF SCH XS	139.750	104.375	10.500		12020	1-6000			NONE	YES	NATL	500
2	A-302	NGL PRODUCT COOLER	(1) 3.00 - 900 # RJ SCH XS	(1) 3.00 - 900 # RJ SCH XS	140.125	104.875	7.125		2967	1-6000			NONE	YES	NATL	1440

TOLERANCES: (ALL DIMENSIONS IN INCHES)
MECHANICAL EQUIPMENT: ± 1/8" PER 10'-0"
NOZZLE: ± 1/8"
STRUCTURAL - HAND TOOL CLEAN
WITH 1 COAT GALVANIZE
FRAME - HAND TOOL CLEAN
WITH 1 COAT GALVANIZE
HEADER - WHITE METAL BLAST CLEAN
WITH 1 COAT METALIZE

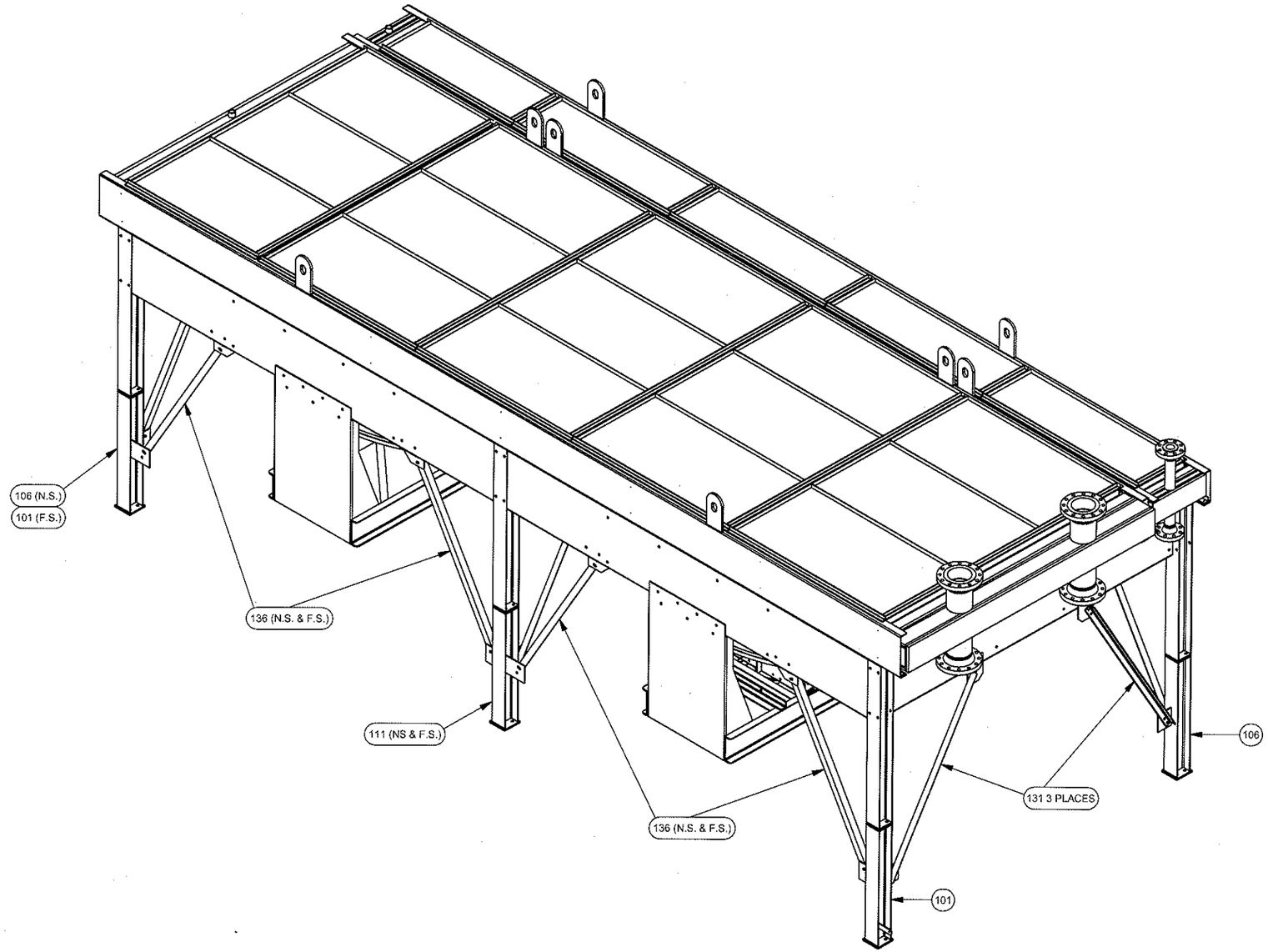
CUSTOMER: UOP RUSSELL
LOCATION: UNKNOWN
REFERENCE: 4500753943

REV 0: CERTIFIED FINAL JC 1-19-2017

SMITHCO
AIR COOLED DIVISION
TULSA, OKLAHOMA

PIPING, EQUIPMENT OUTLINE & ANCHOR BOLT PLAN
MODEL 1 F 30 - 119 - 2 QUANTITY 1

DWN: JC | CKD: | DATE: 1-19-2017
CERTIFIED BY: JCHAPMAN | CERT DATE: 1-19-2017
REV: 0 | REF JOB: 2016B386 | JOB: 2017B430 - A



NOTE:
1. USE 5/8" X 2 1/2" (A-325) BOLT, NUT, LOCKWASHER & (2) FLATWASHERS AT ALL COLUMN SPLICE CONNECTIONS.
2. USE 5/8" X 2" (A325) BOLT, NUT, LOCKWASHER & (2) FLATWASHERS AT ALL COLUMN BRACE CONNECTIONS.
3. REMOVE REAR HEADER BOLTS BEFORE START UP.

PROJECT NETWORK: J447

FOR INFORMATION ONLY
NOT FOR REVIEW

SMITHCO
ENGINEERING, INC.
Tulsa, Oklahoma

1 F 30-119-2
FIELD ERECTION

ENGR: JC	CK'D BY:	DATE: 1/19/2017
JOB NO: 2017B430		DWG NO: 430B-FE1
REV: 0	SCALE:	QTY: 1

HEADER CALCULATIONS

Smithco Engineering

V2.1

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
Item: A-301
Page: 1 of 5

Doc. No.: H 1 **Plug Header Calculations**

TUBES 2015 ASME VIII, Div. 1, App. 1, Eq. (1)
SA-214,WLD

P	Design Pressure	500	psig
Ro	Outside Radius	0.625	in
Sd	Allowable Stress at 250 F	11400	psi
Sa	Allowable Stress at 70 F	11400	psi
E	Longitudinal Weld Eff	1	~
CA	Tube Corrosion Allowance	0	in
t	Tube Thickness	0.06	in
EMB	Embedded Groove Depth	0	in
t(min)	=P*Ro / (Sd*E+0.4*P)+CA	**0.0269**	in
MAWP(hot & corr)	=(t-CA)*Sd*E / (Ro-0.4*(t-CA))	**1138.10**	psig
MAP(new & cold)	=t*Sa*E / (Ro-0.4*t)	**1138.10**	psig

NOZZLES App. 1, Eq. (1)

Ri	Inlet Outside Radius	4.3125	in
ti	Inlet Nozzle Wall (0.5 * 0.875)	0.4375	in
Ro	Outlet Outside Radius	4.3125	in
to	Outlet Nozzle Wall (0.5 * 0.875)	0.4375	in
Sd	Allowable Stress at 250 F	17100	psi
Sa	Allowable Stress at 70 F	17100	psi
E	Longitudinal Weld Eff	1	~
CA	Nozzle Corrosion Allowance	0.0625	in

Inlet Pipe SA-106,B,SMLS

t(min)	=P*Ri / (Sd*E+0.4*P)+CA	**0.1871**	in
MAWP(hot & corr)	=(ti-CA)*Sd*E / (Ri-0.4*(ti-CA))	**1540.54**	psig
MAP(new & cold)	=ti*Sa*E / (Ri-0.4*ti)	**1808.16**	psig

Outlet Pipe SA-106,B,SMLS

t(min)	=P*Ro / (Sd*E+0.4*P)+CA	**0.1871**	in
MAWP(hot & corr)	=(to-CA)*Sd*E / (Ro-0.4*(to-CA))	**1540.54**	psig
MAP(new & cold)	=to*Sa*E / (Ro-0.4*to)	**1808.16**	psig

Flanges SA-105

MAWP(hot & corr)	ASME B16.5 at 250 F	**667.50**	psig
MAP(new & cold)	ASME B16.5 at 70 F	**740.00**	psig

Designer:	ME	Date:	1/18/2017	Chkd By:		Date:	

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
Item: A-301
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Doc. No.: H 1 **NOZZLE Plug Header Calculations** **Box 1**

TUBE, PLUG, AND COVER PLATE App. 13, Figure 13-2(a), Sketch (7) & 13-9(b)

SA-516,70,N

		new & cold	hot & corr	
P	Design Pressure		500	psig
CA	Header Corrosion Allowance		0.0625	in
h	Maximum Vertical Span	4.0625	4.1875	in
H	Horizontal Span	7.625	7.75	in
a	=H/h	1.8769	1.8507	~
t1	Cover Plate	0.875	0.8125	in
t2	Tubesheet	1.125	1.0625	in
t22	Plugsheet	1.125	1.0625	in
I1	=t1^3/12	0.0558	0.0447	in^3
I2	=t2^3/12	0.1187	0.1000	in^3
I22	=t22^3/12	0.1187	0.1000	in^3
K	=(I2/I1)a	3.9891	4.1387	~
k1	=I22/I2	1.0000	1.0000	~
k2	=(I22/I1)a	3.9891	4.1387	~
K1	=2k2+3	10.9783	11.2774	~
K2	=3k1+2k2	10.9783	11.2774	~
N	=K1K2-k2^2	104.6096	110.0508	~
S	Allowable Stress at 70 F & 250 F	20000	20000	psi
d	Plug Thread Pitch Dia at 1.375 Thread	1.3209	1.3209	in
p	Horizontal Tube Pitch	2.5625	2.5625	in
e	Ligament Efficiency of Tube/Plugsheet =1-d/p	0.4845	0.4845	~

COVER PLATE

		new & cold	hot & corr	
Sm	=Ph/4t1(act)*{4-[2+K(5-a^2)]/(1+2K)}	1811	1985	psi
(Sb)N	=P(t1/2)/24I1*[-3H^2+2h^2*(1+2a^2K)/(1+2K)]	-11007	-13109	psi
(Sb)Q	=Ph^2(t1/2)/12I1*(1+2a^2K)/(1+2K)	17470	21010	psi
(Sm+Sb)N	Membrane + Bending at Midpoint	12818	15094	psi
(Sm+Sb)Q	Membrane + Bending at Corner	19282	22995	psi

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
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Doc. No.: H 1 **NOZZLE Plug Header Calculations** **Box 1**

TUBE/PLUG

		new & cold	hot & corr	
Sm	=PH/2t2(act)/e	3497	3764	psi
(Sb)M	=Ph^2(t2/2)/12l2*{[1+K(3-a^2)]/(1+2K)}/e	-814	-657	psi
(Sb)Q	=Ph^2(t2/2)/12l2*(1+2a^2K)/(1+2K)	10569	12286	psi
(Sm+Sb)M	Membrane + Bending at Midpoint	4311	4420	psi
(Sm+Sb)Q	Membrane + Bending at Corner	12263	14109	psi

STAY PLATE

		new & cold	hot & corr	
t4	Stay Thickness	0.375	0.25	in
ep	Stay Ligament & Weld Eff	0.7	0.7	~
t(min)	=Ph/2S*[2+K(5-a^2)]/(1+2K)/ep+2CA		**0.1937**	in

END PLATE

Figure UG-34(g) & Eq. (3)

		new & cold	hot & corr	
d	Minimum Span	4.0625	4.1875	in
D	Maximum Span	7.625	7.75	in
Z	=3.4-2.4d/D (Max 2.5)	2.121	2.103	~
C	[Per 13-4(f)]	0.2	0.2	~
P	Design Pressure		500	psig
S	Allowable Stress at 70 F & 250 F	20000	20000	psi
E	[Per 13-5, Endnote 99]	1	1	~
t	End Plate Thickness	0.5	0.4375	in
CA	Header Corrosion Allowance		0.0625	in
t(min)	=d*sqrt(ZCP/SE)+CA		**0.4919**	in

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

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Doc. No.: H 1 **RETURN Plug Header Calculations** **Box 2**

TUBE, PLUG, AND COVER PLATE App. 13, Figure 13-2(a), Sketch (1) & 13-7(a)

SA-516,70,N

		new & cold	hot & corr	
P	Design Pressure		500	psig
CA	Header Corrosion Allowance		0.0625	in
h	Maximum Vertical Span	8.5	8.625	in
H	Horizontal Span	3.125	3.25	in
a	=H/h	0.3676	0.3768	~
t1	Cover Plate	0.5	0.4375	in
t2	Tubesheet	1.375	1.3125	in
t22	Plugsheet	1.375	1.3125	in
I1	=t1^3/12	0.0104	0.0070	in^3
I2	=t2^3/12	0.2166	0.1884	in^3
I22	=t22^3/12	0.2166	0.1884	in^3
K	=(I2/I1)a	7.6459	10.1739	~
k1	=I22/I2	1.0000	1.0000	~
k2	=(I22/I1)a	7.6459	10.1739	~
K1	=2k2+3	18.2918	23.3478	~
K2	=3k1+2k2	18.2918	23.3478	~
N	=K1K2-k2^2	276.1307	441.6125	~
S	Allowable Stress at 70 F & 250 F	20000	20000	psi
d	Plug Thread Pitch Dia at 1.375 Thread	1.3209	1.3209	in
p	Horizontal Tube Pitch	2.5625	2.5625	in
e	Ligament Efficiency of Tube/Plugsheet =1-d/p	0.4845	0.4845	~

