

UOP RUSSELL LLC
Tulsa, Oklahoma

JOB NO: J-447
CLIENT: UOP Russell
SUBJECT: 60 MMscfd Cryo Plant

DATE: 7/14/2011
BY: JRG

FILTER / SEPARATOR

TAG NO: F-445 & F-446
SERVICE: Mol Sieve Dust Filter

DESCRIPTION: Filter to remove 99.99% of all solid particles 1 micron and larger. Filter is located downstream of mol sieve dehydration beds and upstream of plate-fin exchangers.
(Max. Particle Size)
(Overall Removal Eff.) **TWO IDENTICAL FILTERS, EACH FOR THE LOADS SPECIFIED BELOW.**
Basis: Nominal

	Vapor			Liquid		
Fluid	Dehydrated Gas					
Flow Rate, (Lbs/Hr)	138,897			none		
Density, Lbs/Ft³	3.16					
Viscosity, cP	0.0137					
Mol. Wt.	18.38					
Operating Pressure / Temperature	944	psia	120	°F		
Design Pressure / Temperature	1100	psig	150	°F		
MDMT @ Pressure	-20 @ 1100					
Clean Pressure Drop, Max.	2					
Corrosion Allowance	0.0625					
Code: ASME Section VIII w/Stamp	Yes	X	No			
National Board No.	Yes	X	No			
Materials of Construction	CS					
Closure Type	Quick Open	X	Swing Bolt	Other		
Davited, Hinged, Other	Davited	X	Hinged	Other		
Internals	▲ 1 Set of 4 Porous Media Elements - GE1307L025V					
Dimensions	20" OD x 7' - 0" S/S					
Radiography / Stress Relieve	RT-2 min.			Per Code		
Sandblast / Paint	SSPC SP-6			HUR Std ENG - 36c System 3 (Note 2)		
Insulation Thickness	None					
Connections		Qty	Size	Rating	Face	Type
Filter	Inlet	1	8	600	RF	FLG
	Outlet	1	8	600	RF	FLG
	PDT	2	0.5"	6000		CPLG
	Vent	1	0.75"	6000		CPLG
	PI	1	0.5"	6000		CPLG
	Drain	2	1"	6000		CPLG/PLUGGED
Separator						
Charcoal	Dump					
	Fill					

P.O. # _____ Weight (Lb): 3,300 each
Manufacturer / Model # KMI InterSep GI2004H08

Notes:
1) See attached "Scope of Supply".
2) Use HUR Painting System 3
3) Duplicate of PO 247-5
4) Wind: ASCE 7-10, V=120 MPH, Exp.C, Cat. III
5) Seismic: ASCE 7-10, Sited, I=1.25, Ss=100%, S1=40%

REVISION	A	0	1	2
ENGINEER/DATE	JRG 7/14/11	JRG 07/14/11	BH 11/21/11	SHP 08/01/13
ISSUED FOR	RFQ	Purchase	Revised	Revised



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165052

Quality Documentation Records & Transmittal

DATE:	02/14/2017
CUSTOMER:	UOP RUSSELL LLC
CUSTOMER PO NO.:	4500749401 TAG: F-445
SERIAL, NO.	165052
NATIONAL BOARD, NO.	6565

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410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
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165052

SECTION 1

**MANUFACTURER'S DATA REPORTS AND/OR MANUFACTURERS
PARTIAL DATA REPORTS**

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS

(Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only)

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

1. Manufactured and certified by **KMI Fabricators, Inc., 410 Boyd Road, Mineral Wells, Texas, 76067**

(Name and address of Manufacturer)

2. Manufactured for **UOP RUSSELL LLC/ c/o HONEYWELL INTERNATIONAL, PO Box 981762, EL PASO, Texas, 79998 - 1762**

(Name and address of Purchaser)

3. Location of Installation **UNKNOWN**

(Name and address)

4. Type **VERTICAL** **165052** **N/A** **165052-V REV. 1** **6565** **2017**
 (Horizontal or vertical, tank) (Manufacturer's serial number) (CRN) (Drawing number) (National Board number) (Year built)

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

6. Shell: **SA-106-C** **0.812"** **0.0625"** **20" (OD)** **84"**
 (Material spec. number, grade) (Nominal thickness) (Corr. allow.) (Inner diameter) (Length (overall))

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
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

7. Seams: **TYPE S** **NONE** **100** **N/A** **N/A** **TYPE 1** **FULL** **100** **1**
 [Long. (welded, dbl., sngl., lap, butt)] [R.T. (spot or full)] (Eff., %) (H.T. temp) (Time, hr) [Girth. (welded, dbl., sngl., lap, butt)] [R.T. (spot or full)] (Eff., %) (No. of courses)

8. Heads: (a) Material SA-350-LF2 C1 (Spec. no., grade)											(b) Material SA-516-70N (Spec. no., grade)	
	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)		
(a)	TOP	0.812"	0.0625"	N/A	N/A	N/A	N/A	N/A	18.376"	N/A		
(b)	BOTTOM	0.6875"	0.0625"	N/A	N/A	2:1	N/A	N/A	N/A	CONCAVE		

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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A

9. MAWP **1100 psi** **N/A** at max. temp. **150 °F** **N/A**
 (Internal) (External) (Internal) (External)

Min. design metal temp. **-20 °F** at **1100 psi** Hydro, pneu., or comb. test pressure **HYDRO at 1430 psi**

Proof test **N/A**

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
INLET	1	8"	600# RFLWN		SA-105N	1.375"	0.0625"	INTEGRAL		WELDED	SHELL
GAS OUTLET	1	8"	600# RFLWN		SA-105N	1.375"	0.0625"	INTEGRAL		WELDED	SHELL
DRAIN (SUMP)	1	1"	COUP-O-LET	SA-105		6000#	0.0625"	INTEGRAL	WELDED		BOTTOM HEAD
DRAIN (COALESCER)	1	1"	COUP-O-LET	SA-105		6000#	0.0625"	INTEGRAL	WELDED		SHELL
VENT	1	3/4"	COUP-O-LET	SA-105		6000#	0.0625"	INTEGRAL	WELDED		SHELL
DPI	2	1/2"	COUP-O-LET	SA-105		6000#	0.0625"	INTEGRAL	WELDED		SHELL
PI	1	1/2"	COUP-O-LET	SA-105		6000#	0.0625"	INTEGRAL	WELDED		SHELL

11. Supports: Skirt **YES** Lugs **N/A** Legs **N/A** Other **PLATE/ SA-516-70N** Attached **WELDED/BOTTOM HEAD**
 (Yes or no) (Number) (Number) (Describe) (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors, have been furnished for the following items of the report:

20" CLOSURE, NATIONAL OILWELL VACO
"U" STAMP 10052
S/N ZH550

(Name of part, item number, Manufacturer's name and identifying stamp)

MATERIAL IS EXEMPTED FROM IMPACT TESTING; MDMT: BASED ON USC66(a). DESIGNED TO UG-22 (a) ONLY.
CUSTOMER PO#4500749401 - TAG#F-445; PROJECT#J445XX 1100 PSIG MOL SIEVE DUST FILTER (INTERSEP)C

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 15097

expires May 3, 2018

Date 02/13/2017

Co. name

KMI Fabricators, Inc.
(Manufacturer)

Signed

[Signature]
Representative

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by KMI Fabricators, Inc. at 410 Boyd Road, Mineral Wells, Texas, 76067

I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and employed by OneCIS Insurance Company, of Lynn, MA

have inspected the component described in this Manufacturer's Data Report on February 15, 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 02/15/2017

Signed

[Signature]
Authorized Inspector

Commissions

12125, TX1368

[National Board (incl. endorsements)]

SO No 1531971-2

PO No 10350

FORM U-2A MANUFACTURER'S PARTIAL DATA REPORT (ALTERNATE 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 NATIONAL OILWELL VARCO 10906 FM 2920 TOMBALL, TEXAS 77375

(Name and address of Manufacturer)

2. Manufactured for KMI FABRICATORS INC. 410 BOYD ROAD MINERAL WELLS, TX 76067

(Name and address of Purchaser)

3. Location of Installation UNKNOWN

(Name and address)

4. Type: (2) 20" CLOSURES

(Description of vessel part (shell, two-piece head, tube bundle))

ZH550 THRU ZH551

(Mfg.'s Serial No.)

N/A

(CRN)

N/A

(National Board Number)

1531971-2R1

(Drawing Number)

NATIONAL OILWELL VARCO

(Drawing prepared by)

2017

(Year Built)

5. ASME Code, Section VIII, Div. 1

2015 EDITION

(Edition and Addenda (Date))

N/A

(Code Case No.)

N/A

(Special service per UG-120(d))

6. Shell (a) No. of course(s)

1

(b) Overall length (ft. and in.):

1-00.

Course(s)			Material		Thickness, in.		Long Joint (Cat. A)			Circum. Joint (Cat. A, B, & C)			Heat Treatment	
No.	Diameter, in.	Length, ft. in.	Spec./Grade or Type	Nom.	Corr.		Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp., F	Time
1	18.376	1-00.	SA 350 LF2	0.812	0.063		S	NONE	1	S	NONE	1	N/A	N/A
			CLASS 1											

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	
N/A													

7. Heads: (a)

SA 516-70 N

(Mat'l Spec. no., Grade or Type)(H.T. - Time and Temp.)

(b)

N/A

(Mat'l Spec. no., Grade or Type)(H.T. - Time and Temp.)

	Location (Top, Bottom Ends)	Thickness, in.		Radius, in.		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None.	Eff.
(a)	TOP	0.673	0.063	----	----	2:1	----	----	----		X	S	NONE	1
(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)	N/A											

8. MAWP

1100

internal external

PSI @ max temp. =

150

internal external

°F.

Min Design Metal Temp

-20

°F at

1100

PSI

9. Impact test

Yes - CAP, HUB, & FITTING

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

At a test temp of

-51 & -50 & -50

°F

10. Hydro., pneu. or comb. Test pressure

SEE REMARKS

Proof Test:

N/A

11. Nozzles, inspection, and safety valve openings:

UG-125(a)

At

PSIG

Purpose (Inlet, Outlet, Drain, etc.)	No.	Dia. or Size, in.	Flange Type	Material		Nozzle Thickness, in.		Reinforcement Material	How Attached		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
SEE REMARKS											
OUTLET	1	1/2" NPT	TH'D	SA 350 LF2 CL1		0.500	0.063	INHERENT	*WELDED		HEAD
PAV	1	1/2" NPT	TH'D	SA 350 LF2 CL1		N/A	N/A	INHERENT	INT THD		SHELL

12. Identification of part(s)

Name of Part	Qty.	Line No.	Mfg's. Identification No.	Mfg's. Dwg No.	CRN	National Board No.	Year
N/A							

13. Supports: Skirt

Lugs

Legs

Others

Attached

(Where and How)

14. Remarks:

THIS TEMPERATURE APPLICABLE TO CLOSURE METAL COMPONENTS ONLY. ACTUAL SERVICETEMPERATURE IS DETERMINED BY TEMPERATURE LIMITATIONS OF O-RING MATERIAL.UG-120,c,2 DESIGN & CALCULATION BY NATIONAL OILWELL VARCO.CLOSURE ASSEMBLY IS NOT HYDROSTATICALLY TESTED, PRESSURE ALERT VALVE FURNISHED.*Fig. UW-16.1(x-2).

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. 10052 Expires: July 16, 2017

Date: 01/22/17 Name: NATIONAL OILWELL VARCO

(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 The Hartford Steam Boiler Inspection and Insurance Company of CONNECTICUT have inspected the pressure vessel part described in this Manufacturer's Data Report on 01-20, 2017, 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: 01/24/2017

Signed:

(Authorized Inspector)

Commissions: NB 14370 R/15

(National Board (incl. endorsements))



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165052

SECTION 2

MANUFACTURING DRAWINGS AND/OR SPECIFICATIONS (if required)



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

SPECIFICATION DATA SHEET

(MECHANICAL DESIGN/FABRICATION/INSPECTION/TESTING DATA)

KMI Project No:	Quote No.: Q160140R1
Equip. Description:	Vertical INTERSEP 20" O.D. x 7'-0" sm-sm @ 1100 psig
Model No.:	GE1307L025V
KMI SERIAL NO'S.:	165052 & 165053
Quantity:	2
Tag Number:	F-445 & F-446
Purchaser:	UOP Russell LLC
Purchaser P.O. No.:	4500749401
End User:	Unknown (Not Stated)
Project:	J447XX
Destination:	1401 RUSSELL WAREHOUSE

CUSTOMER SUPPLIED SPECIFICATIONS:

ASME Section VIII, Div 1

Notes:

- 1) Use HUR Painting System 3
- 2) Include initial set of elements in base cost
- 3) Include extra set of elements and spare gasket as an added cost
- 4) Vendor to provide the following fabrication drawings:
 - Two (2) electronic copies "For Approval"
 - Two (2) electronic copies Certified AFC
 - Four (4) Final Hard Copies of As-Built Job Data Book Documentation and (1) CD with all documents available in electronic format
- 5) Vendor to submit weld procedures to UOP Russell for approval prior to start of fabrication
- 6) Provide two (2) carbon steel lifting lugs
- 7) External nozzle projections shall be per UOP Russell Standard 13j
- 8) Vendor shall provide zinc or cadmium plated bolts when design temperture is 650F or less. Bolts shall be black (non-plated) for design tempetures above 650F
- 9) American Piping for Material
- 10) Spare elements for each vessel.
- 11) Spare O-rings for each vessel.

REVISION HISTORY

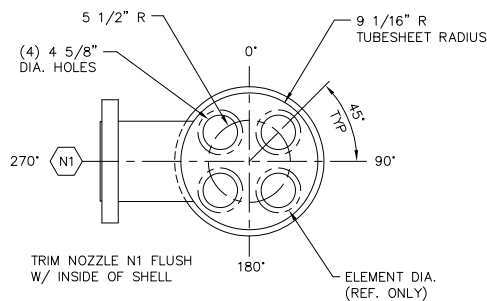
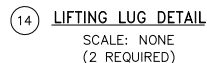
REV	DATE	BY	DESCRIPTION OF CHANGE
0	12/5/2016	MDB	PER PURCHASE ORDER
1			
2			

PROJECT: J447XX	TAG#: F-445 & F-446	CUST. PO#: 4500749401
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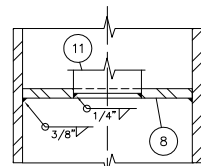
MECHANICAL DESIGN DATA/CONDITIONS					
DESIGN PRESSURE, PSIG:	1,100	DESIGN CODE:	ASME SEC VIII Div. 1		
DESIGN TEMPERATURE, °F:	150				
CORROSION ALLOWANCE:	0.0625	WIND:	ASCE 7-10 (120mph, Exp. C, Cat. III)		
MDMT, °F:	-20	SEISMIC:	ASCE 7-10 (Site D, I=1.25, Ss=100%, S1=40%)		
CONNECTIONS/OPENINGS					
SERVICE	MARK	QTY.	SIZE (NPS)	TYPE	FLG/CPLG RATING
INLET	N1	1	8"	RF FLG	ANSI 600#
OUTLET	N2	1	8"	RF FLG	ANSI 600#
DRAIN (SUMP)	C1	1	1"	NPT	6000#
DRAIN (COALESCER)	C2	1	1"	NPT	6000#
VENT	C3	1	3/4"	NPT	6000#
DPI	C4A-B	2	1/2"	NPT	6000#
PI	C5	1	1/2"	NPT	6000#
FLANGE FINISH:					
MATERIALS					
COMPONENT	PRESSURE PART	NON-PRESSURE ATTACHMENT MATERIALS			
FORGINGS	SA-105 N	LIFT LUG: 2 - KMI STANDARDS			
PLATE	SA-516-70	NAME PLATE BRACKET: SA-992 Beam Material			
PIPE	SA-106 B/C				
FLANGES	SA-105				
FITTINGS	SA-234 WPB				
STUDS	SA-193 B7 Cad. Plt.				
NUTS	SA-194 2H Cad. Plt.				
GASKETS	PTFE				
RESTRICTION ON ORIGIN OF MATERIALS: Domestic, Western Europe, Etc.					
MATERIAL TEST REPORTS (MTR'S) REQUIREMENTS:					
IMPACT TESTING REQUIRED: Not Required					
MATERIALS OF CONSTRUCTION - VESSEL INTERNALS					
PENTAIR Element Support Riser		ELEMENT Part No.: GE1307L025V			
CLOSURE TYPE					
TYPE: YALE Fig 500 Threaded quick opening closure w/ davit					
O-RING: BUNA-N		O-RING Part No.: H70012			
MISCELLANEOUS ATTACHMENTS					
DESCRIPTION	MATERIAL				
NAMEPLATE:	316 SS (Standard KMI)				
SKIRT / BASEPLATE:	SA-53 B ERW Welded Pipe / SA-516-70				
HINGE PLATE:	Not Applicable				

PROJECT: J447XX	TAG#: F-445 & F-446	CUST. PO#: 4500749401
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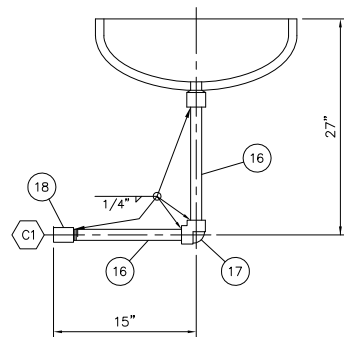
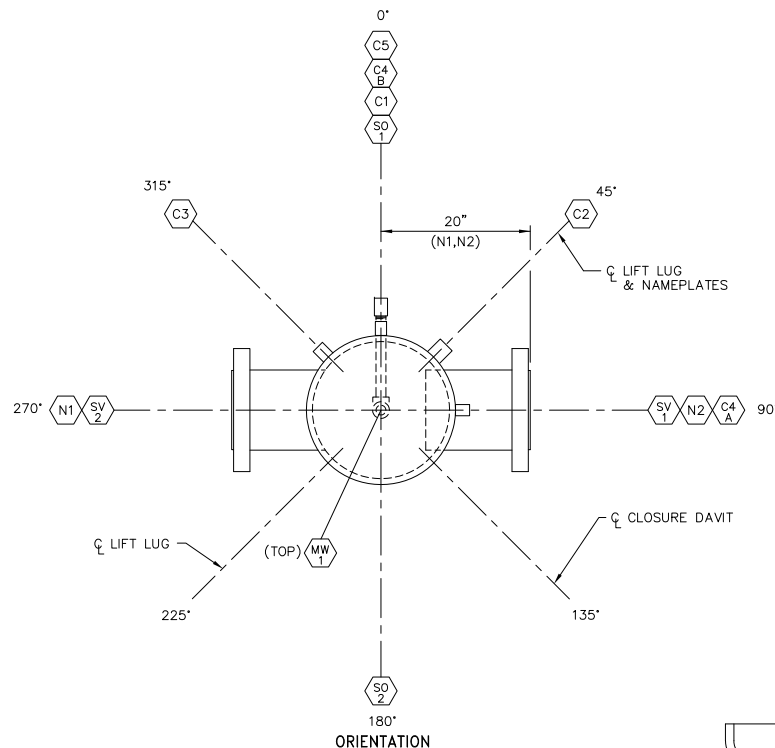
INSPECTION AND TESTING/NDE			
VISUAL EXAMINATION (VT): Per Code			
RADIOGRAPHIC TESTING (RT): RT-2 per ASME Code			
ULTRASONIC TESTING (UT): None			
MAGNETIC PARTICLE TESTING (MT): None			
LIQUID PENETRANT TESTING (PT): None			
HARDNESS TESTING (HDT): None			
PRODUCTION WELD IMPACT TESTING: None			
POST WELD HEAT TREATMENT: None			
HYDROSTATIC TEST (HYT): 1.3 X MAWP			
PNEUMATIC TEST (PNT) OF WEAR PAD: None			
WPS/PQR APPROVAL REQUIRED:		WELD MAPS REQUIRED: No	
NATIONAL BOARD NO.: Yes			
INSPECTION BY:		CUSTOMER:	
INSPECTION AND TESTING NOTES			
MT: None HARDNESS: None HYDRO: 1.3 X MAWP CUSTOMER:			
SURFACE PREPARATION			
INTERNAL: None		EXTERNAL: SSPC-SP 6 Commercial Blast	
EXTERNAL COATINGS REQUIREMENTS (MFR. OF COATINGS:)			
COAT	DESCRIPTION	DFT (MILS)	COLOR
PRIMER	Sherwin Williams Macropoxy 646 (B58-600)	4-6	Not Stated
INTERMEDIATE	Sherwin Williams Macropoxy 646 (B58-600)	4-6	Not Stated
TOPCOAT	Sherwin Williams Hi-Solids Polyurethan B65 Series/B60V30	3-4	*
NOTES: Total System: DFT 12-16 mils VOC's per 1000 sq. ft. = 28 lbs * TOP COAT IS SHERWIN WILLIAMS STRUCTURAL GRAY", SW4031			
INTERNAL COATING			
None			
SHIPPING INFORMATION			
EST. EMPTY WT.: 3374 lbs.		EST. TEST WT.: 4306 lbs.	
EST. OPERATING WT.: 4306 lbs.			
FLANGE PROTECTORS:			
THREADED OPENINGS:			
QA NOTES			
NO. OF COPIES OF FINAL DATA:			
NOTES:			



8 TUBESHEET LAYOUT
SCALE: NONE



TUBESHEET
SCALE: NONE



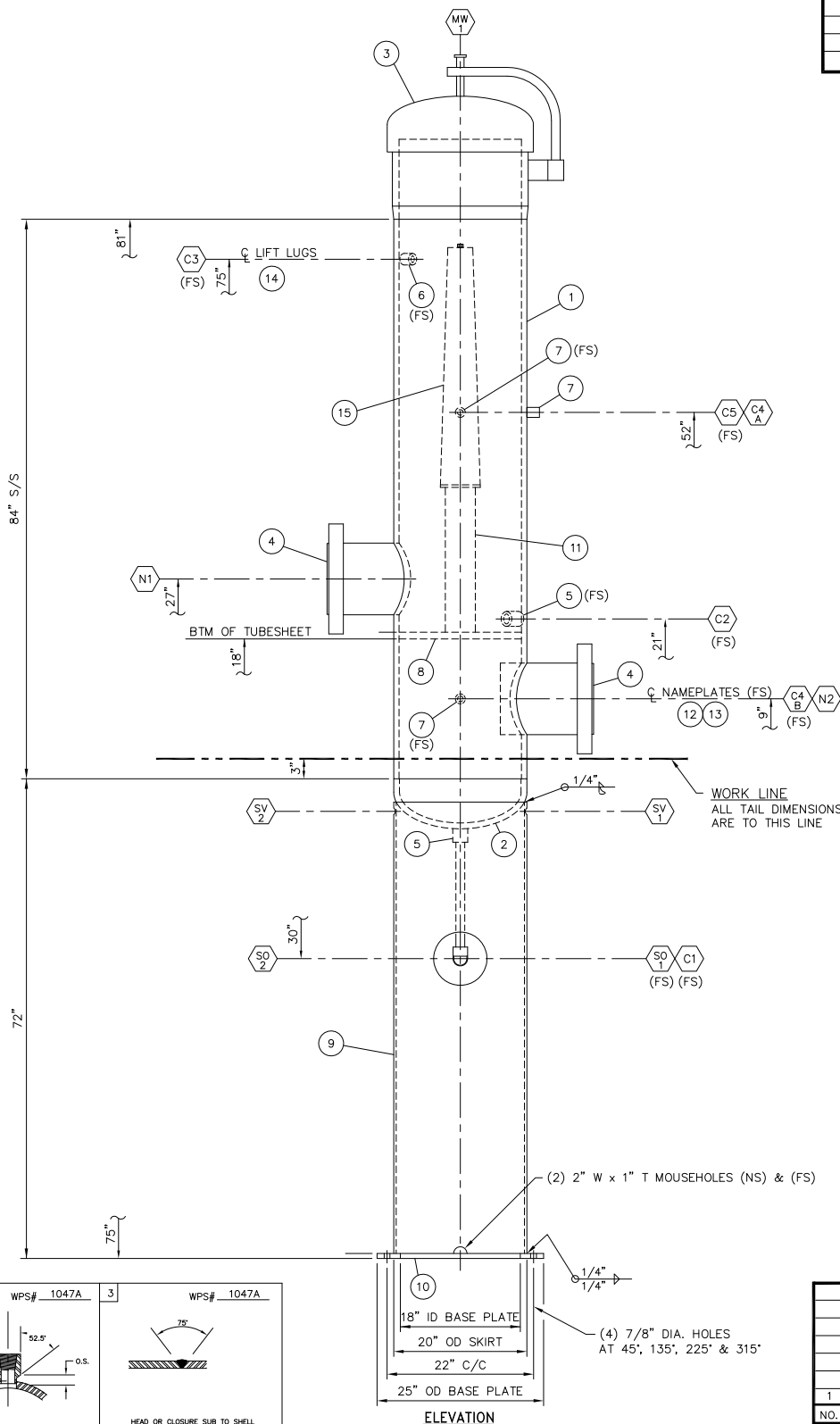
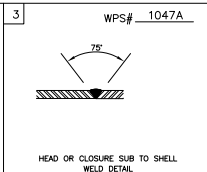
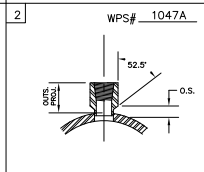
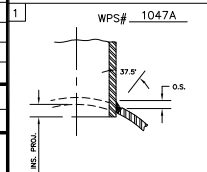
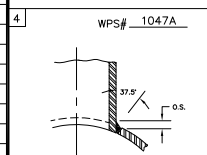
C1 DRAIN DETAIL
SCALE: NONE

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SVI-2	2	1" DIA. HOLES	SKIRT VENTS							
S01-2	2	8" DIA. HOLES	SKIRT OPENING							
MW-1	1	20" 600# ANSI CLOSURE	VESSEL ACCESS	-	-	3	-	-		
C5	1	1/2" 6000# COUP-O-LET	PI	-	-	2	3/8"	-		
C4A-B	2	1/2" 6000# COUP-O-LET	DPI	-	-	2	3/8"	-		
C3	1	3/4" 6000# COUP-O-LET	VENT	-	-	2	3/8"	-		
C2	1	1" 6000# COUP-O-LET	DRAIN (COALESCE)	-	-	2	3/8"	-		
C1	1	1" 6000# COUP-O-LET	DRAIN (SUMP)	-	-	2	3/8"	-		

N2	1	8" 600# RFLWN FLG	GAS OUTLET	10"	-	1	3/8"	-
N1	1	8" 600# RFLWN FLG	INLET	10"	TRM FLUSH	4	3/8"	-
ITEM	QTY.	SIZE & RATING , TYPE	DESCRIPTION	OUTS.	INS.	WELD DETAIL DWG. NO.	O.S.	I.S.
				PROJECTION			WELD SIZE	

SCHEDULE OF OPENINGS



BILL OF MATERIALS

ITEM	QTY REQ'D	DESCRIPTION	MATERIAL
1	1	SHELL, PIPE, 20" SCH 60 (0.812" NOM) SMLS x 84" LG	SA-106-C
2	1	HEAD, 20" OD x 3/4" NOM, 2:1 ELLIP. W/ 2" S.F. (HOT FORMED)	SA-516-70 N
3	1	CLOSURE, 20" OD 600# ANSI FIG. 500 R & M VERTICAL W/ DAVIT	CS
4	2	FLANGE, 8" 600# RFLWN x 14" LG.	SA-105 N
5	2	COUP-O-LET, 1" 6000#	SA-105
6	1	COUP-O-LET, 3/4" 6000#	SA-105
7	3	COUP-O-LET, 1/2" 6000#	SA-105
8	1	PLATE, (TUBESHEET) 18 1/8" OD x 1" THK (SEE DETAIL)	SA-516-70-N
9	1	SKIRT, PIPE, 20" SCH 20 (.375" NOM) X 69" LG (TRIM TO FIT)	SA-53-B/106-B
10	1	PLATE (BASE) 25" OD x 18" ID x 3/4" THK	SA-516-70-N
11	4	RISER, PART NO. GA5536P422CS x 22" LG. (BY PENTAIR)	
12	1	NAME PLATE BRACKET, T-BEAM STYLE x 10 1/2" LG.	SA-36
13	2	NAME PLATE, ASME CODE (KMI & PENTAIR)	SS
14	2	LIFTING LUGS, PHOENIX SERIES 2-899-MLL	A105
15	4	CARTRIDGE, PART NO. GE1307L025V (BY PENTAIR)	
16	1	PIPE, DRAIN, 1" SCH 160 SMLS (CUT TO FIT)	SA-106-B
17	1	ELBOW, 1" 3000# 90° SOCKETWELD	SA-105
18	1	COUPLING, FULL, 1" 3000# THREADED	SA-105

SEE KMI DATA SHEETS FOR NOTES

RELEASED FOR	DATE	BY	CHK
APPROVAL	12/5/16	MDB	
FABRICATION	1/16/17	MDB	
FINAL (AS BUILT)	2/16/17	MDB	

IV. DATA PLATE INFORMATION



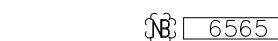
Process Technologies
936-788-1000
www.pentairseparations.com

InterSep[®] ID No.

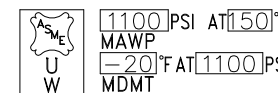
GI2004H08

Replacement Element No.

GE1307L025V



CERTIFIED BY



RT-2 SERIAL NO. 165052
 YR. BLT. 2017
 CORR. ALLOWANCE .0625"
 EXT.PRESS. ☐ PSI AT ☐
 MOL SIEVE DUST
 FILTER
 TAG: F-445



KMI FABRICATORS, INC.

410 BOYD RD.
MINERAL WELLS, TX 76067
PHONE: (800) 325-7841
FAX: (940) 325-3765
EMAIL: kmi@kmifab.com
Web Site: www.kmifab.com

CUSTOMER:	UOP RUSSELL LLC
P.O. NO.:	4500749401
NO. REQ'D.:	ONE (1)
SERIAL NO's.:	165052
EMPTY WT.:	3,374 LBS

DESCRIPTION: 20" OD x 7'-0" S/S x 1100 PSIG
MOL SIEVE DUST FILTER (INTERSEP)

TAG: F-445 JOB NO.: J447XX

						S.S.: F05052					
						EMPTY WT.: 3,374 LBS					
						DESCRIPTION: 20" OD x 7'-0" S/S x 1100 PSIG MOL SIEVE DUST FILTER (INTERSEP)					
						TAG: F-445	JOB NO.: J447XX				
1	2/16/17	MDB		AS BUILT		Drown	MDB	Date	Drawing Number	Rev.	
NO.	DATE	BY	CHK.	DESCRIPTION		Checked		12/5/16 Scale "x=1"-o"	165052-V	1	
REVISIONS											



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165052

SECTION 3
DESIGN CALCULATIONS

KMI Fabricators, Inc.

410 Boyd Road

Mineral Wells, Texas 76067

Phone: 940-325-7841

Revision 0

COMPRESS Pressure Vessel Design Calculations

Item: 20" Mol Sieve Dust Filter

Vessel No: F-445

Customer: UOP Russell LLC

P.O. No.: 4500749401

Designer: Mark Berry

Date: December 5, 2016

KMI Serial No. 165052

UOP Job No.: J447XX

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Deficiencies Summary

No deficiencies found.

Nozzle Summary

Dimensions												
Nozzle mark	OD (in)	t _n (in)	Req t _n (in)	A ₁ ?	A ₂ ?	Shell			Reinforcement Pad		Corr (in)	A _a /A _r (%)
						Nom t (in)	Design t (in)	User t (in)	Width (in)	t _{pad} (in)		
C1	2.25	0.4675	0.125	Yes	Yes	0.6875*	N/A		N/A	N/A	0.0625	Exempt
C2	2.25	0.4675	0.125	Yes	Yes	0.812	N/A		N/A	N/A	0.0625	Exempt
C3	1.75	0.35	0.125	Yes	Yes	0.812	N/A		N/A	N/A	0.0625	Exempt
C4A	1.5	0.33	0.125	Yes	Yes	0.812	N/A		N/A	N/A	0.0625	Exempt
C4B	1.5	0.33	0.125	Yes	Yes	0.812	N/A		N/A	N/A	0.0625	Exempt
C5	1.5	0.33	0.125	Yes	Yes	0.812	N/A		N/A	N/A	0.0625	Exempt
N1	10.75	1.375	0.3819	Yes	Yes	0.812	0.6018		N/A	N/A	0.0625	103.3
N2	10.75	1.375	0.3819	Yes	Yes	0.812	0.6021		N/A	N/A	0.0625	103.2
*Head minimum thickness after forming												

Definitions	
t _n	Nozzle thickness
Req t _n	Nozzle thickness required per UG-45/UG-16
Nom t	Vessel wall thickness
Design t	Required vessel wall thickness due to pressure + corrosion allowance per UG-37
User t	Local vessel wall thickness (near opening)
A _a	Area available per UG-37, governing condition
A _r	Area required per UG-37, governing condition
Corr	Corrosion allowance on nozzle wall

Nozzle Schedule

Specifications									
Nozzle mark	Identifier	Size	Materials		Impact Tested	Normalized	Fine Grain	Flange	Blind
C1	Drain (Sump)	NPS 1 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
	Nozzle Pipe (C1)	NPS 1 Sch 160	Nozzle Piping	SA-106 B Smls pipe	No	No	No	N/A	No
C2	Drain (Coalescer)	NPS 1 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C3	Vent	NPS 0.75 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C4A	DPI	NPS 0.5 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C4B	DPI	NPS 0.5 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C5	PI	NPS 0.5 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
N1	Inlet	10.75 OD x 1.375	Nozzle	SA-105	No	Yes	Yes	NPS 8 Class 600 LWN A105 N	No
N2	Outlet	10.75 OD x 1.375	Nozzle	SA-105	No	Yes	Yes	NPS 8 Class 600 LWN A105 N	No

Pressure Summary

Component Summary									
Identifier	P Design (psi)	T Design (°F)	MAWP (psi)	MAP (psi)	MAEP (psi)	T _e external (°F)	MDMT (°F)	MDMT Exemption	Impact Tested
Closure	1,100	150	1,336.01	1,465.69	633.25	150	-55	Note 1	No
Straight Flange on Closure	1,100	150	1,413.64	1,546.39	653.49	150	-55	Note 2	No
Shell	1,100	150	1,327.21	1,462.57	599.26	150	-20	Note 3	No
Straight Flange on Bottom Head	1,100	150	1,410.53	1,546.39	653.49	150	-55	Note 5	No
Bottom Head	1,100	150	1,332.67	1,465.69	633.25	150	-55	Note 4	No
Drain (Sump) (C1)	1,100	150	1,434.85	1,575.94	633.25	150	-155	Note 6	No
Nozzle Pipe (C1)	1,100	150	N/I	N/I	N/I	150	N/I	N/A	No
Drain (Coalescer) (C2)	1,100	150	1,328.06	1,462.57	599.26	150	-155	Note 7	No
Vent (C3)	1,100	150	1,330.02	1,462.57	599.26	150	-155	Note 8	No
DPI (C4A)	1,100	150	1,329.18	1,462.57	599.26	150	-155	Note 9	No
DPI (C4B)	1,100	150	1,327.63	1,462.57	599.26	150	-155	Note 10	No
PI (C5)	1,100	150	1,329.18	1,462.57	599.26	150	-155	Note 9	No
Inlet (N1)	1,100	150	1,117.02	1,253.65	599.26	150	-44.4	Note 11	No
Outlet (N2)	1,100	150	1,116.37	1,253.65	599.26	150	-44.4	Note 12	No

Chamber Summary	
Design MDMT	-20 °F
Rated MDMT	-20 °F @ 1,116.37 psi
MAWP hot & corroded	1,116.37 psi @ 150 °F
MAP cold & new	1,253.65 psi @ 60 °F
MAEP	599.26 psi @ 150 °F

Notes for MDMT Rating		
Note #	Exemption	Details
1.	Straight Flange governs MDMT	
2.	Material impact test exemption temperature from Fig UCS-66 Curve D = -43.9°F Fig UCS-66.1 MDMT reduction = 20.6°F, (coincident ratio = 0.7943) Rated MDMT of -64.5°F is limited to -55°F by UCS-66(b)(2)	UCS-66 governing thickness = 0.7105 in
3.	Material is impact test exempt per UG-20(f)	UCS-66 governing thickness = 0.7105 in
4.	Straight Flange governs MDMT	
5.	Material impact test exemption temperature from Fig UCS-66 Curve D = -43.9°F Fig UCS-66.1 MDMT reduction = 20.3°F, (coincident ratio = 0.7965) Rated MDMT of -64.2°F is limited to -55°F by UCS-66(b)(2)	UCS-66 governing thickness = 0.7105 in
6.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.103).	
7.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1029).	
8.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1181).	
9.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1043).	
10.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1045).	
11.	LWN rated MDMT per UCS-66(c)(4) Flange rated MDMT per UCS-66(b)(1)(b) = -44.4°F (Coincident ratio = 0.7558) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	
12.	LWN rated MDMT per UCS-66(c)(4) Flange rated MDMT per UCS-66(b)(1)(b) = -44.4°F (Coincident ratio = 0.7562) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

Radiography Summary

UG-116 Radiography							
Component	Longitudinal Seam		Top Circumferential Seam		Bottom Circumferential Seam		Mark
	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	
Closure	N/A	Seamless No RT	N/A	N/A	B	Spot UW-11(a)(5)(b) / Type 1	RT2
Shell	N/A	Seamless No RT	B	Spot UW-11(a)(5)(b) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	RT2
Bottom Head	N/A	Seamless No RT	B	Spot UW-11(a)(5)(b) / Type 1	N/A	N/A	RT2
Nozzle	Longitudinal Seam		Nozzle to Vessel Circumferential Seam		Nozzle free end Circumferential Seam		
Inlet (N1)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
Outlet (N2)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
Drain (Coalescer) (C2)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
Vent (C3)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
DPI (C4A)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
DPI (C4B)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
PI (C5)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
Drain (Sump) (C1)	N/A	Seamless No RT	D	N/A / Type 7	B	UW-11(a)(4) exempt / Type 1	N/A
Nozzle Flange	Longitudinal Seam		Flange Face		Nozzle to Flange Circumferential Seam		
ASME B16.5/16.47 flange attached to Inlet (N1)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
ASME B16.5/16.47 flange attached to Outlet (N2)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
UG-116(e) Required Marking: RT2							

Weight Summary

Weight (lb) Contributed by Vessel Elements										
Component	Metal New*	Metal Corroded	Insulation	Insulation Supports	Lining	Piping + Liquid	Operating Liquid		Test Liquid	
							New	Corroded	New	Corroded
Closure	110.8	101.6	0	0	0	0	49.9	51	49.9	51
Shell	1,119.2	1,036.5	0	0	0	0	831.9	843.9	831.9	843.9
Bottom Head	110	100.9	0	0	0	0	50.4	51.6	50.4	51.6
Skirt	444.1	444.1	0	0	0	0	0	0	0	0
Base Plate	50	50	0	0	0	0	0	0	0	0
TOTAL:	1,834.2	1,733.2	0	0	0	0	932.2	946.5	932.2	946.5
*Shells with attached nozzles have weight reduced by material cut out for opening.										