COVER PLATE

		new & cold	hot & corr	
Sm	=Ph/2t1(act)	4250	4929	psi
(Sb)N	=P(t1/2)/12I1*[-1.5H^2+h^2*(1+a^2K)/(1+K)]	2344	563	psi
(Sb)Q	=Ph^2(t1/2)/12I1*(1+a^2K)/(1+K)	16993	21257	psi
(Sm+Sb)N	Membrane + Bending at Midpoint	6594	5492	psi
(Sm+Sb)Q	Membrane + Bending at Corner	21243	26185	psi

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

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Doc. No.: H 1 **RETURN Plug Header Calculations** **Box 2**

TUBE/PLUG

		new & cold	hot & corr	
Sm	=PH/2t2(act)/e	1173	1278	psi
(Sb)M	=Ph^2(t2/2)/12I2*[-1.5+(1+a^2K)/(1+K)]/e	-24939	-28547	psi
(Sb)Q	=Ph^2(t2/2)/12I2*(1+a^2K)/(1+K)	2247	2362	psi
(Sm+Sb)M	Membrane + Bending at Midpoint	26112	29825	psi
(Sm+Sb)Q	Membrane + Bending at Corner	2815	2981	psi

STAY PLATE

		new & cold	hot & corr	
t4	Stay Thickness	0	0	in
ep	Stay Ligament & Weld Eff			~
t(min)			**0.0000**	in

END PLATE

Figure UG-34(g) & Eq. (3)

		new & cold	hot & corr	
d	Minimum Span	3.125	3.25	in
D	Maximum Span	8.5	8.625	in
Z	=3.4-2.4d/D (Max 2.5)	2.500	2.496	~
C	[Per 13-4(f)]	0.2	0.2	~
P	Design Pressure		500	psig
S	Allowable Stress at 70 F & 250 F	20000	20000	psi
E	[Per 13-5, Endnote 99]	1	1	~
t	End Plate Thickness	0.5	0.4375	in
CA	Header Corrosion Allowance		0.0625	in
t(min)	=d*sqrt(ZCP/SE)+CA		**0.4255**	in

Smithco Engineering

V2.1

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
Item: A-302
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Doc. No.: H 2 **Plug Header Calculations**

TUBES 2015 ASME VIII, Div. 1, App. 1, Eq. (1)
SA-214,WLD

P	Design Pressure	1440	psig
Ro	Outside Radius	0.5	in
Sd	Allowable Stress at 200 F	11400	psi
Sa	Allowable Stress at 70 F	11400	psi
E	Longitudinal Weld Eff	1	~
CA	Tube Corrosion Allowance	0	in
t	Tube Thickness	0.083	in
EMB	Embedded Groove Depth	0	in
t(min)	=P*Ro / (Sd*E+0.4*P)+CA	**0.0601**	in
MAWP(hot & corr)	=(t-CA)*Sd*E / (Ro-0.4*(t-CA))	**2026.99**	psig
MAP(new & cold)	=t*Sa*E / (Ro-0.4*t)	**2026.99**	psig

NOZZLES App. 1, Eq. (1)

Ri	Inlet Outside Radius	1.75	in
ti	Inlet Nozzle Wall (0.3 * 0.875)	0.2625	in
Ro	Outlet Outside Radius	1.75	in
to	Outlet Nozzle Wall (0.3 * 0.875)	0.2625	in
Sd	Allowable Stress at 200 F	17100	psi
Sa	Allowable Stress at 70 F	17100	psi
E	Longitudinal Weld Eff	1	~
CA	Nozzle Corrosion Allowance	0.0625	in
Inlet Pipe	SA-106,B,SMLS		
t(min)	=P*Ri / (Sd*E+0.4*P)+CA	**0.2051**	in
MAWP(hot & corr)	=(ti-CA)*Sd*E / (Ri-0.4*(ti-CA))	**2047.90**	psig
MAP(new & cold)	=ti*Sa*E / (Ri-0.4*ti)	**2728.72**	psig
Outlet Pipe	SA-106,B,SMLS		
t(min)	=P*Ro / (Sd*E+0.4*P)+CA	**0.2051**	in
MAWP(hot & corr)	=(to-CA)*Sd*E / (Ro-0.4*(to-CA))	**2047.90**	psig
MAP(new & cold)	=to*Sa*E / (Ro-0.4*to)	**2728.72**	psig
Flanges	SA-105,N		
MAWP(hot & corr)	ASME B16.5 at 200 F	**2035.00**	psig
MAP(new & cold)	ASME B16.5 at 70 F	**2220.00**	psig

Designer:	ME	Date:	1/19/2017	Chkd By:		Date:	

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
Item: A-302
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Doc. No.: H 2 **NOZZLE Plug Header Calculations** **Box 1**

TUBE, PLUG, AND COVER PLATE App. 13, Figure 13-2(a), Sketch (8) & 13-9(c)
SA-516,70,N

		new & cold	hot & corr	
P	Design Pressure		1440	psig
CA	Header Corrosion Allowance		0.0625	in
h	Maximum Vertical Span	3.375	3.5	in
H	Horizontal Span	2.875	3	in
a	=H/h	0.8519	0.8571	~
t1	Cover Plate	0.625	0.5625	in
t2	Tubesheet	1	0.9375	in
t22	Plugsheet	1	0.9375	in
I1	=t1^3/12	0.0203	0.0148	in^3
I2	=t2^3/12	0.0833	0.0687	in^3
I22	=t22^3/12	0.0833	0.0687	in^3
K	=(I2/I1)a	3.4892	3.9683	~
k1	=I22/I2	1.0000	1.0000	~
k2	=(I22/I1)a	3.4892	3.9683	~
K1	=2k2+3	9.9784	10.9365	~
K2	=3k1+2k2	9.9784	10.9365	~
N	=K1K2-k2^2	87.3935	103.8602	~
S	Allowable Stress at 70 F & 200 F	20000	20000	psi
d	Plug Thread Pitch Dia at 1.125 Thread	1.0787	1.0787	in
p	Horizontal Tube Pitch	2.3125	2.3125	in
e	Ligament Efficiency of Tube/Plugsheet =1-d/p	0.5335	0.5335	~

COVER PLATE

		new & cold	hot & corr	
Sm	=Ph/2t1(act)*{3-[6+K(11-a^2)]/(3+5K)}	3706	4274	psi
(Sb)N	=P(t1/2)/24I1*[-3H^2+2h^2*(3+5a^2K)/(3+5K)]	-6772	-9269	psi
(Sb)Q	=Ph^2(t1/2)/12I1*(3+5a^2K)/(3+5K)	16080	21451	psi
(Sm+Sb)N	Membrane + Bending at Midpoint	10478	13542	psi
(Sm+Sb)Q	Membrane + Bending at Corner	19786	25725	psi

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
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Doc. No.: H 2 **NOZZLE Plug Header Calculations** **Box 1**

TUBE/PLUG

			new & cold	hot & corr	
Sm	=PH/2t2(act)/e		3880	4318	psi
(Sb)M	=Ph^2(t2/2)/12l2*{[3+K(6-a^2)]/(3+5K)}/e		16091	19676	psi
(Sb)Q	=Ph^2(t2/2)/12l2*(3+5a^2K)/(3+5K)		6281	7722	psi
(Sm+Sb)M	Membrane + Bending at Midpoint		19971	23994	psi
(Sm+Sb)Q	Membrane + Bending at Corner		8351	10026	psi

STAY PLATE

		new & cold	hot & corr	
t4	Stay Thickness	0.625	0.5	in
ep	Stay Ligament & Weld Eff	0.7	0.7	~
t(min)	=Ph/2S*[6+K(11-a^2)]/(3+5K)/ep+2CA		**0.4933**	in

END PLATE

Figure UG-34(g) & Eq. (3)

		new & cold	hot & corr	
d	Minimum Span	2.875	3	in
D	Maximum Span	3.375	3.5	in
Z	=3.4-2.4d/D (Max 2.5)	1.356	1.343	~
C	[Per 13-4(f)]	0.2	0.2	~
P	Design Pressure		1440	psig
S	Allowable Stress at 70 F & 200 F	20000	20000	psi
E	[Per 13-5, Endnote 99]	1	1	~
t	End Plate Thickness	0.5	0.4375	in
CA	Header Corrosion Allowance		0.0625	in
t(min)	=d*sqrt(ZCP/SE)+CA		**0.4797**	in

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

Job: 17B430
Item: A-302

Doc. No.: H 2 **RETURN Plug Header Calculations** **Box 2**

TUBE, PLUG, AND COVER PLATE App. 13, Figure 13-2(a), Sketch (7) & 13-9(b)
SA-516,70,N

		new & cold	hot & corr	
P	Design Pressure		1440	psig
CA	Header Corrosion Allowance		0.0625	in
h	Maximum Vertical Span	3.5	3.625	in
H	Horizontal Span	2.875	3	in
a	=H/h	0.8214	0.8276	~
t1	Cover Plate	0.625	0.5625	in
t2	Tubesheet	1	0.9375	in
t22	Plugsheet	1	0.9375	in
I1	=t1^3/12	0.0203	0.0148	in^3
I2	=t2^3/12	0.0833	0.0687	in^3
I22	=t22^3/12	0.0833	0.0687	in^3
K	=(I2/I1)a	3.3646	3.8314	~
k1	=I22/I2	1.0000	1.0000	~
k2	=(I22/I1)a	3.3646	3.8314	~
K1	=2k2+3	9.7291	10.6628	~
K2	=3k1+2k2	9.7291	10.6628	~
N	=K1K2-k2^2	83.3359	99.0163	~
S	Allowable Stress at 70 F & 200 F	20000	20000	psi
d	Plug Thread Pitch Dia at 1.125 Thread	1.0787	1.0787	in
p	Horizontal Tube Pitch	2.3125	2.3125	in
e	Ligament Efficiency of Tube/Plugsheet =1-d/p	0.5335	0.5335	~

COVER PLATE

		new & cold	hot & corr	
Sm	=Ph/4t1(act)*{4-[2+K(5-a^2)]/(1+2K)}	3747	4317	psi
(Sb)N	=P(t1/2)/24I1*[-3H^2+2h^2*(1+2a^2K)/(1+2K)]	-6667	-9152	psi
(Sb)Q	=Ph^2(t1/2)/12I1*(1+2a^2K)/(1+2K)	16185	21568	psi
(Sm+Sb)N	Membrane + Bending at Midpoint	10414	13469	psi
(Sm+Sb)Q	Membrane + Bending at Corner	19932	25884	psi

Smithco Engineering

Customer: UOP Russell
Service: NGL Prod Cooler
Plant:
Revision: 0
PO No: J-447 P.O. 4500753943

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Doc. No.: H 2 **RETURN Plug Header Calculations** **Box 2**

TUBE/PLUG			**new & cold**	**hot & corr**	
	Sm	=PH/2t2(act)/e	3880	4318	psi
	(Sb)M	=Ph^2(t2/2)/12I2*{[1+K(3-a^2)]/(1+2K)}/e	18872	22988	psi
	(Sb)Q	=Ph^2(t2/2)/12I2*(1+2a^2K)/(1+2K)	6322	7764	psi
	(Sm+Sb)M	Membrane + Bending at Midpoint	22752	27307	psi
	(Sm+Sb)Q	Membrane + Bending at Corner	8392	10068	psi

STAY PLATE			**new & cold**	**hot & corr**	
	t4	Stay Thickness	0.625	0.5	in
	ep	Stay Ligament & Weld Eff	0.7	0.7	~
	t(min)	=Ph/2S*[2+K(5-a^2)]/(1+2K)/ep+2CA		**0.5238**	in

END PLATE		Figure UG-34(g) & Eq. (3)			
			new & cold	**hot & corr**	
	d	Minimum Span	2.875	3	in
	D	Maximum Span	3.5	3.625	in
	Z	=3.4-2.4d/D (Max 2.5)	1.429	1.414	~
	C	[Per 13-4(f)]	0.2	0.2	~
	P	Design Pressure		1440	psig
	S	Allowable Stress at 70 F & 200 F	20000	20000	psi
	E	[Per 13-5, Endnote 99]	1	1	~
	t	End Plate Thickness	0.5	0.4375	in
	CA	Header Corrosion Allowance		0.0625	in
	t(min)	=d*sqrt(ZCP/SE)+CA		**0.4906**	in

JOB SPECIFIC VENDOR DATA

BALDOR
A MEMBER OF THE ABB GROUP

BALDOR • RELIANCE

Product Information Packet

UNLAUB COMPANY, INC

M00CEXR3018286T

30HP,1770RPM,3PH,60HZ,286T,1060M,TEFC,F1

Nameplate NP2141L

CAT NO	EXR3018286T								
SPEC.	10H685X207G1			ENCL	TEFC				
FRAME	286T	HP	30						
VOLTS	230/460								
MAG CUR	32/16	FLA	72/36						
RPM	1770	RPM MAX	2700						
HZ	60	PH	3	CLASS	H				
SER.F.	1.00	DES	A	SL HZ	0.83				
NEMA-NOM-EFF	93.6	WK2	4.77						
RATING	50C AMB-CONT								
DE BRG	6311	ODE BRG	6309						
INV.TYPE	PWM	C HP FR	60	C HP TO	90	T. CODE	T3		
CT HZ FROM	30	CT HZ TO	60	VT HZ FROM	6	VT HZ TO	60		
CC	010A	SER.NO							
	1.15 SF ON SINEWAVE								
	SUITABLE FOR VFD								

Nameplate NP2141L

CAT NO	EXR3018286T								
SPEC.	10H685X207G1			ENCL	TEFC				
FRAME	286T	HP	25						
VOLTS	190/380-400-415								
MAG CUR	32/16-18-20	FLA	72/36						
RPM	1475	RPM MAX	2200						
HZ	50	PH	3	CLASS	H				
SER.F.	1.00	DES	A	SL HZ	0.83				
NEMA-NOM-EFF	93	WK2	4.77						
RATING	50C AMB-CONT								
DE BRG	6311	ODE BRG	6309						
INV.TYPE	PWM	C HP FR	50	C HP TO	75	T. CODE	T3		
CT HZ FROM	25	CT HZ TO	50	VT HZ FROM	5	VT HZ TO	50		
CC	010A	SER.NO							
	1.15 SF ON SINEWAVE								
	SUITABLE FOR VFD								