Weight (lb) Contributed by Attachments										
Component	Body Flanges		Nozzles & Flanges		Packed Beds	Ladders & Platforms	Trays	Tray Supports	Rings & Clips	Vertical Loads
	New	Corroded	New	Corroded						
Closure	0	0	0	0	0	0	0	0	0	952
Shell	0	0	473.2	462.2	0	0	0	0	0	89
Bottom Head	0	0	5.6	4.7	0	0	0	0	0	0
Skirt	0	0	0	0	0	0	0	0	0	20
TOTAL:	0	0	478.8	466.8	0	0	0	0	0	1,061

Vessel Totals		
	New	Corroded
Operating Weight (lb)	4,306	4,207
Empty Weight (lb)	3,374	3,261
Test Weight (lb)	4,306	4,207
Capacity** (US gal)	108	110
**The vessel capacity does not include volume of nozzle, piping or other attachments.		

Vessel Lift Condition	
Vessel Lift Weight, New (lb)	3,374
Center of Gravity from Datum (in)	37.9164

Settings Summary

COMPRESS 2016 Build 7600	
ASME Section VIII Division 1, 2015 Edition	
Units	U.S. Customary
Datum Line Location	3.00" from bottom seam
Vessel Design Mode	Get Thickness from Pressure
Minimum thickness	0.0625" per UG-16(b)
Design for cold shut down only	No
Design for lethal service (full radiography required)	No
Design nozzles for	Design P only
Corrosion weight loss	100% of theoretical loss
UG-23 Stress Increase	1.20
Skirt/legs stress increase	1.0
Minimum nozzle projection	1"
Juncture calculations for $\alpha > 30$ only	No
Preheat P-No 1 Materials $> 1.25"$ and $\leq 1.50"$ thick	Yes
UG-37(a) shell tr calculation considers longitudinal stress	No
Cylindrical shells made from pipe are entered as minimum thickness	No
Nozzles made from pipe are entered as minimum thickness	No
ASME B16.9 fittings are entered as minimum thickness	No
Butt welds	Tapered per Figure UCS-66.3(a)
Disallow Appendix 1-5, 1-8 calculations under 15 psi	No
Hydro/Pneumatic Test	
Shop Hydrotest at user defined pressure	1,430 psi
Test liquid specific gravity	1.00
Maximum stress during test	90% of yield
Required Marking - UG-116	
UG-116(e) Radiography	RT2
UG-116(f) Postweld heat treatment	None
Code Cases/Interpretations	
Use Code Case 2547	No
Use Code Case 2695	No
Apply interpretation VIII-1-83-66	No
Apply interpretation VIII-1-86-175	Yes

Apply interpretation VIII-1-01-37	Yes
Apply interpretation VIII-1-01-150	No
Apply interpretation VIII-1-07-50	No
No UCS-66.1 MDMT reduction	No
No UCS-68(c) MDMT reduction	No
Disallow UG-20(f) exemptions	No
UG-22 Loadings	
UG-22(a) Internal or External Design Pressure	Yes
UG-22(b) Weight of the vessel and normal contents under operating or test conditions	Yes
UG-22(c) Superimposed static reactions from weight of attached equipment (external loads)	Yes
UG-22(d)(2) Vessel supports such as lugs, rings, skirts, saddles and legs	Yes
UG-22(f) Wind reactions	Yes
UG-22(f) Seismic reactions	Yes
UG-22(j) Test pressure and coincident static head acting during the test:	Yes
Note: UG-22(b),(c) and (f) loads only considered when supports are present.	

License Information	
Company Name	KMI Fabricators
License	Commercial
License Key ID	31538
Support Expires	May 12, 2017

Test Report

Vertical shop test based on user defined pressure

Gauge pressure at 60°F = 1,430 psi

Vertical shop test					
Identifier	Local test pressure (psi)	Test liquid static head (psi)	Stress during test (psi)	Allowable test stress (psi)	Stress excessive?
Closure	1,430.24	0.24	17,436	34,200	No
Straight Flange on Closure	1,430.24	0.24	18,345	34,200	No
Shell	1,433.272	3.272	19,242	36,000	No
Straight Flange on Bottom Head	1,433.345	3.345	18,385	34,200	No
Bottom Head	1,433.513	3.513	17,476	34,200	No
DPI (C4A)	1,431.302	1.302	19,286	54,000	No
DPI (C4B)	1,432.854	2.854	19,307	54,000	No
Drain (Coalescer) (C2)	1,432.43	2.43	19,711	54,000	No
Drain (Sump) (C1)	1,433.615	3.615	18,546	51,300	No
Inlet (N1)	1,432.334	2.334	21,617	54,000	No
Outlet (N2)	1,432.984	2.984	21,627	54,000	No
PI (C5)	1,431.302	1.302	19,286	54,000	No
Vent (C3)	1,430.476	0.476	19,763	54,000	No
(1) P_L stresses at nozzle openings have been estimated using the method described in PVP-Vol. 399, pages 77-82. (2) $1.5 \times 0.9 \times S_y$ used as the basis for the maximum local primary membrane stress at the nozzle intersection P_L .					

The field test condition has not been investigated.

The test temperature of 60 °F is warmer than the minimum recommended temperature of 10 °F so the brittle fracture provision of UG-99(h) has been met.

Thickness Summary

Component Data								
Component Identifier	Material	Diameter (in)	Length (in)	Nominal t (in)	Design t (in)	Total Corrosion (in)	Joint E	Load
Closure	SA-516 70	20 OD	5.3438	0.6875*	0.5823	0.0625	1.00	Internal
Straight Flange on Closure	SA-516 70	20 OD	2	0.75	0.6008	0.0625	1.00	Internal
Shell	SA-106 C Smls pipe	20 OD	84	0.812	0.6023	0.0625	1.00	Internal
Straight Flange on Bottom Head	SA-516 70	20 OD	2	0.75	0.6023	0.0625	1.00	Internal
Bottom Head	SA-516 70	20 OD	5.3438	0.6875*	0.5838	0.0625	1.00	Internal
Skirt	SA-53 E/B Wld pipe	20 OD	68.63	0.375	0.0273	0	0.55	Seismic
*Head minimum thickness after forming								

Definitions	
Nominal t	Vessel wall nominal thickness
Design t	Required vessel thickness due to governing loading + corrosion
Joint E	Longitudinal seam joint efficiency
Load	
Internal	Circumferential stress due to internal pressure governs
External	External pressure governs
Wind	Combined longitudinal stress of pressure + weight + wind governs
Seismic	Combined longitudinal stress of pressure + weight + seismic governs

Wind Code

Building Code: ASCE 7-10		
Elevation of base above grade		0.00 ft
Increase effective outer diameter by		0.00 ft
Wind Force Coefficient, C_f		0.7000
Risk Category (Table 1.5-1)		III
Basic Wind Speed, V		120.00 mph
Exposure category		C
Wind Directionality Factor, K_d		0.9500
Topographic Factor, K_{zt}		1.0000
Enforce min. loading of 16 psf		Yes
Vessel Characteristics		
Height, h		13.6117 ft
Minimum Diameter, b	Operating, Corroded	1.6667 ft
	Empty, Corroded	1.6667 ft
Fundamental Frequency, n_1	Operating, Corroded	11.0240 Hz
	Empty, Corroded	12.3433 Hz
	Vacuum, Corroded	11.0240 Hz
Damping coefficient, β	Operating, Corroded	0.0249
	Empty, Corroded	0.0200
	Vacuum, Corroded	0.0249

[Table Lookup Values](#)

2.4.1 Basic Load Combinations for Allowable Stress Design	
Load combinations considered in accordance with ASCE section 2.4.1:	
5.	$D + P + P_s + 0.6W$
7.	$0.6D + P + P_s + 0.6W$
Parameter Description	
D	= Dead load
P	= Internal or external pressure load
P_s	= Static head load
W	= Wind load

Wind Deflection Reports:

[Operating, Corroded](#)

[Empty, Corroded](#)

[Vacuum, Corroded](#)

[Wind Pressure Calculations](#)

Wind Deflection Report: Operating, Corroded								
Component	Elevation of Bottom above Base (in)	Effective OD (ft)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Platform Wind Shear at Bottom (lb _f)	Total Wind Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)	Deflection at Top (in)
Closure	155.9964	1.67	29.0	*	0	10	3	0.0042
Shell	71.9964	1.67	28.8	0.1014	0	142	536	0.0039
Bottom Head (top)	68.63	1.67	29.0	*	0	147	577	0.0012
Skirt	0	1.67	29.0	0.0537	0	255	1,742	0.0011
*Moment of Inertia I varies over the length of the component								

Wind Deflection Report: Empty, Corroded								
Component	Elevation of Bottom above Base (in)	Effective OD (ft)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Platform Wind Shear at Bottom (lb _f)	Total Wind Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)	Deflection at Top (in)
Closure	155.9964	1.67	29.4	*	0	10	3	0.0041
Shell	71.9964	1.67	29.2	0.1014	0	142	536	0.0039
Bottom Head (top)	68.63	1.67	29.4	*	0	147	577	0.0012
Skirt	0	1.67	29.4	0.0537	0	255	1,742	0.0011
*Moment of Inertia I varies over the length of the component								

Wind Deflection Report: Vacuum, Corroded								
Component	Elevation of Bottom above Base (in)	Effective OD (ft)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Platform Wind Shear at Bottom (lb _f)	Total Wind Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)	Deflection at Top (in)
Closure	155.9964	1.67	29.0	*	0	10	3	0.0042
Shell	71.9964	1.67	28.8	0.1014	0	142	536	0.0039
Bottom Head (top)	68.63	1.67	29.0	*	0	147	577	0.0012
Skirt	0	1.67	29.0	0.0537	0	255	1,742	0.0011
*Moment of Inertia I varies over the length of the component								

Wind Pressure (WP) Calculations

[Gust Factor \(G_f\) Calculations](#)

$$\begin{aligned}
 K_z &= 2.01 * (Z/Z_g)^{2/\alpha} \\
 &= 2.01 * (Z/900.00)^{0.2105} \\
 q_z &= 0.00256 * K_z * K_{zt} * K_d * V^2 \\
 &= 0.00256 * K_z * 1.0000 * 0.9500 * 120.0000^2 \\
 &= 35.0208 * K_z \\
 WP &= 0.6 * q_z * G * C_f \text{ (Minimum 16 lb/ft}^2\text{)} \\
 &= 0.6 * q_z * G * 0.7000 \text{ (Minimum 16 lb/ft}^2\text{)}
 \end{aligned}$$

Design Wind Pressures							
Height Z (')	Kz	qz (psf)	WP (psf)				
			Operating	Empty	Hydrotest New	Hydrotest Corroded	Vacuum
15.0	0.8489	29.73	11.31	11.31	N.A.	N.A.	11.31
Design Wind Force determined from: F = Pressure * Af , where Af is the projected area.							

Gust Factor Calculations

[Operating, Corroded](#)

[Empty, Corroded](#)

[Vacuum, Corroded](#)

Gust Factor Calculations: Operating, Corroded

Vessel is considered a rigid structure as $n_1 = 11.0240 \text{ Hz} \geq 1 \text{ Hz}$.

$$\begin{aligned}
 z^- &= \max (0.60 * h, z_{min}) \\
 &= \max (0.60 * 13.6117, 15.0000) \\
 &= 15.0000 \\
 I_z^- &= c * (33 / z^-)^{1/6} \\
 &= 0.2000 * (33 / 15.0000)^{1/6} \\
 &= 0.2281 \\
 L_z^- &= l * (z^- / 33)^{ep} \\
 &= 500.0000 * (15.0000 / 33)^{0.2000} \\
 &= 427.0566 \\
 Q &= \text{Sqr}(1 / (1 + 0.63 * ((h + h) / L_z^-)^{0.63})) \\
 &= \text{Sqr}(1 / (1 + 0.63 * ((1.6667 + 13.6117) / 427.0566)^{0.63})) \\
 &= 0.9635 \\
 G &= 0.925 * (1 + 1.7 * g_Q * I_z^- * Q) / (1 + 1.7 * g_v * I_z^-) \\
 &= 0.925 * (1 + 1.7 * 3.40 * 0.2281 * 0.9635) / (1 + 1.7 * 3.40 * 0.2281) \\
 &= 0.9058
 \end{aligned}$$

Gust Factor Calculations: Empty, Corroded

Vessel is considered a rigid structure as $n_1 = 12.3433 \text{ Hz} \geq 1 \text{ Hz}$.

$$\begin{aligned}
 z^- &= \max (0.60 * h, z_{min}) \\
 &= \max (0.60 * 13.6117, 15.0000) \\
 &= 15.0000 \\
 I_z^- &= c * (33 / z^-)^{1/6} \\
 &= 0.2000 * (33 / 15.0000)^{1/6} \\
 &= 0.2281 \\
 L_z^- &= l * (z^- / 33)^{ep} \\
 &= 500.0000 * (15.0000 / 33)^{0.2000} \\
 &= 427.0566
 \end{aligned}$$

$$\begin{aligned}
Q &= \text{Sqr}(1 / (1 + 0.63 * ((b + h) / L_z)^{0.63})) \\
&= \text{Sqr}(1 / (1 + 0.63 * ((1.6667 + 13.6117) / 427.0566)^{0.63})) \\
&= 0.9635 \\
G &= 0.925 * (1 + 1.7 * g_Q * I_z^- * Q) / (1 + 1.7 * g_v * I_z^-) \\
&= 0.925 * (1 + 1.7 * 3.40 * 0.2281 * 0.9635) / (1 + 1.7 * 3.40 * 0.2281) \\
&= 0.9058
\end{aligned}$$

Gust Factor Calculations: Vacuum, Corroded

Vessel is considered a rigid structure as $n_1 = 11.0240 \text{ Hz} \geq 1 \text{ Hz}$.

$$\begin{aligned}
z^- &= \max(0.60 * h, z_{\min}) \\
&= \max(0.60 * 13.6117, 15.0000) \\
&= 15.0000 \\
I_z^- &= c * (33 / z^-)^{1/6} \\
&= 0.2000 * (33 / 15.0000)^{1/6} \\
&= 0.2281 \\
L_z^- &= l * (z^- / 33)^{ep} \\
&= 500.0000 * (15.0000 / 33)^{0.2000} \\
&= 427.0566 \\
Q &= \text{Sqr}(1 / (1 + 0.63 * ((b + h) / L_z)^{0.63})) \\
&= \text{Sqr}(1 / (1 + 0.63 * ((1.6667 + 13.6117) / 427.0566)^{0.63})) \\
&= 0.9635 \\
G &= 0.925 * (1 + 1.7 * g_Q * I_z^- * Q) / (1 + 1.7 * g_v * I_z^-) \\
&= 0.925 * (1 + 1.7 * 3.40 * 0.2281 * 0.9635) / (1 + 1.7 * 3.40 * 0.2281) \\
&= 0.9058
\end{aligned}$$

Table Lookup Values	
$\alpha = 9.5000, z_g = 900.00 \text{ ft}$	[Table 26.9-1, page 256]
$c = 0.2000, l = 500.0000, ep = 0.2000$	[Table 26.9-1, page 256]
$a^- = 0.1538, b^- = 0.6500$	[Table 26.9-1, page 256]
$z_{\min} = 15.0000 \text{ ft}$	[Table 26.9-1, page 256]
$g_Q = 3.40$	[26.9.4 page 254]
$g_v = 3.40$	[26.9.4 page 254]

Seismic Code

Building Code: ASCE 7-10 ground supported		
Site Class		D
Importance Factor, I_e		1.2500
Spectral Response Acceleration at short period (% g), S_s		100.00%
Spectral Response Acceleration at period of 1 sec (% g), S_1		40.00%
Response Modification Coefficient from Table 15.4-2, R		3.0000
Acceleration-based Site Coefficient, F_a		1.1000
Velocity-based Site Coefficient, F_v		1.6000
Long-period Transition Period, T_L		12.0000
Redundancy factor, ρ		1.0000
Risk Category (Table 1.5-1)		III
User Defined Vertical Accelerations Considered		No
Vessel Characteristics		
Height		13.6117 ft
Weight	Operating, Corroded	4,207 lb
	Empty, Corroded	3,261 lb
	Vacuum, Corroded	4,207 lb
Period of Vibration Calculation		
Fundamental Period, T	Operating, Corroded	0.091 sec (f = 11.0 Hz)
	Empty, Corroded	0.081 sec (f = 12.3 Hz)
	Vacuum, Corroded	0.091 sec (f = 11.0 Hz)

The fundamental period of vibration T (above) is calculated using the Rayleigh method of approximation

$T = 2 * \pi * \text{Sqr}(\{\text{Sum}(W_i * y_i^2)\} / \{g * \text{Sum}(W_i * y_i)\})$, where

W_i is the weight of the i^{th} lumped mass, and

y_i is its deflection when the system is treated as a cantilever beam.

12.4.2.3 Basic Load Combinations for Allowable Stress Design			
Load combinations considered in accordance with ASCE section 2.4.1:			
5.	$D + P + P_s + 0.7E$	$= (1.0 + 0.14S_{DS})D + P + P_s + 0.7\rho Q_E$	
8.	$0.6D + P + P_s + 0.7E$	$= (0.6 - 0.14S_{DS})D + P + P_s + 0.7\rho Q_E$	
Parameter description			
D	= Dead load		
P	= Internal or external pressure load		
P_s	= Static head load		
E	= Seismic load	$= E_h \text{ +/- } E_v$	$= \rho Q_E \text{ +/- } 0.2S_{DS}D$

Seismic Shear Reports:

[Operating, Corroded](#)

[Empty, Corroded](#)

[Vacuum, Corroded](#)

[Base Shear Calculations](#)

Seismic Shear Report: Operating, Corroded					
Component	Elevation of Bottom above Base (in)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Seismic Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)
Closure	155.9964	29.0	*	341	193
Shell	71.9964	28.8	0.1014	849	4,397
Bottom Head (top)	68.63	29.0	*	859	4,636
Skirt	0	29.0	0.0537	900	9,712
*Moment of Inertia I varies over the length of the component					

Seismic Shear Report: Empty, Corroded					
Component	Elevation of Bottom above Base (in)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Seismic Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)
Closure	155.9964	29.4	*	327	190
Shell	71.9964	29.2	0.1014	653	3,590
Bottom Head (top)	68.63	29.4	*	659	3,774
Skirt	0	29.4	0.0537	697	7,691
*Moment of Inertia I varies over the length of the component					

Seismic Shear Report: Vacuum, Corroded					
Component	Elevation of Bottom above Base (in)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Seismic Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)
Closure	155.9964	29.0	*	341	193
Shell	71.9964	28.8	0.1014	849	4,397
Bottom Head (top)	68.63	29.0	*	859	4,636
Skirt	0	29.0	0.0537	900	9,712
*Moment of Inertia I varies over the length of the component					

11.4.3: Maximum considered earthquake spectral response acceleration

The maximum considered earthquake spectral response acceleration at short period, S_{MS}

$$S_{MS} = F_a * S_a = 1.1000 * 100.00 / 100 = 1.1000$$

The maximum considered earthquake spectral response acceleration at 1 s period, S_{MI}

$$S_{MI} = F_v * S_v = 1.6000 * 40.00 / 100 = 0.6400$$

11.4.4: Design spectral response acceleration parameters

Design earthquake spectral response acceleration at short period, S_{DS}

$$S_{DS} = 2 / 3 * S_{MS} = 2 / 3 * 1.1000 = 0.7333$$

Design earthquake spectral response acceleration at 1 s period, S_{DI}

$$S_{DI} = 2 / 3 * S_{MI} = 2 / 3 * 0.6400 = 0.4267$$

11.6 Seismic Design Category

The Risk Category is III.

From Table 11.6-1, the Seismic Design Category based on $S_{DS} = 0.7333$ is D.

From Table 11.6-2, the Seismic Design Category based on $S_{DI} = 0.4267$ is D.

This vessel is assigned to Seismic Design Category D.

12.4.2.3: Seismic Load Combinations: Vertical Term

Factor is applied to dead load.

$$\begin{aligned} \text{Compressive Side:} &= 1.0 + 0.14 * S_{DS} \\ &= 1.0 + 0.14 * 0.7333 \\ &= 1.1027 \end{aligned}$$

$$\begin{aligned} \text{Tensile Side:} &= 0.6 - 0.14 * S_{DS} \\ &= 0.6 - 0.14 * 0.7333 \\ &= 0.4973 \end{aligned}$$

Base Shear Calculations

[Operating, Corroded](#)

[Empty, Corroded](#)

[Vacuum, Corroded](#)

Base Shear Calculations: Operating, Corroded

Paragraph 15.4.4: Period Determination

Fundamental Period is taken from the Rayleigh method listed previously in this report.

$$T = 0.0907 \text{ sec.}$$

12.8.1: Calculation of Seismic Response Coefficient

C_s is the value computed below, bounded by $C_{s\text{Min}}$ and $C_{s\text{Max}}$:

$C_{s\text{Min}}$ is calculated with equation 15.4-1 and shall not be less than 0.03; in addition, if $S_1 \geq 0.6g$, $C_{s\text{Min}}$ shall not be less than eqn 15.4-2.

$C_{s\text{Max}}$ calculated with 12.8-3 because $(T = 0.0907) \leq (T_L = 12.0000)$

$$C_s = S_{DS} / (R / I_e) = 0.7333 / (3.0000 / 1.2500) = 0.3056$$

$$C_{s\text{Min}} = \max (0.044 * S_{DS} * I_e, 0.03) = \max (0.044 * 0.7333 * 1.2500, 0.03) = 0.0403$$

$$C_{s\text{Max}} = S_{D1} / (T * (R / I_e)) = 0.4267 / (0.0907 * (3.0000 / 1.2500)) = 1.9598$$

$$C_s = 0.3056$$

12.8.1: Calculation of Base Shear

$$V = C_s * W$$

$$= 0.3056 * 4,207.4937$$

$$= 1,285.62 \text{ lb}$$

12.4.2.1 Seismic Load Combinations: Horizontal Seismic Load Effect, E_h

$$Q_E = V$$

$$E_h = 0.7 * \rho * Q_E \text{ (Only 70\% of seismic load considered as per Section 2.4.1)}$$

$$= 0.70 * 1.0000 * 1,285.62$$

$$= 899.94 \text{ lb}$$

Base Shear Calculations: Empty, Corroded

Paragraph 15.4.4: Period Determination

Fundamental Period is taken from the Rayleigh method listed previously in this report.

$$T = 0.0810 \text{ sec.}$$

12.8.1: Calculation of Seismic Response Coefficient

C_s is the value computed below, bounded by $C_{s\text{Min}}$ and $C_{s\text{Max}}$:

$C_{s\text{Min}}$ is calculated with equation 15.4-1 and shall not be less than 0.03; in addition, if $S_1 \geq 0.6g$, $C_{s\text{Min}}$ shall not be less than eqn 15.4-2.

$C_{s\text{Max}}$ calculated with 12.8-3 because $(T = 0.0810) \leq (T_L = 12.0000)$

$$C_s = S_{DS} / (R / I_e) = 0.7333 / (3.0000 / 1.2500) = 0.3056$$

$$C_{s\text{Min}} = \max (0.044 * S_{DS} * I_e, 0.03) = \max (0.044 * 0.7333 * 1.2500, 0.03) = 0.0403$$

$$C_{s\text{Max}} = S_{D1} / (T * (R / I_e)) = 0.4267 / (0.0810 * (3.0000 / 1.2500)) = 2.1944$$

$$C_s = 0.3056$$

12.8.1: Calculation of Base Shear

$$\begin{aligned}
 V &= C_s * \underline{W} \\
 &= 0.3056 * 3,261.0378 \\
 &= 996.43 \text{ lb}
 \end{aligned}$$

12.4.2.1 Seismic Load Combinations: Horizontal Seismic Load Effect, E_h

$$\begin{aligned}
 Q_E &= V \\
 E_h &= 0.7 * \rho * Q_E \text{ (Only 70\% of seismic load considered as per Section 2.4.1)} \\
 &= 0.70 * 1.0000 * 996.43 \\
 &= 697.50 \text{ lb}
 \end{aligned}$$

Base Shear Calculations: Vacuum, Corroded

Paragraph 15.4.4: Period Determination

Fundamental Period is taken from the Rayleigh method listed previously in this report.

$$T = 0.0907 \text{ sec.}$$

12.8.1: Calculation of Seismic Response Coefficient

C_s is the value computed below, bounded by $C_{s\text{Min}}$ and $C_{s\text{Max}}$:

$C_{s\text{Min}}$ is calculated with equation 15.4-1 and shall not be less than 0.03; in addition, if $S_1 \geq 0.6g$, $C_{s\text{Min}}$ shall not be less than eqn 15.4-2.

$C_{s\text{Max}}$ calculated with 12.8-3 because $(T = 0.0907) \leq (T_L = 12.0000)$

$$\begin{aligned}
 C_s &= \underline{S_{DS}} / (\underline{R} / \underline{I_e}) = 0.7333 / (3.0000 / 1.2500) = 0.3056 \\
 C_{s\text{Min}} &= \max (0.044 * \underline{S_{DS}} * \underline{I_e} , 0.03) = \max (0.044 * 0.7333 * 1.2500 , 0.03) = 0.0403 \\
 C_{s\text{Max}} &= \underline{S_{D1}} / (T * (\underline{R} / \underline{I_e})) = 0.4267 / (0.0907 * (3.0000 / 1.2500)) = 1.9598 \\
 C_s &= 0.3056
 \end{aligned}$$

12.8.1: Calculation of Base Shear

$$\begin{aligned}
 V &= C_s * \underline{W} \\
 &= 0.3056 * 4,207.4937 \\
 &= 1,285.62 \text{ lb}
 \end{aligned}$$

12.4.2.1 Seismic Load Combinations: Horizontal Seismic Load Effect, E_h

$$\begin{aligned}
 Q_E &= V \\
 E_h &= 0.7 * \rho * Q_E \text{ (Only 70\% of seismic load considered as per Section 2.4.1)} \\
 &= 0.70 * 1.0000 * 1,285.62 \\
 &= 899.94 \text{ lb}
 \end{aligned}$$

Shell

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-106 C Smls pipe (II-D p. 22, ln. 1)		
Pipe NPS and Schedule		NPS 20 Sch 60		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	No	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		1,100	150	-20
External		15	150	
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		3.27	90.7188	1
Test vertical		3.27	90.6563	1
Dimensions				
Outer Diameter		20"		
Length		84"		
Pipe Nominal Thickness		0.812"		
Pipe Minimum Thickness ¹		0.7105"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		1,119.2		96.44
Corroded		1,036.55		97.76
Radiography				
Longitudinal seam		Seamless No RT		
Top Circumferential seam		Spot UW-11(a)(5)(b) Type 1		
Bottom Circumferential seam		Spot UW-11(a)(5)(b) Type 1		

¹Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	$0.0625" + 0.0625" = 0.125"$
Design thickness due to internal pressure (t)	0.6023"
Design thickness due to external pressure (t_e)	0.1833"
Design thickness due to combined loadings + corrosion	0.3171"
Maximum allowable working pressure (MAWP)	1,327.21 psi
Maximum allowable pressure (MAP)	1,462.57 psi
Maximum allowable external pressure (MAEP)	599.26 psi
Rated MDMT	-20 °F

UCS-66 Material Toughness Requirements	
Governing thickness, $t_g =$	0.7105"
MDMT =	-20°F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20°F.	

Design thickness, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 t &= P \cdot R_o / (S \cdot E + 0.40 \cdot P) + \text{Corrosion} \\
 &= 1,103.27 \cdot 10 / (20,000 \cdot 1.00 + 0.40 \cdot 1,103.27) + 0.0625 \\
 &= \a href="#">0.6023"
 \end{aligned}$$

Maximum allowable working pressure, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) - P_s \\
 &= 20,000 \cdot 1.00 \cdot (0.812 \cdot 0.875 - 0.0625) / (10 - 0.40 \cdot (0.812 \cdot 0.875 - 0.0625)) - 3.27 \\
 &= \a href="#">1,327.21 \text{ psi}
 \end{aligned}$$

Maximum allowable pressure, (at 60 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) \\
 &= 20,000 \cdot 1.00 \cdot (0.812 \cdot 0.875) / (10 - 0.40 \cdot (0.812 \cdot 0.875)) \\
 &= \a href="#">1,462.57 \text{ psi}
 \end{aligned}$$

External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned}
 L / D_o &= 91.1458 / 20 = 4.5573 \\
 D_o / t &= 20 / 0.1208 = 165.6173
 \end{aligned}$$

From table G: A = 0.000130
 From table CS-2: B = 1,863.2016 psi

$$\begin{aligned}
 P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\
 &= 4 \cdot 1,863.2 / (3 \cdot (20 / 0.1208)) \\
 &= 15 \text{ psi}
 \end{aligned}$$

Design thickness for external pressure $P_a = 15$ psi

$$t_a = t + \text{Corrosion} = 0.1208 + 0.0625 = \underline{0.1833"}$$

Maximum Allowable External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned} L / D_o &= 91.1458 / 20 = 4.5573 \\ D_o / t &= 20 / (0.812 \cdot 0.875 - 0.0625) = 30.8642 \end{aligned}$$

$$\text{From table G: } A = 0.001522$$

$$\text{From table CS-2: } B = 13,871.6537 \text{ psi}$$

$$\begin{aligned} P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\ &= 4 \cdot 13,871.65 / (3 \cdot (20 / (0.812 \cdot 0.875 - 0.0625))) \\ &= \underline{599.26} \text{ psi} \end{aligned}$$

External Pressure + Weight + Wind Loading Check (Bergman, ASME paper 54-A-104)

$$\begin{aligned} P_v &= W / (2 \cdot \pi \cdot R_m) + M / (\pi \cdot R_m^2) \\ &= 2,641.3 / (2 \cdot \pi \cdot 9.6253) + 6,433 / (\pi \cdot 9.6253^2) \\ &= 65.776 \text{ lb/in} \end{aligned}$$

$$\begin{aligned} \alpha &= P_v / (P_e \cdot D_o) \\ &= 65.776 / (15 \cdot 20) \\ &= 0.2193 \end{aligned}$$

$$n = 2$$

$$\begin{aligned} m &= 1.23 / (L / D_o)^2 \\ &= 1.23 / (91.1458 / 20)^2 \\ &= 0.0592 \end{aligned}$$

$$\begin{aligned} \text{Ratio } P_e &= (n^2 - 1 + m + m \cdot \alpha) / (n^2 - 1 + m) \\ &= (2^2 - 1 + 0.0592 + 0.0592 \cdot 0.2193) / (2^2 - 1 + 0.0592) \\ &= 1.0042 \end{aligned}$$

$$\text{Ratio } P_e \cdot P_e \leq \text{MAEP}$$

$$(1.0042 \cdot 15 = 15.06) \leq 599.26$$

Cylinder design thickness is satisfactory.

External Pressure + Weight + Seismic Loading Check (Bergman, ASME paper 54-A-104)

$$\begin{aligned} P_v &= (1 + 0.14 \cdot S_{DS}) \cdot W / (2 \cdot \pi \cdot R_m) + M / (\pi \cdot R_m^2) \\ &= 1.10 \cdot 2,641.3 / (2 \cdot \pi \cdot 9.6253) + 52,762 / (\pi \cdot 9.6253^2) \\ &= 229.4381 \text{ lb/in} \end{aligned}$$

$$\begin{aligned} \alpha &= P_v / (P_e \cdot D_o) \\ &= 229.4381 / (15 \cdot 20) \\ &= 0.7648 \end{aligned}$$

$$n = 2$$

$$\begin{aligned} m &= 1.23 / (L / D_o)^2 \\ &= 1.23 / (91.1458 / 20)^2 \\ &= 0.0592 \end{aligned}$$

$$\begin{aligned} \text{Ratio } P_e &= (n^2 - 1 + m + m \cdot \alpha) / (n^2 - 1 + m) \\ &= (2^2 - 1 + 0.0592 + 0.0592 \cdot 0.7648) / (2^2 - 1 + 0.0592) \\ &= 1.0148 \end{aligned}$$

$$\text{Ratio } P_e \cdot P_e \leq \text{MAEP}$$

$$(1.0148 \cdot 15 = 15.22) \leq 599.26$$

Cylinder design thickness is satisfactory.

Thickness Required Due to Pressure + External Loads								
Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S _t	S _c					
Operating, Hot & Corroded	1,100	20,000	17,319	150	0.0625	Wind	0.2465	0.2435
						Seismic	0.2546	0.2355
Operating, Hot & New	1,100	20,000	17,342	150	0	Wind	0.2448	0.2417
						Seismic	0.2531	0.2335
Hot Shut Down, Corroded	0	20,000	17,319	150	0.0625	Wind	0.0002	0.0032
						Seismic	0.0078	0.011
Hot Shut Down, New	0	20,000	17,342	150	0	Wind	0.0002	0.0033
						Seismic	0.008	0.0113
Empty, Corroded	0	20,000	17,319	70	0.0625	Wind	0.0002	0.0032
						Seismic	0.0062	0.0094
Empty, New	0	20,000	17,342	70	0	Wind	0.0002	0.0033
						Seismic	0.0064	0.0098
Vacuum	-15	20,000	17,319	150	0.0625	Wind	0.0035	0.0065
						Seismic	0.0044	0.0144
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	20,000	17,319	150	0.0625	Weight	0.0025	0.0025

Bottom Head

ASME Section VIII Division 1, 2015 Edition				
Component		Ellipsoidal Head		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Attached To		Shell		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	Yes	Yes	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		1,100	150	-20
External		15	150	
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		3.52	97.4375	1
Test vertical		3.51	97.3125	1
Dimensions				
Outer Diameter		20"		
Head Ratio		2		
Minimum Thickness		0.6875"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Length L _{sf}		2"		
Nominal Thickness t _{sf}		0.75"		
Weight and Capacity				
		Weight (lb) ¹		Capacity (US gal) ¹
New		110.03		5.99
Corroded		100.91		6.12
Radiography				
Category A joints		Seamless No RT		
Head to shell seam		Spot UW-11(a)(5)(b) Type 1		

¹ includes straight flange

Results Summary	
Governing condition	internal pressure
Minimum thickness per UG-16	$0.0625" + 0.0625" = 0.125"$
Design thickness due to internal pressure (t)	0.5838"
Design thickness due to external pressure (t_e)	0.1112"
Maximum allowable working pressure (MAWP)	1,332.67 psi
Maximum allowable pressure (MAP)	1,465.69 psi
Maximum allowable external pressure (MAEP)	633.25 psi
Straight Flange governs MDMT	-55°F

Factor K		
$K = (1/6) * [2 + (D / (2 * h))^2]$		
Corroded	$K = (1/6) * [2 + (18.75 / (2 * 4.7188))^2]$	0.9912
New	$K = (1/6) * [2 + (18.625 / (2 * 4.6563))^2]$	1

Design thickness for internal pressure, (Corroded at 150 ° F) Appendix 1-4(c)

$$\begin{aligned}
 t &= P * D_o * K / (2 * S * E + 2 * P * (K - 0.1)) + \text{Corrosion} \\
 &= 1,103.52 * 20 * 0.991199 / (2 * 20,000 * 1 + 2 * 1,103.52 * (0.991199 - 0.1)) + 0.0625 \\
 &= \a href="#">0.5838"
 \end{aligned}$$

Maximum allowable working pressure, (Corroded at 150 ° F) Appendix 1-4(c)

$$\begin{aligned}
 P &= 2 * S * E * t / (K * D_o - 2 * t * (K - 0.1)) - P_s \\
 &= 2 * 20,000 * 1 * 0.625 / (0.991199 * 20 - 2 * 0.625 * (0.991199 - 0.1)) - 3.52 \\
 &= \a href="#">1,332.67 \text{ psi}
 \end{aligned}$$

Maximum allowable pressure, (New at 60 ° F) Appendix 1-4(c)

$$\begin{aligned}
 P &= 2 * S * E * t / (K * D_o - 2 * t * (K - 0.1)) - P_s \\
 &= 2 * 20,000 * 1 * 0.6875 / (1 * 20 - 2 * 0.6875 * (1 - 0.1)) - 0 \\
 &= \a href="#">1,465.69 \text{ psi}
 \end{aligned}$$

Design thickness for external pressure, (Corroded at 150 ° F) UG-33(d)

Equivalent outside spherical radius (R_o)

$$\begin{aligned}
 R_o &= K_o * D_o \\
 &= 0.8421 * 20 \\
 &= 16.8421 \text{ in}
 \end{aligned}$$

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (16.8421 / 0.048644) \\
 &= 0.000361
 \end{aligned}$$

From Table CS-2:

$$B = 5,193.4548 \text{ psi}$$

$$\begin{aligned}
 P_a &= B / (R_o / t) \\
 &= 5,193.4548 / (16.8421 / 0.0486) \\
 &= 15 \text{ psi}
 \end{aligned}$$

$$t = 0.0486" + \text{Corrosion} = 0.0486" + 0.0625" = 0.1111"$$

Check the external pressure per UG-33(a)(1) Appendix 1-4(c)

$$\begin{aligned} t &= 1.67 * P_e * D_o * K / (2 * S * E + 2 * 1.67 * P_e * (K - 0.1)) + \text{Corrosion} \\ &= 1.67 * 15 * 20 * 0.991199 / (2 * 20,000 * 1 + 2 * 1.67 * 15 * (0.991199 - 0.1)) + 0.0625 \\ &= 0.0749" \end{aligned}$$

The head external pressure design thickness (t_e) is [0.1111"](#).

Maximum Allowable External Pressure, (Corroded at 150 ° F) UG-33(d)

Equivalent outside spherical radius (R_o)

$$\begin{aligned} R_o &= K_o * D_o \\ &= 0.8421 * 20 \\ &= 16.8421 \text{ in} \end{aligned}$$

$$\begin{aligned} A &= 0.125 / (R_o / t) \\ &= 0.125 / (16.8421 / 0.625) \\ &= 0.004639 \end{aligned}$$

From Table CS-2:

$$B = 17,064.49 \text{ psi}$$

$$\begin{aligned} P_a &= B / (R_o / t) \\ &= 17,064.49 / (16.8421 / 0.625) \\ &= 633.2525 \text{ psi} \end{aligned}$$

Check the Maximum External Pressure, UG-33(a)(1) Appendix 1-4(c)

$$\begin{aligned} P &= 2 * S * E * t / ((K * D_o - 2 * t * (K - 0.1)) * 1.67) \\ &= 2 * 20,000 * 1 * 0.625 / ((0.991199 * 20 - 2 * 0.625 * (0.991199 - 0.1)) * 1.67) \\ &= 800.11 \text{ psi} \end{aligned}$$

The maximum allowable external pressure (MAEP) is [633.25](#) psi.

% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned} EFE &= (75 * t / R_f) * (1 - R_f / R_o) \\ &= (75 * 0.75 / 3.5413) * (1 - 3.5413 / \infty) \\ &= 15.8842\% \end{aligned}$$

The extreme fiber elongation exceeds 5 percent and the thickness exceeds 5/8 inch;. Heat treatment per UCS-56 is required if fabricated by cold forming.

Straight Flange on Bottom Head

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	Yes	Yes	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		1,100	150	-20
External		15	150	
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		3.35	92.7188	1
Test vertical		3.34	92.6563	1
Dimensions				
Outer Diameter		20"		
Length		2"		
Nominal Thickness		0.75"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		25.67		2.33
Corroded		23.61		2.36
Radiography				
Longitudinal seam		Seamless No RT		
Top Circumferential seam		Spot UW-11(a)(5)(b) Type 1		

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	$0.0625" + 0.0625" = 0.125"$
Design thickness due to internal pressure (t)	0.6023"
Design thickness due to external pressure (t_e)	0.1833"
Design thickness due to combined loadings + corrosion	0.3189"
Maximum allowable working pressure (MAWP)	1,410.53 psi
Maximum allowable pressure (MAP)	1,546.39 psi
Maximum allowable external pressure (MAEP)	653.49 psi
Rated MDMT	-55 °F

UCS-66 Material Toughness Requirements	
Governing thickness, $t_g =$	0.7105"
Exemption temperature from Fig UCS-66 Curve D =	-43.9°F
$t_r = 1,119.72 \times 10 / (20,000 \times 1 + 0.4 \times 1,119.72) =$	0.5476"
Stress ratio $= t_r \times E^* / (t_n - c) = 0.5476 \times 1 / (0.75 - 0.0625) =$	0.7965
Reduction in MDMT, T_R from Fig UCS-66.1 =	20.3°F
MDMT $= \max[\text{MDMT} - T_R, -55] = \max[-43.9 - 20.3, -55] =$	-55°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Design thickness, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 t &= P \cdot R_o / (S \cdot E + 0.40 \cdot P) + \text{Corrosion} \\
 &= 1,103.35 \times 10 / (20,000 \times 1.00 + 0.40 \times 1,103.35) + 0.0625 \\
 &= \a href="#">0.6023"
 \end{aligned}$$

Maximum allowable working pressure, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) - P_s \\
 &= 20,000 \times 1.00 \times 0.6875 / (10 - 0.40 \times 0.6875) - 3.35 \\
 &= \a href="#">1,410.53 \text{ psi}
 \end{aligned}$$

Maximum allowable pressure, (at 60 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) \\
 &= 20,000 \times 1.00 \times 0.75 / (10 - 0.40 \times 0.75) \\
 &= \a href="#">1,546.39 \text{ psi}
 \end{aligned}$$

External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned}
 L / D_o &= 91.1458 / 20 = 4.5573 \\
 D_o / t &= 20 / 0.1208 = 165.6173
 \end{aligned}$$

$$\begin{aligned}
 \text{From table G: } A &= 0.000130 \\
 \text{From table CS-2: } B &= 1,863.2016 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 P_a &= 4*B / (3*(D_o / t)) \\
 &= 4*1,863.2 / (3*(20 / 0.1208)) \\
 &= 15 \text{ psi}
 \end{aligned}$$

Design thickness for external pressure $P_a = 15$ psi

$$t_a = t + \text{Corrosion} = 0.1208 + 0.0625 = \underline{0.1833"}$$

Maximum Allowable External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned}
 L / D_o &= 91.1458 / 20 = 4.5573 \\
 D_o / t &= 20 / 0.6875 = 29.0909
 \end{aligned}$$

From table G: $A = 0.001675$

From table CS-2: $B = 14,258.0447 \text{ psi}$

$$\begin{aligned}
 P_a &= 4*B / (3*(D_o / t)) \\
 &= 4*14,258.04 / (3*(20 / 0.6875)) \\
 &= \underline{653.49} \text{ psi}
 \end{aligned}$$

% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 EFE &= (50*t / R_f)*(1 - R_f / R_o) \\
 &= (50*0.75 / 9.625)*(1 - 9.625 / \infty) \\
 &= 3.8961\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

Thickness Required Due to Pressure + External Loads								
Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S _t	S _c					
Operating, Hot & Corroded	1,100	20,000	17,334	150	0.0625	Wind	0.2482	0.2451
						Seismic	0.2564	0.2369
Operating, Hot & New	1,100	20,000	17,355	150	0	Wind	0.2465	0.2433
						Seismic	0.255	0.2349
Hot Shut Down, Corroded	0	20,000	17,334	150	0.0625	Wind	0.0002	0.0032
						Seismic	0.008	0.0113
Hot Shut Down, New	0	20,000	17,355	150	0	Wind	0.0002	0.0033
						Seismic	0.0082	0.0116
Empty, Corroded	0	20,000	17,334	70	0.0625	Wind	0.0002	0.0032
						Seismic	0.0064	0.0096
Empty, New	0	20,000	17,355	70	0	Wind	0.0002	0.0033
						Seismic	0.0066	0.0099
Vacuum	-15	20,000	17,334	150	0.0625	Wind	0.0035	0.0066
						Seismic	0.0046	0.0146
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	20,000	17,334	150	0.0625	Weight	0.0025	0.0025

Skirt

ASME Section VIII Division 1, 2015 Edition		
Component		Support Skirt
Material		SA-53 E/B Wld pipe (II-D p. 14, ln. 12)
Skirt is Attached To		Bottom Head
Skirt Attachment Offset		3.3664" down from the top seam
Design Temperature		
Internal		150°F
External		150°F
Dimensions		
Inner Diameter	Top	19.25"
	Bottom	19.25"
Length (includes base ring thickness)		68.63"
Nominal Thickness		0.375"
Corrosion	Inner	0"
	Outer	0"
Weight		
New		444.14 lb
Corroded		444.14 lb
Joint Efficiency		
Top		0.55
Bottom		0.8

Skirt design thickness, largest of the following + corrosion = 0.0273 in

The governing condition is due to seismic, compressive stress at the base, operating & new.

The skirt thickness of 0.3281 in is adequate.

Results Summary							
Loading	Condition	Tensile or Compressive Side	Governing Skirt Location	Temperature (°F)	Allowable Stress (psi)	Calculated Stress/E (psi)	Required thickness (in)
Wind	operating, corroded	Tensile	bottom	150	17,176.47	95.44	0.0021
		Compressive			17,176.47	364.07	0.0079
	operating, new	Tensile	bottom	150	17,176.47	92.31	0.002
		Compressive			17,176.47	368.39	0.008
	empty, corroded	Tensile	bottom	60	17,176.47	126.15	0.0028
		Compressive			17,176.47	323.13	0.0071
	empty, new	Tensile	bottom	60	17,176.47	122.55	0.0027
		Compressive			17,176.47	328.07	0.0072
	test, new	Tensile	bottom	60	17,176.47	-108.3	0.0024
		Compressive				186.28	0.0041
	vacuum, corroded	Tensile	bottom	150	17,176.47	95.44	0.0021
		Compressive			17,176.47	364.07	0.0079
Seismic	operating, corroded	Tensile	bottom	150	17,176.47	1,172.44	0.0256
		Compressive			17,176.47	1,225.67	0.0268
	operating, new	Tensile	bottom	150	17,176.47	1,197.7	0.0261
		Compressive			17,176.47	1,252.7	0.0273
	empty, corroded	Tensile	bottom	60	17,176.47	930.74	0.0203
		Compressive			17,176.47	966.8	0.0211
	empty, new	Tensile	bottom	60	17,176.47	959.62	0.021
		Compressive			17,176.47	997.72	0.0218
	vacuum, corroded	Tensile	bottom	150	17,176.47	1,172.44	0.0256
		Compressive			17,176.47	1,225.67	0.0268

Loading due to seismic, operating & new

Tensile side

Required thickness, tensile stress at base:

$$\begin{aligned}
 t &= -(0.6 - 0.14 \cdot S_{DS}) \cdot W / (\pi \cdot D \cdot S_t \cdot E) + 48 \cdot M / (\pi \cdot D^2 \cdot S_t \cdot E) \\
 &= -(0.6 - 0.14 \cdot 0.7333) \cdot 4,256.19 / (\pi \cdot 19.625 \cdot 17,176 \cdot 0.8) + 48 \cdot 9,922.7 / (\pi \cdot 19.625^2 \cdot 17,176 \cdot 0.8) \\
 &= 0.0261 \text{ in}
 \end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}
 t &= -(0.6 - 0.14 \cdot S_{DS}) \cdot W_t / (\pi \cdot D_t \cdot S_t \cdot E) + 48 \cdot M_t / (\pi \cdot D_t^2 \cdot S_t \cdot E) \\
 &= -(0.6 - 0.14 \cdot 0.7333) \cdot 3,792.05 / (\pi \cdot 19.625 \cdot 17,176 \cdot 0.55) + 48 \cdot 4,741.6 / (\pi \cdot 19.625^2 \cdot 17,176 \cdot 0.55) \\
 &= 0.0167 \text{ in}
 \end{aligned}$$

Compressive side

Required thickness, compressive stress at base:

$$\begin{aligned} t &= (1 + 0.14 \cdot S_{DS}) \cdot W / (\pi \cdot D \cdot S_c \cdot E_c) + 48 \cdot M / (\pi \cdot D^2 \cdot S_c \cdot E_c) \\ &= (1 + 0.14 \cdot 0.7333) \cdot 4,256.19 / (\pi \cdot 19.625 \cdot 17,176 \cdot 1) + 48 \cdot 9,922.7 / (\pi \cdot 19.625^2 \cdot 17,176 \cdot 1) \\ &= 0.0273 \text{ in} \end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned} t &= (1 + 0.14 \cdot S_{DS}) \cdot W_t / (\pi \cdot D_t \cdot S_c \cdot E_c) + 48 \cdot M_t / (\pi \cdot D_t^2 \cdot S_c \cdot E_c) \\ &= (1 + 0.14 \cdot 0.7333) \cdot 3,792.05 / (\pi \cdot 19.625 \cdot 17,176 \cdot 1) + 48 \cdot 4,741.6 / (\pi \cdot 19.625^2 \cdot 17,176 \cdot 1) \\ &= 0.0149 \text{ in} \end{aligned}$$

Base Plate

Inputs	
Base configuration	single base plate without gussets
Base plate material	SA-36
Base plate allowable stress, S_p	16,600 psi
Foundation compressive strength	1,658 psi
Concrete ultimate 28-day strength	3,000 psi
Bolt circle, BC	22"
Base plate inner diameter, D_i	18"
Base plate outer diameter, D_o	25"
Base plate thickness, t_b	0.75"
Anchor Bolts	
Material	CS
Allowable stress, S_b	20,000 psi
Bolt size and type	0.75" series 8 threaded
Number of bolts, N	4
Corrosion allowance (applied to root radius)	0"
Anchor bolt clearance	0.125"
Bolt root area (corroded), A_b	0.3 in ²
Diameter of anchor bolt holes, d_b	0.875"
Initial bolt preload	0% (0 psi)
Bolt at 0°	No

Results Summary							
Load	Vessel condition	Base V (lb _f)	Base M (lb _f -ft)	W (lb)	Required bolt area (in ²)	t _r Base (in)	Foundation bearing stress (psi)
Wind	operating, corroded	254.7	1,741.7	4,207.5	0.0159	0.2316	47.49
Wind	operating, new	254.7	1,742.2	4,306.2	0.0152	0.2045	37.04
Wind	empty, corroded	254.7	1,741.7	3,261	0.023	0.2319	47.59
Wind	empty, new	254.7	1,742.2	3,374	0.0222	0.2319	47.59
Wind	test, new	91.5	20.5	4,306.6	0	0.145	18.62
Wind	vacuum, corroded	254.7	1,741.7	4,207.5	0.0159	0.2316	47.49
Seismic	operating, corroded	899.9	9,711.7	4,207.5	0.2387	0.5187	238.19
Seismic	operating, new	921	9,922.7	4,306.2	0.2438	0.5244	243.43
Seismic	empty, corroded	697.5	7,691.3	3,261	0.1895	0.4607	187.94
Seismic	empty, new	721.7	7,932.7	3,374	0.1954	0.468	193.94
Seismic	vacuum, corroded	899.9	9,711.7	4,207.5	0.2387	0.5187	238.19

Anchor bolt load (governing)

$$\begin{aligned}
 P &= -(0.6 - 0.14 \cdot S_{DS}) \cdot W / N + 48 \cdot M / (N \cdot BC) \\
 &= -(0.6 - 0.14 \cdot 0.7333) \cdot 4,306.19 / 4 + 48 \cdot 9,922.7 / (4 \cdot 22) \\
 &= 4,876.99 \text{ lb}_f
 \end{aligned}$$

$$\text{Required area per bolt} = P / S_b = \text{0.2438} \text{ in}^2$$

The area provided (0.302 in²) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, governing)

Base plate width, t_c: 3.5 in
Average base plate diameter, d: 21.5 in
Base plate elastic modulus, E_s: 29.0E+06 psi
Base plate yield stress, S_y: 36,000 psi

$$E_c = 57,000 \cdot \text{Sqr}(3,000) = 3,122,019 \text{ psi}$$

$$n = E_s / E_c = 29.0E+06 / 3,122,019 = 9.2889$$

$$\begin{aligned}
 t_s &= (N \cdot A_b) / (\pi \cdot d) \\
 &= (4 \cdot 0.302) / (\pi \cdot 21.5) \\
 &= 0.0179 \text{ in}
 \end{aligned}$$

From table 12.4 for k = 0.168159:

$$\begin{aligned}
 K_1 &= 2.7317, K_2 = 1.1127 \\
 L_1 &= 7.1365, L_2 = 13.7429, L_3 = 2.8759
 \end{aligned}$$

Total tensile force on bolting

$$T = (12 \cdot M - (0.6 - 0.14 \cdot S_{DS}) \cdot W \cdot (L_1 + L_3)) / (L_2 + L_3)$$

$$= (12 * 9,922.7 - (0.6 - 0.14 * 0.7333) * 4,306.19 * (7.1365 + 2.8759)) / (13.7429 + 2.8759)$$

$$= 5,874.67 \text{ lb}_f$$

Tensile stress in bolts use the larger of f_s or bolt preload = 0 psi

$$f_s = T / (t_s * (d / 2) * K_1)$$

$$= 5,874.67 / (0.0179 * (21.5 / 2) * 2.7317)$$

$$= 11,186 \text{ psi}$$

Total compressive load on foundation

$$C_c = T + (1 + 0.14 * S_{DS}) * W + \text{Bolt Preload}$$

$$= 5,874.67 + (1 + 0.14 * 0.7333) * 4,306.19 + 0$$

$$= 10,622.96 \text{ lb}_f$$

Foundation bearing stress

$$f_c = C_c / (((t_c - t_s) + n * t_s) * (d / 2) * K_2)$$

$$= 10,622.96 / (((3.5 - 0.0179) + 9.2889 * 0.0179) * (21.5 / 2) * 1.1127)$$

$$= 243 \text{ psi}$$

As $f_c \leq 1,658 \text{ psi}$ the base plate width is satisfactory.

$$k = 1 / (1 + f_s / (n * f_c))$$

$$= 1 / (1 + 11,186 / (9.2889 * 243))$$

$$= 0.168159$$

Base plate required thickness (governing)

$$t_r = (3 * f_c * L^2 / S_p)^{0.5}$$

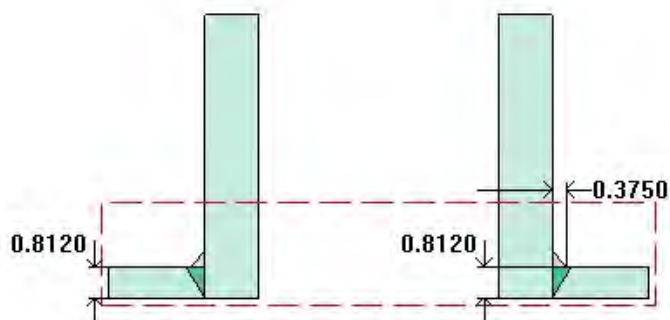
$$= (3 * 243 * 2.5^2 / 16,600)^{0.5}$$

$$= 0.5244 \text{ in}$$

The base plate thickness is satisfactory.

Inlet (N1)

ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	270°
Nozzle center line offset to datum line	27"
End of nozzle to shell center	20"
Passes through a Category A joint	No

Nozzle

Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23) (normalized)
Inside diameter, new	8"
Nominal wall thickness	1.375"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	7.56"
Projection available outside vessel to flange face, L _f	10"
Local vessel minimum thickness	0.7105"
Liquid static head included	2.34 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
Nozzle to vessel groove weld	0.812"

ASME B16.5-2013 Flange	
Description	NPS 8 Class 600 LWN A105 N
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-44.4°F
Liquid static head	2.19 psi
Consider External Loads on Flange MAWP Rating	No
MAWP rating	1,420 psi @ 150°F
MAP rating	1,480 psi @ 60°F
Hydrotest rating	2,225 psi @ 60°F
PWHT performed	No
Impact Tested	No
Gasket	
Description	Flexitallic Spiral Wound CG 304 S.S.
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -44.4°F (Coincident ratio = 0.7558) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements	
LWN rated MDMT per UCS-66(c)(4) =	-44.4°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,102.34 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
4.3817	4.5261	0.8834	3.5021	--	--	0.1406	0.3819	1.375

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

WRC 107												
Load Case	P (psi)	P _r (lb _f)	M _c (lb _f -in)	V _c (lb _f)	M _L (lb _f -in)	V _L (lb _f)	M _t (lb _f -in)	Max Comb Stress (psi)	Allow Comb Stress (psi)	Max Local Primary Stress (psi)	Allow Local Primary Stress (psi)	Over stressed
Load case 1	1,102.34	2,400	49,740	2,970	74,640	2,970	119,280	26,615	60,000	20,566	30,000	No
Load case 1 (Hot Shut Down)	0	2,400	49,740	2,970	74,640	2,970	119,280	-13,648	60,000	-3,654	30,000	No

Reinforcement Calculations for External Pressure

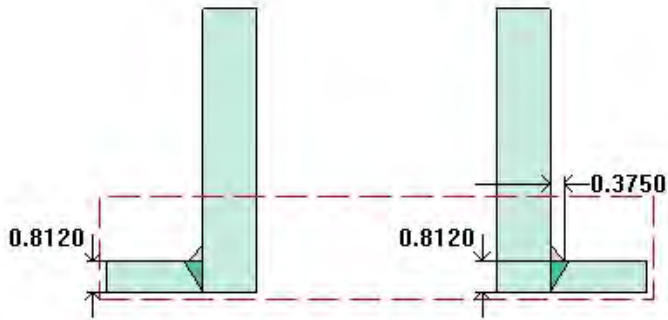
UG-37 Area Calculation Summary (in ²)								UG-45 Summary (in)	
For P _e = 15 psi @ 150 °F The opening is adequately reinforced								The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}	
0.4906	8.5609	4.2838	4.1365	--	--	0.1406	0.125	1.375	

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Outlet (N2)

ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	90°
Nozzle center line offset to datum line	9"
End of nozzle to shell center	20"
Passes through a Category A joint	No

Nozzle

Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23) (normalized)
Inside diameter, new	8"
Nominal wall thickness	1.375"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	7.56"
Projection available outside vessel to flange face, L _f	10"
Local vessel minimum thickness	0.7105"
Liquid static head included	2.99 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
Nozzle to vessel groove weld	0.812"

ASME B16.5-2013 Flange	
Description	NPS 8 Class 600 LWN A105 N
Bolt Material	SA-193 B7 Bolt $\leq 2\frac{1}{2}$ (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-44.4°F
Liquid static head	2.84 psi
Consider External Loads on Flange MAWP Rating	No
MAWP rating	1,420 psi @ 150°F
MAP rating	1,480 psi @ 60°F
Hydrotest rating	2,225 psi @ 60°F
PWHT performed	No
Impact Tested	No
Gasket	
Description	Flexitallic Spiral Wound CG 304 S.S.
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -44.4°F (Coincident ratio = 0.7562) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements	
LWN rated MDMT per UCS-66(c)(4) =	-44.4°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,102.99 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A _{required}	A _{available}	A ₁	A ₂	A ₃	A ₅	A _{welds}	t _{req}	t _{min}
4.3842	4.5232	0.8808	3.5018	--	--	0.1406	0.3819	1.375

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

WRC 107												
Load Case	P (psi)	P _r (lb _f)	M _c (lb _f -in)	V _c (lb _f)	M _L (lb _f -in)	V _L (lb _f)	M _t (lb _f -in)	Max Comb Stress (psi)	Allow Comb Stress (psi)	Max Local Primary Stress (psi)	Allow Local Primary Stress (psi)	Over stressed
Load case 1	1,102.99	2,400	49,740	2,970	74,640	2,970	119,280	26,625	60,000	20,578	30,000	No
Load case 1 (Hot Shut Down)	0	2,400	49,740	2,970	74,640	2,970	119,280	-13,648	60,000	-3,654	30,000	No

Reinforcement Calculations for External Pressure

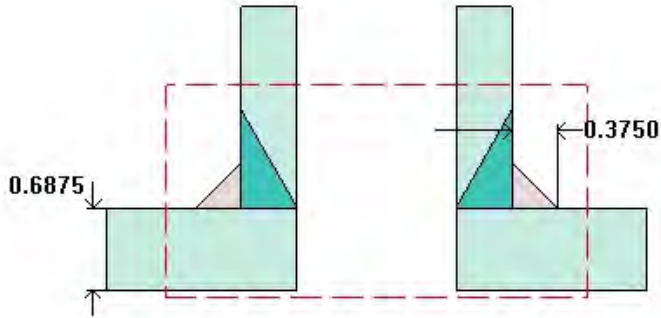
UG-37 Area Calculation Summary (in ²)								UG-45 Summary (in)	
For P _e = 15 psi @ 150 °F The opening is adequately reinforced								The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}	
0.4906	8.5609	4.2838	4.1365	--	--	0.1406	0.125	1.375	

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Drain (Sump) (C1)

ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Bottom Head
Orientation	0°
End of nozzle to datum line	-12.5"
Calculated as hillside	No
Distance to head center, R	0"
Passes through a Category A joint	No

Nozzle

Description	NPS 1 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.315"
Nominal wall thickness	0.4675"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.1902"
Local vessel minimum thickness	0.6875"
Liquid static head included	3.59 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,119.97 * 0.72 / (20,000 * 1 - 0.6 * 1,119.97) =$	0.0417"
Stress ratio = $t_r * E^* / (t_n - c) = 0.0417 * 1 / (0.4675 - 0.0625) =$	0.103
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,103.59 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.4675

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P _e = 15 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.4675

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Nozzle Pipe (C1)

ASME Section VIII Division 1, 2015 Edition				
Component		Nozzle Pipe		
Material		SA-106 B Smls pipe (II-D p. 14, ln. 15)		
Pipe NPS and Schedule		NPS 1 Sch 160		
Attached To		Drain (Sump) (C1)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	No	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		1,100	150	-20
External		15	150	
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		4.12	114.2188	1
Test vertical		4.23	117.1563	1
Dimensions				
Outer Diameter		1.315"		
Length		17"		
Pipe Nominal Thickness		0.25"		
Pipe Minimum Thickness ¹		0.2188"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		4.02		0.04
Corroded		3.2		0.05
Radiography				
Longitudinal seam		Seamless No RT		
Left Circumferential seam		None UW-11(c) Type 1		
Right Circumferential seam		None UW-11(c) Type 1		

¹Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	$0.0625" + 0.0625" = 0.125"$
Design thickness due to internal pressure (t)	0.111"
Design thickness due to external pressure (t_e)	0.075"
Maximum allowable working pressure (MAWP)	3,812.84 psi
Maximum allowable pressure (MAP)	5,879.63 psi
Maximum allowable external pressure (MAEP)	3,042.51 psi
Rated MDMT	-155 °F

UCS-66 Material Toughness Requirements	
Impact test exempt per UCS-66(d) (NPS 4 or smaller pipe) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Design thickness, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 t &= P \cdot R_o / (S \cdot E + 0.40 \cdot P) + \text{Corrosion} \\
 &= 1,104.12 \cdot 0.6575 / (17,100 \cdot 0.85 + 0.40 \cdot 1,104.12) + 0.0625 \\
 &= \underline{0.111"}
 \end{aligned}$$

Maximum allowable working pressure, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) - P_s \\
 &= 17,100 \cdot 0.85 \cdot (0.25 \cdot 0.875 - 0.0625) / (0.6575 - 0.40 \cdot (0.25 \cdot 0.875 - 0.0625)) - 4.12 \\
 &= \underline{3,812.84 \text{ psi}}
 \end{aligned}$$

Maximum allowable pressure, (at 60 ° F) Appendix 1-2

$$\begin{aligned}
 P &= S \cdot E \cdot \ln(R_o / (R_o - t)) \\
 &= 17,100 \cdot 0.85 \cdot \ln(0.6575 / (0.6575 - (0.25 \cdot 0.875))) \\
 &= \underline{5,879.63 \text{ psi}}
 \end{aligned}$$

External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned}
 L / D_o &= 19.1902 / 1.315 = 14.5933 \\
 D_o / t &= 1.315 / 0.0125 = 105.1813
 \end{aligned}$$

$$\begin{aligned}
 \text{From table G: } A &= 0.000105 \\
 \text{From table CS-2: } B &= 1,508.5888 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\
 &= 4 \cdot 1,508.59 / (3 \cdot (1.315 / 0.0125)) \\
 &= 19.12 \text{ psi}
 \end{aligned}$$

Design thickness for external pressure $P_a = 19.12 \text{ psi}$

$$t_a = t + \text{Corrosion} = 0.0125 + 0.0625 = \underline{0.075"}$$

Maximum Allowable External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned} L / D_o &= 19.1902 / 1.315 &= 14.5933 \\ D_o / t &= 1.315 / (0.25 \times 0.875 - 0.0625) &= 8.4160 \end{aligned}$$

From table G: $A = 0.016165$

From table CS-2: $B = 17,490.7297 \text{ psi}$

$$S_y = 2 \times B_{(sy)} = 2 \times 17,600 = 35,200 \text{ psi}$$

$$S_1 = 2 \times S_e = 2 \times 17,100 = 34,200 \text{ psi}$$

$$S_2 = 0.90 \times S_y = 0.90 \times 35,200 = 31,680 \text{ psi}$$

$$S = \min(S_1, S_2) = \min(34,200, 31,680) = 31,680 \text{ psi}$$

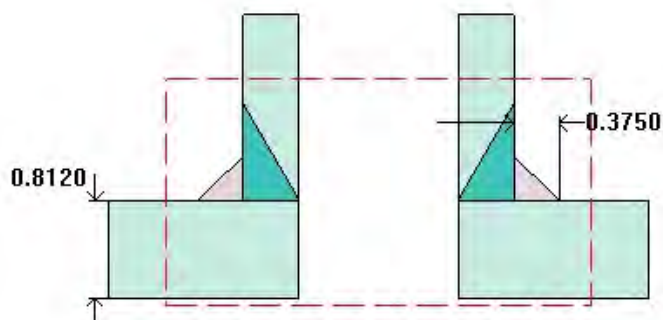
$$\begin{aligned} P_{a1} &= [2.167 / (D_o / t) - 0.08333] \times B - P_{se} \\ &= [2.167 / 8.4160 - 0.08333] \times 17,491 - 4.12 \\ &= 3,042.51 \text{ psi} \end{aligned}$$

$$\begin{aligned} P_{a2} &= (2 \times S / (D_o / t)) \times [1 - 1 / (D_o / t)] - P_{se} \\ &= (2 \times 31,680 / 8.416) \times [1 - 1 / 8.416] - 4.12 \\ &= 6,629.85 \text{ psi} \end{aligned}$$

$$\text{Maximum Allowable External Pressure} = \min(P_{a1}, P_{a2}) = \underline{3,042.51} \text{ psi}$$

Drain (Coalescer) (C2)

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Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	45°
Nozzle center line offset to datum line	21"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

Nozzle

Description	NPS 1 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.315"
Nominal wall thickness	0.4675"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.375"
Local vessel minimum thickness	0.7105"
Liquid static head included	2.43 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,118.81 * 0.72 / (20,000 * 1 - 0.6 * 1,118.81) =$	0.0417"
Stress ratio = $t_r * E^* / (t_n - c) = 0.0417 * 1 / (0.4675 - 0.0625) =$	0.1029
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,102.43 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.4675

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P _e = 15 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.4675