Parts List

Part Number	Description	Quantity
SA232393	SA 10H685X207G1	1.000 EA
RA219400	RA 10H685X207G1	1.000 EA
10CB1000A09	CONDUIT BOX, MACH	1.000 EA
12GS1000SP	GASKET	1.000 EA
10XN3118K16	5/16-18 X 1' GRADE #5, STL, ZINC PLATE	4.000 EA
HW1001A31	LOCKWASHER 5/16, ZINC PLT.591 OD, .319 I	4.000 EA
WD1000B16	T&B CX70TN TERMINAL	1.000 EA
10XN2520K06	1/4-20 X 3/8" HX HD SCREWGRADE 5, ZINC P	1.000 EA
HW1001A25	LOCKWASHER 1/4, ZINC PLT .493 OD, .255 I	1.000 EA
10EP1104A21	FR ENDPLATE, MACH FOR LOCKED BRG.	1.000 EA
10XN3816K28	3/8-16 X 1.75 HEX HD CAP SCREW, GRADE 5	4.000 EA
HW1001A38	LOCKWASHER 3/8, ZINC PLT .688 OD, .382 I	4.000 EA
HA4017A13	GREASER EXTENSION A=4.50	1.000 EA
HA4017A13	GREASER EXTENSION A=4.50	1.000 EA
HA4017A06	/125 X 3.00 GREASER EXT. (F/S)	1.000 EA
HW4019A01	PIPE COUPLING 1/8 NPT,STEEL,ZINC COATING	1.000 EA
HA1005A26	SLINGER, OD 3.00, ID 1.75, 309 BRG	1.000 EA
10XN2520K32	1/4-20 X 2.00 HX HD SCRW GRADE 5, ZINC P	2.000 EA
HW1001A25	LOCKWASHER 1/4, ZINC PLT .493 OD, .255 I	2.000 EA
10EP1105A92	PU ENDPLATE, MACH	1.000 EA
10XN3816K28	3/8-16 X 1.75 HEX HD CAP SCREW, GRADE 5	4.000 EA
HW1001A38	LOCKWASHER 3/8, ZINC PLT .688 OD, .382 I	4.000 EA
HW4600B40	V-RING SLINGER 2.000 X 2.680 X .28 VITON	1.000 EA
HW5100A13	W4627-047 WVY WSHER	1.000 EA

Parts List (continued)

Part Number	Description	Quantity
10XN3118K40	5/16-18 X 2.50" HEX HD, GRADE 5	4.000 EA
HW1001A31	LOCKWASHER 5/16, ZINC PLT.591 OD, .319 I	4.000 EA
10FH1007A24	FAN COVER W/1.00 SLOT @ 6:00	1.000 EA
10XN3118K16	5/16-18 X 1' GRADE #5, STL, ZINC PLATE	3.000 EA
HW1001A31	LOCKWASHER 5/16, ZINC PLT.591 OD, .319 I	3.000 EA
10CB1500A01SP	CONDUIT BOX LID, MACH	1.000 EA
14GS1001	GASKET, CONDUIT BOX LID 314 FRAME	1.000 EA
10XN2520K16	1/4-20 X 1" HX HD SCRW GRADE 5, ZINC P	4.000 EA
HW1001A25	LOCKWASHER 1/4, ZINC PLT .493 OD, .255 I	4.000 EA
HW2501H28	KEY, 1/2 SQ X 3.250	1.000 EA
MN416A01	TAG-INSTAL-MAINT no wire (1000/bx) 11/14	1.000 EA
LB1115N	LABEL,LIFTING DEVICE (ON ROLLS)	1.000 EA
HA4051A00	PLASTIC CAP FOR GREASE FITTING	1.000 EA
HW4500A21	1618BALEMITE FITTING 825 UNIVERSAL	1.000 EA
HW4500A17	317400 ALEMITE GREASE RELIEF	1.000 EA
HA4001A01SP	DRAIN PLUG, PLASTIC (MICRO PLAS)	3.000 EA
HW4500A21	1618BALEMITE FITTING 825 UNIVERSAL	1.000 EA
HW4500A17	317400 ALEMITE GREASE RELIEF	1.000 EA
HA4001A01SP	DRAIN PLUG, PLASTIC (MICRO PLAS)	1.000 EA
MJ1000A02	GREASE, POLYREX EM EXXON (USe 4824-15A)	0.130 LB
HA4051A00	PLASTIC CAP FOR GREASE FITTING	1.000 EA
09FN3001C02	EXTERNAL FAN, PLASTIC	1.000 EA
HW2500A25	WOODRUFF KEY USA #1008 #BLOW CARBON STEE	1.000 EA
51XB1214A20	12-14X1.25 HXWSSLD SERTYB	1.000 EA

MG1000G27	MED CHARCOAL METALLIC GREY 400-0096	0.070 GA
85XU0407S04	4X1/4 U DRIVE PIN STAINLESS	4.000 EA
LB1119N	WARNING LABEL	1.000 EA
LC0005	CONN.DIA.,TY M,9-LD,DUAL VOLT,REVERSING	1.000 EA
NP2141L	ALUM INV DIV-2 UL CSA-C US CC	1.000 EA
NP2141L	ALUM INV DIV-2 UL CSA-C US CC	1.000 EA
10PA1000	PACKAGING GROUP COMBINED PRINT PK1023A06	1.000 EA
LB1449	DIV-2/NEC WARNING LABEL	1.000 EA
LB1417	LABEL CARTON 6X4 PERFORATED BLANK ROLLS	1.000 EA

AC Induction Motor Performance Data

Record # 55006 - Typical performance - not guaranteed values

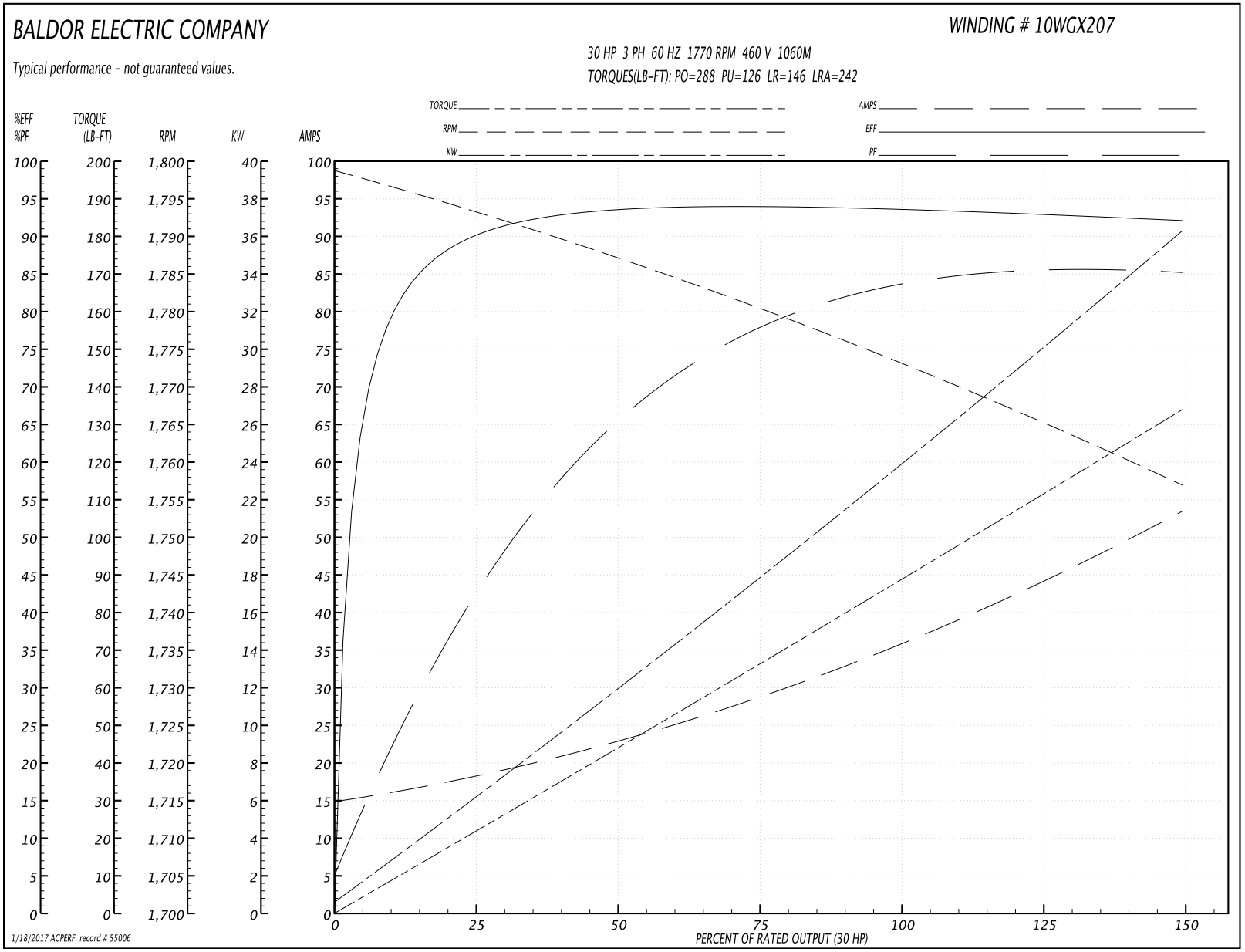
Winding: 10WGX207-R026	**Type:** 1060M	**Enclosure:** TEFC

Nameplate Data				460 V, 60 Hz: High Voltage Connection	
Rated Output (HP)	30			Full Load Torque	88.7 LB-FT
Volts	230/460			Start Configuration	direct on line
Full Load Amps	72/36			Breakdown Torque	288 LB-FT
R.P.M.	1770			Pull-up Torque	126 LB-FT
Hz	60	Phase	3	Locked-rotor Torque	146 LB-FT
NEMA Design Code	A	KVA Code	H	Starting Current	242 A
Service Factor (S.F.)	1			No-load Current	15.4 A
NEMA Nom. Eff.	93.6	Power Factor	83	Line-line Res. @ 25ºC	0.2348 Ω
Rating - Duty	50C AMB-CONT			Temp. Rise @ Rated Load	63°C
				Locked-rotor Power Factor	31.8

Load Characteristics 460 V, 60 Hz, 30 HP

% of Rated Load	25	50	75	100	125	150
Power Factor	44	66	78	82	85	86
Efficiency	89.8	93.3	94	93.8	93.2	92.4
Speed	1793.3	1786.8	1780.3	1773.6	1765.6	1756.7
Line amperes	17.5	22.7	28.8	36.2	44.3	53.1

Performance Graph at 460V, 60Hz, 30.0HP Typical performance - Not guaranteed values



AC Induction Motor Performance Data

Record # 55001 - Typical performance - not guaranteed values

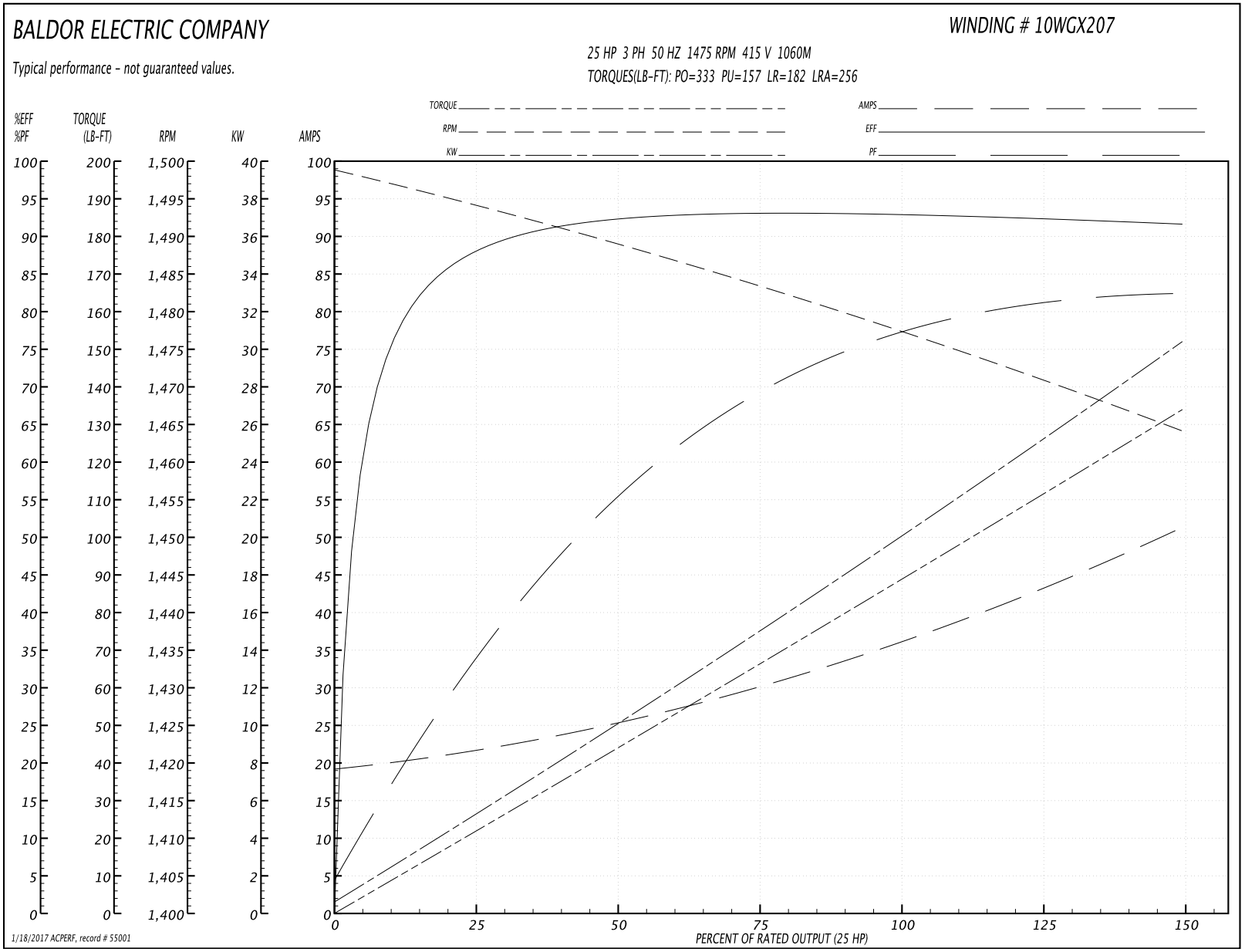
Winding: 10WGX207-R025	**Type:** 1060M	**Enclosure:** TEFC

Nameplate Data				415 V, 50 Hz: High Voltage Connection	
Rated Output (HP)	25			Full Load Torque	88.8 LB-FT
Volts	190/380-400-415			Start Configuration	direct on line
Full Load Amps	72/36			Breakdown Torque	333 LB-FT
R.P.M.	1475			Pull-up Torque	157 LB-FT
Hz	50	Phase	3	Locked-rotor Torque	182 LB-FT
NEMA Design Code	A	KVA Code	J	Starting Current	256 A
Service Factor (S.F.)	1			No-load Current	19.6 A
NEMA Nom. Eff.	93	Power Factor	77	Line-line Res. @ 25ºC	0.218 Ω
Rating - Duty	50C AMB-CONT			Temp. Rise @ Rated Load	63°C
S.F. Amps				Temp. Rise @ S.F. Load	76°C
				Locked-rotor Power Factor	35.5
				Rotor inertia	4.77 LB-FT2

Load Characteristics 415 V, 50 Hz, 25 HP

% of Rated Load	25	50	75	100	125	150
Power Factor	35	56	70	77	80	83
Efficiency	87.8	92.1	93	93.1	92.4	91.6
Speed	1494	1489	1483	1478	1471	1464
Line amperes	21.1	25.2	30.1	36.4	43.4	51

Performance Graph at 415V, 50Hz, 25.0HP Typical performance - Not guaranteed values



AC Induction Motor Performance Data

Record # 55002 - Typical performance - not guaranteed values

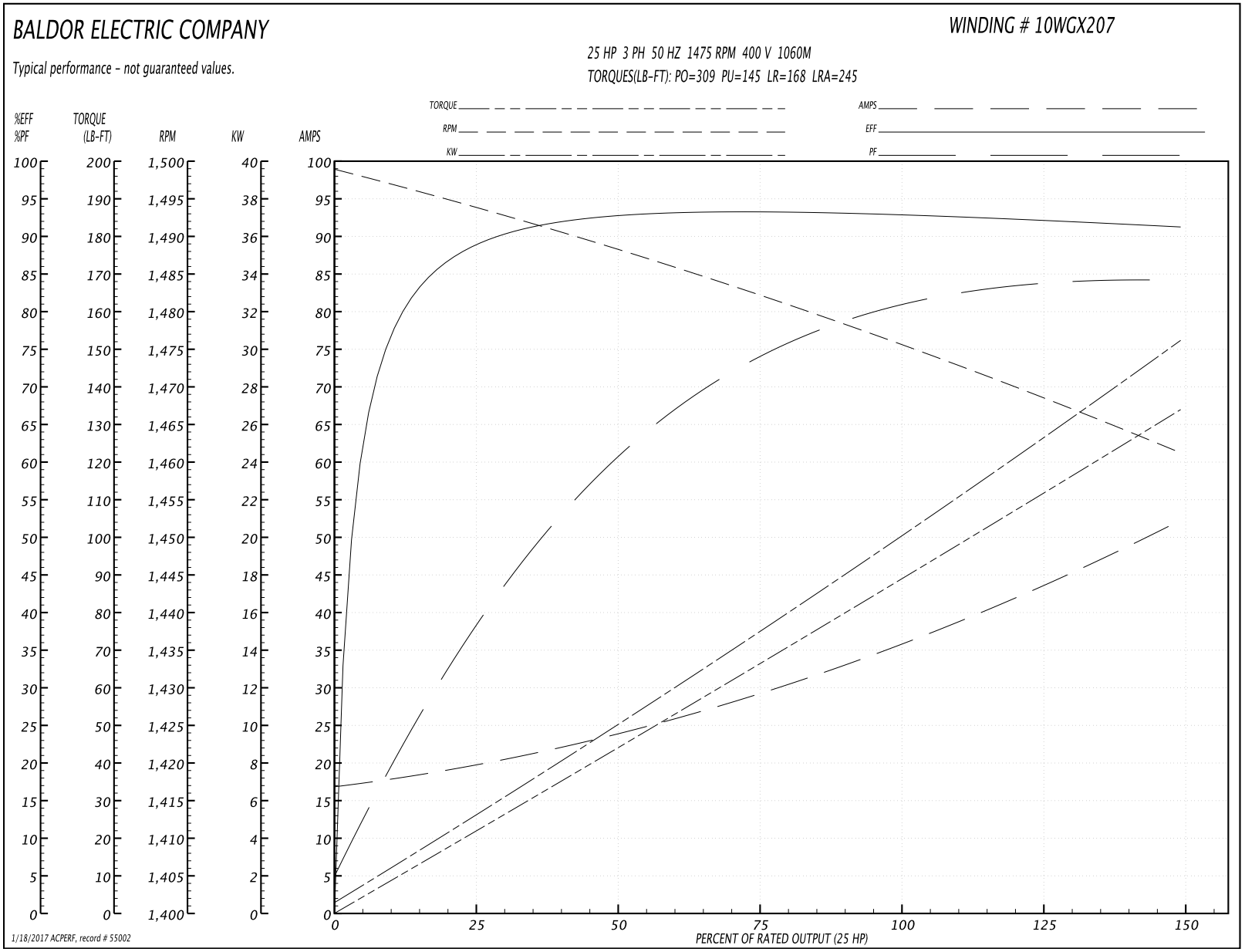
Winding: 10WGX207-R025	**Type:** 1060M	**Enclosure:** TEFC

Nameplate Data				400 V, 50 Hz: High Voltage Connection	
Rated Output (HP)	25			Full Load Torque	88.8 LB-FT
Volts	190/380-400-415			Start Configuration	direct on line
Full Load Amps	72/36			Breakdown Torque	309 LB-FT
R.P.M.	1475			Pull-up Torque	145 LB-FT
Hz	50	Phase	3	Locked-rotor Torque	168 LB-FT
NEMA Design Code	A	KVA Code	J	Starting Current	245 A
Service Factor (S.F.)	1			No-load Current	17.3 A
NEMA Nom. Eff.	93.6	Power Factor	77	Line-line Res. @ 25ºC	0.218 Ω
Rating - Duty	50C AMB-CONT			Temp. Rise @ Rated Load	63°C
S.F. Amps				Temp. Rise @ S.F. Load	76°C
				Locked-rotor Power Factor	35.4
				Rotor inertia	4.77 LB-FT2

Load Characteristics 400 V, 50 Hz, 25 HP

% of Rated Load	25	50	75	100	125	150
Power Factor	40	61	74	80	83	85
Efficiency	88.4	92.5	93.3	93.1	92.2	91.2
Speed	1494	1488	1482	1476	1469	1461
Line amperes	19.1	23.7	29.2	36.1	43.7	51.9

Performance Graph at 400V, 50Hz, 25.0HP Typical performance - Not guaranteed values



AC Induction Motor Performance Data

Record # 55003 - Typical performance - not guaranteed values

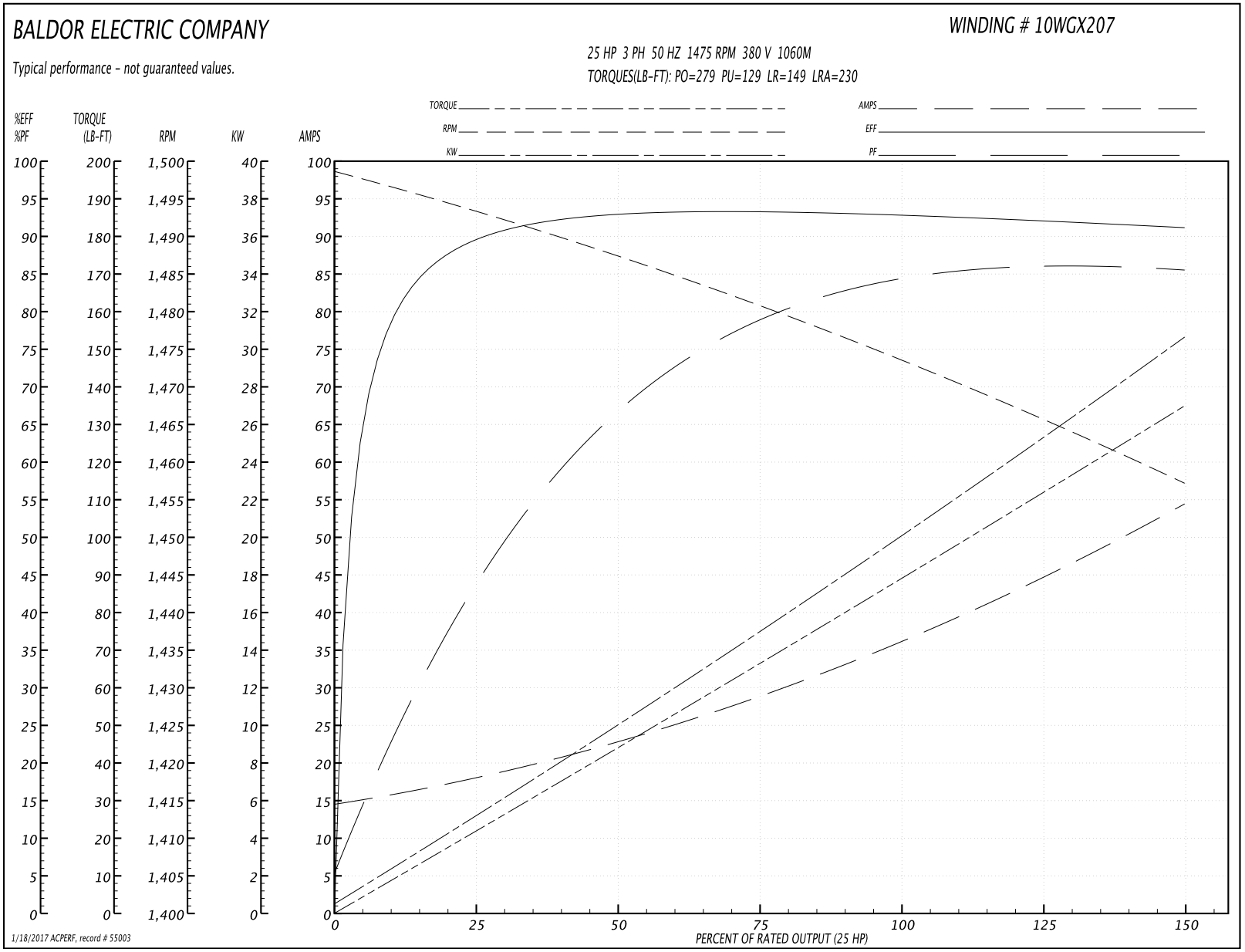
Winding: 10WGX207-R025	**Type:** 1060M	**Enclosure:** TEFC

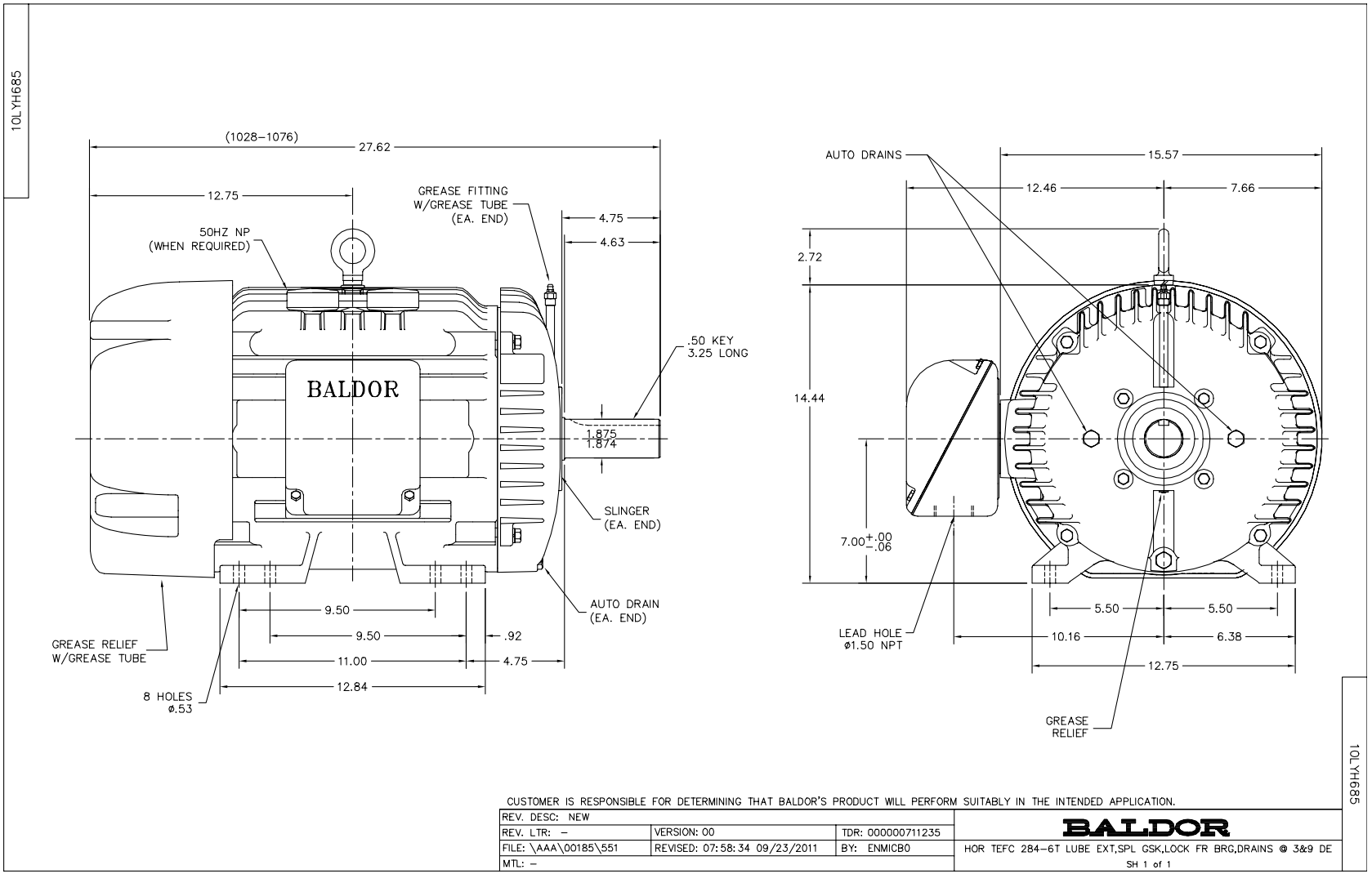
Nameplate Data				380 V, 50 Hz: High Voltage Connection	
Rated Output (HP)	25			Full Load Torque	89 LB-FT
Volts	190/380-400-415			Start Configuration	direct on line
Full Load Amps	72/36			Breakdown Torque	279 LB-FT
R.P.M.	1475			Pull-up Torque	129 LB-FT
Hz	50	Phase	3	Locked-rotor Torque	149 LB-FT
NEMA Design Code	A	KVA Code	J	Starting Current	230 A
Service Factor (S.F.)	1			No-load Current	15.1 A
NEMA Nom. Eff.	93.6	Power Factor	77	Line-line Res. @ 25ºC	0.218 Ω
Rating - Duty	50C AMB-CONT			Temp. Rise @ Rated Load	63°C
S.F. Amps				Temp. Rise @ S.F. Load	78°C
				Locked-rotor Power Factor	35.2
				Rotor inertia	4.77 LB-FT2