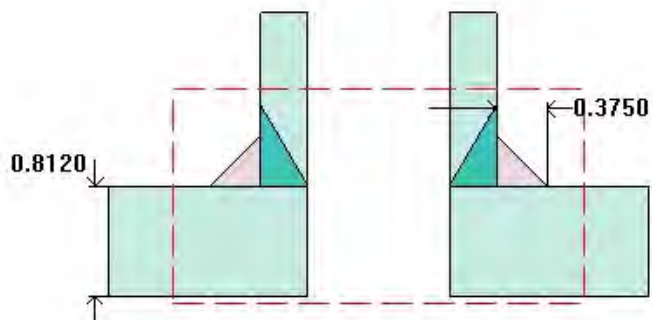
UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Vent (C3)

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Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	315°
Nozzle center line offset to datum line	75"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

Nozzle

Description	NPS 0.75 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.05"
Nominal wall thickness	0.35"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.375"
Local vessel minimum thickness	0.7105"
Liquid static head included	0.48 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,116.85 * 0.5875 / (20,000 * 1 - 0.6 * 1,116.85) =$	0.0339"
Stress ratio $= t_r * E^* / (t_n - c) = 0.0339 * 1 / (0.35 - 0.0625) =$	0.1181
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,100.48 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.35

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.2012	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For $P_e = 15 \text{ psi @ } 150 \text{ }^\circ\text{F}$							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.35

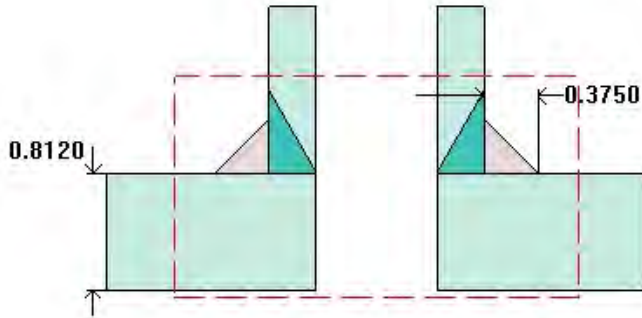
UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.2012	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

DPI (C4A)

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Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	90°
Nozzle center line offset to datum line	52"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

Nozzle

Description	NPS 0.5 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	0.84"
Nominal wall thickness	0.33"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.375"
Local vessel minimum thickness	0.7105"
Liquid static head included	1.3 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,117.68 * 0.4825 / (20,000 * 1 - 0.6 * 1,117.68) =$	0.0279"
Stress ratio $= t_r * E^* / (t_n - c) = 0.0279 * 1 / (0.33 - 0.0625) =$	0.1043
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,101.3 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

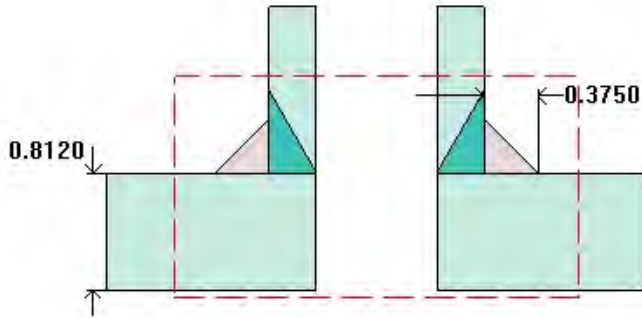
UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For $P_e = 15 \text{ psi @ } 150 \text{ }^\circ\text{F}$							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	0°
Nozzle center line offset to datum line	9"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

Nozzle

Description	NPS 0.5 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	0.84"
Nominal wall thickness	0.33"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.375"
Local vessel minimum thickness	0.7105"
Liquid static head included	2.86 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,119.23 * 0.4825 / (20,000 * 1 - 0.6 * 1,119.23) =$	0.0279"
Stress ratio $= t_r * E^* / (t_n - c) = 0.0279 * 1 / (0.33 - 0.0625) =$	0.1045
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,102.86 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

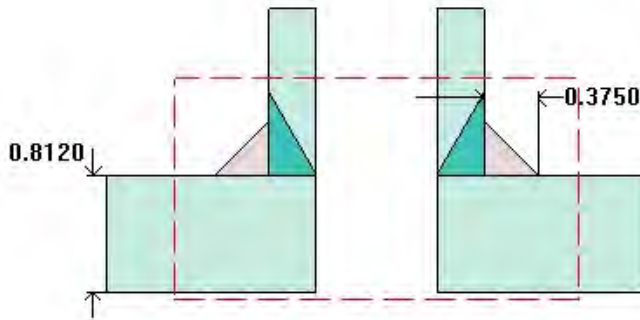
UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For $P_e = 15 \text{ psi @ } 150 \text{ }^\circ\text{F}$							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	0°
Nozzle center line offset to datum line	52"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

Nozzle

Description	NPS 0.5 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	0.84"
Nominal wall thickness	0.33"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.375"
Local vessel minimum thickness	0.7105"
Liquid static head included	1.3 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,117.68 * 0.4825 / (20,000 * 1 - 0.6 * 1,117.68) =$	0.0279"
Stress ratio $= t_r * E^* / (t_n - c) = 0.0279 * 1 / (0.33 - 0.0625) =$	0.1043
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,101.3 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For $P_e = 15 \text{ psi @ } 150 \text{ }^\circ\text{F}$							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165052

SECTION 4

MATERIAL TEST REPORTS AND/OR MATERIAL CERTIFICATIONS

165052		INDEX OF MATERIAL CERTIFICATION		
ITEM	QTY	DESCRIPTION	HEAT NUMBERS	MATERIAL
1	1	SHELL, PIPE, 20" SCH 60 (0.812" NOM) SMLS x 84" LG	945635	SA-106-C
2	1	HEAD, 20" OD x 3/4" NOM, 2:1 ELLIP. W/ 2" S.F. (HOT FORMED)	AAX	SA-516-70 N
3	1	CLOSURE, 20" OD 600# ANSI FIG. 500 R & M VERTICAL W/DAVIT	ZH550	CS
4	2	FLANGE, 8" 600# RFLWN x 14" LG	C1009AN,C1031AN	SA-105 N
5	2	COUP-O-LET, 1" 6000#	A2K	SA-105
6	1	COUP-O-LET, 3/4" 6000#	TTP	SA-105
7	3	COUP-O-LET, 1/2" 6000#	74FJ	SA-105
8	1	PLATE, TUBESHEET, 18 1/8" OD x 1" THK (SEE DETAIL)	6506641	SA-516-70
9	1	SKIRT, PIPE, 20" SCH 20 (.375") X 69" LG	N13597	SA-53-B/1-6-B
10	1	PLATE (BASE) 25" OD x 18" ID x 3/4" THK	W6C510	SA-516-70 N
14	2	LIFTING LUGS, PHOENIX SERIES 2-899-MLL	ADOB	A105
16	1	PIPE, DRAIN, 1" SCH 160 SMLS	1015378774	SA-106-B
17	1	ELBOW, 1" 3000# 90° SOCKETWELD	138VVV	SA-105
18	1	COUPLING, FULL, 1" 3000# THREADED	413DD	SA-105



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24044 Dalmine (BG) - Italy
+39 035 560 111 fax

Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.		Customer's Order Item / Rifer. Ordine Cliente - Item	Customer's Reference / Posizione Cliente:		Manufacturer's Works Order N° / Conferma-Posizione:
		HR055166			1232079/005
Manufacture Process / Processo di fabbricazione:		Product Type / Tipo di prodotto:		Surface / Superficie:	
		SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS)		See note nr.3	
		TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)		Vedi nota nr.3	
Standard or Specification / Norme o specifica:		Steel Grade / Grado dell'Acciaio:		Ends / Estremità:	
See note nr.1		See note nr.2		BEVEL API 5L / ISO 3183 CT4:8825	
Vedi nota nr.1		Vedi nota nr.2		SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825	
Dimensions / Dimensioni:		Length / Lunghezza:		Quantity / Quantità: 4Pcs/Pz	
ø 20.000" O.D. x 0.812" W.T.		37.999 ft ÷ 42.001 ft		163.75 ft	
ø 508mm O.D. x 20.62mm W.T.		11582 mm ÷ 12802 mm		27374.7 lb	
				49.91 mt	
				12417 kg	
				Nominal Weight / Peso nominale:	
				166.68 lb/ft	
				247.90 Kg/m	

DELIVERY NOTES / AVVISI DI SPEDIZIONE

Delivery Notes Avvisi di spedizione		Delivery Notes Avvisi di spedizione	
Job number: 0031105304 / 000050		Town: 74158 TULSA	
Shipping note: 97280165 - 18/12/2014		Country: USA	
Address: PO BOX 581270			

TENSILE TEST / PROVA DI TRAZIONE

Heat N° Colata N°	Sample N° Prova N°	Specimen condition Condizioni della provetta				Specimen dimensions Dimensioni della provetta		Test temp. Temp. di prova	Y.S.	U.T.S.	Elongation / Allungamento			
		Ls	Sc	Type Tipo	Ori	Size Dimensioni	Area Area		EUL 0.5%	Req.	Lo	Min.	Min.	Obl.
									Min: 421.00	Min: 703.00				
									Max: —	Max: —				
		mm	mm2	°C	KSI*10	KSI*10	cal.	mm	%	%				
945033	L1468	B	AM	Cs	L	12.64	125.50	+20	530.00	771.00	2"	50.8	23.0%	34.1%
945035	L1471	B	AM	Ss	L	37.64 x 20.27	767.80	+20	574.00	773.00	2"	50.8	30.0%	46.3%

AM: As manufactured / Come laminato	Lx: Initial length / Lunghezza iniziale	Obl: Obtained / Ottenuto	Ss: Strip specimen / Rettangolare
B: Body / Corpo	Ls: Location of sample / Ubicazione provetta	Ori: Orientation / Orientamento	U.T.S: Ultimate Tensile Strength / Rottura
Cs: Cylindrical specimen / Cilindrica	Max: Maximum / Massimo	Req: Required / Richiesto	Y.S: Yield Strength / Snervamento
L: Longitudinal / Longitudinale	Min: Minimum / Minimo	Sc: Specimen condition / Condizioni Provetta	

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Piazza Caduti 6 Luglio 1944, 1
24044 Dalmine (BG) - Italy
+39 035 560 111 tel

Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.		Customer's Order Item / Rifer. Ordine Cliente - Item	Customer's Reference / Posizione Cliente:	Manufacturer's Works Order N° / Conferma Posizione:
		HR055166		1232079/005
Manufacture Process / Processo di fabbricazione:		Product Type / Tipo di prodotto: SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS) TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)		Surface / Superficie: See note nr.3 Vedi nota nr.3
Standard or Specification / Norme o specifica: See note nr.1 Vedi nota nr.1		Steel Grade / Grado dell'Acciaio: See note nr.2 Vedi nota nr.2		Ends / Estremità: BEVEL API 5L / ISO 3183 CT4:8825 SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825
Dimensions / Dimensioni: ø 20.000" O.D. x 0.812" W.T. ø 508mm O.D. x 20.62mm W.T.	Schedule / Schedula: 60	Length / Lunghezza: 37.999 ft ÷ 42.001 ft 11582 mm ÷ 12802 mm	Quantity / Quantità: 4Pcs/Pz 163,75 ft 49.91 mt	Nominal Weight / Peso nominale: 27374,7 lb 12417 kg 247.90 Kg/m

CHEMICAL COMPOSITION / COMPOSIZIONE CHIMICA

		Composition % / Composizione %																	
		x 100										x 1000						x 10000	
		C	Mn	Si	Ni	Cr	Mo	Cu	Ce LF	F1	F2	P	S	Ti	Nb	V	B		
Heat N° Colata N°	Sample N° Prova N°	H	Max	23	120	--	40	40	15	40	41	100	12	30	30	--	--	80	10
		Min	--	29	10	--	--	--	--	--	--	--	--	--	--	--	--	--	
		P	Max	23	120	--	40	40	15	40	41	100	12	30	30	--	--	80	10
		Min	--	29	10	--	--	--	--	--	--	--	--	--	--	--	--	--	
		H	12	116	26	10	12	8	13	38	50	9.1	14	2	2	21	70	2	
945633	L1468	P	12	115	25	10	12	8	13	38	49	7.8	13	2	2	18	60	1	
945633	L1469	P	12	114	25	10	12	8	13	38	49	7.8	13	2	2	18	60	1	
945635		H	12	120	20	11	16	8	14	40	56	9.3	17	2	1	23	70	2	
945635	L1471	P	12	119	19	11	16	8	14	40	55	8	16	2	1	20	60	1	
945635	L1472	P	13	120	19	12	17	8	15	41	58	8.1	17	3	1	21	60	1	

Ce LF: C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15
F1: (V+Ni+Cr+Mo+Cu)

F2: (Nb+V)
H: Heat / Colata

Max: Maximum / Massimo
Min: Minimum / Minimo

P: Product / Prodotto

SUPERFICIAL HARDNESS / DUREZZA SUPERFICIALE

Heat N° Colata N°	Sample N° Prova N°	Ls	Sc	External / Esterna Scale / Scala: HRB
				Req. Min: -- Req. Max: 100.0
945633	L1468	B	AM	79.0

Heat N° Colata N°	Sample N° Prova N°	Ls	Sc	External / Esterna Scale / Scala: HRB
				Req. Min: -- Req. Max: 100.0
945635	L1471	B	AM	83.0

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[LN: 15] | TY023201-1 | FSDA2060

[945635] |

[10352] |

[945635] |

[10352] |

[945635] |

[10352] |





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Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.		Customer's Order Item / Rifer. Ordine Cliente - Item HR055166		Customer's Reference / Posizione Cliente:		Manufacturer's Works Order N° / Conferma-Posizione: 1232079/005	
Manufacture Process / Processo di fabbricazione:		Product Type / Tipo di prodotto: SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS) TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)				Surface / Superficie: See note nr.3 Vedi nota nr.3	
Standard or Specification / Norme o specifica: See note nr.1 Vedi nota nr.1				Steel Grade / Grado dell'Acciaio: See note nr.2 Vedi nota nr.2		Ends / Estremità: BEVEL API 5L / ISO 3183 CT4:8825 SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825	
Dimensions / Dimensioni: ø 20.000" O.D. x 0.812" W.T. ø 508mm O.D. x 20.62mm W.T.		Schedule / Scheda: 60		Length / Lunghezza: 37.999 ft ÷ 42.001 ft 11582 mm ÷ 12802 mm		Quantity / Quantità: 4Pcs/Pz 163,75 ft 27374,7 lb 49.91 mt 12417 kg	
						Nominal Weight / Peso nominale: 166.58 lb/ft 247.90 Kg/m	

SUPERFICIAL HARDNESS / DUREZZA SUPERFICIALE

AM: As manufactured / Come laminato B: Body / Corpo L: Location of sample / Ubicazione provetta Sc: Specimen condition / Condizioni Provetta

FLATTENING TEST / PROVA DI SCHIACCIAMENTO

Standard / Norma:						Standard / Norma:					
Heat N°	Sample N°	Zone	Sc	Test Frequency	Result	Heat N°	Sample N°	Zone	Sc	Test Frequency	Result
Colata N°	Prova N°	Zona		Frequenza prova	Esito	Colata N°	Prova N°	Zona		Frequenza prova	Esito
945633	L1467	E1	AM	pipes of the lot	Good /Buono	945635	L1470	E1	AM	pipes of the lot	Good /Buono

AM: As manufactured / Come laminato E1 / E2: Ends of Sampling / Estremità della provetta Sc: Specimen condition / Condizioni Provetta

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+39 035 560 1111

Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.		Customer's Order Item / Rifer. Ordine Cliente - Item HR055166	Customer's Reference / Posizione Cliente:	Manufacturer's Works Order N° / Conferma-Posizione: 1232079/005
Manufacture Process / Processo di fabbricazione:		Product Type / Tipo di prodotto: SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS) TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)		Surface / Superficie: See note nr.3 Vedi nota nr.3
Standard or Specification / Norme o specifica: See note nr.1 Vedi nota nr.1		Steel Grade / Grado dell'Acciaio: See note nr.2 Vedi nota nr.2		Ends / Estremità: BEVEL API 5L / ISO 3183 CT4:8825 SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825
Dimensions / Dimensioni: ø 20.000" O.D. x 0.812" W.T. ø 508mm O.D. x 20.62mm W.T.	Schedule / Schedule: 60	Length / Lunghezza: 37.999 ft ÷ 42.001 ft 11582 mm ÷ 12802 mm	Quantity / Quantità: 4Pcs/Pz 163,75 ft 27374,7 lb 49.91 mt 12417 kg	Nominal Weight / Peso nominale: 166.58 lb/ft 247.90 Kg/m

HYDROSTATIC TEST / PROVA IDRAULICA

Pressure / Pressione		Time / Tempo	Results / Risultato
Unit / Unità	Value / Valore	Seconds / Secondi	
psi	2,970	5	Satisfactory / Soddisfacente

SUPPLEMENTARY INFORMATION / INFORMAZIONI SUPPLEMENTARI

STANDARD EDITIONS EDIZIONI NORME	
Standard:API 5L Year:2012 Revision:Ed... Revision year:45th Standard:ASTM A53/A106 Year:2010 Standard:ASME SA53/SA106 Year:2013 Standard:NACE MR0175/ISO 15156 Year:2009 Standard:NACE MR0103 Year:2012	Norma:API 5L Anno:2012 Revisione:Ed... Anno della revisione:45th Norma:ASTM A53/A106 Anno:2010 Norma:ASME SA53/SA106 Anno:2013 Norma:NACE MR0175/ISO 15156 Anno:2009 Norma:NACE MR0103 Anno:2012

PRODUCT DESCRIPTION NOTES NOTE DI DESCRIZIONE DEL PRODOTTO	
Note 1 is the full description of the 'Standard or specification' ACC. TO THE NORM API 5L PSL1 45TH ED., A/SA 106/53, IPS SPEC.1, NACE MR01.75/01.03 + TEMP TQ NO.1 20013058/4.1 V.4 Note 2 is the full description of the 'Steel grade' STEEL GR. X42 PSL1 GR.B PSL1, GR.B/C A/SA 106, GR. B A/SA 53 Note 3 is the full description of the 'Surface' BARE INSIDE, EXTERNALLY PROTECTED BY VARNISH, SUITABLE FOR COATING,	La nota 1 è la descrizione completa delle 'Norme o specifiche' NORMA API 5L PSL1 45A EDIZ., A/SA 106/53, IPS SPEC.1, NACE MR01.75/01.03 + TEMP TQ NO.1 20013058/4.1 V.4 La nota 2 è la descrizione completa del 'Grado acciaio' ACCIAIO GR. X42 PSL1 GR.B PSL1, GR.B/C A/SA 106, GR. B A/SA 53 La nota 3 è la descrizione completa della 'Superficie' GREZZI INTERNAMENTE, OLEATI ESTERNAMENTE ATTI AL RIVESTIMENTO

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Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.		Customer's Order Item / Rifer. Ordine Cliente - Item HR055166	Customer's Reference / Posizione Cliente:	Manufacturer's Works Order N° / Conferma-Posizione: 1232079/005
Manufacture Process / Processo di fabbricazione:		Product Type / Tipo di prodotto: SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS) TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)		Surface / Superficie: See note nr.3 Vedi nota nr.3
Standard or Specification / Norme o specifica: See note nr.1 Vedi nota nr.1		Steel Grade / Grado dell'Acciaio: See note nr.2 Vedi nota nr.2		Ends / Estremità: BEVEL API 5L / ISO 3183 CT4:8825 SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825
Dimensions / Dimensioni: ø 20.000" O.D. x 0.812" W.T. ø 508mm O.D. x 20.62mm W.T.	Schedule / Scheda: 60	Length / Lunghezza: 37.999 ft ÷ 42.001 ft 11582 mm ÷ 12802 mm	Quantity / Quantità: 4Pcs/Pz 163,75 ft 49.91 mt	Nominal Weight / Peso nominale: 27374,7 lb 12417 kg 166.58 lb/ft 247.90 Kg/m

SUPPLEMENTARY INFORMATION / INFORMAZIONI SUPPLEMENTARI

Supplementary Information Informazioni supplementari	
AFTER INSPECTION OPERATION, THE MATERIAL HAS NOT A RESIDUAL MAGNETISM GREATER THAN 20 GAUSS HARDNESS HRC 22 MAX, ACCORDING TO NACE MR-01-75/ISO 15156 HARDNESS HBW 225 MAX, ACCORDING TO NACE MR-01-03 COUNTRY OF MELT: TENARIS DALMINE (ITALY) SEAMLESS HOT FINISHED PIPES VISUAL AND DIMENSIONAL CONTROL HAS BEEN CARRIED OUT WITH SATISFACTORY RESULT STEEL IS FULLY KILLED AND PRODUCED BY ELECTRIC FURNACE TO A FINE GRAIN PRACTICE THE PRODUCT SUPPLIED IS IN COMPLIANCE WITH THE REQUIREMENTS OF THE ORDER. MANUFACTURED BY TENARIS DALMINE NO WELD REPAIR, MERCURY AND RADIATION FREE Tenaris IT identification number for MTC: 56v(□)H	DOPO LE OPERAZIONI DI CONTROLLO, IL MATERIALE NON PRESENTA UN MAGNETISMO RESIDUO SUPERIORE A 20 GAUSS DUREZZA HRC 22 MAX, IN ACCORDO ALLA SPEC. NACE MR-01-75/ISO 15156 DUREZZA HBW 225 MAX, IN ACCORDO ALLA SPEC. NACE MR-01-03 PAESE FUSIONE ACCIAIO: TENARIS DALMINE (ITALIA) TUBI SENZA SALDATURA FINITI A CALDO IL CONTROLLO VISIVO E DIMENSIONALE HA DATO ESITO SODDISFACENTE L'ACCIAIO E' DI TIPO CALMATO, A GRANO FINE, PRODOTTO AL FORNO ELETTRICO IL MATERIALE FORNITO E' IN ACCORDO AI REQUISITI DELL'ORDINE. FABBRICATO DA TENARIS DALMINE NON RIPARATO MEDIANTE SALDATURA, ESENTE DA MERCURIO E RADIAZIONI Numero Identificativo Tenaris IT per MTC: 56v(□)H

MARKING / MARCATURA

Marking Marcatura	
STENCILING _T SPEC 5L 0038.1 _API _DATA 20 0,812 B-X42 PSL 1 SMLS ASTM ASME A SA 106 B/C PSI:2970 ASTM ASME A SA 53 B S HEAT: _C OLATA FT _FT LBS _LBS NR. _NR LEGEND _T = TENARIS Logo	VERNICIATURA _T SPEC 5L 0038.1 _API _DATA 20 0,812 B-X42 PSL 1 SMLS ASTM ASME A SA 106 B/C PSI:2970 ASTM ASME A SA 53 B S HEAT: _C OLATA FT _FT LBS _LBS NR. _NR LEGENDA _T = Logo TENARIS

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trade-mark green colored "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use. Any alteration and/or falsification will be subjected to the law.

Questo certificato è emesso da un sistema computerizzato ed è valido con firma elettronica. Il certificato originale riporta il marchio "Tenaris" in colore verde. Il possessore dell'originale, qualora rilasci copia, deve attestare a suo nome la conformità all'originale, assumendosene ogni responsabilità per usi illeciti e non consentiti. Qualunque alterazione o falsificazione sarà perseguita a norma di legge.

FOR03171





INSPECTION CERTIFICATE
CERTIFICATO DI COLLAUDO
(UNI EN 10204 3.1 / ISO 10474 3.1.B)

Number / Numero:

01/14/14320

Page / Pagina:

6 / 6

Date / Data: December 20, 2014

Dalmine S.p.A. - Dalmine plant
Piazza Caduti 6 Luglio 1944, 1
24044 Dalmine (BG) - Italy
+39 035 590 111 tel

Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.		Customer's Order Item / Rifer. Ordine Cliente - Item: HR055166		Customer's Reference / Posizione Cliente:		Manufacturer's Works Order N° / Conferma Posizione: 1232079/005	
Manufacture Process / Processo di fabbricazione:		Product Type / Tipo di prodotto: SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS) TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)				Surface / Superficie: See note nr.3 Vedi nota nr.3	
Standard or Specification / Norme o specifica: See note nr.1 Vedi nota nr.1				Steel Grade / Grado dell'Acciaio: See note nr.2 Vedi nota nr.2		Ends / Estremità: BEVEL API 5L / ISO 3183 CT4:8825 SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825	
Dimensions / Dimensioni: ø 20.000" O.D. x 0.812" W.T. ø 508mm O.D. x 20.62mm W.T.		Schedule / Scheda: 60		Length / Lunghezza: 37.999 ft ÷ 42.001 ft 11582 mm ÷ 12802 mm		Quantity / Quantità: 4Pcs/Pz 163,75 ft 27374,7 lb 49.91 mt 12417 kg	
						Nominal Weight / Peso nominale: 166.58 lb/ft 247.90 Kg/m	

MARKING / MARCATURA

Marking Marcatura	
_API = API Logo _DATA = Marking Date _FT = Pipe/Tube Length in feet _LBS = Pipe/Tube Weight in pounds _NR = Pipe/Tube Identifier	_API = Logo API _DATA = Data di marcatura _FT = Lunghezza del tubo in piedi _LBS = Peso del tubo in libbre _NR = Identificativo numerico del tubo

This is to certify that the product described here has been manufactured, sampled, tested, and inspected in accordance with purchaser order requirements. This certificate is not a declaration of origin nor may it be used as a declaration of origin.

Si certifica che il prodotto descritto è stato prodotto, provato, testato e controllato in conformità ai requisiti dell'ordine del cliente. Questo certificato non è una dichiarazione d'origine e non può essere usato come tale.

CUSTOMER THIRD PARTY		TENARIS QUALITY DEPARTMENT SIGNATURE	
INSPECTION COMPANY COMPAGNIA D'ISPEZIONE		 QUALITY CERTIFICATION DEPT. UFFICIO CERTIFICAZIONE QUALITA' SIGOLI Gianluca	 CHIEF OF QUALITY CERTIFICATION DEPT. RESPONSABILE DELL'UFFICIO CERTIFICAZIONE QUALITA' RAVANELLI Pietro

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trade-mark green colored "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use. Any alteration and/or falsification will be subjected to the law.

Questo certificato è emesso da un sistema computerizzato ed è valido con firma elettronica. Il certificato originale riporta il marchio "Tenaris" in colore verde. Il possessore dell'originale, qualora rilasci copia, deve attestare a suo nome la conformità all'originale, assumendosi ogni responsabilità per usi leciti o non consentiti. Qualunque alterazione o falsificazione sarà perseguita a norma di legge.

FOR03171



50*165052



BAKER TANKHEAD

INCORPORATED

BAKER TANKHEAD, INC.
P.O. BOX 77021
10405 NORTH FREEWAY
FORT WORTH, TX 76177
United States of America
Ph: 866-232-8030
Fax: 817-847-7244

Cert # 93563

Material Certification

Date :7-Dec-16

To:

KMI FABRICATORS, INC.
410 BOYD ROAD
MINERAL WELLS, TX 76067

Phone: 940-325-7841

Fax: 940-325-3765

Ship To:

ERBY ATKINS
KMI FABRICATORS, INC.
410 BOYD ROAD
MINERAL WELLS, TX 76067

Phone: 940-325-7841

Fax: 940-325-3765

Job #	Customer PO	Qty	Code/Lot	Material	Mill*	Heat No*	SLab/Pc No*
169084	10349	1	AAX	20 X 3/4 E HP PFS INV	* See Mill Test Report		
		1	AKC	20 X 3/4 E HP PFS INV			
20 X 3/4 E HP PFS 20"OD X 3/4"NOM 2:1 ELLIP .6875"MIN - SA516-70 - 2"Sf 6 5/8"IOH 5' 2 13/16"OSC 30 DEG OS BEVEL W/ 1/16"LD 26 1/2"DIA - 118# NORMALIZED IN HOT FORMING DOMESTIC MATERIAL CUSTOMER 165052 & CUSTOMER 165053							
* The items listed above were formed in strict accordance with all applicable requirements of the ASME Boiler and Pressure Vessel Code Section VIII, Div. 1.							
* We hereby certify that these parts comply with tolerances of UG-81 of ASME Section VIII, Div. 1.							
* We hereby certify that these heads were heated to 1650 degree F min, held for one hour per inch of thickness, hot formed and still air cooled.							
KMI FAB S/O 165052 Date 2-8-17 Item # 2							

50+ 165052

PO# 45465 (1pc) 120x480x3/4" SA516-70 code: AAX

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANALYSES

US HWY 12 Burns Harbor, Indiana

SHIPMENT NO. 803-15118		DATE SHIPPED 11-09-14		CAR OR VEHICLE NO. CSS-CHGO-UP		LMIC 036333		PAGE 4				
S O L D T O	LEEEO STEEL L L C 1011 WARRENVILLE RD STE 500 LISLE IL 60532				S H I P T O	LEEEO STEEL LLC FWWR DELIVERY TRACK 1907 CLEBURNE TX						
N O T E	SERIAL NUMBER	PAT NO.	HEAT NUMBER	NO. PCS.	SIZE AND QUANTITY				YIELD POINT	TENSILE STRENGTH	ELONG.	RED.
					THICKNESS	WIDTH OR DIA.	LENGTH	WEIGHT				
					INCHES	INCHES	INCHES	POUNDS	PSI	PSI	IN	%

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A. ←

PLATES - ASTM A516-06 GR 70 PVQ, ASME SA516
GR 70 PVQ 2013 EDITION, FIRST TST
AS ROLLED-ADD'L TENSION PER TST PC
HEAT TREATMENT --- MILL TEST PCS
→ NORM 1650F FOR 30 MINS/IN MIN & AIR
COOL --- PLATES WILL CONTAIN LESS
THAN 1.00% NICKEL & WILL NOT BE
RESULPHURIZED - MATL WILL NOT
EXCEED 200 MAX BHN PER NACE MR0175 ←

NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)

MFST - MFST MILL SERIAL# MFST PPI 0055237- 0001 MFST
PLATES WILL CONTAIN LESS THAN 1.00% NICKEL.
WILL NOT BE RESULPHURIZED MFST PLATES WILL CONTAIN
LESS THAN 1.00% NICKEL. WILL NOT BE RESULPHURIZED
MFST RIZED - MATL WILL NOT EXCEED 200 MAX BHN
PER NACE MR0175 - LIFT MAX 15
TON-GAUGES SEP UNLDG OH-MAGNET LOAD SAME SIZE &
GRADES TOGETHER

CO# V03928-ASO09 GH 875-0754A

AAX W068147 - 811K03350 1 3/4 120 480 12252 46600\ 75300\ 8 26\ 49400\ 74400\ 8 26\

(M55)MFST REF#:075120480A516-70

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			SHEAR(%)			LAT. EXP MILS		
										1	2	3	1	2	3	1	2	3

HEAT NUMBER	CHEMICAL ANALYSIS																MQUAID GRAIN SIZE
	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Co	N	Sn	
AAX-811K03350	.18	1.12	.018	.005	.322	.014	.01	.12	.088	.002	.002	.030	.0002	.002	.004	.002	

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.

BHPLTRPT.TIF

SUPV. QUALITY ASSURANCE

D. W. ELWOOD PER WNK

2 of 2

Process & Flow Technology
10906 FM 2920
Tomball, TX 77375
Telephone: (281) 351-2222
Facsimile: (281) 351-6557

20" ZH550 165052
SO# 165052

CUSTOMER: KMI FABRICATORS, INC.

P.O.# 10350

S.O.#: 1531971

PER YOUR INSTRUCTIONS, WE ARE ENCLOSING THE FOLLOWING DOCUMENTS:

_____	COPIES OF APPROVED DRAWINGS
_____	COPIES OF CERTIFIED DIM. DRAWINGS
X	COPIES OF PARTIAL DATA REPORT
X	COPIES OF MILL TEST REPORTS
_____	(ONE COPY ON CAP & ONE COPY ON HUB)
_____	COPIES OF SPARE PARTS LIST
_____	COPIES OF WELDING INSTRUCTIONS
_____	COPIES OF MAINTENANCE & OPERATIONS INSTRUCTIONS
_____	COPIES OF ASME CERTIFICATIONS
_____	COPIES OF DOT CERTIFICATIONS
_____	COPIES OF NACE CERTIFICATIONS
_____	COPIES OF API CERTIFICATIONS
_____	COPIES OF NDE CERTIFICATIONS

13 pgs

KMI FAB
S/O 165052
Date 2-8-17
Item # 3

Q

S.O. No. 1531971

[illegible]

SO No 1531971-2

PO No 10350

FORM U-2A MANUFACTURER'S PARTIAL DATA REPORT (ALTERNATE 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 NATIONAL OILWELL VARCO 10906 FM 2920 TOMBALL, TEXAS 77375

(Name and address of Manufacturer)

2. Manufactured for KMI FABRICATORS INC. 410 BOYD ROAD MINERAL WELLS, TX 76067

(Name and address of Purchaser)

3. Location of Installation UNKNOWN

(Name and address)

4. Type: (2) 20" CLOSURES

(Description of vessel part (shell, two-piece head, tube bundle))

ZH550 THRU ZH551

(Mfg.'s Serial No.)

N/A

(CRN)

N/A

(National Board Number)

1531971-2R1

(Drawing Number)

NATIONAL OILWELL VARCO

(Drawing prepared by:)

2017

(Year Built)

5. ASME Code, Section VIII, Div. 1

2015 EDITION

(Edition and Addenda (Date))

N/A

(Code Case No.)

N/A

(Special service per UG-120(d))

6. Shell (a) No. of course(s) 1

(b) Overall length (ft. and in.):

1-00.

Course(s)			Material	Thickness, in.		Long Joint (Cat. A)			Circum. Joint (Cat. A, B, & C)			Heat Treatment	
No.	Diameter, in	Length, ft+in	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp., F	Time
1	18.376	1-00.	SA 350 LF2	0.812	0.063	S	NONE	1	S	NONE	1	N/A	N/A
			CLASS 1										

Body Flanges on Shells

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

7. Heads: (a)

SA 516-70 N

(b)

N/A

(Mat'l Spec. no., Grade or Type)(H.T. - Time and Temp.)

(Mat'l Spec. no., Grade or Type)(H.T. - Time and Temp.)

	Location (Top, Bottom Ends)	Thickness, in.		Radius, in.		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None.	Effc.
(a)	TOP	0.673	0.063	-----	-----	2:1	-----	-----	-----		X	S	NONE	1
(b)														

Body Flanges on Heads

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

8. MAWP

1100

internal external

PSI @ max temp. =

150

internal external

°F.

Min Design Metal Temp

-20

°F at

1100

PSI

9. Impact test

Yes - CAP, HUB, & FITTING

At a test temp of

-51& -50& -50

°F

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

10. Hydro., pneu., or comb. Test pressure

SEE REMARKS

Proof Test:

N/A

11. Nozzles, inspection, and safety valve openings:

UG-125(a)

At

PSIG

Purpose (Inlet, Outlet, Drain, etc.)	No.	Dia. or Size, in.	Flange Type	Material		Nozzle Thickness, in		Reinforcement Material	How Attached		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
SEE REMARKS											
OUTLET	1	1/2" NPT	TH'D	SA 350 LF2 CL1		0.500	0.063	INHERENT	*WELDED		HEAD
PAV	1	1/2" NPT	TH'D	SA 350 LF2 CL1		N/A	N/A	INHERENT	INT THD		SHELL

12. Identification of part(s)

Name of Part	Qty.	Line No.	Mfg's. Identification No.	Mfg's. Dwg No.	CRN	National Board No.	Year
N/A							

13. Supports: Skirt

Lugs

Legs

Others

Attached

(Where and How)

14. Remarks:

THIS TEMPERATURE APPLICABLE TO CLOSURE METAL COMPONENTS ONLY. ACTUAL SERVICETEMPERATURE IS DETERMINED BY TEMPERATURE LIMITATIONS OF O-RING MATERIAL.UG-120,c,2 DESIGN & CALCULATION BY NATIONAL OILWELL VARCO.CLOSURE ASSEMBLY IS NOT HYDROSTATICALLY TESTED, PRESSURE ALERT VALVE FURNISHED.*Fig. UW-16.1(x-2).

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. 10052 Expires: July 16, 2017

Date: 01/22/17 Name: NATIONAL OILWELL VARCO

Signed: _____

(Manufacturer)

(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 The Hartford Steam Boiler Inspection and Insurance Company of CONNECTICUT have inspected the pressure vessel part described in this Manufacturer's Data Report on 01-20, 2017, 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: 01/20/2017

Signed: _____

(Authorized Inspector)

Commissions: NB 14370A/15

(National Board (incl. endorsements))

Tank Head Manufacturing Complex
10703 Sheldon Road
Houston, TX 77044

UNI-FORM
COMPONENTS CO.

(281) 456-9310
(800) 231-3272 toll-free
(281) 456-0245 fax

MATERIAL CERTIFICATION

Packlist No.	Customer ID	
PL-82914	RMENSY	
Customer PO No.	UCC Job No.	Date Cert. Originated
7317449	127779	12/8/2016

Sold To:
R&M ENERGY SYSTEM
NATIONAL OILWELL VARCO LP
10906 FM 2920

Ship To:
R&M ENERGY SYSTEM
NATIONAL OILWELL VARCO LP
10906 FM 2920

TOMBALL TX 77375

TOMBALL TX 77375

Ln	Order Qty	Ship Qty	B/O Qty	Part Description
----	-----------	----------	---------	------------------

1 2 2 0 HEAD 2:1ELIP, 21.313 ID X 2 SA 516-70
Unit of Measure: EA

Code: 3T325 HEAT/SLAB: 414212 / 345002-01 GRADE: SA516-70 Size: 2 X 98 X 480 MILL: DILLINGER

3T325

part # H60270

mat # 2060F

MILL TEST REPORTS ATTACHED

The chemical and physical properties as indicated on the attached report are the results of the Mill Tests of the raw material used in the manufacture of these products and are certified to meet only the minimum requirements of the ASME and/or ASTM specifications for the material.

1. We hereby certify that these heads were hot formed at the required normalizing temperature and air cooled, in accordance with all applicable specifications.
2. We hereby certify that these heads comply with tolerances of UG-81 or ASME Section VIII, Div. 1.
3. Materials listed above are NACE MR-0175:2015 compliant

Approved for Manufacture
by Bruce [Signature]
Date 12/9/16

WE HEREBY CERTIFY THAT THIS REPORT COVERING THE ABOVE AND ATTACHED INFORMATION IS TRUE AND CORRECT AS SHOWN AND CONTAINED IN OUR RECORDS.

Stephen [Signature]

Quality Control

[Signature]

QM-System: Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1 AS PER ISO 10474:2013 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 5483199-23.12.14	A08/ Manufacturer's order/ A03 Certificate No. 398993-001	Sheet 1/...
A05 Established inspecting body DF	A05 Purchaser UNI-FORM, HOUSTON, TX Final receiver UNI-FORM, HOUSTON, TX	A07.1 No. 34453A A07.2 No.	B01 Product HEAVY PLATES	
B02/ Steel design. SA516-70/SA516-60 B03 Any suppl. ASME-IIA:2013 requirements				

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width INCH	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414430	352001-01	11250X096SA51670 3T311
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414430	352001-02	11250X096SA51670 3T312
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414430	352002-01	11250X096SA51670 3T313
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414430	352002-02	11250X096SA51670 3T314
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414432	351244-01	11250X096SA51670 3T315
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414432	352003-01	11250X096SA51670 3T316
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414432	352003-02	11250X096SA51670 3T317
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414432	352369-02	11250X096SA51670 3T318
**	8				53352				
03	1	2,0000 x	79,00000 x	316,00000	6423	N	414206	349077-01	20000X079SA51670 3T319
03	1	2,0000 x	79,00000 x	316,00000	6423	N	414208	349077-02	20000X079SA51670 3T320
03	1	2,0000 x	79,00000 x	316,00000	6423	N	414210	349078-01	20000X079SA51670 3T321
03	1	2,0000 x	79,00000 x	316,00000	6423	N	414210	349078-02	20000X079SA51670 3T322
**	4				25692				
04	1	2,0000 x	96,00000 x	480,00000	11855	N	414208	345003-01	20000X096SA51670 3T323
04	1	2,0000 x	96,00000 x	480,00000	11855	N	414212	345001-01	20000X096SA51670 3T324
04	1	2,0000 x	96,00000 x	480,00000	11855	N	414212	345002-01	20000X096SA51670 3T325
04	1	2,0000 x	96,00000 x	480,00000	11855	N	414212	345004-01	20000X096SA51670 3T326
**	4				47420				
05	1	2,5000 x	79,00000 x	316,00000	8028	N	414207	349079-01	25000X079SA51670 3T327
05	1	2,5000 x	79,00000 x	316,00000	8028	N	414207	349079-02	25000X079SA51670 3T328
05	1	2,5000 x	79,00000 x	316,00000	8028	N	414207	349081-01	25000X079SA51670 3T329
05	1	2,5000 x	79,00000 x	316,00000	8028	N	414207	349081-02	25000X079SA51670 3T330

A04	201/202/203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 Manufacturer's mark	 POISSONNET Test House Manager	Dillinger France Port 3032 3032 rue du Comte Jean - CS 56317 F-59379 Dunkerque Cedex 1 - FRANCE Service Qualité-Essais Date 24.12.14	A01 CD 1
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QM-System: Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1 AS PER ISO 10474:2013 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 5483199-23.12.14	A08/ Manufacturer's order/ A03 Certificate No. 398993-001	Sheet 3/...
B05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX Final receiver UNI-FORM, HOUSTON, TX	A07.1 No. 34453A A07.2 No.	B01 Product HEAVY PLATES	
B02 Steel design. SA516-70/SA516-60				
B03 Any suppl. requirements ASME-IIA:2013				

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width INCH	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414216	347285-01	36250X076SA515703T350
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414216	347286-01	36250X076SA515703T351
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	345298-01	36250X076SA515703T352
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347278-01	36250X076SA515703T353
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347281-01	36250X076SA515703T354
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347282-01	36250X076SA515703T355
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347287-01	36250X076SA515703T356
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347288-01	36250X076SA515703T357
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347289-01	36250X076SA515703T358
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	348091-01	36250X076SA515703T359
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	348096-01	36250X076SA515703T360
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414219	347283-01	36250X076SA515703T361
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414219	347284-01	36250X076SA515703T362
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414219	348093-01	36250X076SA515703T363
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414219	348094-01	36250X076SA515703T364
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414219	348095-01	36250X076SA515703T365
***	17				183158				
***	55				508978				

B04 Product delivery condition

ITEM NO.: 01,03-05,08-11

N: HT: 1670 GR.F +27 -27 GR.F

SOAKING TIME TO ATTAIN THE TARGET TEMPERATURE OVER THE WHOLE SECTION: 1-1,75 MIN/MM (25-45 MIN/INCH)

COOLING IN STILL AIR

A04 Z01/Z02/203 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.



[Signature]
POISSONNET
Test House Manager

Dillinger France
Port 3032
3032 rue du Comte Jean - CS 56317
F-59379 Dunkerque Cedex 1 - FRANCE
Service Qualité-Essais
Date 24.12.14 CD 1

A01

QM-System: Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1 AS PER ISO 10474:2013 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 5483199-23.12.14	A08/ Manufacturer's order/ A03 Certificate No. 398993-001	Sheet 4/...
A05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX Final receiver UNI-FORM, HOUSTON, TX	A07.1 No. 34453A A07.2 No.	B01 Product HEAVY PLATES	
B02/ Steel design. SA516-70/SA516-60 B03 Any suppl. ASME-IIA:2013 requirements				

_____ B06 Marking of the product _____
ITEM NO.: 01.03-05,08-11
STEEL DESIGNATION SA516 70 60 MT LTV
HEAT NO. / TRADEMARK / ROLLED PLATE NO.-TEST NO.

_____ B07-B99 Further information about the product _____
ITEM NO.: 01.03-05,08-11
THICKNESS REDUCTION RATIO $\geq 3,0$ IS FULFILLED (CF. A/SA20 PAR. 5.3)

C10-C29 Tensile test														
B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01 C01	C02 Temp. GRF	C10 C11	C12 RM	C13 A %	A LO=21N	C14-C15 A % LO=81N				
01	414430	352001		K1	QO	RT	52,6	75,1		30				
01	414430	352002		K1	QO	RT	53,2	75,1		29				
01	414432	351244		K1	QO	RT	48,7	73,8		29				
01	414432	352003		K1	QO	RT	53,4	74,7		30				
01	414432	352369		K1	QO	RT	52,3	74,5		31				
03	414208	349077		K1	QV	RT	52,9	77,3	39					
03	414210	349078		K1	QV	RT	50,9	75,3	40					
04	414208	345003		K1	QV	RT	50,6	75,1	37					
04	414212	345001		K1	QV	RT	52,1	76,7	37					
04	414212	345002		K1	QV	RT	52,3	76,0	38					
04	414212	345004		K1	QV	RT	53,4	77,4	39					
05	414207	349079		K1	QV	RT	50,3	75,1	39					
05	414207	349081		K1	QV	RT	50,6	75,3	40					
05	414207	349082		K1	QV	RT	51,0	75,1	41					
05	414207	349083		K1	QV	RT	49,7	75,1	38					

A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 POISSONNET Test House Manager	Dillinger France Port 3032 3032 rue du Comte Jean - CS 56317 F-59379 Dunkerque Cedex 1 - FRANCE Service Qualité-Essais Date 24.12.14	A01 CD 1
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QM-System: Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1 AS PER ISO 10474:2013 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 5483199-23.12.14	A08/ Manufacturer's order/ A03 Certificate No. 398993-001	Sheet 6/...
A05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX Final receiver UNI-FORM, HOUSTON, TX	A07.1 No. 34453A A07.2 No.		B01 Product HEAVY PLATES
B02/ Steel design. SA516-70/SA516-60				
B03 Any suppl. ASME-IIA:2013 requirements				

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01 C02/ C01 Temp. GR.F	C03 C10 C11 KSI RP02	C12 RM	C13 A % LO=2IN	C14-C15 A % LO=3IN
1.1	414219	348094		K1 QV	RT 47,3	74,5	40	
1.1	414219	348095		K1 QV	RT 46,0	74,2	37	

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01 C02/ C01 Temp. GR.F	C03 C41 Width of test piece	C40 Type of test piece	C44 Testing method	C46 Energy	C45 AV 8	C42 Individual values AV=FT.LBF	C43 Mean value
01	414430	352001		K1 LV	-51	CHP-V			AV 8	273 268	260 267
01	414430	352002		K1 LV	-51	CHP-V			AV 8	285 270	276 277
01	414432	351244		K1 LV	-51	CHP-V			AV 8	288 268	150 235
01	414432	352003		K1 LV	-51	CHP-V			AV 8	275 297	288 287
01	414432	352369		K1 LV	-51	CHP-V			AV 8	268 279	276 274
03	414208	349077		K1 LV	-51	CHP-V			AV 8	234 221	227 227
03	414210	349078		K1 LV	-51	CHP-V			AV 8	266 242	277 262
04	414208	345003		K1 LV	-51	CHP-V			AV 8	218 209	212 213
04	414212	345001		K1 LV	-51	CHP-V			AV 8	215 219	217 217
04	414212	345002		K1 LV	-51	CHP-V			AV 8	204 112	114 143
04	414212	345004		K1 LV	-51	CHP-V			AV 8	223 144	221 196
05	414207	349079		K1 LV	-51	CHP-V			AV 8	206 226	177 203
05	414207	349081		K1 LV	-51	CHP-V			AV 8	219 226	179 208
05	414207	349082		K1 LV	-51	CHP-V			AV 8	112 178	258 183
05	414207	349083		K1 LV	-51	CHP-V			AV 8	202 221	215 213
05	414529	345358		K1 LV	-51	CHP-V			AV 8	218 226	233 226
05	414529	345360		K1 LV	-51	CHP-V			AV 8	184 221	257 221
05	414529	345361		K1 LV	-51	CHP-V			AV 8	168 134	248 183

A04	D01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 Manufacturer's mark	 POISSONNET Test House Manager	Dillinger France Port 3032 3032 rue du Comte Jean - CS 56317 F-59379 Dunkerque Cedex 1 - FRANCE Service Qualité-Essais Date 24.12.14	A01
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QM-System: Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1 AS PER ISO 10274:2013 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 5483199-23.12.14	A08/ Manufacturer's order/ A03 Certificate No. 398993-001	Sheet 8/...
A05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX A07.1 No. 34453A Final receiver UNI-FORM, HOUSTON, TX A07.2 No.		B01 Product HEAVY PLATES	
302/ Steel design. SA516-70/SA516-60 303 Any suppl. ASME-III:2013 requirements				

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C70	C	SI	MN	P	S	CU	MO	NI	CR	V	NB	TI	B	O
414207	Y	0,163	0,384	1,47	0,005	0,0009	0,037	0,016	0,045	0,026	0,001	0,001	0,003	0,0005	0,0012
414208	Y	0,170	0,375	1,46	0,005	0,0008	0,024	0,008	0,032	0,020	0,001	0,001	0,003	0,0002	0,0007
414210	Y	0,163	0,378	1,47	0,005	0,0006	0,035	0,011	0,055	0,031	0,001	0,001	0,002	0,0002	0,0006
414212	Y	0,168	0,376	1,46	0,005	0,0007	0,028	0,013	0,034	0,027	0,001	0,001	0,002	0,0002	0,0004
414214	Y	0,159	0,381	1,48	0,006	0,0011	0,033	0,009	0,045	0,028	0,001	0,001	0,002	0,0002	0,0004
414216	Y	0,162	0,378	1,46	0,006	0,0008	0,038	0,018	0,052	0,038	0,001	0,001	0,002	0,0002	0,0005
414218	Y	0,160	0,361	1,46	0,006	0,0007	0,035	0,014	0,036	0,045	0,001	0,001	0,002	0,0002	0,0008
414219	Y	0,161	0,380	1,46	0,006	0,0006	0,036	0,009	0,040	0,028	0,001	0,001	0,002	0,0001	0,0007
414430	Y	0,140	0,376	1,46	0,006	0,0008	0,031	0,013	0,046	0,032	0,001	0,001	0,002	0,0001	0,0012
414432	Y	0,138	0,378	1,46	0,007	0,0008	0,027	0,011	0,042	0,037	0,001	0,001	0,002	0,0001	0,0005
414529	Y	0,159	0,380	1,46	0,007	0,0007	0,062	0,011	0,063	0,024	0,001	0,001	0,003	0,0001	0,0012

B07.2 Heat	C70	AL-T
414207	Y	0,034
414208	Y	0,031
414210	Y	0,033
414212	Y	0,033
414214	Y	0,035
414216	Y	0,034
414218	Y	0,040
414219	Y	0,035
414430	Y	0,033
414432	Y	0,035
414529	Y	0,046

304  Manufacturer's mark	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 POISSONNET Test House Manager	Dillinger France Port 3032 3032 rue du Comte Jean - CS 56317 F-59379 Dunkerque Cedex 1 - FRANCE Service Qualité-Essais Date 24.12.14	A01 CD 1
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QM-System: Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1 AS PER ISO 10474:2013 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 5483199-23.12.14	A08/ Manufacturer's order/ A03 Certificate No. 398993-001	Sheet 9/...
A05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX Final receiver UNI-FORM, HOUSTON, TX	A07.1 No. 34453A A07.2 No.	B01 Product HEAVY PLATES	
B02 Steel design. SA516-70/SA516-60				
B03 Any suppl. ASME-IIA:2013 requirements				

C94 Heat analysis Carbon equivalent / Alloying restrictions

B07.2
Heat

414207	FO-02=	0,42	FO-55=	0,12	FO-78=	0,04
414208	FO-02=	0,42	FO-55=	0,08	FO-78=	0,03
414210	FO-02=	0,42	FO-55=	0,13	FO-78=	0,04
414212	FO-02=	0,42	FO-55=	0,10	FO-78=	0,04
414214	FO-02=	0,42	FO-55=	0,12	FO-78=	0,04
414216	FO-02=	0,42	FO-55=	0,15	FO-78=	0,06
414218	FO-02=	0,42	FO-55=	0,13	FO-78=	0,06
414219	FO-02=	0,42	FO-55=	0,11	FO-78=	0,04
414430	FO-02=	0,40	FO-55=	0,12	FO-78=	0,05
414432	FO-02=	0,40	FO-55=	0,12	FO-78=	0,05
414529	FO-02=	0,42	FO-55=	0,16	FO-78=	0,04

C95 Ladle treatment

ITEM NO.: 01,03-05,08-11

HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

C95 Further information about ladle treatment

ITEM NO.: 01,03-05,08-11

CALCIUM TREATED

ITEM NO.: 01,03-05,08-11

MELTED IN GERMANY BY -AG DER DILLINGER HUETTENWERKE, DILLINGEN/SAAR-

C70-C99 Further information about heat analysis

ITEM NO.: 01,03-05,08-11

CA & O: VALUES INFORMATIVE.

A04



Manufacturer's
mark

Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

[Signature]

POISSONNET
Test House Manager

Dillinger France
Port 3032
3032 rue du Comte Jean - CS 56317
F-59379 Dunkerque Cedex 1 - FRANCE
Service Qualité-Essais
Date 24.12.14

A01

CD 1

QM-System: Certification as per ISO 9001

Erklärungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1 AS PER ISO 10474:2013 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 5483199-23.12.14	A08/ Manufacturer's order/ A03 Certificate No. 398993-001	Sheet 10
A05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX Final receiver UNI-FORM, HOUSTON, TX	A07.1 No. 34453A A07.2 No.	B01 Product HEAVY PLATES	
302/ Steel design. SA516-70/SA516-60				
303 Any suppl. ASME-IIA:2013 requirements				

———— C94 Carbon equivalent formula / Alloying restrictions ————

FO-02 = $C + (MN/6) + (CR+MO+V)/5 + (NI+CU)/15$
 FO-55 = $CU+MO+NI+CR$
 FO-78 = $CR+MO$

———— D01 Marking and identification, surface appearance, shape and dimensional properties ————

ITEM NO.: 01,03-05,08-11
 EXAMINATION OF MARKING, SURFACE, SHAPE AND DIMENSIONS: THE RESULTS MEET THE REQUIREMENTS.
 SURFACE AS PER ASME-SA20
 THICKNESS AS PER ASME-SA20
 LENGTH AND WIDTH AS PER ASME-SA20 ✓
 FLATNESS AS PER ASME-SA20

———— D02 Non-destructive tests - Ultrasonic testing ————

ITEM NO.: 01,03-05,08-11
 UT-SPECIFICATION : ASME-SA578 (M) LEVEL C SUPPLEMENTARY REQUIREMENTS S1 ✓
 SCANNING PLAN BODY : 100% OF PLATE SURFACE
 PERSONNEL QUALIFICATION : LEVEL 2 IN ACC. TO EN 473 / ISO 9712 AND SNT-TC-1A
 THE TEST RESULTS MEET THE REQUIREMENTS OF THE ORDER.

A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 POISSONNET Test House Manager	Dillinger France Port 3032 3032 rue du Comte Jean - CS 56317 F-59379 Dunkerque Cedex 1 - FRANCE Service Qualité-Essais Date 24.12.14	A01
 Manufacturer's mark		CD 1		



Reg. Nr.: 10537



TÜV nach AD 2000 W 07 TRD 1007 PED 97/23EC Annex I- Bureau Veritas
DET NORSKE VERITAS - Germanischer Lloyd - Lloyd's Register of Shipping
URZAD DOZURU TECHNICZNEGO, UDT-Polen, American Bureau of Shipping
Russian Maritime Register of Shipping, RMRS

Herstellerzeichen
Manufacturer's stamp

ORIGINAL

Abnahmeprüfzeugnis **EN 10 204 3.1** **Inspection certificate**

Kunde Customer	NATIONAL OILWELL VARCO 10906 FM 2920 TOMBALL/TEXAS 77375 USA		
Kd. Bestell Nr. Cust. Order no.	7317446	Position Item	4
Bezeichnung Designation	20" 150/600 Ring Forging	unsere Ref. Job no./Certificate no.	56093D12
Kd. Material Cust. Material	SA 105/SA 350 LF2 Cl. 1 / A694 F48	Anzahl Quantity	4
Lieferzustand condition of delivery	unmachined	Charge Nr. Heat no.	J0417
Kd. Zeichn. Nr. Cust. Drawing	Stock Ring Forging Rev. 3	Probe Nr. Test no.	50247
Artikel No. Part no	H61533	Dimension Dimension	FS d 559/466 x 305 mm
Kd. Spezifikation Cust. Specification	ASME Sect. II Part A SA105: 2013 Ed./ ASME Sect. II Part A SA 350 LF2-Cl. 1: 2013 Ed. - ASTM A694-F48: 08		
Stempelung Marking	56093D12 - SA 105/SA 350 LF2 Cl. 1 / A694 F48 - J0417 - 3144 - Stock Ring Forging (3) - H61533 - ST 50247 QI - item:4		

Wärmebehandlung / Heat treatment: 900°C/3h/water//600°C/5h/air
wassertemperatur before quenching: 26°C after quenching: 29°C

Chemische Zusammensetzung gem. Hersteller / Chemical composition acc. to manufacturer:

Heat no.	C	Si	Mn	P	S	Cr	Mo
J0417	0.19	0.20	0.95	0.009	0.004	0.11	0.02
ESB	Ni	V	Al	Cu	N	Ti	Nb
	0.11	0.004	0.034	0.18	0.0055	0.001	0.003
	Co	W	Sn	Ca	B	H	As
	0.011	0.006	0.009	0.0009	0.0003	0.00010	0.008
	Sb	CEI	Ni+Cr+Mo+Cu	Cr+Mo			
	0.002	0.394	0.420	0.13			

Melting practices: VD, E

Product analysis

Heat no.	C	Si	Mn	P	S	Cr	Mo
J0417	0.21	0.21	0.94	0.011	0.005	0.10	0.024
	Ni	V	Cu	Nb	CEI	Ni+Cr+Mo+Cu	Cr+Mo
	0.12	<0.010	0.19	<0.010	0.4141	0.4340	0.124

Mech. Werkstoffprüfung / Mechanical testing

Zugversuch / tensile test

ASTM A370-12a

Kerbschlagbiegeversuch / Impact test

ASTM A370-12a

	ReH Yield strength MPa	Rp 0,2 % MPa	Rp 1 % MPa	Rm Tensile strength MPa	A 4 d El. %	Z ROA %	A _v Joule Charpy-V -46 °C	Probenlage Orientation of specimen
Sollwert/ Requirements	min. 330	min.	min.	485-655	min. 22	inf.	single 16 average 20	
50247	386			547	33	76	166/131/152	tangential ¼ T

Härteprüfung / Hardness test:
ASTM E 10 :2012

Sollwert/ Requirements :
Resultate/ Results :

145 - 187 HBW

170, 168, 166, 169, 171, 167, 172, 170, 168, 166,
168, 170, 168, 171, 168, 167, 173, 171, 167, 169,
171, 166, 168, 169, 172 HBW

Visuelle Prüfung / Visual Inspection
Masskontrolle / dimension

in Ordnung / accepted
in Ordnung / accepted

Es wird bestätigt, dass die Lieferung den Vereinbarungen bei der Bestellannahme entspricht.
We confirm that the test results are in acc. to the order.

Approved for Manufacture

by Bruno SchenkerDate 12/7/16

Beilagen / Enclosure: 2 heat treatment charts

Hedingen, 30. September 2014/sk

Werksachverständige / Inspector:

FO 62-09

SCHMIEDWERK STOOS AG

Seite 1 von 1

Maienbrunnstrasse 8 CH-8908 Hedingen Tel. 043 322 62 00 Fax 043 322 62 01 www.stoos.com e-mail: info@stoos.com

NOV HEAT CODE #

10703

50+ 165052



[10352 | | C1009AN] [LN: 5] TY023201-2 D860RFLN14]

Material Test Report

FVC
an **AFGlobal** Company

FVC Heat Nbr: C1009AN

Forged Vessel Connections

An AFGlobal Company

2525 De Soto, Houston, TX 77091

Sales: (713) 868-4421 Fax: (713) 455-8366

ISO 9001:2008 Certified

Industrial Piping	00011500	PO: HP232569	Sales Order: 150716	Line: 39
P.O. Box 581270		Item Code: LWN080600140A002A1	Qty: 1	
Tulsa, OK 74158-1270		Item Desc: LWN, SA105N, 600#, 8"x14", RF		
Spec: ASME SA105N: 2015 Edition				

Element	(%wt)	Ladle	Product	EPCRA	CAS#	Element	(%wt)	Ladle	Product	EPCRA	CAS#
C Carbon	0.19					Cb Columbium (Nb)	0.001				
Mn Manganese	1.14			✓	7439-96-5	Sn Tin	0.008				
P Phosphorous	0.011					B Boron	0.0002				
S Sulphur	0.00					Ti Titanium	0.002			✓	7440-02-0
Si Silicon	0.24					Al Aluminum	0.024				
Cu Copper	0.21			✓	7440-50-8	Ca Calcium	0.0019				
Ni Nickel	0.06			✓	7440-02-0	N Nitrogen	0.0071				
Cr Chromium	0.08			✓	7440-47-3	As Arsenic	0.005			✓	7440-33-2
Mo Molybdenum	0.014					Sb Antimony	0.005			✓	7440-36-0
V Vanadium	0.02					CE C+Mn/6+ (Cr+M)	0.42				

Mechanical Testing					Other				
Test Lab		AFLAB	59291		MHC		217W891		
BHN (QTC)		143			Production Method		EF		
Elg (%)		34.0			VD		YES		
RA (%)		67.0			Reduction Ratio (Mill) x:1		2.39:1		
Tensile (ksi)		70.9			Made to Fine Grain Practice		YES		
Yield (ksi)		44.6			Calcium Treated		YES		
Heat Treat									
Heat Treatment		Normalize							

CE=C+(Mn/6)+((Cr+Mo+V)/5)+((Ni+Cu)/15)
PRODUCT COMPLIANT TO NACE MR0175 AND NACE MR0103 LATEST EDITION.
YIELD STRENGTH CALCULATED AT 0.2% OFFSET.

FVC STANDARD MANUFACTURING PRACTICES:

- 1) FLANGE DIMENSIONS & BOLTING COMPLY - ASME B16.5. 2015 EDITION
- 2) SELF-REINFORCING NOZZLES COMPLY WITH SPECIFICATION OF SECTION VIII DIV. 1 OR DIV. 2 PER CUSTOMER DESIGN/FVC DESIGN.
- 3) MATERIAL SPECIFICATION COMPLIES WITH ASME SECT. II PART A.
- 4) ALL FVC MATERIAL MANUFACTURED PER FINE GRAIN PRACTICE.
- 5) ALL FVC MATERIAL CERTIFIED PER EN 10204 Type 3.1 UNLESS OTHERWISE SPECIFIED.
- 6) CERTIFICATE OF INSURANCE AVAILABLE UPON REQUEST.
- 7) PRODUCT FREE OF MERCURY CONTAMINATION.
- 8) ALL FVC MATERIAL MANUFACTURED UNDER ISO 9001:2008 QUALITY MANAGEMENT SYSTEM.

The recording of false, fictitious, or fraudulent statement or entries on this document may be punishable as a felony under federal statute.

EPCRA Supplier Notification: This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with a checkmark in the "EPCRA" column and a Chemical Abstract Services (CAS) registry number is provided for each such chemical in addition to the percent by weight of the chemical present in this product. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Certification No.: 1236289

Certification Date: 1/21/2016

Issued By: Ana Robles

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

KMI FAB

S/O

Date

Item #

Ana Robles
Ana Robles - QA Technician

165052

2-8-17

4

4

165052



[10352 | | C1031AN] | [LN: 5] | TY023201-2 | D860RFLN14 |

Material Test Report

FVC
an **AFGlobal** Company

FVC Heat Nbr: **C1031AN**

Forged Vessel Connections

An AFGlobal Company

2525 De Soto, Houston, TX 77091

ISO 9001:2008 Certified

Sales: (713) 868-4421 Fax: (713) 455-8366

Industrial Piping	00011500	PO: HP232569	Sales Order: 150716	Line: 39
P.O. Box 581270		Item Code: LWN080600140A002A1	Qty: 1	
Tulsa, OK 74158-1270		Item Desc: LWN, SA105N, 600#, 8"x14", RF		
Spec: ASME SA105N: 2015 Edition				

Element	(%wt)	Ladle	Product	EPCRA	CAS#	Element	(%wt)	Ladle	Product	EPCRA	CAS#
C Carbon	0.19					Cb Columbium (N)	0.001				
Mn Manganese	1.17			✓	7439-96-5	Sn Tin	0.009				
P Phosphorous	0.009					B Boron	0.0002				
S Sulphur	0.00					Ti Titanium	0.002			✓	7440-02-0
Si Silicon	0.25					Al Aluminum	0.027				
Cu Copper	0.19			✓	7440-50-8	Ca Calcium	0.0013				
Ni Nickel	0.06			✓	7440-02-0	N Nitrogen	0.0082				
Cr Chromium	0.05			✓	7440-47-3	As Arsenic	0.005			✓	7440-38-2
Mo Molybdenum	0.015					Sb Antimony	0.005			✓	7440-36-0
V Vanadium	0.02					CE C+Mn/6+ (Cr+M	0.42				

Mechanical Testing		Other	
Test Lab	AFLAB, 60367	MHC	207X370
BHN (QTC)	143 143	Production Method	EF
Elg (%)	32.0	VD	Yes
RA (%)	62.0	Fully Killed	Yes
Tensile (ksi)	71.1	Made to Fine Grain Practice	Yes
Yield (ksi)	44.1	Calcium Treated	Yes
Heat Treat			
Heat Treatment	Normalize		

CE=C+ (Mn/6) + ((Cr+Mo+V)/5) + ((Ni+Cu)/15)
PRODUCT COMPLIANT TO NACE MR0175 AND NACE MR0103 LATEST EDITION.
YIELD STRENGTH CALCULATED AT 0.2% OFFSET.

FVC STANDARD MANUFACTURING PRACTICES:

- 1) FLANGE DIMENSIONS & BOLTING COMPLY - ASME B16.5. 2015 EDITION
- 2) SELF-REINFORCING NOZZLES COMPLY WITH SPECIFICATION OF SECTION VIII DIV. 1 OR DIV. 2 PER CUSTOMER DESIGN/FVC DESIGN.
- 3) MATERIAL SPECIFICATION COMPLIES WITH ASME SECT. II PART A.
- 4) ALL FVC MATERIAL MANUFACTURED PER FINE GRAIN PRACTICE.
- 5) ALL FVC MATERIAL CERTIFIED PER EN 10204 Type 3.1 UNLESS OTHERWISE SPECIFIED.
- 6) CERTIFICATE OF INSURANCE AVAILABLE UPON REQUEST.
- 7) PRODUCT FREE OF MERCURY CONTAMINATION.
- 8) ALL FVC MATERIAL MANUFACTURED UNDER ISO 9001:2008 QUALITY MANAGEMENT SYSTEM.

The recording of false, fictitious, or fraudulent statement or entries on this document may be punishable as a felony under federal statute.

EPCRA Supplier Notification: This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with a checkmark in the "EPCRA" column and a Chemical Abstract Services (CAS) registry number is provided for each such chemical in addition to the percent by weight of the chemical present in this product. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Certification No.: 1236287

Certification Date: 1/21/2016

Issued By: Ana Robles

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

Ana Robles

Ana Robles - QA Technician

KMI FAB

S/O **165052**
Date **2-8-17**
Item # **4**

4

50# 165052



[10352 | | A2K] | [LN: 18] | TY023201-1 | D16TCPLT |

1/19/2016 10:35 9188359681

PAGE 01/01

16Dec14 7: 9

TEST CERTIFICATE

12-16-14

No: 1 112992

KREHER STEEL COMPANY, LLC.
1550 NORTH 25TH AVENUE
MELROSE PARK, LL 80160
Tel: 708-345-8180 Fax: 708-345-8293

P/O No 3213
Rel
S/O No 1 272430-001
B/L No 1 219587-002 Ship 16Dec14
Inv. No Inv

Sold To: (7811)
PRODUCTION MANUFACTURING CO., INC..
5909 EAST 13TH STREET
TULSA OK 74112

Ship To: (1)
PRODUCTION MANUFACTURING CO., INC..
5909 EAST 13TH STREET
TULSA OK 74112

Tel: 918-836-3585 Fax: 918-835-9681

CERTIFICATE of ANALYSIS and TESTS

Cert. No: 1 112992
16Dec14

Part No
TURN & POLISH ROUNDS A105
2.2500 X 17'R/L

2 1/4 Ø SA105

A2K

CONFORMS TO ASTM A105 & ASME SA105
HEAT NUMBER A142612
Cu .12 , V .003 AND Cb/Nb .001
LOT NUMBER 163361 WEIGHT 3220
TENSILE 73,200
YIELD 43,900
ELONGATION 22 %
REDUCTION OF AREA 40 %
HARDNESS 151--150 AT SURFACE
MADE IN THE USA

Heat Number
A142612

*** Chemical Analysis ***
C=0.1900 Mn=0.9200 P=0.0090 S=0.0210 Si=0.2100 Cu=0.1200
Ni=0.1000 Cr=0.1400 Mo=0.0400 Al=0.0360 Cb=0.0010 V=0.0030
B=<.0004> Ca=<.0012> W=<.0> Ti=<.001> Fe=<.002> Co=<.005>
As=<.004> Sb=<.002>

I hereby certify that this data is correct as
contained in the records of this company.
I hereby certify that no mercury came in contact
with or no weld repair was done to this product
while in our possession.

[Signature]

PRODUCTION MFG, TULSA, OKLA
CUSTOMER TPS
P.O. # Kim
ITEM 1-6000 Compnet
HEAT CODE A2K

Page: 1 Last

KMI FAB
S/O 165052
Date 2-8-17
Item # 5



Phoenix * Capitol * Camco CapProducts

Certified Mill Test Report

Heat Code: TTP

Heat Number: 121991

Item: 12305607: 3/4 6M THD COUPLET

Material: ASTM A105-2011a / ASME SA105-2010 Edition

Chemistry Properties

C	Mn	P	S	Si	Cu	Cr
0.2000	0.9200	0.0060	0.0290	0.2400	0.1900	0.1110
Ni	Mo	V	Co	Al	Cb	N
0.0680	0.0220	0.0340		0.0010	0.0020	
Pb	Sn	Ta	Ti	C Eq. Long		
				0.4039		

Additional Chemical Properties

Mechanical Properties

Tensile(PSI)	Yield(PSI)	Elong. % in 2 in. or 4D	Reduction	HBW	HBW 2
78800	55800	26%	45	162	150

Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Avg.	Test Temp.