Load Characteristics 380 V, 50 Hz, 25 HP

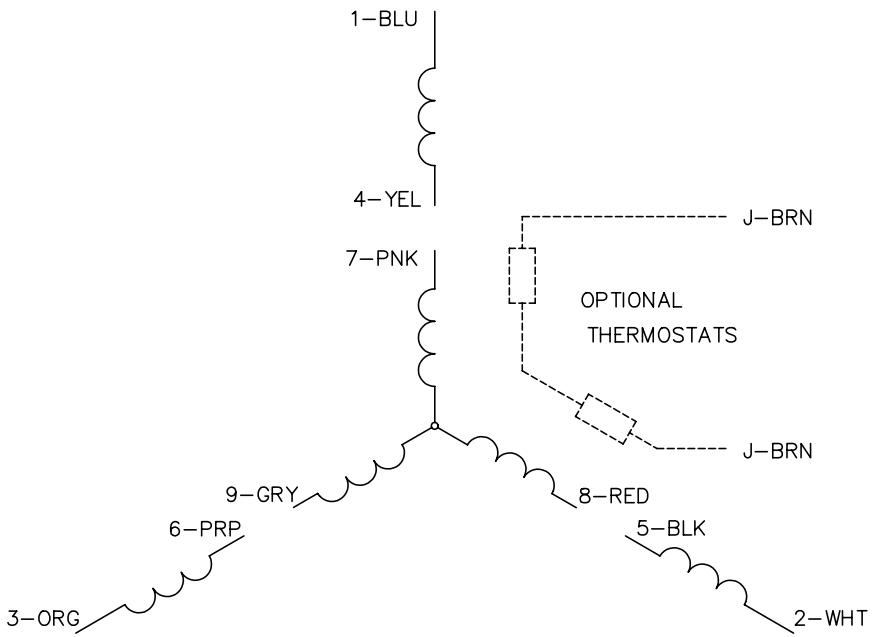
% of Rated Load	25	50	75	100	125	150
Power Factor	46	67	79	83	85	86
Efficiency	89.3	92.8	93.5	93.1	91.8	91.3
Speed	1493	1487	1481	1474	1466	1457
Line amperes	17.2	22.6	28.9	36.5	44.8	54

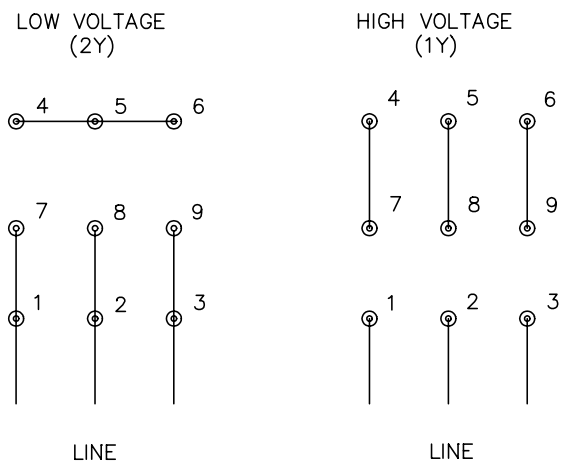
Performance Graph at 380V, 50Hz, 25.0HP Typical performance - Not guaranteed values




10LYH685
(1028–1076)
27.62
12.75
GREASE FITTING
W/GREASE TUBE
(EA. END)
4.75
4.63
50HZ NP
(WHEN REQUIRED)
.50 KEY
3.25 LONG
BALDOR
1.875
1.874
SLINGER
(EA. END)
AUTO DRAIN
(EA. END)
9.50
9.50
.92
11.00
4.75
12.84
GREASE RELIEF
W/GREASE TUBE
8 HOLES
ø.53
AUTO DRAINS
15.57
12.46
7.66
2.72
14.44
7.00 +.00 −.06
5.50
5.50
LEAD HOLE
ø1.50 NPT
10.16
6.38
12.75
GREASE
RELIEF
10LYH685
CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT BALDOR'S PRODUCT WILL PERFORM SUITABLY IN THE INTENDED APPLICATION.
REV. DESC: NEW
REV. LTR: –
VERSION: 00
TDR: 000000711235
FILE: \AAA\00185\551
REVISED: 07:58:34 09/23/2011
BY: ENMICB0
MTL: –
BALDOR
HOR TEFC 284–6T LUBE EXT,SPL GSK,LOCK FR BRG,DRAINS @ 3&9 DE
SH 1 of 1

CD0005





NOTES:

1. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
2. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
3. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY BE A MULTIPLE OF THOSE SHOWN ABOVE.
4. LEAD COLORS ARE OPTIONAL. LEADS MUST ALWAYS BE NUMBERED AS SHOWN.

CD0005

REV. DESC: REVISE TO SHOW OPTIONAL COLORS			BALDOR ELECTRIC Co.
REV. LTR: E	BY: JLP	REVISED: 01/19/99 10:15	TDR: 0171435
CD0005		FILE: AAA00005140	MDL: –
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Marketing maintained PDF of MN408:

http://www.baldor.com/support/Literature/Load.ashx/MN408?ManNumber=MN408

Marketing maintained PDF of MN416:

http://www.baldor.com/support/Literature/Load.ashx/MN416?ManNumber=MN416

Via A. Gramsci, 62 - 28050 Pombia (NO) Italy - Phone +39-0321-968311 - Fax +39-0321-958992
9660 Grunwald Road - Beasley Texas 77417 - Phone +1 -281-396-8385 - Fax +1 -281-396-8388
Kai Xuan Hua Yuan, 111 Zhong Cao Road, Shanghai 200030, P.R.China - Phone +86-2164-686460 - Fax +86-2164-686460
Cofimco Industrial Fans India Pvt. Ltd. - Survey Nos. 15/2A - Mel Ayanambakkam Main Road, Chennai - India - Phone +91-4465510390

Customer Name	Smithco	Job Reference	J-447
Job Name	UOP RUSSELL		
Item Number	17B430	Date	01/09/2017

CHARACTERISTICS

Required Volume	135900.00	ACFM	Required Static Pressure	0.6800	Inch H2O
Pressure recovery	0.0000	Inch H2O	Fan static pressure	0.6800	Inch H2O
Velocity pressure	0.1536	Inch H2O	Total pressure	0.8336	Inch H2O
Air Temperature	110.0	°F	Site Elevation	3000.0	ft
Inlet Air Humidity (%)			Inlet Air Density	0.0640	lb/ft³
Fan diameter	10.0	ft	Fan ring diameter	3072	mm
Blade Airfoil	24L	ALU	Rotor hub type	B3	
Speed	346.00	RPM	Blade Tip Speed	10869.91	ft/min
N. blades	5		Blade Operating Freq. +/-5%	469	cpm
Static efficiency	65.4	%	Total efficiency	80.2	%
Blade pitch angle	7.3	(°)	Rotor shaft power	22.3	hp
			Rotor shaft power @ API point	29.9	hp
Pressure Margin (%)	60 [1] / 76 [2]		Volume Margin (%)	27 [1]	
Tip Clearance/D	0.004		Inlet	Flanged	
Diffuser angle (°)			Diffuser:Length/D		
Inlet Obstacle a/A			Inlet Obstacle x/D		
Outlet Obstacle a/A			Outlet Obstacle x/D		
Installation Type	Forced		Aerod axial force	1513	N
Rotor total weight	70	kg			
Rotor inertia PD²	114	kg x m²			
Max residual unbalance	16.0	N			
Blade Failure Load	5694	N			
2 Blades Failure Load	9213	N			
Xs Static deflection	93	mm	Xr Running deflection	76	mm

[1] according to API [2] at Design Pitch Angle

NOISE CHARACTERISTICS

Tolerance on sound values +/- 2 dB(A)

PWL (± 2)	SPL @	Inlet / outlet (± 2)	Side (± 2)
93.7 dB(A)	3.0 ft From Fan	82.1 dB(A)	72.0 dB(A)

Octave [Hz]	31.5	63	125	250	500	1000	2000	4000	8000

ROTOR MODEL 3048- 5-24L/B3T PAC

All data must be approved by Cofimco Fantastic.NET 5.0

Industrial Belt Design - Drive Detail Report

Unlaub® Problem Solver using Gates DF-Pro

Designed For: REGINA
SMITHCO

Provided By: Marty Lansford
The Unlaub Co.
1722 E. King Pl.
Tulsa, Oklahoma 74110
United States
918-895-8814 Phone

Application: **17B430**

INPUT

Known Belt: **Super HC**
5VX1250 - 3

Speed Ratio: 5.06 Down
Input Load: 30 hp, Efficiency: 93.00 %
Service Factor: 1.4
Design Power: 42 hp
Center Distance: 30.14 in
Motor Standards: NEMA Electric Motor, NEMA 286T frame

	DriveR	DriveN
Known Size:	6.3 in Outside	31.5 in Outside
RPM:	1750.0	345.5
Shaft Diameter:	1.875 in	2.4375 in
Bushings Checked:	QD, No MPB	
Belts Checked:	Super HC	
		Single Belts

SELECTED DRIVE

Belt Type: **Super HC - 5VX**
Speed Ratio: **5.06 Down**
dN RPM: **345.5**
Rated Load: **47.07 hp**
ODR: **1.12**
Belt Pull: **620 lbf**
Center Distance: 30.14 in
Install/Take-Up Range: 29.14 in to 31.94 in

	Belt	DriveR	DriveN
Total # of Strands/Ribs:	3		
Part No:	3-5VX1250	QD3/5V6.30	QD3/5V31.50
Product No:	9414-1250	7874-3063	7874-3315
Top Width:	--	2.38 in	2.38 in
Weight:	3.4 lb	9.6 lb	110 lb
Rim/Belt Speed:	2840 ft/min	2886 ft/min	2849 ft/min
RPM:	272.7	1750.0	345.5
Bushing Part No:	--	SK 1 7/8	F 2 7/16
Bushing Product No:	--	7838-4114	7839-2207
Bore:	--	1.875 in	2.4375 in
Bolt Torque	--	180 lb-in	1320 lb-in
Pitch Diameter:	--	6.20 in	31.40 in

TENSION

	New Belt	Used Belt
Static Tension (per rib/strand):	148 to 159 lbf	127 to 138 lbf
Static Belt Pull (total pull):	809 to 867 lbf	693 to 751 lbf
Rib/Strand Deflection Distance:	0.43 in	0.43 in
Rib/Strand Deflection Force:	10 to 11 lbf	8.8 to 9.4 lbf
Sonic Tension Meter:	660 to 707 N	566 to 613 N
Belt Frequency:	49 to 51 Hz	46 to 48 Hz
507C/508C Model STM Settings:	Mass 140.38g/m,Width: 1 mm/#R, Span: 695 mm	
Powerband Multiplier:	1.0049 to 1.0053	1.0042 to 1.0046

NOTES

- The belt width was user specified.
- This drive was not selected by Design Flex; the belt width/length was specified by the user.
- User requested non-PowerBand belts.
- The DriveN pulley/bushing weight exceeds 50 lb. Exercise care during installation.

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.

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.

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)

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, 8200-003-IEC, 8200-008-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

A A A - B C D - E F
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]
	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	1	2	3	4	5	6	7	8
0	Y	Y	N	N	N	Y	N	Y
1	Y	Y	N	N	N	Y	N	Y
2	Y	N	Y	Y	Y	N	Y	N
3	Y	N	Y	Y	Y	N	Y	N
4	Y	N	Y	Y	Y	N	Y	N
5	Y	Y	N	N	N	N	N	N
6	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	None	None	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	4		½" NPT	3-position	Powder	None	None	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	None	None	Copper-free aluminum
0	1	0		¾" NPT	4-position	Powder	None	None	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
   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)
2. B=IEC is only available for AAA=001, 003, and 008 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

ACCESSORIES - CABLES

	Part Number	Description
	**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.
	**9334-111-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. 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.
	**9334-211-XXXX-YYYY**	**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.
	**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

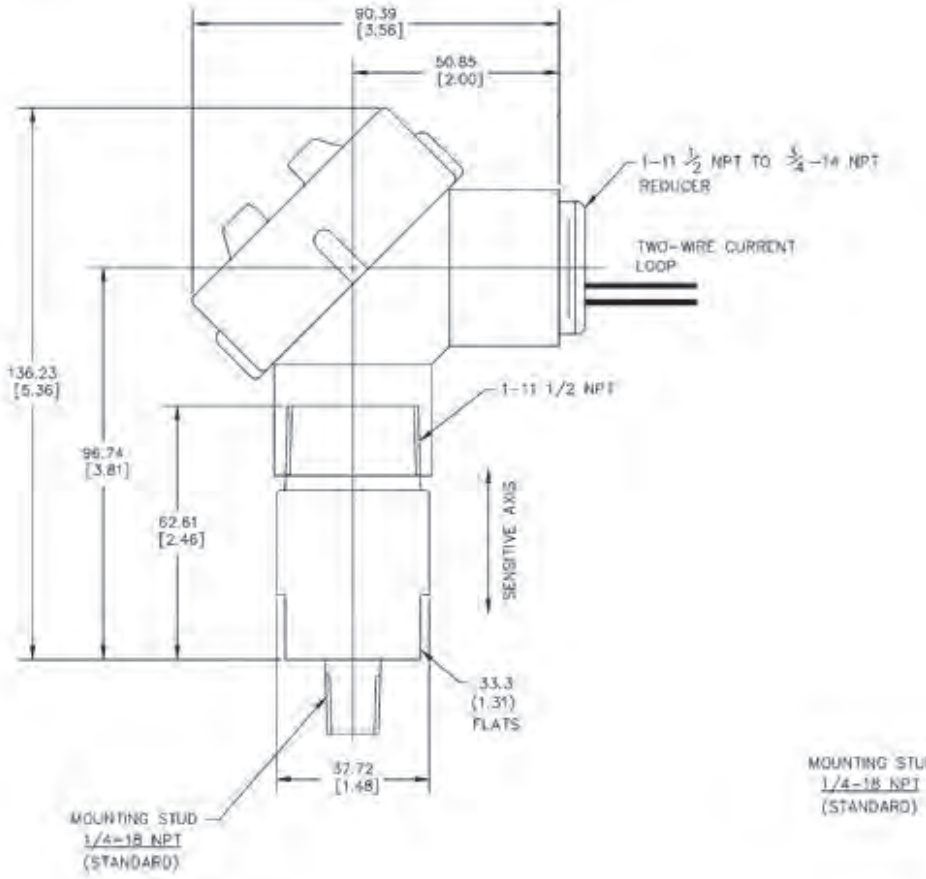


Figure 1: Outline dimensions of the ST5484E (all versions except MIL-Style Connector). Dimensions in mm [inches]. Optional* 8200-001 conduit elbow shown installed.

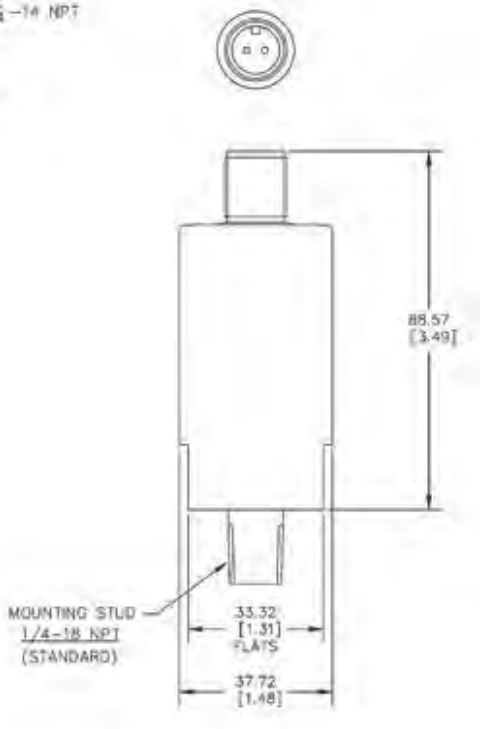


Figure 2: Outline dimensions of the ST5484E-XXX-XX4-XX (MIL-Style Connector). Dimensions in mm [inches].

* **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	

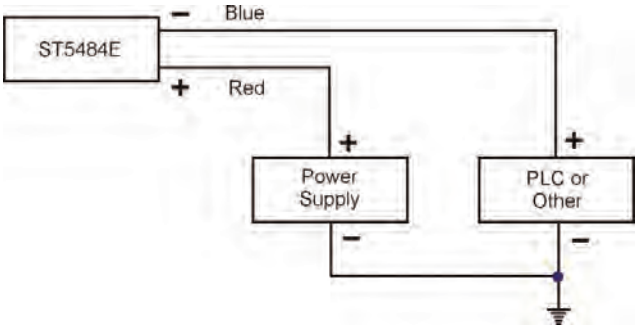


Figure 3: Typical installation for a single ST5484E seismic vibration transmitter.

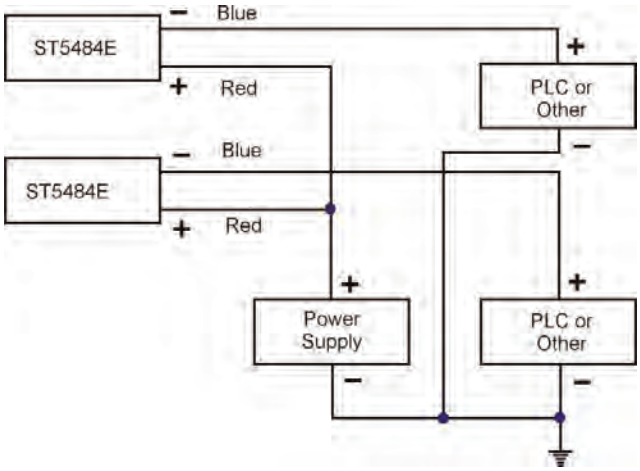


Figure 4: Typical installation for multiple ST5484E seismic vibration transmitters.

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

Pneumatic Actuator

Durastroke Series 1500 – 1999

Installation & Maintenance Instructions

INSTALLATION

Installation of Airtech Products Durastroke pneumatic actuator is a simple three-step process; Mounting of the actuator & attachment to load, connection of air line and connection of the control signal. Before starting installation, inspect the actuator and contents of the shipping carton to ensure all required parts are present. Check the following:

- Ensure all parts are firmly secured to the mounting plate and the mounting plate is firmly secured to the actuator body.
- Clevis is present at the end of travel stem?
- The following hardware kit was included:
    1. Five (5) 3/8-16 x 1 ½" long bolts
    2. Four (4) 3/8" lock washers
    3. One (1) 3/8-16 locking nut

A) Mounting The Actuator:

1. The actuator can be mounted in either a vertical or horizontal position.
2. The actuator is supplied with four (4) 3/8"-16 bolt-holes in the bottom plate for attachment to a mounting plate or bracket.
3. A hole at least 13/16" (but not larger than 1" diameter) must be provided in the center of the actuator mounting bolthole pattern for penetration of the actuator travel stem and clevis.
4. Attach the actuator to the mounting bracket with the four supplied 3/8"-16 x 1½ " bolts and lock washers. In a rotating pattern, tighten each to 16 Ft-Lbs torque.
5. **DO NOT ATTACH THE ACTUATOR TO THE TORQUE TUBE LEVER ARM YET.**

B) Air Line Connections:

1. Blow out all piping before connections are made to prevent dirt, chips, etc from entering the positioner. Ensure all air entering the positioner and actuator is clean, dry and oil free. Failure to do so increases the possibility of operational problems and/or deviation from specified performance.
2. Locate the 1/4" NPT ports on the two Fisher 67CFR Filter Regulators.
3. Install a 1/4" threaded adapter in the air inlet ports of both filter regulators. Non-hardening sealant (used sparingly) on male threads only is suggested.
4. Connect 1/4" or 3/8" air line to the supply ports of both filter regulators. Total air pressure in these lines should be regulated to approximately 100 psig.

C) Control Signal Connection:

1. Locate the 1/2" NPT port for the conduit connection and install male adapter.
2. Connect conduit and thread wiring into transducer connection terminals
3. Connect leads for control signal to corresponding terminals in transducer.
4. Securely reinstall cap.

D) Connecting The Linkage:

1. In most cases**, the torque tube lever arm will be preset at the factory to drive the louver either "Fail Open" or "Fail Closed" upon loss of air and / or actuator retraction. As a result, connection of the linkage will be a simple matter of manually situating the louver blades and actuator stem to the correct position and then attaching the control link to the clevis (at the base of the actuator stem) and finally to the torque tube lever arm. To determine how the actuator and louver blades should be positioned, please note the following instructions:

    a. **"Fail Open" Louvers**
        - Stroke actuator to fully extended and manually set louver to fully closed position before connecting louver lever arm & link to actuator clevis.
    b. **"Fail Closed" Louvers**
        - Ensure actuator is completely retracted and manually set louvers to fully closed position before connecting louver lever arm & link to actuator clevis.

2. When all sections are installed and connected, stroke the actuator several times to ensure it moves the entire louver freely without binding or interference. On very large louvers with multiple sections, inspect to confirm all the sections are fully open and completely closing in unison. Some adjustment of end links or torque tube clamps may be required to ensure all louver blades open and shut consistently down the entire length or across the entire width of the louver.
3. Check all attachment fasteners to ensure all are properly tightened and completely engaged to the louver flange.
4. If applicable, check all end link connections and torque tube couplers to ensure they are properly tightened and fasteners are completely engaged.

For new orders only when the actuator is purchased in conjunction w/louvers. Please contact the factory for specific instructions on retrofit or other applications that did not see both the actuator and louver originate as simultaneous/concurrent Airtech orders

MAINTENANCE

Annual Inspection:

1. Inspect and verify all mechanical connections
    - Actuator bolting to mounting plate or bracket
        - Check mounting plate or bracket rigidity
        - Confirm actuator to mounting bracket bolt tightness
    - Clevis general condition
        - Visually inspect overall clevis condition
        - Confirm fastener between clevis and actuator link is sound
    - Link to torque tube lever arm
        - Visually inspect overall link condition
        - Confirm fastener between link and torque tube lever arm is sound
    - Positioner attachment to actuator body
        - Visually inspect positioner for visible cracks or damage
        - Confirm positioner is securely fastened to actuator body

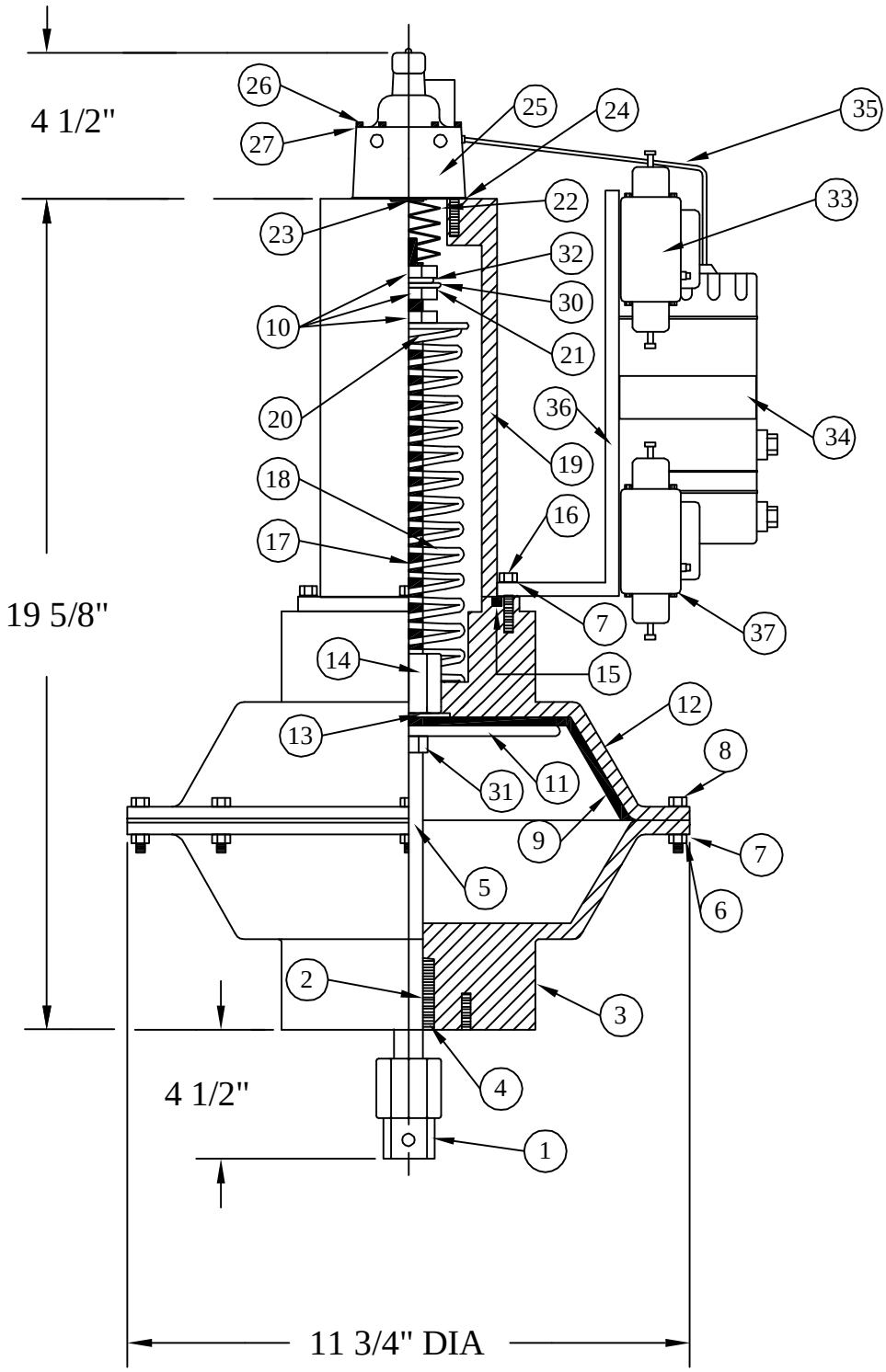
2. Inspect and verify all pneumatic and electrical connections
    - Air connections to filter regulators
        - Supply line to threaded adapters
        - Adapters to filter regulators
    - Diaphragm
        - Confirm 35-50 psig air at Positioner Supply Port
            - § Listen for leaks at stem
    - Positioner
        - Confirm 3 – 15 psig at instrument air port
            - § Confirm louver operation in response to proportioned air

Repair Kit & Recommended Spare Parts List

The following items are recommended as a single actuator repair kit. It is suggested that one repair kit be kept on hand for each 3 actuators on site and in service. Please note a repair & maintenance kit is not offered for the positioner because of the complexity of that particular item. Best practice is simply to replace a non-operational positioner. Item numbers noted below refer to Airtech Products, Inc. drawing, "Durastroke 1100 Actuator".