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements. We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

KMI FAB

S/O 165052

Date 2-8-17

Item # 6

80# 165052



[10352 | 74FJ] [LN: 20] TY023201-1 D.56TCPLT

Capitol Manufacturing
1125 Capitol Avenue
Crowley, LA 70526

Phoenix * Capitol * Camco
CapProducts

Commanding a Higher Standard_{sm}

Certified Mill Test Report

Printed: 9/15/2016

Certified: 09/25/2015

Customer

P.O. TP519240

Heat No 145117

INDUSTRIAL PIPING SPECIALISTS

Tag

Heat Code 74FJ

P.O. BOX 581270

Phoenix Order # 1229129

TULSA, OK 74158

Material ASTM A105-2011a / ASME SA105-2010 Edition

Part Number

Description

12305605

1/2 6M THD COUPLET

Chemical Properties

C	Mn	P	S	Si	Cu	Ni	Cr	C Eq. Long	
0.2000	0.9500	0.0120	0.0210	0.2200	0.1900	0.0630	0.0990	0.4056	
Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0150	0.0380								

Additional Chemical Properties

					Cr + Cu + Ni	
					0.3520	

Mechanical Properties

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
83,100	58,700	24.0%	47.0%	165	165

Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Average	Test Temp.
N/A	N/A	N/A	N/A	N/A

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements.

We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

KMI FAB

S/O

Date

Item #

165052
2-8-17
7

KMI

8

NUCOR
PLATE MILL

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

Mill Test Report

Page 7

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

NUCOR
It's Our Nature

Issuing Date : 11/09/2016 B/L No. : 457293 Load No. : 466391 Our Order No. : 141569/4 Cust. Order No. : MUS-247109
Vehicle No: TTPX 806104 Sold To: METALS USA - SOUTHCENTRAL 2800 N 43RD ST E Ship To: METALS USA - PLATES AND SHAPES TRACK 747 MUSKOGEE, OK 74401
Specification: 1.0000" x 96.000" x 480.000" ASTMA516 70/65/60-10(2015)/ASME SA516-70/65/60 PVQ 2013/2015 Normalized Plate NACE MR0175 Annex 2.1.2, MR0103 (2010) Section 2.1.2 (2015) 13.1.1, 13.1.2) Compliant

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm	J	X			
6506641	0.19	1.04	0.010	0.001	0.19	0.19	0.08	0.09	0.03	0.031	0.006	0.002	0.002	0.0069	0.0010	0.0001	0.008	0.41	0.27	#####	#####			
Plate Serial No	Pieces	Tons	Dir.	Tensile Test				Heat Treat				Charpy Impacts										Temp °F	Size	
				Yield (psi)	Tensile (psi)	Elong. % in 2"	Elong. % in 8"	Norm °F	Time (min)	Temper °F	Time (min)	Absorbed Energy (Ft-lbs)					Shear (%)							
6506641-05	3	19.60	T	46,500	73,400	54.6		1650	41			H-L	112.3	109.4	107.9	109.9	15							-50 10mm

KMI FAB
S/O 165052
Date 2-8-17
Item # 8

NACE MR0175 ANNEX 2.1.2 COMPLIANT
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 (#010940) by SRI Quality System Registrar (#0985-09). 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. Depretis
T. A. Depretis, Metallurgist

11/10/2016 8:35:36 AM

9

FERW HU1610, FERW HU2010, FERW HU20STD, FERW HU2410, FERW HU24STD, FERW HU24

20" skirt

25051602

[10352] [LN: 16] [TY023201-2 | FERW HU20STD]

P/O No. : MIP00035		L/C No. : HU20110829001		ISSUED DATE : 2014.09.05		COMMODITY : E.R.W. STEEL PIPE		SPECIFICATION : ASTM A53B/ASME SA 53B		INSPECTION CERTIFICATE		주식회사 휴스틸 HUSTEEL Co., Ltd.		CERTIFICATE No. : 140905-315		MANUFACTURED No. : 2014-08-203		SUPPLIER : HUSTEEL CO., LTD.		CUSTOMER : HUSTEEL USA INC.															
HEAD OFFICE : SHINAN B/D 15F, 943-19, DAECHE-DONG, KANGNAM-GU, SEOUL, KOREA		DAEBUL PLANT : 3RO, DAEBUL INDUSTRIAL COMPLEX, SAMHO-EUP, YEONGAM-GUN, JEOLLANAM-DO, KOREA																																	
NO.	HEAT_NO	QUANTITY PCS	TYPE	NOMINAL SIZE	ORDER SIZE			WEIGHT lb/ft	TENSILE TEST						CHEMICAL COMPOSITION(%)																				
					O.D. inch	WT inch	LENGTH ft		DIR	TS PSI	YS %	EL %	YR %	WTS PSI	DIV	C	SI	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	CEQ	PCM					
01	N16483	34	BPEB	16	16.000	0.250	42	42.09	T	68,310	56,417	39	83	72,371	H	6	1	74	12	5	13	10	20	TR	TR	160	10								
02	N15568	25	BPEB	16	16.000	0.250	42	42.09	T	66,569	54,097	40	81	70,050	H	6	1	76	12	6	12	8	22	10	10	201	9								
03	N12472	93	BPEB	16	16.000	0.250	42	42.09	T	67,295	54,242	41	81	70,340	H	6	1	76	10	4	11	10	20	TR	10	130	10								
HYDROSTATIC TEST		HEAT TREATMENT		ZINC COATING TEST		THREADS		HARDNESS TEST		IMPACT TEST		*13 N · D · T (UT)		FLATTENING OR BEND TEST		VISUAL & DIMENSION		METALLOGRAPHIC TEST		RESIDUAL MAGNETISM															
T.P. H.T. RESULT		WZC CST		TPI ETL		HV		DIV		Energy (Ind, I)		SIZE		GOOD		GOOD		GOOD		GOOD															
PSI sec		g/m ² TIMES		TPI Inch		HV		DIV		Energy (Ind, I)		SIZE		FLANGE TEST		REVERSE FLATTENING TEST		CRUSH TEST																	
*9		*10		*11		*12		*7		*8																									
01	1120	5	GOOD	930										- Latest edition per API 5L(45th,2013) ASTM(2012) ASME SA 53B(2013) - HARDNESS MAX 22 HRC AS PER NACE MR 0175 / ISO 15156																					
02	1120	5	GOOD	930																															
03	1120	5	GOOD	930																															
*1. Type of Pipe Ends DPE Black Plain Ends GPE Galvanized Plain Ends BPEB BPE Bevelled GPEB GPE Bevelled DTE Black Threaded Ends GTE Galvanized Threaded Ends BYC Black Threaded & Coupled GTC Galvanized Threaded & Coupled																																			
*2. O.D. : Outside Diameter, WT : Wall Thickness *3. Direction: L : Longitudinal, T : Transverse *4. Tensile Test -TS : Tensile Strength, YS : Yield Strength, YR : Yield Ratio, EL : Elongation, WTS : Weld tensile strength, Gauge Length : 2 inch, Y.P method : 0.5% Underload *5. H : Heat analysis, P : Product analysis *6. -2 : x1/100, -3 : x1/1000, -4 : x1/10000, -5 : x1/100000, Tr : Trace *7. B : Base Metal, W : Weld Line, H : Heat Affected Zone *8. Specimen Size -A:10x10mm, B:10x7.5mm, C:10x6.5mm, D:10x5.0mm, Direction: Transverse *9. T.P. : Testing Pressure, H.T. : Holding Time *10. Heat Treatment : Seam Normalizing *11. WZC : Weight of Zinc Coating, CST : Copper Sulphate Test *12. TPI : Threads per inch, ETL : Effective length of threads *13. NDT : UT, Reference Standard 3.2 & Drilled Hole																																			
SURVEYOR		WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE AND TESTED IN ACCORDANCE WITH THE ORDER AND ABOVE SPECIFICATION THIS CERTIFICATE IS ISSUED ACCORDING TO EN 10204 3.1(ISO 10474 3.1 B)																MANAGER OF QA TEAM																	

KMI FAB
S/O 165052
Date 2-8-17
Item # 9



HMC C-30-05-(21)

본 검사증명서에 명기된 규격용도 외 사용시 안전상 문제가 발생할 수 있으며, 검사증명서 위·변조시 사문서 위조(형법231조)로 불이익을 당하실 수 있습니다.

PAGE : 1 / 7

INSPECTION CERTIFICATE

P/O No. : MIP00035
L/C No. : HU20110829001

ISSUED DATE : 2014.09.05

COMMODITY : E.R.W. STEEL PIPE

API 5L X-42 PSL1/API 5LB/

SPECIFICATION : ASTM A53B/ASME SA 53B



주식회사 휴스틸

HUSTEEL Co., Ltd.

HEAD OFFICE : SHINAN B/D 15F, 943-19, DAECHE-DONG,
KANGNAM-GU, SEOUL, KOREA

DAEBUL PLANT : 3RD, DAEBUL INDUSTRIAL COMPLEX, SAMHO-EUP,
YEONGAM-GUN, JEOLLANAM-DO, KOREA

CERTIFICATE No. : 140905-315

MANUFACTURED No. : 2014-08-203

SUPPLIER : HUSTEEL CO., LTD.

CUSTOMER : HUSTEEL USA INC.

NO.	HEAT_NO	QUAN- TITY	TYPE	NOMINAL SIZE	ORDER SIZE			WEIGHT	TENSILE TEST						CHEMICAL COMPOSITION(%)																
		O.D			WT	LENGTH	DIR.		TS	YS	EL	YR	WTS	DIV	C	SI	Mn	P	S	Cu	NI	Cr	Mo	V	Nb	TI	B	CEQ	PCM		
		inch	inch		ft	PSI		%	%	PSI	-2	-3	-4		-5	-3															
		PCS	*1		*2	lb/ft		*3	*4	*5	*6																				
04	N16761	31	BPEB	16	16.000	0.250	42	42.09	T	69,035	56,707	39	82	75,271	H	7	1	76	13	5	18	10	20	TR	10	140	10				
05	N11531	21	BPEB	16	16.000	0.250	42	42.09	T	68,890	56,417	37	82	79,622	P	7	1	78	13	5	17	9	28	18	12	205	7				
															P	7	1	78	13	5	17	8	28	15	10	200	7				
															H	6	1	76	15	4	18	10	20	TR	TR	140	10				
06	M88025	18	BPEB	20	20.000	0.250	42	52.78	T	67,150	52,936	41	79	70,195	P	6	2	77	16	4	17	6	29	10	12	189	9				
															P	6	2	77	15	4	17	6	28	10	12	183	8				
															H	6	1	78	11	6	17	10	20	TR	10	140	10				
															P	7	2	80	11	8	18	11	28	34	10	187	7				
															P	7	2	80	11	8	18	9	27	24	8	172	6				

NO.	HYDROSTATIC TEST			HEAT TREATMENT	ZINC COATING TEST		THREADS		HARDNESS TEST	IMPACT TEST			*13 N · D · T (UT)	FLATTENING OR BEND TEST	VISUAL & DIMENSION	METALLOGRAPHIC TEST	RESIDUAL MAGNETISM
	TP	H.T	RESULT		WZC	CST	TPI	ETL inch		(0) °C							
	PSI	sec			g/m²	TIMES				DIV	Energy (Ind. I)	SIZE					
	*9	*10	*11		*12	HV	*7			*8							
04	1120	5	GOOD	930													
05	1120	5	GOOD	930													
06	950	10	GOOD	930													
													- Latest edition per API 5L(45th,2013) ASTM(2012) ASME SA 53B(2013) - HARDNESS MAX 22 HRC AS PER NACE MR 0175 / ISO 15156				

NOTE	*1. Type of Pipe Ends				*2. O.D : Outside Diameter, W.T : Wall Thickness				*3. Direction: L : Longitudinal, T : Transverse			
	BPE	Black Plain Ends	GPE	Galvanized Plain Ends	BPEB	BPE Bevelled	GPEB	GPE Bevelled	*4. Tensile Test -TS : Tensile Strength, YS : Yield Strength, YR : Yield Ratio, EL : Elongation, WTS : Weld tensile strength, Gauge Length : 2 Inch, Y.P method : 0.5% Underload	*5. H : Heat analysis, P : Product analysis	*6. -2 : x1/100, -3 : x1/1000, -4 : x1/10000, -5 : x1/100000, Tr : Trace	*7. B : Base Metal, W : Weld Line, H : Heat Affected Zone
	BTE	Black Threaded Ends	GTE	Galvanized Threaded Ends	BTEB	BTE Bevelled	GTEB	GTE Bevelled	*8. Specimen Size -A: 10x10mm, B: 10x7.5mm, C: 10x6.5mm, D: 10x5.0mm, Direction: Transverse	*9. T.P : Testing Pressure, H.T : Holding Time	*10. Heat Treatment: Soak Normalizing	*11. WZC : Weight of Zinc Coating, CST : Copper Sulphate Test
	BTC	Black Threaded & Coupled	GTC	Galvanized Threaded & Coupled					*12. TPI : Threads per inch, ETL : Effective length of threads	*13. NDT : UT, Reference Standard 3.2 0 Drilled Hole		

SURVEYOR		WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE AND TESTED IN ACCORDANCE WITH THE ORDER AND ABOVE SPECIFICATION THIS CERTIFICATE IS ISSUED ACCORDING TO EN 10204 3.1 (ISO 10474 3.1 B)										MANAGER OF QA TEAM	
----------	--	--	--	--	--	--	--	--	--	--	--	--------------------	--

HMC C-30-05(21)

본 검사증명서에 명기된 규격용도 외 사용시 안전상 문제가 발생할 수 있으며, 검사증명서 위·변조시 사문서 위조(형법231조)로 불이익을 당하실 수 있습니다.

PAGE : 2 / 7



50# 165052

[10352] [N13597] [1N: 16] [TY023201-2] FERWU203TD

P/O No. : MIP00035
L/C No. : HU20110829001

ISSUED DATE : 2014.09.05

COMMODITY : E.R.W. STEEL PIPE
API 5L X-42 PSL1/API 5LB/
SPECIFICATION : ASTM A53B/ASME SA 53B

INSPECTION CERTIFICATE



주식회사 휴스틸

HUSTEEL Co., Ltd.

HEAD OFFICE : SHINAN B/D 15F, 943-19, DAECHE-DONG,
KANGNAM-GU, SEOUL, KOREA
DAEBUL PLANT 3RO, DAEBUL INDUSTRIAL COMPLEX, SAMHO-EUP,
YEONGAM-GUN, JEOLLANAM-DO, KOREA

CERTIFICATE No. : 140905-315

MANUFACTURED No. : 2014-08-203

SUPPLIER : HUSTEEL CO., LTD.

CUSTOMER : HUSTEEL USA INC.

NO.	HEAT_NO	QUAN- TITY PCS	TYPE	NOMINAL SIZE	ORDER SIZE			WEIGHT lb/ft	TENSILE TEST						CHEMICAL COMPOSITION(%)																																																
					O.D	W.T	LENGTH		DIR.	TS	YS	EL	YR	WTS	DIV	C	SI	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	CEQ	PCM																																	
					Inch	inch	ft																								PSI	%	%	PSI	*5	-2	-3	-4	-5	-3																							
07	N13101	20	BPEB	20	20.000	0.250	42	52.78	T	68,455	56,272	38	82	73,096	H	7	1	77	12	5	12	10	20	TR	10	150	10																																				
08	N16664	17	BPEB	20	20.000	0.250	42	52.78	T	67,440	55,257	40	82	71,355	P	7	2	80	13	6	13	9	24	32	10	191	7																																				
09	N18421	43	BPEB	20	20.000	0.250	42	52.78	T	67,440	55,692	40	83	71,936	P	7	1	79	13	6	13	9	23	29	8	180	7																																				
															H	6	1	76	13	3	14	10	20	TR	10	160	10																																				
															P	7	2	78	14	4	15	11	25	31	13	205	8																																				
															P	7	2	78	14	4	15	10	25	25	13	205	8																																				
															H	7	1	74	14	5	15	10	20	TR	TR	140	10																																				
															P	7	2	77	16	5	18	13	32	27	13	199	8																																				
															P	7	2	77	16	5	17	12	32	22	13	202	9																																				
NO.	HYDROSTATIC TEST			HEAT TREATMENT	ZINC COATING TEST		THREADS		HARDNESS TEST	IMPACT TEST			*13 N · D · T (UT)	FLATTENING OR BEND TEST	VISUAL & DIMENSION	METALLOGRAPHIC TEST	RESIDUAL MAGNETISM																																														
	TP	H.T	RESULT		WZC	CST	TPI	ETL		[0] °C	DIV	Energy (Ind, J)						SIZE																																													
	PSI	sec																	°C	g/m ²	TIMES	inch	HV	*7	*8																																						
	*9			*10	*11		*12																																																								
07	950	10	GOOD	930																																																											
08	950	10	GOOD	930																																																											
09	950	10	GOOD	930																																																											
NOTE	*1. Type of Pipe Ends																*2. O.D : Outside Diameter, W.T : Wall Thickness																*3. Direction L : Longitudinal, T : Transverse																														
	BPE Black Plain Ends				GPE Galvanized Plain Ends				*4. Tensile Test -TS : Tensile Strength, YS : Yield Strength, YR : Yield Ratio, EL : Elongation, WTS : Weld tensile strength, Gauge Length : 2 Inch, Y.P method : 0.5% Underload																																																						
	BPEB BPE Bevelled				GPEB GPE Bevelled				*5. H : Heat analysis, P : Product analysis																																																						
	BTE Black Threaded Ends				GTE Galvanized Threaded Ends				*6. -2 : x1/100, -3 : x1/1000, -4 : x1/10000, -5 : x1/100000, Tr : Trace																																																						
	BTC Black Threaded & Coupled				GTC Galvanized Threaded & Coupled				*7. B : Base Metal, W : Weld Line, H : Heat Affected Zone																																																						
																*8. Specimen Size -A:10x10mm, B:10x7.5mm, C:10x6.5mm, D:10x5.0mm, Direction: Transverse																*9. T.P : Testing Pressure, H.T : Holding Time																*10. Heat Treatment Seam Normalizing Reference Standard 3.2 & Drilled Hole															
																*11. WZC : Weight of Zinc Coating, CST : Copper Sulphate Test																*12. TPI : Threads per Inch, ETL : Effective length of threads																*13. NDT : UT,															
SURVEYOR																WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE AND TESTED IN ACCORDANCE WITH THE ORDER AND ABOVE SPECIFICATION THIS CERTIFICATE IS ISSUED ACCORDING TO EN 10204 3.1 (ISO 10474 3.1 B)																																MANAGER OF QA TEAM															

HMC C-30-05-(21)

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PAGE : 3 / 7



INSPECTION CERTIFICATE

P/O No. : MIP00035
L/C No. : HU20110829001

ISSUED DATE : 2014.09.05

COMMODITY : E.R.W. STEEL PIPE
API 5L X-42 PSL1/API 5L/
SPECIFICATION : ASTM A53B/ASME SA 53B



주식회사 휴스틸

HUSTEEL Co., Ltd.

HEAD OFFICE : SHINAN B/D 15F, 943-19, DAECHE-DONG,
KANGNAM-GU, SEOUL, KOREA
DAEBUL PLANT : 3RO, DAEBUL INDUSTRIAL COMPLEX, SAMHO-EUP,
YEONGAM-GUN, JEOLLANAM-DO, KOREA

CERTIFICATE No. : 140905-315

MANUFACTURED No. : 2014-08-203

SUPPLIER : HUSTEEL CO., LTD.

CUSTOMER : HUSTEEL USA INC.

NO.	HEAT_NO	QUAN- TITY PCS	TYPE	NOMINAL SIZE	ORDER SIZE			WEIGHT lb/ft	TENSILE TEST						CHEMICAL COMPOSITION(%)																	
					O.D.	WT	LENGTH		DIR.	TS	YS	EL	YR	WTS	DIV	C	SI	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	CEQ	PCM		
					inch	inch	ft																								PSI	%
10	N18465	21	BPEB	20	20.000	0.250	42	52.78	T	70,485	58,883	39	84	73,241	H	6	1	76	13	6	12	10	10	TR	10	160	10					
11	N13605	33	BPEB	20	20.000	0.375	42	78.67	T	70,630	59,028	41	84	73,676	H	6	1	75	14	4	19	10	30	TR	10	240	10					
12	N13597	62	BPEB	20	20.000	0.375	42	78.67	T	71,065	59,898	40	84	77,302	H	7	1	75	13	5	29	10	30	TR	10	240	10					
															P	7	2	76	14	4	19	12	29	28	8	266	6					
															P	7	1	75	14	4	19	10	28	18	7	256	5					
															P	7	2	75	15	5	25	12	30	35	7	266	7					
															P	7	1	74	14	5	24	11	29	28	5	259	6					

NO.	HYDROSTATIC TEST			HEAT TREATMENT °C	ZINC COATING TEST		THREADS		HARDNESS TEST HV	IMPACT TEST (J) °C			*13 N · D · T (UT)	FLATTENING OR BEND TEST	VISUAL & DIMENSION	METALLOGRAPHIC TEST	RESIDUAL MAGNETISM
	T.P	H.T	RESULT		WZC	CST	TPI	ETL		DIV	Energy (Ind. J)	SIZE					
	PSI	sec	°C		g/m²	TIMES	Inch	*7									
10	950	10	GOOD	930													
11	1430	10	GOOD	950													
12	1430	10	GOOD	950													

NOTE	*1. Type of Pipe Ends				*2. O.D : Outside Diameter, W.T : Wall Thickness				*3. Direction - L : Longitudinal, T : Transverse							
	BPE	Black Plain Ends	GPE	Galvanized Plain Ends	*4. Tensile Test - TS : Tensile Strength, YS : Yield Strength, YR : Yield Ratio, EL : Elongation, WTS : Weld tensile strength, Gauge Length : 2 inch, YP method : 0.5% Underload				*5. H : Heat analysis, P : Product analysis							
	BPEB	BPE Bevelled	GPEB	GPE Bevelled	*6. -2 : x1/100, -3 : x1/1000, -4 : x1/10000, -5 : x1/100000, Tr : Trace				*7. B : Base Metal, W : Weld Line, H : Heat Affected Zone							
	BTE	Black Threaded Ends	GTE	Galvanized Threaded Ends	*8. Specimen Size - A:10x10mm, B:10x7.5mm, C:10x6.5mm, D:10x5.0mm, Direction Transverse				*9. T.P : Testing Pressure, H.T : Holding Time							
	BTC	Black Threaded & Coupled	GTC	Galvanized Threaded & Coupled	*11. WZC : Weight of Zinc Coating, CST : Copper Sulphate Test				*12. TPI : Threads per inch, ETL : Effective length of threads				*13. NDT : UT, Reference Standard 3.2 & Drilled Hole			

SURVEYOR

WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE AND TESTED IN ACCORDANCE WITH THE ORDER AND ABOVE SPECIFICATION
THIS CERTIFICATE IS ISSUED ACCORDING TO EN 10204 3.1(ISO 10474 3.1 B)

MANAGER OF QA TEAM

HMC C-30-05-(21)

본 검사증명서에 명기된 규격용도 외 사용시 안전상 문제가 발생할 수 있으며, 검사증명서 위·변조시 사문서 위조(형법231조)로 불이익을 당할 수 있습니다.

PAGE : 4 / 7



본 검사증명서 3.1(ISO 10474 3.1 B)

[IN: 16] | TY023201-2 | FERWU20STD | N13597] | 10352 | 50# 165052

INSPECTION CERTIFICATE

P/O No. : MIP00035
L/C No. : HU20110829001



주식회사 휴스틸

HUSTEEL Co., Ltd.

CERTIFICATE No. : 140905-315

ISSUED DATE : 2014.09.05

MANUFACTURED No. : 2014-08-203

COMMODITY : E.R.W. STEEL PIPE
API 5L X-42 PSL1/API 5LB/
SPECIFICATION : ASTM A53B/ASME SA 53B

HEAD OFFICE : SHINAN B/D 15F, 943-19, DAECHE-DONG,
KANGNAM-GU, SEOUL, KOREA
DAEBUL PLANT : 3RD, DAEBUL INDUSTRIAL COMPLEX, SAMHO-EUP,
YEONGAM-GUN, JEOLLANAM-DO, KOREA

SUPPLIER : HUSTEEL CO., LTD.

CUSTOMER : HUSTEEL USA INC.

NO.	HEAT_NO	QUAN- TITY	TYPE	NOMINAL SIZE	ORDER SIZE			WEIGHT	TENSILE TEST						CHEMICAL COMPOSITION(%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
		O.D			WT	LENGTH	DIR.		TS	YS	EL	YR	WTS	DIV	C	SI	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	CEQ	PCQ																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
		inch	inch		ft	lb/ft		PSI	%	%	PSI	-2			-3			-4			-5	-3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
		PCS	*1		*2			*3	*4				*5		*6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
13	N17333	36	BPEB	24	24.000	0.250	42	63.47	T	66,714	57,287	41	86	70,775	H	6	1	74	16	6	11	10	20	TR	10	150	10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
14	N17338	89	BPEB	24	24.000	0.250	42	63.47	T	66,279	54,097	40	82	72,081	P	5	1	75	15	5	13	8	22	10	7	168	9																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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15	M98433	10	BPEB	24	24.000	0.375	42	94.71	T	75,416	59,753	40	79	79,187	P	6	1	76	17	7	14	10	30	21	10	205	6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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NO.	HYDROSTATIC TEST			HEAT TREATMENT	ZINC COATING TEST		THREADS		HARDNESS TEST	IMPACT TEST			*13 N - D - T (UT)	FLATTENING OR BEND TEST		VISUAL & DIMENSION	METALLOGRAPHIC TEST	RESIDUAL MAGNETISM																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
	T.P	H.T	RESULT		WZC	CST	TPI	ETL		(0) °C				GOOD	GOOD				GOOD	GOOD																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
	PSI	sec								°C	g/m²	TIMES		inch	HV				DIV	Energy (Ind, J)	SIZE	FLANGE TEST	REVERSE FLATTENING TEST	CRUSH TEST																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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HMC C-30-05-(21)

본 검사증명서에 명기된 규격용도 외 사용시 안전상 문제가 발생할 수 있으며, 검사증명서 위·변조시 사문서 위조(형법231조)로 불이익을 당하실 수 있습니다.

PAGE : 5 / 7



R E T U R N E D

[10352] [N13597] [LN: 16] [TY023201-2] [FERWHD20STD]

750521-02

P/O No. : MIP00035
I/C No. : HU20110829001

ISSUED DATE : 2014.09.05

COMMODITY : E.R.W. STEEL PIPE
API 5L X-42 PSL1/API 5LB/
SPECIFICATION : ASTM A53B/ASME SA 53B

INSPECTION CERTIFICATE



주식회사 휴스틸

HUSTEEL Co., Ltd.

HEAD OFFICE : SHINAN B/D 15F, 943-19, DAECHE-DONG,
KANGNAM-GU, SEOUL, KOREA
DAEBUL PLANT : 3RO, DAEBUL INDUSTRIAL COMPLEX, SAMHO-EUP,
YEONGAM-GUN, JEOLLANAM-DO, KOREA

CERTIFICATE No. : 140905-315

MANUFACTURED No. : 2014-08-203

SUPPLIER : HUSTEEL CO., LTD.

CUSTOMER : HUSTEEL USA INC.

NO.	HEAT_NO	QUAN- TITY	TYPE	NOMINAL SIZE	ORDER SIZE			WEIGHT	TENSILE TEST						CHEMICAL COMPOSITION(%)																	
		O.D			W.T	LENGTH	DIR.		TS	YS	EL	YR	WTS	DIV	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	CEQ	PCM			
		inch	inch		ft	PSI		%	%	PSI	*5	-2			-3			-4			-5		-3									
		PCS	*1		*2			lb/ft	*3	*4			PSI		*6																	
16	680050	74	BPEB	24	24.000	0.375	42	94.71	T	77,012	58,883	39	76	79,187	H	7	18	107	15	2	10	10	20	30	10	210	80					
17	592974	11	BPEB	24	24.000	0.375	42	94.71	T	81,508	64,684	37	79	80,492	P	7	21	108	16	2	7	10	26	33	11	259	77					
															P	7	21	107	15	2	7	9	26	28	11	252	77					
															H	9	18	109	18	2	10	10	10	20	10	210	90					
18	595028	8	BPEB	24	24.000	0.500	42	125.61	T	70,340	49,601	44	71	75,416	P	6	19	110	16	2	6	8	15	27	16	253	82					
															P	6	19	109	16	2	6	7	13	17	13	243	81					
															H	15	1	83	15	2	10	10	10	10	10	10	10	10				
															P	14	2	86	15	2	8	8	15	18	8	21	8					
															P	15	2	86	15	2	8	7	15	15	7	16	7					
NO.	HYDROSTATIC TEST			HEAT TREATMENT	ZINC COATING TEST		THREADS		HARDNESS TEST	IMPACT TEST			*13 N · D · T (UT)	FLATTENING OR BEND TEST		VISUAL& DIMENSION		METALLOGRAPHIC TEST		RESIDUAL MAGNETISM												
	T.P	H.T	RESULT		WZC	CST	TP1	ETL		(0) °C	GOOD	GOOD	GOOD	GOOD	GOOD																	
	PSI	sec			g/n'	TIMES		Inch								HV	DIV *7	Energy (Ind, J)	SIZE *8													
	*9				*10	*11		*12																								
16	1190	10	GOOD	950																												
17	1190	10	GOOD	950																												
18	1580	10	GOOD	950																												
																					- Latest edition per API 5L(45th,2013) ASTM(2012) ASME SA 53B(2013)											
																					- HARDNESS MAX 22 HRC AS PER NACE MR 0175/ ISO 15156											

*1.Type of Pipe Ends

BPE	Black Plain Ends	GPE	Galvanized Plain Ends
BPEB	BPE Bevelled	GPEB	GPE Bevelled
BTE	Black Threaded Ends	GTE	Galvanized Threaded Ends
BTC	Black Threaded & Coupled	GTC	Galvanized Threaded & Coupled

*2. O.D : Outside Diameter, W.T : Wall Thickness

*3. Direction : L : Longitudinal, T : Transverse

*4. Tensile Test : TS : Tensile Strength, YS : Yield Strength, YR : Yield Ratio, EL : Elongation, WTS : Weld tensile strength, Gauge Length : 2 Inch, Y.P method : 0.5% Underload

*5. H : Heat analysis, P : Product analysis

*6. -2 : x1/100, -3 : x1/1000, -4 : x1/10000, -5 : x1/100000, Tr : Trace

*7. B : Base Metal, W : Weld Line, H : Heat Affected Zone

*8. Specimen Size : A:10x10mm, B:10x7.5mm, C:10x6.5mm, D:10x5.0mm, Direction: Transverse

*9. T.P : Testing Pressure, H.T : Holding Time

*10. Heat Treatment : Seam Normalizing

*11. WZC : Weight of Zinc Coating, CST : Copper Sulphate Test

*12. TP1 : Threads per inch, ETL : Effective length of threads

*13. NDT : UT, Reference Standard : 3.2C Drilled Hole

SURVEYOR

WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE AND TESTED IN ACCORDANCE WITH THE ORDER AND ABOVE SPECIFICATION
THIS CERTIFICATE IS ISSUED ACCORDING TO EN 10204 3.1(ISO 10474 3.1 B)

MANAGER OF QA TEAM

HMC C-30-05-(21)

본 검사증명서에 명기된 규격용도 외 사용시 안전상 문제가 발생할 수 있으며, 검사증명서 위·변조시 사문서 위조(형법231조)로 불이익을 당하실 수 있습니다.

PAGE : 6 / 7



INSPECTION CERTIFICATE

P/O No. : MIP00035
L/C No. : HU20110829001



주식회사 휴스틸

HUSTEEL Co., Ltd.

CERTIFICATE No. : 140905-315

ISSUED DATE : 2014.09.05

MANUFACTURED No. : 2014-08-203

COMMODITY : E.R.W STEEL PIPE

HEAD OFFICE : SHINAN B/D 15F, 943-19, DAECHE-DONG,
KANGNAM-GU, SEOUL, KOREA

SUPPLIER : HUSTEEL CO., LTD.

API 5L X-42 PSL1/API 5LB/

DAEBUL PLANT : 3RO, DAEBUL INDUSTRIAL COMPLEX, SAMHO-EUP,
YEONGAM-GUN, JEOLLANAM-DO, KOREA

CUSTOMER : HUSTEEL USA INC.

SPECIFICATION : ASTM A53B/ASME SA 53B

NO.	HEAT_NO	QUAN- TITY	TYPE	NOMINAL SIZE	ORDER SIZE			WEIGHT	TENSILE TEST						CHEMICAL COMPOSITION(%)																	
		O.D			WT	LENGTH	DIR.		TS	YS	EL	YR	WTS	DIV	C	SI	Mn	P	S	Cu	NI	Cr	Mo	V	Nb	TI	B	CEQ	PCM			
		inch			inch	ft			PSI	%	%	%	PSI		-2				-3				-4				-5	-3				
		*2			*3	*4				PSI	*5	*6																				
19	4B9394	21	BPEB	24	24.000	0.500	42	125.61	T	70,340	49,456	45	70	74,836	H P P	16 14 14	TR 2 2	85 85 85	14 15 15	2 2 2	10 8 8	10 8 8	10 14 13	20 16 14	10 7 6	10 16 11	10 7 7					

NO.	HYDROSTATIC TEST			HEAT TREATMENT	ZINC COATING TEST		THREADS		HARDNESS TEST	IMPACT TEST				*13 N · D · T (UT)	FLATTENING OR BEND TEST	VISUAL& DIMENSION	METALLOGRAPHIC TEST	RESIDUAL MAGNETISM
	T.P	H.T	RESULT		WZC	CST	TPI	ETL		[0] °C								
	PSI	sec			g/m'	TIMES		Inch		HV	DIV *7	Energy (Ind, J)	SIZE *8					
	*9				*10			*11										
19	1580	10	GOOD	950														
- Latest edition per API 5L(45th,2013) ASTM(2012) ASME SA 53B(2013) - HARDNESS MAX 22 HRC AS PER NACE MR 0175 / ISO 15156																		

NOTE	*1. Type of Pipe Ends				*2. O.D : Outside Diameter, W.T : Wall Thickness				*3. Direction: L : Longitudinal, T : Transverse							
	BPE	Black Plain Ends	GPE	Galvanized Plain Ends	BPE	Black Plain Ends	GPE	Galvanized Plain Ends	*4. Tensile Test -TS : Tensile Strength, YS : Yield Strength, YR : Yield Ratio, EL : Elongation, WTS : Weld tensile strength, Gauge Length : 2 Inch, YP method : 0.5% Underload							
	BPEB	BPE Bevelled	GPEB	GPE Bevelled	*5. H : Heat analysis, P : Product analysis				*6. -2 : x1/100, -3 : x1/1000, -4 : x1/10000, -5 : x1/100000, Tr : Trace				*7. B : Base Metal, W : Weld Line, H : Heat Affected Zone			
	BTE	Black Threaded Ends	GTE	Galvanized Threaded Ends	*8. Specimen Size -A:10x10mm, B:10x7.5mm, C:10x6.6mm, D:10x5.0mm, Direction: Transverse				*9. T.P : Testing Pressure, H.T : Holding Time				*10. Heat Treatment Seam Normalizing			
	BTC	Black Threaded & Coupled	GTC	Galvanized Threaded & Coupled	*11. WZC : Weight of Zinc Coating, CST : Copper Sulphate Test				*12. TPI : Threads per inch, ETL : Effective length of threads				*13. NDT : UT, Reference Standard 3.2 C Drilled Hole			

SURVEYOR		WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE AND TESTED IN ACCORDANCE WITH THE ORDER AND ABOVE SPECIFICATION THIS CERTIFICATE IS ISSUED ACCORDING TO EN 10204 3.1(ISO 10474 3.1 B)										MANAGER OF Q.A TEAM	
----------	--	---	--	--	--	--	--	--	--	--	--	---------------------	--

HMC C-30-05-(21)

본 검사증명서에 명시된 규격용도 외 사용시 안전상 문제가 발생할 수 있으며, 검사증명서 위·변조시 사문서 위조(형법231조)로 불이익을 당하실 수 있습니다.