Item Number	Description
2	Guide Bushing
4	Snap Ring
9	Diaphragm
13	Diaphragm Washer
15	O-Ring
23/24/25	Kit, Positioner, Std Duty
33/37	Fisher 67 CFR w/gauge
34	Fisher 646 I/P Transducer w/0-30 Gauge

12-22-08



AIRTECH PRODUCTS, INC.	
Dwg. Name: DURASTROKE 1500 ACTUATOR	
Date: 1/30/08	By: STEWART
Customer:	File #: AIR MOTOR

ITEM	QTY.	DESCRIPTION
1	1	CLEVIS
2	1	GUIDE BUSHING
3	1	LOWER HOUSING
4	1	SNAP RING
5	1	STEM
6	8	HOUSING NUT
7	12	LOCKWASHER
8	12	HOUSING SCREW
9	1	DIAPHRAGM
10	3	LOCKNUT
11	1	DIAPHRAGM PLATE
12	1	UPPER HOUSING
13	1	DIAPHRAGM WASHER
14	1	CONNECTOR NUT
15	1	O-RING
16	4	SPRING COVER SCREW
17	1	SPRING ROD
18	1	MAIN SPRING
19	1	SPRING COVER
20	1	SPRING WASHER
21	1	WASHER
22	1	POSITIONER SPRING
23	1	POSITIONER WASHER
24	1	GASKET
25	1	POSITIONER
26	6	POSITIONER SCREW
27	6	LOCKWASHER
28		
29		
30	1	WASHER
31	1	LOCKNUT
32	1	SAE FLAT WASHER
33	1	FISHER 67CFR-235 WITH 0-30 GAUGE
34	1	FISHER 646 I/P WITH 0-30 GAUGE
35	1	AIR LINE
36	1	MOUNTING BRACKET
37	1	FISHER 67CFR-237 WITH 0-60 GAUGE

AIRTECH PRODUCTS, INC.	
Dwg. Name: DURASTROKE 1500 ACTUATOR	
Date: 12/22/08	By: Stewart
Customer:	File #: AIR MOTOR

SPARE PARTS

Serving the Industry Since 1952
Member of HTRI & ACHEMA

SMITHCO ENGINEERING
7718 E. 91st St. Suite #200
Tulsa, Oklahoma 74133
Phone: (918) 446-4406
Fax: (918) 446-7439

Co: UOP Russell LLC
Ref: 4500753943
A-301

Date: 6/20/2017

RECOMMENDED SPARE PARTS FOR 2 YEAR OPERATION
SMITHCO JOB NO. 2017B430

Item #	QTY	Description	Net Each	Total Net
001	18	A1052222 Plugs	$6.25	$112.50
002	36	CS2213 gasket	$.50	$18.00
003	4	A1051822 Plugs	$5.00	$20.00
004	8	CS1813 gasket	$.50	$4.00
005	1	Cofimco Fan #3048-5-24L/B3T	$1,749.00	$1,749.00
006	1	2.4375 X 46.5 Shaft with 0.6250 X 0.3125 Keyway 4.25 one end 4.620 other end with keys (2) snap rings	$354.00	$354.00
007	1	30 HP Electric Motor, Smithco Job 2017B430	$2,224.00	$2,224.00
008	2	2.4375 SCM Flange Bearings	$256.68	$513.36
009	1	Matched set of (3) 5VX1250 V-Belt	$269.10	$269.10
010	1	3 groove 5V - 31.50 sheave with bushing	$1,020.28	$1,020.28
011	1	3 groove 5V - 6.30 sheave with bushing	$137.08	$137.08
012	1	Metrix ST5484E-122-120 Vibration Switch	$1,326.00	$1,326.00
			TOTAL	**$7,747.32**

The recommended quantities are for remote locations.

SECTION (4)

MAINTENANCE

Warranty Contacts

Parts, Service and Warranty Manager

Smithco Engineering

6312 S. 39th West Ave.

Tulsa, OK 74132

Phone: (918) 388-0325

Fax: (918) 446-7439

E-mail: parts@smithco-eng.com

Parts Sales Associate

Smithco Engineering

6312 S. 39th West Ave.

Tulsa, OK 74132

Phone: (918) 388-0328

Fax: (918) 446-7439

E-mail: parts@smithco-eng.com

Equipment Warranty is based on negotiated Terms and Conditions as stated in

Customer PO #: 4500741425

Smithco Job #: 16B376

Smithco Engineering

6312 S. 39th West Ave., Tulsa, OK 74132

(918) 446-4406

www.smithco-eng.com

Maintenance

This section of the manual contains information concerning service and maintenance of your air-cooled heat exchanger.

WARNING: Turn off and lock out or tag power source before proceeding with inspection of the cooler internal surfaces or mechanical equipment.

General Maintenance:

The interior and exterior of the air-cooled heat exchanger should be inspected periodically for safety, damage and cleanliness. All guards provided with the unit must be in place and properly attached. No buildup of grease or dirt should be allowed on any of the components. The finned tubes exterior should be checked for dirty fins and clogging of the fins with dirt or lint. The interior of the tubes should be checked for rust and scale. The thermal design is based on clean exterior and interior heat exchanger surfaces.

Mechanical Equipment References:

VENDOR WEBSITES:

ELECTRIC MOTORS:	www.reliance.com
	www.sea.siemens.com/motors
FANS:	www.cofimco.com
	www.moorefans.com
FAN SHAFT BEARINGS:	www.dodge-pt.com
V-BELTS:	www.gates.com
	www.dayco.com
VIBRATION SWITCHES:	www.fwmurphy.com
	www.metrix1.com
	www.icca.invensys.com (Robert Shaw)
SPIRAL BEVEL GEAR BOXES:	www.amarillogear.com
	www.hubcityinc.com
LOUVER ACTUATORS AND CONTROLLERS:	www.airtechproducts.com
	www.emersonprocess.com (Fisher Actuators and Controls)
LOUVERS:	www.airtechproducts.com

ELECTRIC MOTOR MAINTENANCE

WARNING! Turn off and lock out or tag power source before proceeding.

Inspection:

Each motor should be inspected at regular intervals. The frequency and thoroughness will depend on the amount of operation, nature of service and the environment.

Cleanliness:

The motor exterior should be kept free of oil, dust, dirt, water and chemicals. For fan-cooled motors, it is important to keep the air intake opening clear of debris.

Moisture:

On non-explosion proof TEFC motors, a removable plug in the bottom center of the motor frame permits removal of any accumulated moisture. Drain regularly.

Lubrication Schedule:

Check and re-lubricate bearings each six months (more often if conditions require) as follows:
For best results, grease should be compounded from a lithium soap base and petroleum oil. It should be of No. 2 consistency and stabilized against oxidation. Operating temperature range should be from -15°F to +250°F for Class B insulation and to +300°F for Class F and H. Most major oil companies have special bearing greases that are satisfactory.

CAUTION! Adding grease to bearing when motor is operating may cause grease to go through clearance around inside end cap and be slung onto motor windings.

1. Thoroughly clean the grease connections at the ends of the extended lube lines.

2. Remove plugs from drains.

3 Remove hardened grease from drains with stiff wire or rod.

4. Add grease to inlet with hand type gun until small amount of new grease is forced out of the drain.

5. Clean excess grease from the drains and grease connections and run the motor 30 minutes before replacing the drain plug.

V-BELT TENSIONING INSTRUCTIONS

WARNING! Turn off and lock out or tag power source before proceeding.

SIMPLIFIED BELT TENSIONING METHOD

This tensioning method assumes average static tensions for drives, thereby eliminating the need for calculating static tension. Use this method if the small sheave diameter, small sheave rpm and speed ratio fall within the limits as given in table number 1; the number of belts used corresponds to the number recommended in this manual; and the drive has at least 2 belts.

Step 1: From TABLE NUMBER 1, determine the force required to deflect one belt 1/64" per inch of span length (length from C to C of sheaves along the belt)

- Measure the span length (t) of the drive.
- At the center of the span measure the force required to deflect one belt on the drive 1/64 per inch of span length from its normal position. The adjacent belt can be used as a reference for measuring the deflection. (see the figure below TABLE NUMBER 1, Page 10) Be sure to apply the force perpendicular to the belt.
- Measure the force required to deflect a band of belts 1/64 per inch of span length as discussed above. Divide the value by the number of belt strands in the band to find the deflection force per belt.

Note: Lay a steel bar or a narrow block of wood across the belt and apply the deflection force to the bar so that all of the individual strands in the band are deflected the same amount. If more than one belt is used in the drive, the neighboring band can be used as a reference for measuring the deflection, just as is done with individual belts. If only one band is used, lay a straightedge or stretch a string from sheave-to-sheave to use as a reference for measuring the deflection. Lay the straightedge or string across the back of the belt on the sheaves.

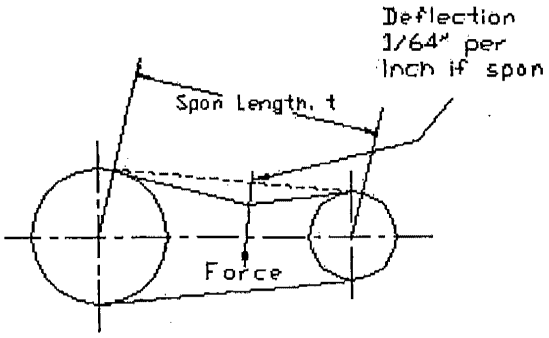
Step 2: Compare this deflection with the range of forces given in TABLE NUMBER 1.

- If it is less than the minimum recommended force, the belts tensioned must be increased.
- If it is more than the maximum recommended force, the drive tension must be reduced.

TABLE NUMBER 1

RECOMMENDED DEFLECTION FORCE PER BELT

Cross Section	Smallest Sheave Diameter Range	RPM Range	Belt Deflection Force				Cross Section	Smallest Sheave Diameter Range	RPM Range	Belt Deflection Force			
			S-L Classic & Polyband		Classic Cog					D-V Wrapped		D-V Cog	
			Normal	New Belt	Normal	New Belt				Normal New	New Belt	Normal	New Belt
A, AX	3.0-3.6	1000-2500 2501-4000	3.7 2.8	5.5 4.2	4.1 3.4	6.1 5.0	3VX	2.2-2.4	1000-2500 2501-4000			3.3 2.9	4.9 4.3
	3.8-4.8	1000-2500 2501-4000	4.5 3.8	6.8 5.7	5.0 4.3	7.4 6.4		2.65-3.65	1000-2500 2501-4000	3.6 3.0	5.1 4.4	4.2 3.8	6.2 5.6
	5.0-7.0	1000-2500 2501-4000	5.4 4.7	8.0 7.0	5.7 5.1	9.4 7.6		4.12-6.90	1000-2500 2501-4000	4.9 4.4	7.3 6.6	5.3 4.9	7.9 7.3
B, BX	3.4-4.2	860-2500 2501-4000			4.9 4.2	7.2 6.2	5V, 5VX	4.4-8.7	500-1749 1750-3000 3001-4000			10.2 8.8 5.6	15.2 13.2 8.5
	4.4-5.6	860-2500 2501-4000	5.3 4.5	7.9 6.7	7.1 7.1	10.5 9.1		7.1-10.9	500-1740 1741-3000	12.7 11.2	18.9 16.7	14.8 13.7	22.1 20.1
	5.8-8.6	860-2500 2501-4000	6.3 6.0	9.4 8.9	8.5 7.3	12.6 10.9		11.8-16.0	500-1740 1741-3000	15.5 14.6	23.4 21.8	17.1 16.8	25.5 25.0
C, CX	7.0-9.0	500-1740 1741-3000	11.5 9.4	17.0 13.8	14.7 11.9	21.8 17.5	8V	12.5-17.0	200-850 851-1500	33.0 26.8	49.3 39.9		
	9.5-16.0	500-1740 1741-3000	14.1 12.5	21.0 18.5	15.9 14.6	23.5 21.6		18.0-22.4	200-850 851-1500	39.6 35.3	59.2 52.7		
D	12.0-16.0	200-850 851-1500	24.9 21.2	37.0 31.3									
	18.0-20.0	200-850 851-1500	30.4 25.6	45.2 38.0									



Belt Deflection Figure

HTD BELT TENSIONING INSTRUCTIONS

WARNING! ***Turn off and lock out or tag power source before proceeding***

BELT TENSION

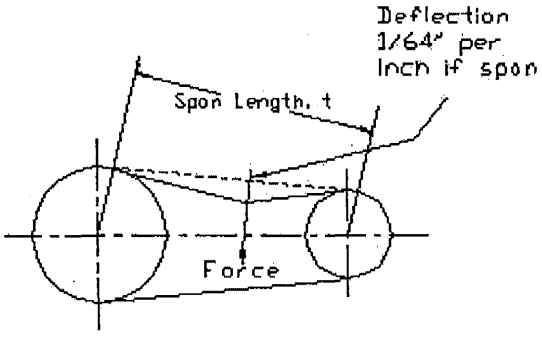
HTD drives do not require as much tension as V- belt drives that depend on friction to transmit the load. HTD belts should be installed with a snug fit, neither too taut nor too loose. After the belt has been so tensioned, a force to deflect the belt by an amount to assure proper tension can be measured. Measure the belt span (see sketch). Using a spring scale, apply force perpendicular to the center of the belt width and the center of the belt span. Measure the force necessary to deflect the belt 1/64" for each inch of belt span. For example, the deflection for a 32" belt span is 32 x 1/64 = 1/2" deflection. The force required to deflect the belt the amount required at the proper tension is listed in table below.