PAGE : 7 / 7



2014.09.05

[10352 | N13597 | [LN: 16] | TY023201-2 | FERWU20STD]

503165052

KMI

10

SSAB

3/4 x 40 x 121 1/2

Test Certificate

12400 Highway 43 North, Axis, Alabama 36505, US

Form TC1: Revision 2: Date 23 Apr 2014

Customer: METALS USA PLATES & SHAPES-SOUTHCENTRAL P.O. BOX 3528 101 EAST ILLINOIS ENID OK 73702				Customer P.O.No.: MUS-245345				Mill Order No. 41-458113-05				Shipping Manifest: AR222006									
				Product Description: ASME SA516-70/SA516-65/SA516-60(15) ASTM A516-70/A516-65/A516-60(10/15) LCVN 15/12 FT.LBS @ -60F/A673-P NORMALIZED				Ship Date: 23 Mar 16 Cert Date: 23 Mar 16				Cert No: 081549355 (Page 1 of 1)									
				Size: 0.750 X 120.0 X 480.0 (IN)																	
Tested Pieces:				Tensiles:				Charpy Impact Tests													
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir	Hardness	Abs. Energy(FTLB) 1 2 3 Avg				% Shear 1 2 3 Avg				Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
W6C510	F33	0.750 (DISCRT)	C 50	73			29	T		106	80	103	96				-60F	L	10.		
Heat Id				Chemical Analysis																	
	C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	Cev	ORGN				
W6C510	.19	1.03	.012	.001	.23	.027	.026	.23	.12	.13	.03	.001	.004	.009	.0001	.42	USA				
KILLED STEEL MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT. KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15 NACE MR0175(09) ANNEX A2.1.2 COMPLIANT MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT 100% MELTED AND MANUFACTURED IN THE USA. NORMALIZED PLATES. HEATED AT 1665F FOR 31 MINUTES. TEST COUPONS TAKEN FROM HEAT TREATED PLATE. PRODUCTS SHIPPED: W6C510 F33 6650740 PCES: 1, LBS: 12252 W6C510 F33 6650741 PCES: 1, LBS: 12252																					
(P)										Cust Part #:											
WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION										Justin Ward SENIOR METALLURGIST - PRODUCT											

KMI FAB
S/O 165052-
Date 2-8-17
Item # 10



Phoenix * Capitol * Camco CapProducts

Certified Mill Test Report

Heat Code: ADOB

Heat Number: 031794

Item: 2.1.0900.134: MEDIUM LIFTING LUG

Material: ASTM A105-2011a / ASME SA105-2010 Edition

Chemistry Properties

C	Mn	P	S	Si	Cu	Cr
0.2000	0.9200	0.0080	0.0370	0.2200	0.3700	0.0700
Ni	Mo	V	Co	Al	Cb	N
0.0900	0.0300	0.0240				
Pb	Sn	Ta	Ti	C Eq. Long		
				0.4088		

Additional Chemical Properties

Mechanical Properties

Tensile(PSI)	Yield(PSI)	Elong. % in 2 in. or 4D	Reduction	HBW	HBW 2
76000	48800	30%	65	152	156

Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Avg.	Test Temp.

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements. We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

KMI FAB

S/O 165052

Date 2-8-17

Item # 14



10308 | RFQ | 1015378774 | [LN: 4] | TY022731-1 | FSVAT1160 |
voestalpine Tubulars GmbH & Co KG

Alpinstrasse 17
8652 Kindberg-Aumühl
T. +4373865/22 15-0
F. +4373865/2216-532
www.vatubulars.com

Legal Structure: Limited Partnership
Location: Kindberg/Austria
Company Registry Number 165400k
Commercial Court of Leoben
DPR 0592684, VAT Nr. ATU 43630406

General Partner: voestalpine Tubulars GmbH
Legal Structure: Limited Liability Company
Location: Linz, Company Registry Number 1068331
Commercial Court of Linz

FSVAT 1160

INSPECTION - CERTIFICATE 3.1

(according to EN 10204)

ABNAHMEPRUEFZEUGNIS 3.1

(gem. EN 10204)

CERTIFICAT DE CONTROLE DES PRODUITS PAR L'USINE 3.1

(selon EN 10204)

Hersteller:
Manufacturer:
Producteur: voestalpine Tubulars GmbH & Co KG, Austria

Besteller:
Purchaser:
Archeteur: VOEST-ALPINE TUBULAR CORPORATION
USA-77077 HOUSTON, TEXAS
INDUSTRIAL PIPING
SPECIALISTS, INC.
TULSA OK 74158-1270, US

Pruefgegenstand:
Object of tests:
Epreuve: Line Pipe
LP-USA-01
LINEPIPE-01.0
non upset ends (API 5 D + 5 L) - non upset
UV coating

Werkstoff:
Material:
Matières: GRADE B

Anforderungen:
Requirements:
Exigence: Grade B acc. to ASTM A 53 / A 53M-2012
ASME SA 53-2015
Grade B acc. to ASTM A 106 / A 106M-2015,
ASME SA 106-2015
Grade B acc. to API 5 L, 45.edt.-2012 (PSL1)
NACE MR 0175 / ISO 15156-2009
NACE MR 0103-2012
LINEPIPE-01.0; LP-USA-01

Ausführung:
Condition:
Cond. de livraison: NU, PLAIN END, PE,

Wärmebehandlung: AS ROLLED

Heat treatment

Traitement de chaleur:

Coupl.die stamped:

Coupl.paint stencilling:

Colour coding: Fully painted: Bands:

Tube die stamped:

Tube paint stencilling: va SPEC 5L-0033 "API" 04.2016 1.315" 0.250" B PSL1 SMLS TESTED 2500 PSI Length ft Heat No. A/SA 53
GRADE B S A/SA 106 GRADE B SCHED.160 PO No.: HR066557 Made in Austria

Colour coding: Fully painted: Bands: purple

Label: PO No.: HR066557, DAT Port of Houston

Remarks: *) SI units have been converted to US customary units

No. 119903

Auftrags-Nr.: 20850 / 3
Our works order No.:
No usine:

Bestellnr.: HR066557/VATC PO#
Your order No.: 602604

No de la commande:

Zeichen des Lieferwerks:
Marking of producer: va
Marque du fabricant:

Erschmelzungsart: BOF
Melting process: fully killed, produced to
Procédé d'élaboration: fine grain practice

Kindberg, 18.04.2016

Page 1 of 4

No. 119903

Abnahmeprüfzeugnis wurde digital signiert und ist ohne
Originalunterschrift gültig/
Inspection certificate has been signed digitally and is
valid without an original signature

voestalpine Tubulars GmbH & Co KG
Qualitätsstelle / Quality Department
WEITZER

Abnahmebeauftragter
authorized inspection representative
représentant autorisé du contrôle

voestalpine

ONE STEP AHEAD.

KMI FAB

S/O

Date

Item #

165052
2-8-17
16

14



[10308 | RFQ | 1015378774] | [LN: 4] | TY022731-1 | FSVAT1160 |
voestalpine Tubulars GmbH & Co KG

Umfang der Lieferung / Volume of delivery / Contenu de la livraison:

Versandanzeige: Dispatch advice No. Avis d'expédition:	Pos.: Pos.:	Abmessung: Dimension: Dimension:	Bundnr.: Bundle No.: Nombre Fret:	Stückzahl: Number Of: Pièces:	Länge: Length: Longueur:	Gewicht: Weight: Poids:	Los: Lot: Lot:	Schmelze: Heat: Soufflage:
	3	1,315 in x 0,250 in; 2,84 lbs/ft SCHED.160	1-8	894	19 792.075ft	25 209.50kg		

Volume of delivery

Heat	Lot	Remark
1015378774	206455	AD 01

Test results

- 1 Biegeversuch/Bend test: bestanden/passed
- 2 Dimensionskontrolle/ Dimensional inspection: bestanden/passed
- 3 Streifflussprüfung gem. ASTM E 570 / Flux leakage testing acc. ASTM E 570 (N 12,5 longitudinal, type and size of reference Indicator used): bestanden/passed
- 4 Visuelle Inspektion/ Visual inspection: bestanden/passed
- 5 Wasserinnendruckversuch/Hydrostatic test: 2500 PSI (duration min. 5 sec.) bestanden/passed

Test remarks

Wir bestätigen, dass die gelieferten Erzeugnisse den Anforderungen der Bestellung entsprechen.
We hereby certify that the goods delivered are in compliance with the requirements of the order.

Kindberg, 18.04.2016

Page 2 of 4

No. 119903

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voestalpine Tubulars GmbH & Co KG
Qualitätsstelle / Quality Department

WEITZER

Abnahmebeauftragter
authorized inspection representative
représentant autorisé du contrôle

voestalpine

ONE STEP AHEAD.



[10308 | RF | 1015378774] | [LN: 4] | TY022731-1 | FSVAT1160 |

voestalpine Tubulars GmbH & Co KG

Tensile testing

Lot No	Test Type	Heat treatment	Temp		Specimen			Yield	Tensile	Elong.Reduct.	Rt/Rm	
			[°C]	No.	Type	Dimension [mm]	Strength [PSI]	Strength [PSI]	In area [%]	In area [%]		
Requ. from 35 534								60 190	30.00			
Requ. to												
206455	AD 01	Standard	as rolled	20	1	Full Section	33.40 x 6.35	Rt0.50	47 572	65 847	50.40	0.72
206455	AD 01	Standard	as rolled	20	2	Full Section	33.40 x 6.35	Rt0.50	45 977	64 686	52.10	0.71
206455	AD 01	Standard	as rolled	20	3	Full Section	33.40 x 6.35	Rt0.50	46 702	64 977	49.20	0.72
yield strength:												
Gr B: 35500 PSI												
tensile strength:												
Gr. B: 60200 PSI												

Hardness testing

Lot No	Test Type		Heat treatment	Specimen		Test Method	Hardness Number		Mean Hardness Number		Variation
				No.	Location		from	to	from	to	
Requ.:											
206455	AC01	Standard	as rolled	1	Body	HRB	74.70	75.60	74.97	75.50	0.53

Kindberg, 18.04.2016

Page 3 of 4

No. 119903

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voestalpine

ONE STEP AHEAD.



[10308 | RFQ | 1015378774] | [LN: 4] | TY022731-1 | FSVAT1160 |

voestalpine Tubulars GmbH & Co KG

Chemical test results
Product analysis

C	Si	Mn	P	S	Cr	Ni	Cu	Al	Ti	Mo	V	Sn	B	N2	Nb	Ca	CEQ
max. Requ.																	
0.2300		1.0600	0.0300	0.0300	0.4000	0.4000	0.4000			0.1500	0.0800						0.4000

min. Requ.
0.0000 0.1000 0.2900

1015378774

0.1557 0.1953 0.7289 0.0146 0.0073 0.0260 0.0212 0.0230 0.0288 0.0009 0.0036 0.0018 0.0013 0.0002 0.0059 0.0000 0.0022 0.2684

Chemical test results

Product analysis

C	Si	Mn	P	S	Cr	Ni	Cu	Al	Ti	Mo	V	Sn	B	N2	Nb	Ca	CEQ
Lot No.	206455	AD 01	1	Standard	Heat No.	1015378774											
0.1545	0.1737	0.6971	0.0137	0.0072	0.0233	0.0215	0.0242	0.0233	0.0012	0.0041	0.0033	0.0019	0.0002	0.0067	0.0007	0.0000	0.2799

Lot No.	206455	AD 01	2	Standard	Heat No.	1015378774											
0.1539	0.1665	0.6953	0.0107	0.0067	0.0237	0.0232	0.0291	0.0236	0.0013	0.0042	0.0032	0.0022	0.0002	0.0063	0.0007	0.0000	0.2795

Lot No.	206455	AD 01	3	Standard	Heat No.	1015378774											
0.1522	0.1790	0.7080	0.0114	0.0075	0.0244	0.0227	0.0297	0.0263	0.0016	0.0044	0.0041	0.0025	0.0002	0.0061	0.0013	0.0000	0.2804

Lot No.	206455	AD 01	4	Standard	Heat No.	1015378774											
0.1590	0.1867	0.7181	0.0146	0.0071	0.0241	0.0211	0.0252	0.0254	0.0015	0.0042	0.0041	0.0022	0.0002	0.0066	0.0013	0.0000	0.2883

Lot No.	206455	AD 01	5	Standard	Heat No.	1015378774											
0.1524	0.1837	0.7065	0.0146	0.0069	0.0269	0.0215	0.0247	0.0248	0.0014	0.0040	0.0039	0.0023	0.0002	0.0060	0.0011	0.0000	0.2802

Lot No.	206455	AD 01	6	Standard	Heat No.	1015378774											
0.1535	0.1828	0.7042	0.0145	0.0071	0.0267	0.0213	0.0248	0.0246	0.0014	0.0039	0.0038	0.0022	0.0002	0.0055	0.0010	0.0000	0.2808

Kindberg, 18.04.2016

Page 4 of 4

No. 119903

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voestalpine Tubulars GmbH & Co KG
Qualitätsstelle / Quality Department
WEITZER

Abnahmebeauftragter
authorized inspection representative
représentant autorisé du contrôle

voestalpine

ONE STEP AHEAD.

5016505



[10352 | 138VVV] [LN: 14] TY023201-1 D13S90



Capitol Manufacturing
1125 Capitol Avenue
Crowley, LA 70526

Phoenix * Capitol * Camco
CapProducts

Commanding a Higher Standardsm

Certified Mill Test Report

Printed: 3/14/2016

Certified: 03/11/2016

Customer

P.O. HP235613

INDUSTRIAL PIPING SPECIALISTS

Tag

Heat No 166142

P.O. BOX 581270

Heat Code 138VVV

TULSA, OK 74158

Phoenix Order # 1187112

Material ASTM A105-2014 / ASME SA105-2015 Edition

Part Number

Description

12400110

1 90 FS 3M SW ELL

Chemical Properties

C	Mn	P	S	Si	Cu	Ni	Cr	C Eq. Long	
0.2100	0.9100	0.0080	0.0230	0.2300	0.1600	0.0930	0.1410	0.4199	
Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0330	0.0330								

Additional Chemical Properties

					Cr + Cu + Ni	
					0.3940	

Mechanical Properties

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
88,000	59,500	26.0%	64.0%	179	179

Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Average
N/A	N/A	N/A	N/A

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements.

We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

KMI FAB

S/O

Date

Item #

165052
2-8-17
17

30-165052



[10352] [413DD] [LN: 21] [TY023201-1] [D13TCO]



Capitol Manufacturing
1125 Capitol Avenue
Crowley, LA 70526

Phoenix * Capitol * Camco
CapProducts

Commanding a Higher Standard™

Certified Mill Test Report

Printed: 9/30/2016

Customer

INDUSTRIAL PIPING SPECIALISTS

P.O. BOX 581270

TULSA, OK 74158

Certified: 07/13/2016

P.O. CP170450

Tag

Material ASTM A105-2014 / ASME SA105-2015 Edition

Heat No 166339

Heat Code 413DD

Phoenix Order # 1232832

Part Number

12202010

Description

1 FS 3M THD COUPLING

Chemical Properties

C	Mn	P	S	Si	Cu	Ni	Cr	C Eq. Long	
0.2000	0.9200	0.0050	0.0220	0.2400	0.1700	0.0730	0.1130	0.4029	
Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0180	0.0360								

Additional Chemical Properties

					Cr + Cu + Ni	
					0.3560	

Mechanical Properties

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
71,500	42,500	31.0%	64.0%	143	143

Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Average	Test Temp.
N/A	N/A	N/A	N/A	N/A

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements.

We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

KMI FAB

S/O 165052

Date 2-8-17

Item # 18



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165052

SECTION 5
NDE REPORTS

Customer:	KMI	Job No.	165052	PO No.		Page	1	of	1	
Description:	20 " PRESSURE VESSEL		Code /Spec	ASME	SECT VIII RT 2	Film Type:	AGFA D7			
Energy Type:	Iridium 192	Source Strength:	15 curies	Focal spot:	.146	Lead Screens:	.010 Front and Back		Geometric Unsharpness:	.02 max
Exposure Arrangement see Sect V Article 2			C/S = Carbon Steel S/S = Stainless Steel			S= Single D = Double				

[illegible]

Defect Codes: 1-Slag; 2-Porosity; 3-Crack; 4-Incomplete Penetration; 5-Incomplete Fusion; 6-Surface; 7-Underfill; 8-Excessive Reinforcement; 9-Other

Interpreted by/ Date 2/2/17 ASNT / ACCP LEVEL II BUTCH JOHNSON RT CERT.NO. 180764	Radiographer: Dale Young ASNT/ACCP II 180763 Radiographer :Butch Johnson ASNT/ACCP II 180764	Manufacturer Representative 	Date 2-7-17
---	---	--	----------------



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165052

SECTION 6

PROCESS CONTROL SHEETS (TRAVELERS)

KMI FABRICATORS, LLC STANDARD INSPECTION CHECKLIST FOR PRESSURE VESSELS FOR PRESSURE VESSELS ASME SECTION VIII, DIVISION 1			CUSTOMER: UOP RUSSELL KMI PROJECT: Q160140R1 PO: 44500749401		JOB/SERIAL NO. 165052 TAG: F-445		MODEL NO. GE1307L025V 20"OD X 7' 0" S/S		PAGE 1 OF 2 165052	
NO	CHECKLIST ATTRIBUTES/TESTS TO BE VERIFIED			MFG		AI WITNESS		QA AUDIT/NDE		CI
				HP	INIT/DATE	HP	INIT/DATE	HP	INIT/DATE	
1.	MATERIAL TRACEABILITY	VERIFY THAT MATERIAL TRACEABILITY HAS BEEN CONFIRMED BY QA AND THAT MATERIAL IS IDENTIFIED WITH HEAT/QC NUMBERS. REVIEW MTR'S			X	J.S. 1-23-17			X	<i>RB</i>
2.	JOINT FIT UP (SHELL SEAMS)	VERIFY WELD JOINT FITUP IN ACCORDANCE WITH APPROVED DRAWINGS FOR ALL SEAMS ON THE VESSEL AND SUMP			X	J.S. 1-24-17				
3.	LAYOUT	VERIFY NOZZLE/COUPLING OPENINGS IN VESSEL IS PROPERLY LOCATED PER DRAWING.			X	J.S. 1-23-17				
4.	NOZZLES	VERIFY NOZZLES/COUPLINGS FITUP IN ACCORDANCE WITH APPROVED DRAWINGS, VERIFY NOZZLES INSTALLED PLUMB/LEVEL			X	J.S. 1-24-17				
5.	OPEN END/ INTERNALS	VERIFY INTERNALS ARE INSTALLED IN ACCORDANCE WITH DIMENSIONS, CONFIGURATION, ORIENTATION SHOWN ON DRAWING.	1 ST STAGE	X	J.S. 1-25-17	X	<i>W</i> 1-30-17			
			2 ND STAGE*	N/A		N/A				
6.	WELDING INSPECTION	VISUALLY EXAMINE COMPLETED WELDMENTS IN ACCORDANCE WITH APPROVED DRAWINGS. INSPECT ALL ACCESSIBLE WELDS (FILLET, GROOVE, etc.-INTERNAL & EXTERNAL). DIRECT VISUAL EXAMINATION VERIFY THAT WELDS ARE STAMPED WITH WELDERS'S SYMBOL (S) & THAT SYMBOLS ARE RECORDED ON INSPECTION COPY OF DRAWINGS	VERIFY WELD SURFACE QUALITY	X	J.S. 1-26-17			X	<i>RB 2/8/17</i>	
			VERIFY LENGTH/TYPE SIZE/LOCATION	X	J.S. 1-30-17				PRIOR TO HYDRO	
7.	DIMENSIONS & CONFIGURATION VERIFICATION	A) VERIFY FINAL CONFIGURATION OF VESSEL (INCLUDING CLOSURE, DAVIT, SUMP, VESSEL SUPPORTS, etc.) COMPLIES WITH DIMENSIONS AND ORIENTATIONS SHOWN ON DRAWING.		X	J.S. 2-3-17			X	PRIOR TO HYDRO	
		B) VERIFY HEAT /QC NUMBERS AND BOLT MARKINGS REMAIN VISIBLE AND LEGIBLE AND THAT NO MATERIAL HAS BEEN SUBSTITUTED WITHOUT ENG. APPROVAL: RECORD HEAT/QC NUMBERS ON INSPECTION COPY OF VESSEL DRAWING.		X	J.S. 1-24-17					
		C) VERIFY THAT NOZZLES/COUPLINGS ARE INSTALLED PLUMB/LEVEL WITH FLANGE BOLTHOLES STRADDLING VESSEL CENTERLINE.		X	J.S. 1-24-17					
		D) VERIFY THAT VESSEL SHELL ROUNDNESS COMPLIES WITH ASME VIII UG80		X	J.S. 1-23-17					
		E) VERIFY THAT MATERIAL TYPES INSTALLED IN VESSEL CONFORM TO REQUIREMENTS OF BILL OF MATERIAL/ENG. DATA SHEET/JOB PICK LIST.		X	J.S. 1-24-17					
		F) VERIFY THAT BASE METAL IS FREE OF DAMAGE (DENTS, GOUGES, etc.).		X	J.S. 1-25-17					
APPROVED WPS (USE CURRENT REVISION) 1047A ☒ 1064 ☐ 1071 ☐ OTHER WPS ☐				* WHERE APPLICABLE						
HEAT TREAT: YES ☐ NO ☒			LEGEND: HP = HOLD INSPECTION POINT AI = AUTHORIZED INSPECTOR CI = CUSTOMER INSPECTOR							
APPROVED BY QUALITY ASSURANCE: <i>H Barnes</i>			DATE: 1-17-17							

KMI FABRICATORS, INC. STANDARD INSPECTION CHECKLIST FOR PRESSURE VESSELS			JOB NO.: 165052 TAG: F-445		PROJECT: Q160140R1		Page 2 of 2		
NO	CHECKLIST ATTRIBUTES/TESTS TO BE VERIFIED (CON'T FROM PG 1)		MFG		AI WITNESS		QA AUDIT/NDE		CP
			HP	INIT/DATE	HP	INIT/DATE	HP	INIT/DATE	
8.	NONDESTRUCTIVE EXAMINATION (CONTACT QA TO PERFORM/VERIFY NDE)	MAGNETIC PARTICLE INSPECTION	N/A						
		LIQUID PENETRANT INSPECTION	N/A						
		ULTRASONIC INSPECTION (SUBCONTRACT)	N/A						
		BRINELL HARDNESS TESTING ☐ OTHER ☐	N/A						
		RT (SUBCONTRACT) RT1 ☐ RT2 ☒ RT3 ☐ RT4 ☐ RADIOGRAPH ☐ USE TYPE _____ FILM	X	ITS 2-7-17					
9.	PRESSURE TEST	A) PERFORM REINFORCING PAD LEAK TEST IAW SPECIFICATION DATA SHEET	N/A		N/A				
		B) PERFORM HYDROSTATIC TEST IAW SPECIFICATION DATA SHEET 1430 PSIG for 15 minutes	X	T.O. 2-8-17	X	mm 2-8-17	X	KB 2/8/17	
10.	NAMEPLATE	VERIFY NAMEPLATE (CODE OR NON-CODE) AND CUSTOMER NAMEPLATE WHEN REQUIRED IS ATTACHED PER DRAWING (AFTER HYDRO/PRIOR TO SHIPPING)	X	mm 2-21-17	X		X	AB 2/8/17	
11.	DAVIT TEST	PERFORM DAVIT TEST	X	2-21-17 JC					
12.	COATINGS	A) VERIFY BLAST CLEANING IN ACCORDANCE WITH PAINT SPECIFICATION							
		B) VERIFY COATINGS APPLICATION IS ACCORDANCE WITH PAINT SPEC AND SPEC DATA SHEET	X	2-21-17 JC					
13.	INTERNAL CLEANING	VERIFY INTERNAL CLEANING IN ACCORDANCE WITH SPECIFICATION DATA SHEET	X	2-21-17 JC					
14.	ELEMENTS	VERIFY FILTER MEDIA (ELEMENTS, REPACK, etc.) IS INSTALLED PER DRAWING	N/A						
15.	AUXILIARY EQUIPMENT	VERIFY AUXILIARY EQUIPMENT (PIPING, VALVES, etc.) IS INSTALLED FOR TRIAL FIT (WHEN REQUIRED) IN ACCORDANCE WITH THE DRAWINGS	N/A						
16.	BOLT TORQUING	VERIFY THAT ALL PERMANENT BOLTING IS INSTALLED AND TORQUED	X	2-21-17 JC					
17.	PREPARATION FOR SHIPMENT	VERIFY THAT SHIPPING PREPARATIONS ARE COMPLETE, IN ACCORDANCE WITH THE REQUIREMENTS OF THE SPECIFICATION DATA SHEET AND DRAWINGS.	X	2-21-17 JC			X	AB 2/22/17	
OTHER REQUIREMENTS									
NOTES: Use TRCo Painting System 3 per the Specification Data Sheet.									

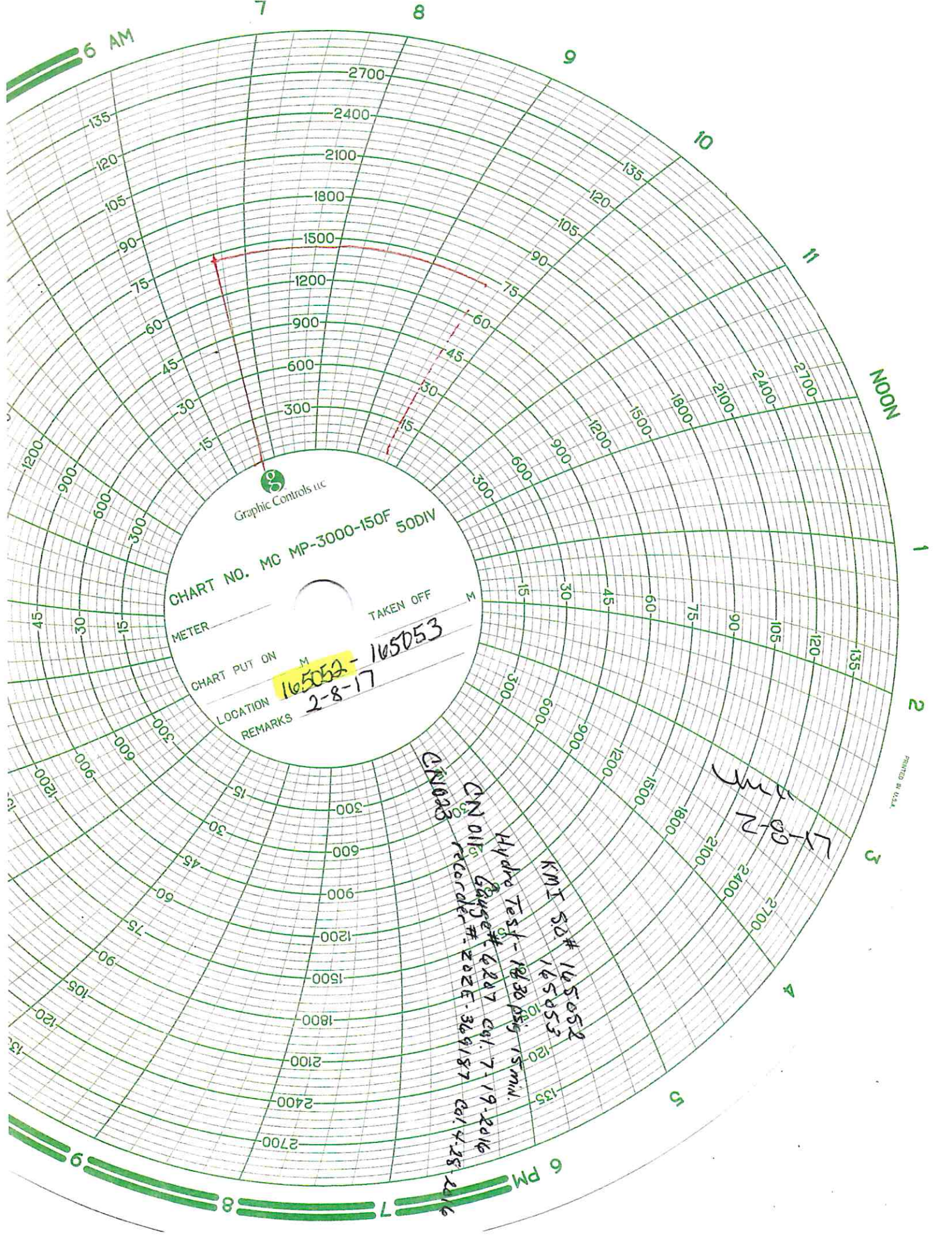


410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165052

SECTION 7

HYDROSTATIC / PRESSURE TEST RECORDS



Graphic Controls LLC

CHART NO. MC MP-3000-150F 50DIV

METER

TAKEN OFF

CHART PUT ON

LOCATION

REMARKS

165052-165053
2-8-17

CN 0115

Hydro Test - 1650 psig 15 min.
Gauge # 6287 Cal. 7-19-2016
Recorder # 2025-369187 Cal. 4-28-2016

KMI SD # 165052
165053

L-20

PRINTED IN U.S.A.



**D.S. BEEK 7172
FORT WORTH, TEXAS 76111
(817) 882-8884
FAX (817) 882-8812**

PRESS. _____ TEMP. _____ GAUGE _____ REC. _____ PK/Dead Wt. _____

SERIAL NUMBER 16207 MODEL McDaniels RANGE 0.3000 ACCURACY .51%

CNOH

CALIBRATION

[illegible]

CALIBRATED IN Vertical POSITION. AMBIENT TEMPERATURE 70°

THIS IS TO CERTIFY THAT THIS INSTRUMENT HAS BEEN INSPECTED AND TESTED AGAINST
PRESSURE STANDARD T155 T16004
TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS TECHNOLOGY.
TRACEABILITY REFERENCE P8003
SPECIAL CONDITIONS:

DATE OF CALIBRATION 7-19-16 INSPECTOR Zin



**P.O. BOX 7172
FORT WORTH, TEXAS 76111
[817] 532-2524
FAX [817] 532-2516**

SERIAL NUMBER 702F-31A187 MODEL Barton RANGE 0-3000 ACCURACY 1%

CN 23

CALIBRATION

[illegible]

CALIBRATED IN Vertical POSITION. AMBIENT TEMPERATURE 70°

THIS IS TO CERTIFY THAT THIS INSTRUMENT HAS BEEN INSPECTED AND TESTED AGAINST
PRESSURE STANDARD T155 T16004
TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS TECHNOLOGY.
TRACEABILITY REFERENCE P8003
SPECIAL CONDITIONS:

DATE OF CALIBRATION 4-28-16 INSPECTOR [Signature]



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165052

SECTION 8
NAMEPLATE FASCIMILE



PENTAIR

Filtration & Process

936-788-1000

www.pentairseparations.com

InterSep® ID No.

GI2004H08

Replacement Element No.

GE1307L025V

13

65 65

CERTIFIED BY



KMI FABRICATORS, INC.

410 BOYD RD.

MINERAL WELLS, TX 76067



1100 PSI AT 150 °F

MAWP

-20 °F AT 1100 PSI

MDMT

RT-2

SERIAL NO. 165052

YR. BLT.

2017

CORR. ALLOWANCE

-0625"

EXT. PRESS.

XXX

PSI AT XX

°F

MOL SIEVE DUST

FILTER

TAG: F-445

CERTIFIED BY



KMI FABRICATORS, INC.

410 BOYD RD.
MINERAL WELLS, TX 76067

U
W

1100 PSI AT 150 °F

MAWP

-20 °F AT 1100 PSI

MDMT

RT-2

SERIAL NO.

165032

YR. BLT.

2017

CORR. ALLOWANCE

.0625"

EXT. PRESS.

XXX

PSI AT XX

°F

WOL SIEVE DUST

FILTER

TAG: F-445



PENTAIR

Filtration & Process

936-788-1000

www.pentairseparations.com

InterSep® ID No.

GI2004H08

Replacement Element No.

GE1307L025V



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165052

SECTION 9
PAINT REPORT

165052



PRESS-O-FILM™

No. _____

Reading _____
Gage less 2.0 mils
or 50 micronsTESTEX
NEWARK, DE 19715
USA

COARSE (.8-2.0 mils) or (20 to 50 microns)

410 BOYD ROAD

MINERAL WELLS, TEXAS 76067

PHONE: 940-325-7841

FAX: 940-325-3765

PAINT LOG

Description of Item: MOL SIEVE DUST FILTER

Serial No. 165052 Note: Use TRCo Painting System 3

1. Date of Blasting 2-15-2017 Type of Sand: 2
 2. Atmospheric Temp. 74 °F
 3. Surface Temp. 76 °F
 4. Wet Bulb Temp. 55 °F, Dry Bulb Temp. 74 °F
 5. Dew Point 40 °F, Humidity 61 °F
 6. Surface Preparation Quality _____

7. Blast Profile 2 SSPC-SP 6 Commercial Blast MILS

8. Method of Checking Profile TEXTEX PROFILE Comparator

9. Date of Prime Coat 2-15-2017
 10. Atmospheric Temp. 74 °F
 11. Surface Temp. 76 °F
 12. Wet Bulb Temp. 55 °F, Dry Bulb Temp. 74 °F
 13. Dew Point 40 °F, Air Quality Good Humidity 61
 14. Product Name Sherwin Williams Macropoxy 646 (B58-600) Batch No. KM 34 76 FM
 15. Cure Time 24 Hrs. Dry Film Thk. _____ MILS (AVG.)

16. Date of Intermediate Coat 2-16-2017
 17. Atmospheric Temp. 85 °F
 18. Surface Temp. 89 °F
 19. Wet Bulb Temp. 61 °F, Dry Bulb Temp. 85 °F
 20. Dew Point 46 °F, Air Quality Good Humidity 63
 21. Product Name Sherwin Williams Macropoxy 646 (B58-600) Batch No. KM 34 76 FM
 22. Cure Time 24 Hrs. Dry Film Thk. _____ MILS (AVG.)

23. Date of Intermediate Coat 2-17-2017
 24. Atmospheric Temp. 88 °F
 25. Surface Temp. 89 °F
 26. Wet Bulb Temp. 61 °F, Dry Bulb Temp. 88 °F
 27. Dew Point 48 °F, Air Quality Good Humidity 58
 28. Product Name Sherwin Williams Hi-Solids Polyurethan B65 Series/B60V30 Batch No. KM 316 566 50
 29. Cure Time 24 Hrs. Dry Film Thk. _____ MILS (AVG.)