DEFLECTION FORCE FOR Power Grip & Poly Chain GT2 BELTS

PITCH	WIDTH	FORCE
8mm	20mm	24 lbs.
	30mm	39 lbs.
	50mm	67 lbs.
	85mm	122 lbs.
14mm	40mm	99 lbs.
	55mm	156 lbs.
	85mm	266 lbs.
	115mm	378 lbs.
	170mm	581 lbs.

NOTE: For belts wider than 2" (50mm), it is suggested that a strip of key stock, or something similar, be placed across the belt under the point of force to prevent distortion.

For drives with shock loading or other unusual conditions, the force may have to be increased for proper operation of the drive.



LUBRICATION OF FAN BEARINGS

The bearings have been greased at the factory and are ready to run. The following table is a general guide for re-lubrication. Operating conditions may require different lubrication periods.
Bearings have been lubricated at the factory with number two consistency lithium base grease which is suitable for normal operating conditions.

Re-lubricate with lithium base grease or grease compatible with original lubricant and suitable for ball bearing service. In certain cases, such as low temperature or high temperature applications, it may be necessary to consult a lubrication supplier for recommendations.

LUBRICATION GUIDE

Read Preceding Paragraphs Before Establishing Lubrication Schedule.

Hours Run Per Day	Fan Shaft RPM and Suggested Lubrication Period In Weeks							
	1 to 250 RPM	251 to 500 RPM	501 to 750 RPM	751 to 1000 RPM	1001 to 1500 RPM	1501 to 2000 RPM	2001 to 2500 RPM	2501 to 3000 RPM
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	1	1
24	10	5	3	2	1	1	1	1

GEAR MAINTENANCE

LUBRICATION INSTRUCTIONS

Recommended lubricants are as follows:

AMBIENT-DEGREES F	15-50	50-125
AGMA NUMBER	4EP	5EP
VISCOSITY RANGE	626-755 SSU @ 100°F	918-1122 SSU @ 100°f

Consult the gear manufacturer's data for a recommended oil and manufacturer.

SYNTHETIC GEAR LUBRICANTS

Synthetic oils have been used in enclosed gear drives for special operating conditions. Synthetic lubricants can be advantageous over standard oils in that they are generally more stable, have a longer life, and operate over a wider temperature range.

INSTRUCTIONS FOR INSTALLATION AND STARTING NEW UNIT

WARNING! Turn off and lock out or tag power source before proceeding.

1. When units are shipped, internal parts are protected by rust preventive film. Flushing is not required since it is soluble in the lubricant. Fill the case with recommended lubricant to the proper oil level.
   NOTE: units may be shipped without oil and must be filled before starting.
2. Gear units may be shipped with the breather port plugged. Prior to operation, a breather type plug (supplied with the unit) must be installed in the upper housing.
3. Coupling connections must be aligned for proper parallel and angular misalignment.
4. If it is required to shim the gearbox for alignment, care must be taken to prevent distortion of the housing. **Note: coupling and unit alignment should be rechecked after two weeks operation.**
5. When units furnished with force feed lubrication are started, it should be confirmed that oil is being pumped.
6. For low temperature operation, with oil viscosity at starting greater than 5,000 SUV, heaters must be used. For units with pressure lubrication systems, confirm the pump is pumping the cold oil.

7. The minimum viscosity required under normal operating conditions ranges from 150 to 400 SUV. Oils having this viscosity under normal operating conditions may not be satisfactory for low temperature starting and heaters must be used.

8. Where unit will not warm up under intermittent operating conditions, low-viscosity oil may be required for low temperature operation.

WARNING! Turn off and lock out or tag power source before proceeding.

OIL CHANGES

After installation, the first oil change should occur after two weeks of operation. After the original oil has been drained, fill the case to the required level with SAE-10 straight run mineral flushing oil containing no additives. Start the fan and let it get up to speed, then stop it. This works as a flushing procedure. Drain the flushing oils and fill with the recommended lubricant to the proper level.

Change the oil every six months unless conditions warrant closer intervals. If the oil temperature is continuously above 200°F, or if the unit is subjected to an unusually moist atmosphere, oil changes may be necessary at one, two or three month intervals, as determined by field inspection of the oil.

Prevent any foreign matter from entering the gear case. Dust, dirt, moisture, and chemical fumes form sludge.

INSTRUCTIONS FOR MAINTENANCE

1. Stop the unit and check the oil level once a week. The lubricant level should be no more than 1/4" below specified level.
2. Units should be given daily visual inspections and observation for oil leaks or unusual noises. If either occurs, the cause must be found and corrected.
3. The operating temperature of the unit is the temperature of the oil inside the housing. The maximum operating temperature should not exceed 200°F.

INSTRUCTIONS FOR SHUTDOWN PERIODS

If unit will be idle for a period longer than one week, it will be necessary to run the unit for ten minutes every week it is idle. This short operation will keep the gears and bearings coated with oil and prevent rusting due to condensations of moisture resulting from temperature changes.

PLUG TIGHTENING PROCEDURE

SMITHCO ENGINEERING, INC.
P.O. Box 571330 • Tulsa, Oklahoma 74157-1330
Phone Number (918) 446-4406 • 6312 S. 39th West Ave Tulsa, OK 74132-1237• Office
Fax Number (918) 445-2857 • 6211 S. 39th West Ave Tulsa, OK 74132-1237• Plant

Plug Torquing Procedure

On plug type headers, plugs are installed at room temperature in our plant and have passed a hydrostatic test. Occasionally, field leak testing or heating up of the unit will indicate that some natural relaxation of the load on the gasket has occurred and therefore results in a leak. When this occurs, it is necessary to re-tighten the plugs in the field. The plugs are already tightened to a minimum torque in Smithco's shop as shown in the following table:

Plug Threaded Diameter	Max Plug Length	Minimum Torque Value (ft-lbs)
1 1/8"	1 ¼"	150
1 1/8"	1 ½"	200
1 1/8"	1 ¾"	250
1 1/8"	2"	300
1 1/8"	> 2"	400
1 3/8"	1 ½"	300
1 3/8"	> 1 ½"	400

The coefficient of friction in our shop is for new, well lubricated threads and so therefore field torque values will probably be higher. Giving precise torque values can not be completely accurate due to the variation in the lubrication and smoothness of the surfaces. A better method of sealing the leaks is as follows:

1) Locate the leaking plug.
2) Administer an impact using an 18" inch swing of a 2 lb hammer to the outside face of the plug to assist in the plastic flow of the gasket into the microscopic surface irregularities.
3) Turn the plug ½ of a flat (30° rotation) clockwise. This results in approximately 0.007" additional compression on the gasket.
4) Repeat steps 1) through 3) just until the leak is sealed. Do not repeat steps 1) through 3) more than 4 times. After the 4th time. Remove the plug. Check the gasket surfaces and recondition if necessary. Replace the gasket and start the process from the initial torque step.

The plugs are NOT indestructible. The threaded surfaces should be in good condition. We recommend against the use of impact wrenches, however, any plugs damaged by use of an impact wrench should be replaced.

Box Wrenches

Striking-Face Box Wrenches

Rap the large striking surface with a hammer when extreme force is necessary to loosen and set large fasteners. Wrenches are made of forged steel with a black finish. Meet Fed. Spec. GGG-W-636e.

Offset—Handle is offset 45° to help clear obstructions.

Straight—Designed to apply maximum force directly through the handle to the fastener head and to keep wrench head on the fastener when wrench is struck.

Size	Head Thick.	O'all Lg.		Each
12-Point Offset				
11/16"(27mm)	11/16"	10"	**5455A11**	$31.16
1 1/8"	3/4"	11"	**5455A12**	32.72
1 3/16"(30mm)	3/4"	11"	**5455A47**	37.11
1 1/4"(32mm)	3/4"	11"	**5455A13**	34.37
1 5/16"	3/4"	11"	**5455A14**	35.67
1 3/8"	7/8"	11 17/32"	**5455A36**	39.80
1 7/16"	7/8"	11 17/32"	**5455A15**	41.47
1 1/2"	1"	12 1/32"	**5455A16**	43.03
36mm	7/8"	11 17/32"	**5455A51**	48.35
1 9/16"	1 1/8"	12 1/2"	**5455A33**	49.90
1 5/8"(41mm)	1"	12 1/32"	**5455A17**	49.70
1 11/16"	1 1/8"	12 9/16"	**5455A18**	52.41
1 3/4"	1 1/8"	12 9/16"	**5455A42**	56.58
1 13/16"(46mm)	1 1/8"	12 9/16"	**5455A19**	57.86
1 7/8"	1 1/4"	13 1/32"	**5455A21**	61.01
1 15/16"	1 1/4"	13 1/32"	**5455A43**	61.91
50mm	1 1/4"	13 1/32"	**5455A52**	70.74
2"	1 1/4"	13 1/32"	**5455A22**	63.31
2 1/16"	1 1/8"	12 3/4"	**5455A34**	63.60
2 1/8"	1 3/8"	13 19/32"	**5455A44**	64.94
2 3/16"(55mm)	1 3/8"	13 19/32"	**5455A23**	68.02
2 1/4"	1 3/8"	13 19/32"	**5455A24**	72.40
2 5/16"	1 3/8"	13 19/32"	**5455A49**	74.03
2 3/8"(60mm)	1 1/2"	14 1/8"	**5455A25**	76.76
2 1/2"	1 1/2"	14 1/8"	**5455A46**	94.52
2 9/16"(65mm)	1 1/2"	14 1/8"	**5455A26**	97.86
2 5/8"	1 5/8"	15 1/32"	**5455A27**	98.09
2 3/4"(70mm)	1 5/8"	15 1/32"	**5455A28**	98.09
2 7/8"	1 3/4"	16 1/32"	**5455A48**	140.00
12-Point Offset (Cont.)				
2 15/16"(75mm)	1 3/4"	16 1/32"	**5455A29**	$115.67
3"	1 3/4"	16 1/32"	**5455A31**	119.08
3 1/8"(80mm)	1 3/4"	16 1/32"	**5455A32**	121.92
3 3/8"	2"	18 1/4"	**5455A61**	177.14
3 1/2"	2"	18 1/4"	**5455A62**	184.78
3 3/4"	2"	18 1/4"	**5455A63**	195.10
3 7/8"	2"	18 1/4"	**5455A64**	226.37
4 1/8"	2"	18 1/4"	**5455A85**	238.50
4 1/4"	2"	18 1/4"	**5455A66**	240.44
12-Point Straight				
1 1/16"(27mm)	5/8"	9 1/8"	**5456A47**	34.22
1 3/16"(30mm)	7/8"	7 9/16"	**5456A43**	32.97
1 1/4"(32mm)	7/8"	7 9/16"	**5456A11**	30.95
1 5/16"	7/8"	7 9/16"	**5456A12**	30.96
1 3/8"	15/16"	8 1/4"	**5456A51**	32.68
1 7/16"	15/16"	8 1/4"	**5456A13**	32.67
1 1/2"	31/32"	7 21/32"	**5456A14**	34.81
36mm	31/32"	7 21/32"	**5456A53**	36.73
1 5/8"(41mm)	1 5/32"	7 27/32"	**5456A15**	37.04
1 11/16"	1 5/32"	7 27/32"	**5456A16**	39.48
1 3/4"	1 1/8"	9"	**5456A18**	40.23
1 13/16"(46mm)	1 7/32"	7 15/16"	**5456A17**	40.46
1 7/8"	1 1/4"	10"	**5456A21**	42.85
50mm	1 13/32"	11 5/8"	**5456A54**	73.63
2"	1 13/32"	11 5/8"	**5456A22**	60.71
2 1/16"	1 3/8"	11"	**5456A52**	64.44
2 1/8"	1 7/16"	12"	**5456A29**	68.97
2 3/16"(55mm)	1 17/32"	11 3/4"	**5456A23**	74.48
2 1/4"	1 17/32"	11 3/4"	**5456A24**	79.13
2 3/8"(60mm)	1 21/32"	11 29/32"	**5456A25**	93.94
12-Point Straight (Cont.)				
2 9/16"(65mm)	1 25/32"	13 1/32"	**5456A26**	$106.25
2 5/8"	1 13/16"	14"	**5456A27**	107.65
2 3/4"(70mm)	1 15/16"	14 5/16"	**5456A31**	125.12
2 15/16"(75mm)	2 1/16"	14 7/16"	**5456A44**	144.70
3"	2"	18"	**5456A32**	154.50
3 1/8"(80mm)	2 9/32"	17 5/8"	**5456A33**	198.20
3 3/8"(85mm)	2 9/32"	17 5/8"	**5456A34**	217.90
3 1/2"	2 7/16"	17 27/32"	**5456A35**	248.94
3 3/4"	2 3/8"	18"	**5456A36**	273.52
3 7/8"	2 3/8"	18"	**5456A37**	291.80
4 1/8"	2 3/8"	18"	**5456A38**	324.91
4 1/4"	2 3/8"	18"	**5456A39**	337.56
4 1/2"	2 3/4"	21"	**5456A41**	453.51
4 5/8"	2 3/4"	21"	**5456A42**	456.59
6-Point Straight				
1 1/16"	5/8"	9 7/8"	**8341A41**	25.76
1 1/4"	45/64"	10 1/4"	**8341A42**	25.76
1 7/16"	55/64"	10 9/16"	**8341A43**	31.45
1 5/8"	61/64"	11"	**8341A44**	38.00
1 13/16"	63/64"	11 5/16"	**8341A45**	38.00
2"	1 15/64"	11 11/16"	**8341A46**	45.63
2 3/16"	1 1/4"	12"	**8341A47**	57.12
2 3/8"	1 23/64"	12 3/8"	**8341A48**	60.83
2 9/16"	1 31/64"	12 11/16"	**8341A49**	66.21
2 3/4"	1 33/64"	13 1/16"	**8341A51**	91.47
2 15/16"	1 33/64"	13 7/16"	**8341A52**	100.41
3 1/8"	1 37/64"	13 13/16"	**8341A53**	117.04
3 1/2"	1 43/64"	14 1/8"	**8341A54**	153.10
3 7/8"	1 49/64"	14 1/2"	**8341A55**	216.69