THE ABOVE INFORMATION CERTIFIED CORRECT BY KMI FABRICATORS, INC

BY: Jayl CampbellDATE: 2-21-17



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165053

Quality Documentation Records & Transmittal

DATE:	02/14/2017
CUSTOMER:	UOP RUSSELL LLC
CUSTOMER PO NO.:	4500749401 TAG: F-446
SERIAL, NO.	165053
NATIONAL BOARD, NO.	6566

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- ✓ SECTION 1: MANUFACTURERS DATA AND/OR MANUFACTURERS PARTIAL DATA REPORTS
- ✓ SECTION 2: MANUFACTURING DRAWINGS AND/OR SPECIFICATIONS (if required)
- ✓ SECTION 3: DESIGN CALCULATIONS
- ✓ SECTION 4: MATERIAL TEST REPORTS AND/OR MATERIAL CERTIFICATIONS
- ✓ SECTION 5: NDE REPORTS
- ✓ SECTION 6: PROCESS CONTROL SHEETS (TRAVELERS)
- ✓ SECTION 7: HYDROSTATIC / PRESSURE TEST RECORDS
- ✓ SECTION 8: NAMEPLATE FASCIMILE
- ✓ SECTION 9: PAINT REPORT



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165053

SECTION 1

**MANUFACTURER'S DATA REPORTS AND/OR MANUFACTURERS
PARTIAL DATA REPORTS**

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS

(Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only)

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

1. Manufactured and certified by **KMI Fabricators, Inc., 410 Boyd Road, Mineral Wells, Texas, 76067**

(Name and address of Manufacturer)

2. Manufactured for **UOP RUSSELL LLC/ c/o HONEYWELL INTERNATIONAL, PO Box 981762, EL PASO, Texas, 79998 - 1762**

(Name and address of Purchaser)

3. Location of Installation **UNKNOWN**

(Name and address)

4. Type **VERTICAL** **165053** **N/A** **165053-V REV. 1** **6566** **2017**
 (Horizontal or vertical, tank) (Manufacturer's serial number) (CRN) (Drawing number) (National Board number) (Year built)

5. ASME Code, Section VIII, Division 1 **2015/ N/A** **N/A** **N/A**
 (Edition and Addenda, if applicable (date)) (Code Case numbers) (Special service per UG-120(d))

6. Shell: **SA-106-C** **0.812"** **0.0625"** **20" (OD)** **84"**
 (Material spec. number, grade) (Nominal thickness) (Corr. allow.) (Inner diameter) (Length (overall))

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
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

7. Seams: **TYPE S** **NONE** **100** **N/A** **N/A** **TYPE 1** **FULL** **100** **1**
 (Long, (welded, dbl., singl., lap, butt)) (R.T. (spot or full)) (Eff., %) (H.T. temp) (Time, hr) (Girth, (welded, dbl., singl., lap, butt)) (R.T. (spot or full)) (Eff., %) (No. of courses)

8. Heads: (a) Material **SA-350-LF2 C1** (b) Material **SA-516-70N**
 (Spec. no., grade) (Spec. no., grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	TOP	0.812"	0.0625"	N/A	N/A	N/A	N/A	N/A	18.376"	N/A
(b)	BOTTOM	0.6875"	0.0625"	N/A	N/A	2:1	N/A	N/A	N/A	CONCAVE

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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A

9. MAWP **1100 psi** **N/A** at max. temp. **150 °F** **N/A**
 (Internal) (External) (Internal) (External)
 Min. design metal temp. **-20 °F** at **1100 psi** Hydro, pneu., or comb. test pressure **HYDRO at 1430 psi**

Proof test **N/A**

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
INLET	1	8"	600# RFLWN		SA-105N	1.375"	0.0625"	INTEGRAL		WELDED	SHELL
GAS OUTLET	1	8"	600# RFLWN		SA-105N	1.375"	0.0625"	INTEGRAL		WELDED	SHELL
DRAIN (SUMP)	1	1"	COUP-O-LET	SA-105		6000#	0.0625"	INTEGRAL	WELDED		BOTTOM HEAD
DRAIN (COALESCER)	1	1"	COUP-O-LET	SA-105		6000#	0.0625"	INTEGRAL	WELDED		SHELL
VENT	1	3/4"	COUP-O-LET	SA-105		6000#	0.0625"	INTEGRAL	WELDED		SHELL
DPI	2	1/2"	COUP-O-LET	SA-105		6000#	0.0625"	INTEGRAL	WELDED		SHELL

Additional Nozzles - See Attached U-4...

11. Supports: Skirt **YES** Lugs **N/A** Legs **N/A** Other **PLATE/ SA-516-70N** Attached **WELDED/BOTTOM HEAD**
 (Yes or no) (Number) (Number) (Describe) (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors, have been furnished for the following items of the report:

**20" CLOSURE, NATIONAL OILWELL VARCO
 TOMBALL, TEXAS
 S/N: ZH551
 "U" STAMP 10052**

(Name of part, item number, Manufacturer's name and identifying stamp)

**MATERIAL IS EXEMPTED FROM IMPACT TESTING; MDMT: BASED ON USC66 (a). DESIGNED TO UG-22 (a) ONLY.
 CUSTOMER PO#4500749401 - TAG#F-446; PROJECT#J445XX 1100 PSIG MOL SIEVE DUST FILTER (INTERSEP)C**

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 15097

expires May 3, 2018

Date 02/13/2017

Co. name

KMI Fabricators, Inc.

(Manufacturer)

Signed

Karen Barnes
Representative

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by KMI Fabricators, Inc. at 410 Boyd Road, Mineral Wells, Texas, 76067

I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and employed by OneCIS Insurance Company, of Lynn, MA

have inspected the component described in this Manufacturer's Data Report on February 15, 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 02/15/2017

Signed

[Signature]
(Authorized Inspector)

Commissions

12125, TX1368

(National Board (incl. endorsements))

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 KMI Fabricators, Inc., 410 Boyd Road, Mineral Wells, Texas, 76067
(Name and address of Manufacturer)

2. Manufactured for UOP RUSSELL LLC/ c/o HONEYWELL INTERNATIONAL, PO Box 981762, EL PASO, Texas, 79998 - 1762
(Name and address of Purchaser)

3. Location of installation UNKNOWN
(Name and address)

4. Type VERTICAL N/A 165053
(Horizontal, vertical, or sphere) (Tank, separator, heat exch., etc.) (Manufacturer's serial number)

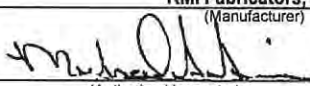
N/A 165053-V REV. 1 6566 2017
(CRN) (Drawing number) (National Board number) (Year built)

Data Report
Item Number _____ Remarks _____

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	
PI	1	1/2"	COUP-O-LET	SA-105		6000#	0.0625"	INTEGRAL	WELDED		SHELL

Certificate of Authorization: Type "U" No. 15097 Expires May 3, 2018

Date 02/13/2017 Name KMI Fabricators, Inc.
(Manufacturer)

Date 02/15/2017 Name  Commissions: 12125, TX1368
(Authorized Inspector) [National Board (incl. endorsements)]

Signed 
(Representative)

SO No 1531971-2

PO No 10350

FORM U-2A MANUFACTURER'S PARTIAL DATA REPORT (ALTERNATE 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 NATIONAL OILWELL VARCO 10906 FM 2920 TOMBALL, TEXAS 77375
(Name and address of Manufacturer)2. Manufactured for KMI FABRICATORS INC. 410 BOYD ROAD MINERAL WELLS, TX 76067
(Name and address of Purchaser)3. Location of Installation UNKNOWN
(Name and address)4. Type: (2) 20" CLOSURES ZH550 THRU ZH551 N/A
(Description of vessel part (shell, two-piece head, tube bundle)) (Mfg.'s Serial No.) (CRN)
N/A 1531971-2R1 NATIONAL OILWELL VARCO 2017
(National Board Number) (Drawing Number) (Drawing prepared by) (Year Built)5. ASME Code, Section VIII, Div. 1 2015 EDITION N/A N/A
(Edition and Addenda (Date)) (Code Case No.) (Special service per UG-120(d))6. Shell (a) No. of course(s) 1 (b) Overall length (ft. and in.): 1-00.

Course(s)			Material		Thickness, in.		Long Joint (Cat. A)			Circum. Joint (Cat. A, B, & C)			Heat Treatment	
No.	Diameter, in	Length, ft+in	Spec./Grade or Type		Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp., F	Time
1	18.376	1-00.	SA 350 LF2		0.812	0.063	S	NONE	1	S	NONE	1	N/A	N/A
			CLASS 1											

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	
N/A													

7. Heads: (a) SA 516-70 N (b) N/A										(Mat'l Spec. no., Grade or Type)(H.T. - Time and Temp.)				
	Location (Top, Bottom Ends)	Thickness, in.		Radius, in.		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None.	Eff.
(a)	TOP	0.673	0.063	----	----	2:1	----	----	----		X	S	NONE	1
(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)	N/A												

8. MAWP 1100 PSI @ max temp. = 150 °F. Min Design Metal Temp -20 °F at 1100 PSI
internal external internal external9. Impact test Yes - CAP, HUB, & FITTING At a test temp of -51 & -50 & -50 °F
(Indicate yes or no and the component(s) impact tested)10. Hydro., pneu., or comb. Test pressure SEE REMARKS Proof Test: N/A11. Nozzles, inspection, and safety valve openings: UG-125(a) At PSIG

Purpose (Inlet, Outlet, Drain, etc.)	No.	Dia. or Size, in.	Flange Type	Material		Nozzle Thickness, in		Reinforcement Material	How Attached		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
SEE REMARKS											
OUTLET	1	1/2" NPT	TH'D	SA 350 LF2 CL1		0.500	0.063	INHERENT	*WELDED		HEAD
PAV	1	1/2" NPT	TH'D	SA 350 LF2 CL1		N/A	N/A	INHERENT	INT THD		SHELL

12. Identification of part(s)

Name of Part	Qty.	Line No.	Mfg's. Identification No.	Mfg's. Dwg No.	CRN	National Board No.	Year
N/A							

13. Supports: Skirt --- Lugs --- Legs --- Others --- Attached ---
(Yes or No) (Number) (Number) (Describe) (Where and How)

14. Remarks: THIS TEMPERATURE APPLICABLE TO CLOSURE METAL COMPONENTS ONLY. ACTUAL SERVICE TEMPERATURE IS DETERMINED BY TEMPERATURE LIMITATIONS OF O-RING MATERIAL. UG-120,c,2 DESIGN & CALCULATION BY NATIONAL OILWELL VARCO. CLOSURE ASSEMBLY IS NOT HYDROSTATICALLY TESTED, PRESSURE ALERT VALVE FURNISHED. *Fig. UW-16.1(x-2).

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. 10052 Expires: July 16, 2017

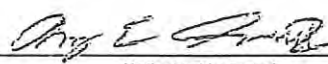
Date: 01/22/17 Name: NATIONAL OILWELL VARCO

Signed: 
(Representative)

(Manufacturer)

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 The Hartford Steam Boiler Inspection and Insurance Company of CONNECTICUT have inspected the pressure vessel part described in this Manufacturer's Data Report on 01-20, 2017, 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: 01/24/2017 Signed: 
(Authorized Inspector)

Commissions: NB 14870A/LS
(National Board (incl. endorsements))



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165053

SECTION 2

MANUFACTURING DRAWINGS AND/OR SPECIFICATIONS (if required)



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

SPECIFICATION DATA SHEET

(MECHANICAL DESIGN/FABRICATION/INSPECTION/TESTING DATA)

KMI Project No:	Quote No.: Q160140R1
Equip. Description:	Vertical INTERSEP 20" O.D. x 7'-0" sm-sm @ 1100 psig
Model No.:	GE1307L025V
KMI SERIAL NO'S.:	165052 & 165053
Quantity:	2
Tag Number:	F-445 & F-446
Purchaser:	UOP Russell LLC
Purchaser P.O. No.:	4500749401
End User:	Unknown (Not Stated)
Project:	J447XX
Destination:	1401 RUSSELL WAREHOUSE

CUSTOMER SUPPLIED SPECIFICATIONS:

ASME Section VIII, Div 1

Notes:

- 1) Use HUR Painting System 3
- 2) Include initial set of elements in base cost
- 3) Include extra set of elements and spare gasket as an added cost
- 4) Vendor to provide the following fabrication drawings:
 - Two (2) electronic copies "For Approval"
 - Two (2) electronic copies Certified AFC
 - Four (4) Final Hard Copies of As-Built Job Data Book Documentation and (1) CD with all documents available in electronic format
- 5) Vendor to submit weld procedures to UOP Russell for approval prior to start of fabrication
- 6) Provide two (2) carbon steel lifting lugs
- 7) External nozzle projections shall be per UOP Russell Standard 13j
- 8) Vendor shall provide zinc or cadmium plated bolts when design temperature is 650F or less. Bolts shall be black (non-plated) for design temperatures above 650F
- 9) American Piping for Material
- 10) Spare elements for each vessel.
- 11) Spare O-rings for each vessel.

REVISION HISTORY

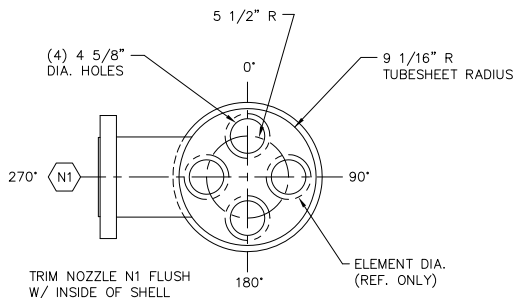
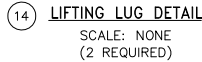
REV	DATE	BY	DESCRIPTION OF CHANGE
0	12/5/2016	MDB	PER PURCHASE ORDER
1			
2			

PROJECT: J447XX	TAG#: F-445 & F-446	CUST. PO#: 4500749401
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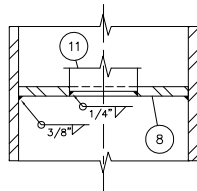
MECHANICAL DESIGN DATA/CONDITIONS					
DESIGN PRESSURE, PSIG:	1,100	DESIGN CODE:	ASME SEC VIII Div. 1		
DESIGN TEMPERATURE, °F:	150				
CORROSION ALLOWANCE:	0.0625	WIND:	ASCE 7-10 (120mph, Exp. C, Cat. III)		
MDMT, °F:	-20	SEISMIC:	ASCE 7-10 (Site D, I=1.25, Ss=100%, S1=40%)		
CONNECTIONS/OPENINGS					
SERVICE	MARK	QTY.	SIZE (NPS)	TYPE	FLG/CPLG RATING
INLET	N1	1	8"	RF FLG	ANSI 600#
OUTLET	N2	1	8"	RF FLG	ANSI 600#
DRAIN (SUMP)	C1	1	1"	NPT	6000#
DRAIN (COALESCER)	C2	1	1"	NPT	6000#
VENT	C3	1	3/4"	NPT	6000#
DPI	C4A-B	2	1/2"	NPT	6000#
PI	C5	1	1/2"	NPT	6000#
FLANGE FINISH:					
MATERIALS					
COMPONENT	PRESSURE PART	NON-PRESSURE ATTACHMENT MATERIALS			
FORGINGS	SA-105 N	LIFT LUG: 2 - KMI STANDARDS			
PLATE	SA-516-70	NAME PLATE BRACKET: SA-992 Beam Material			
PIPE	SA-106 B/C				
FLANGES	SA-105				
FITTINGS	SA-234 WPB				
STUDS	SA-193 B7 Cad. Plt.				
NUTS	SA-194 2H Cad. Plt.				
GASKETS	PTFE				
RESTRICTION ON ORIGIN OF MATERIALS: Domestic, Western Europe, Etc.					
MATERIAL TEST REPORTS (MTR'S) REQUIREMENTS:					
IMPACT TESTING REQUIRED: Not Required					
MATERIALS OF CONSTRUCTION - VESSEL INTERNALS					
PENTAIR Element Support Riser		ELEMENT Part No.: GE1307L025V			
CLOSURE TYPE					
TYPE: YALE Fig 500 Threaded quick opening closure w/ davit					
O-RING: BUNA-N		O-RING Part No.: H70012			
MISCELLANEOUS ATTACHMENTS					
DESCRIPTION	MATERIAL				
NAMEPLATE:	316 SS (Standard KMI)				
SKIRT / BASEPLATE:	SA-53 B ERW Welded Pipe / SA-516-70				
HINGE PLATE:	Not Applicable				

PROJECT: J447XX	TAG#: F-445 & F-446	CUST. PO#: 4500749401
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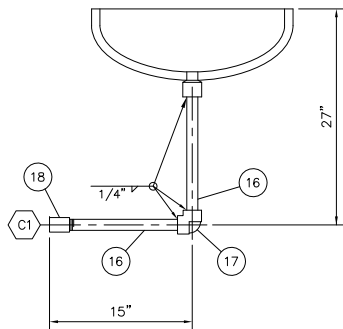
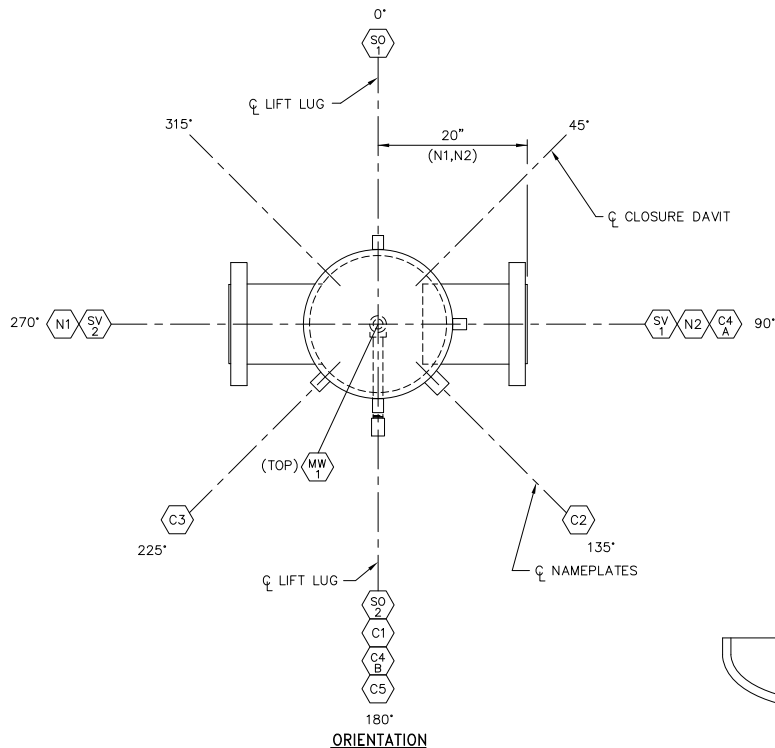
INSPECTION AND TESTING/NDE			
VISUAL EXAMINATION (VT): Per Code			
RADIOGRAPHIC TESTING (RT): RT-2 per ASME Code			
ULTRASONIC TESTING (UT): None			
MAGNETIC PARTICLE TESTING (MT): None			
LIQUID PENETRANT TESTING (PT): None			
HARDNESS TESTING (HDT): None			
PRODUCTION WELD IMPACT TESTING: None			
POST WELD HEAT TREATMENT: None			
HYDROSTATIC TEST (HYT): 1.3 X MAWP			
PNEUMATIC TEST (PNT) OF WEAR PAD: None			
WPS/PQR APPROVAL REQUIRED:		WELD MAPS REQUIRED: No	
NATIONAL BOARD NO.: Yes			
INSPECTION BY:		CUSTOMER:	
INSPECTION AND TESTING NOTES			
MT: None HARDNESS: None HYDRO: 1.3 X MAWP CUSTOMER:			
SURFACE PREPARATION			
INTERNAL: None		EXTERNAL: SSPC-SP 6 Commercial Blast	
EXTERNAL COATINGS REQUIREMENTS (MFR. OF COATINGS:)			
COAT	DESCRIPTION	DFT (MILS)	COLOR
PRIMER	Sherwin Williams Macropoxy 646 (B58-600)	4-6	Not Stated
INTERMEDIATE	Sherwin Williams Macropoxy 646 (B58-600)	4-6	Not Stated
TOPCOAT	Sherwin Williams Hi-Solids Polyurethan B65 Series/B60V30	3-4	*
NOTES: Total System: DFT 12-16 mils VOC's per 1000 sq. ft. = 28 lbs * TOP COAT IS SHERWIN WILLIAMS STRUCTURAL GRAY", SW4031			
INTERNAL COATING			
None			
SHIPPING INFORMATION			
EST. EMPTY WT.: 3374 lbs.		EST. TEST WT.: 4306 lbs.	
EST. OPERATING WT.: 4306 lbs.			
FLANGE PROTECTORS:			
THREADED OPENINGS:			
QA NOTES			
NO. OF COPIES OF FINAL DATA:			
NOTES:			



8 TUBESHEET LAYOUT
SCALE: NONE



TUBESHEET
SCALE: NONE

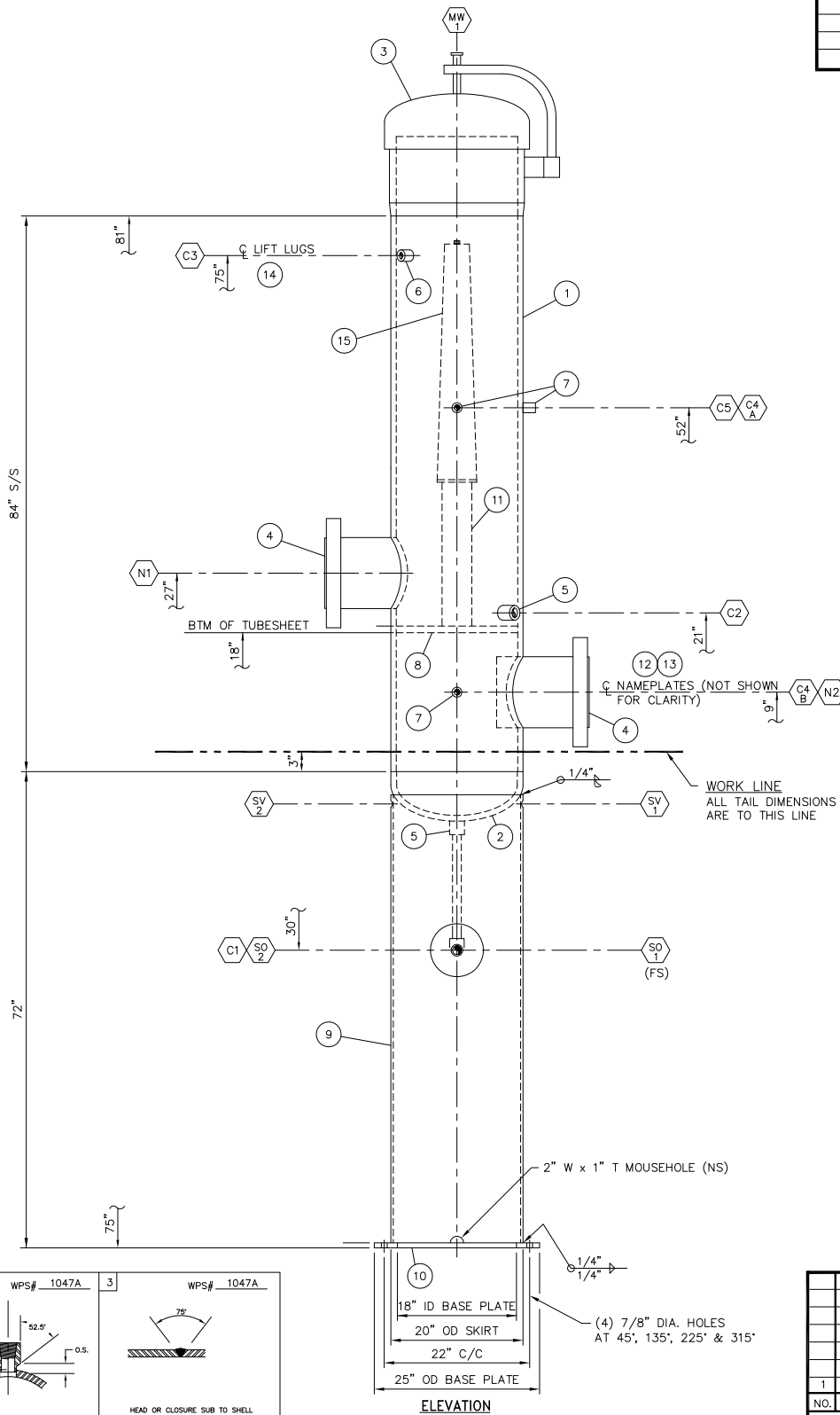
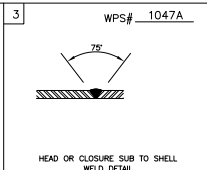
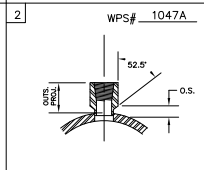
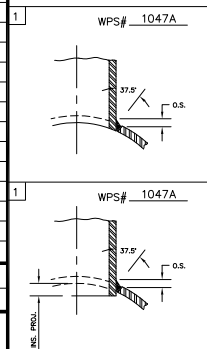


C1 DRAIN DETAIL
SCALE: NONE

THIS DRAWING IS THE PROPERTY OF KMI FABRICATORS, INC. IN CONSIDERATION OF THE USE OF THIS DRAWING, USER AGREES THAT IT SHALL BE TREATED AS CONFIDENTIAL MATERIAL, THAT IT SHALL BE RETURNED UPON REQUEST, & THAT THE CONTENTS THEREOF SHALL NOT BE DISCLOSED, REPRODUCED, COPIED OR OTHERWISE DISPOSED OF DIRECTLY OR INDIRECTLY, NOR SHALL IT BE LOANED, REPRODUCED, COPIED, OR OTHERWISE USED, IF IT IS SPECIFICALLY FURNISHED, EXCEPT BY WRITTEN PERMISSION OF KMI FABRICATORS, INC.

ITEM	QTY.	SIZE & RATING , TYPE	DESCRIPTION	OUTS.	INS.	WELD DETAIL	O.S.	I.S.	
				PROJECTION		DWG. NO.	WELD SIZE		

SCHEDULE OF OPENINGS



ITEM	QTY REQ'D		DESCRIPTION	MATERIAL	M R
1	1		SHELL, PIPE, 20" SCH 60 (0.812" NOM) SMLS x 84" LG	SA-106-C	
2	1		HEAD, 20" OD x 3/4" NOM, 2:1 ELLIP. W/ 2" S.F. (HOT FORMED)	SA-516-70 N	
3	1		CLOSURE, 20" OD 600# ANSI FIG. 500 R & M VERTICAL W/ DAVIT	CS	
4	2		FLANGE, 8" 600# RFLWN x 14" LG.	SA-105 N	
5	2		COUP-O-LET, 1" 6000#	SA-105	
6	1		COUP-O-LET, 3/4" 6000#	SA-105	
7	3		COUP-O-LET, 1/2" 6000#	SA-105	
8	1		PLATE, (TUBESHEET) 18 1/8" OD x 1" THK (SEE DETAIL)	SA-516-70-N	
9	1		SKIRT, PIPE, 20" SCH 20 (.375" NOM) X 69" LG (TRIM TO FIT)	SA-53-B/106-B	
10	1		PLATE (BASE) 25" OD x 18" ID x 3/4" THK	SA-516-70-N	
11	4		RISER, PART NO. GA5536P422CS x 22" LG. (BY PENTAIR)		
12	1		NAME PLATE BRACKET, T-BEAM STYLE x 10 1/2" LG.	SA-36	
13	2		NAME PLATE, ASME CODE (KMI & PENTAIR)	SS	
14	2		LIFTING LUGS, PHOENIX SERIES 2-899-MLL	A105	
15	4		CARTRIDGE, PART NO. GE1307L025V (BY PENTAIR)		
16	1		PIPE, DRAIN, 1" SCH 160 SMLS (CUT TO FIT)	SA-106-B	
17	1		ELBOW, 1" 3000# 90° SOCKETWELD	SA-105	
18	1		COUPLING, FULL, 1" 3000# THREADED	SA-105	

SEE KMI DATA SHEETS FOR NOTES

RELEASED FOR	DATE	BY	CHK
APPROVAL	12/6/16	MDB	
FABRICATION	1/16/17	MDB	
FINAL (AS BUILT)	2/16/17	MDB	

IV. DATA PLATE INFORMATION

InterSep[®] ID No.

H08

Replacement Element No.

L025V



CERTIFIED BY



KMI FABRICATORS, INC.
410 BOYD RD.
MINERAL WELLS, TX 76067



1100 PSI AT 150°F
MAWP
-20°F AT 1100 PSI
MDMT

RT-2

SERIAL NO. 165053
YR. BLT. 2017

CORR. AL
EVT PRES

ALLOWANCE .0625"

MOL S

SIEVE DUST

FILTER
TAG: F

-446

REVISIONS

SPECIFICATIONS				
I. GENERAL				
1. VESSEL TO BE CONSTRUCTED AND STAMPED PER A.S.M.E. CODE SECTION VIII, DIVISION 1. — 2015				
2. ADDENDA <u> NONE </u>				
3. JOINT EFFICIENCY (SHELL) <u> 100 </u> %				
4. JOINT EFFICIENCY (HEAD) <u> 100 </u> %				
5. DIMENSIONAL TOLERANCES $\pm 1/8$ INCH UNLESS OTHERWISE NOTED				
6. FLANGE AND ANCHOR BOLTS TO STRADDLE VESSEL CENTERLINES.				
II. NON DESTRUCTIVE TESTING				
1. RADIOGRAPH <u> RT-2 (SEE KMI DATA SHEETS) </u>				
2. ULTRASONIC <u> NONE </u>				
3. MAGNETIC PARTICLE <u> NONE </u>				
4. DYE PENETRANT <u> NONE </u>				
5. STRESS RELIEVE <u> NONE </u>				
III. DESIGN				
1. DESIGN PRESS. <u>1100</u> PSIG AT <u>150</u> °F.				
2. HYDROSTATIC TEST AT <u>1430</u> PSIG.				
3. CORROSION ALLOWANCE <u>0.0625</u> INCHES.				
KMI FABRICATORS, INC. 410 BOYD RD. MINERAL WELLS, TX 76067 PHONE: (800) 325-7841 FAX: (940) 325-3765 EMAIL: kmi@kmifab.com Web Site: www.kmifab.com				
CUSTOMER: UOP RUSSELL LLC P.O. NO.: 4500749401 NO. REQ'D: ONE (1) SERIAL NO's: 165053 EMPTY WT.: 3,374 LBS				
DESCRIPTION: 20" OD x 7'-0" S/S x 1100 PSIG MOL SIEVE DUST FILTER (INTERSEP)				
TAG: F-446 JOB NO.: J447XX				
Drawn MDB Checked	Date 12/6/16 Scale 1"=1'-0"	Drawing Number 165053-V		
				Rev. 1



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165053

SECTION 3
DESIGN CALCULATIONS

KMI Fabricators, Inc.

410 Boyd Road

Mineral Wells, Texas 76067

Phone: 940-325-7841

Revision 0

COMPRESS Pressure Vessel Design Calculations

Item: 20" Mol Sieve Dust Filter

Vessel No: F-446

Customer: UOP Russell LLC

P.O. No.: 4500749401

Designer: Mark Berry

Date: December 6, 2016

KMI Serial No. 165053

UOP Job No.: J447XX

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<u>Drain (Coalescer) (C2)</u>	50
<u>Vent (C3)</u>	53
<u>DPI (C4A)</u>	56
<u>DPI (C4B)</u>	59
<u>PI (C5)</u>	62

Deficiencies Summary

No deficiencies found.

Nozzle Summary

Dimensions												
Nozzle mark	OD (in)	t _n (in)	Req t _n (in)	A ₁ ?	A ₂ ?	Shell			Reinforcement Pad		Corr (in)	A _a /A _r (%)
						Nom t (in)	Design t (in)	User t (in)	Width (in)	t _{pad} (in)		
C1	2.25	0.4675	0.125	Yes	Yes	0.6875*	N/A		N/A	N/A	0.0625	Exempt
C2	2.25	0.4675	0.125	Yes	Yes	0.812	N/A		N/A	N/A	0.0625	Exempt
C3	1.75	0.35	0.125	Yes	Yes	0.812	N/A		N/A	N/A	0.0625	Exempt
C4A	1.5	0.33	0.125	Yes	Yes	0.812	N/A		N/A	N/A	0.0625	Exempt
C4B	1.5	0.33	0.125	Yes	Yes	0.812	N/A		N/A	N/A	0.0625	Exempt
C5	1.5	0.33	0.125	Yes	Yes	0.812	N/A		N/A	N/A	0.0625	Exempt
N1	10.75	1.375	0.3819	Yes	Yes	0.812	0.6018		N/A	N/A	0.0625	103.3
N2	10.75	1.375	0.3819	Yes	Yes	0.812	0.6021		N/A	N/A	0.0625	103.2
*Head minimum thickness after forming												

Definitions	
t _n	Nozzle thickness
Req t _n	Nozzle thickness required per UG-45/UG-16
Nom t	Vessel wall thickness
Design t	Required vessel wall thickness due to pressure + corrosion allowance per UG-37
User t	Local vessel wall thickness (near opening)
A _a	Area available per UG-37, governing condition
A _r	Area required per UG-37, governing condition
Corr	Corrosion allowance on nozzle wall

Nozzle Schedule

Specifications									
Nozzle mark	Identifier	Size	Materials		Impact Tested	Normalized	Fine Grain	Flange	Blind
C1	Drain (Sump)	NPS 1 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
	Nozzle Pipe (C1)	NPS 1 Sch 160	Nozzle Piping	SA-106 B Smls pipe	No	No	No	N/A	No
C2	Drain (Coalescer)	NPS 1 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C3	Vent	NPS 0.75 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C4A	DPI	NPS 0.5 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C4B	DPI	NPS 0.5 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C5	PI	NPS 0.5 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
N1	Inlet	10.75 OD x 1.375	Nozzle	SA-105	No	Yes	Yes	NPS 8 Class 600 LWN A105 N	No
N2	Outlet	10.75 OD x 1.375	Nozzle	SA-105	No	Yes	Yes	NPS 8 Class 600 LWN A105 N	No

Pressure Summary

Component Summary									
Identifier	P Design (psi)	T Design (°F)	MAWP (psi)	MAP (psi)	MAEP (psi)	T _e external (°F)	MDMT (°F)	MDMT Exemption	Impact Tested
Closure	1,100	150	1,336.01	1,465.69	633.25	150	-55	Note 1	No
Straight Flange on Closure	1,100	150	1,413.64	1,546.39	653.49	150	-55	Note 2	No
Shell	1,100	150	1,327.21	1,462.57	599.26	150	-20	Note 3	No
Straight Flange on Bottom Head	1,100	150	1,410.53	1,546.39	653.49	150	-55	Note 5	No
Bottom Head	1,100	150	1,332.67	1,465.69	633.25	150	-55	Note 4	No
Drain (Sump) (C1)	1,100	150	1,434.85	1,575.94	633.25	150	-155	Note 6	No
Nozzle Pipe (C1)	1,100	150	N/I	N/I	N/I	150	N/I	N/A	No
Drain (Coalescer) (C2)	1,100	150	1,328.06	1,462.57	599.26	150	-155	Note 7	No
Vent (C3)	1,100	150	1,330.02	1,462.57	599.26	150	-155	Note 8	No
DPI (C4A)	1,100	150	1,329.18	1,462.57	599.26	150	-155	Note 9	No
DPI (C4B)	1,100	150	1,327.63	1,462.57	599.26	150	-155	Note 10	No
PI (C5)	1,100	150	1,329.18	1,462.57	599.26	150	-155	Note 9	No
Inlet (N1)	1,100	150	1,117.02	1,253.65	599.26	150	-44.4	Note 11	No
Outlet (N2)	1,100	150	1,116.37	1,253.65	599.26	150	-44.4	Note 12	No

Chamber Summary	
Design MDMT	-20 °F
Rated MDMT	-20 °F @ 1,116.37 psi
MAWP hot & corroded	1,116.37 psi @ 150 °F
MAP cold & new	1,253.65 psi @ 60 °F
MAEP	599.26 psi @ 150 °F

Notes for MDMT Rating		
Note #	Exemption	Details
1.	Straight Flange governs MDMT	
2.	Material impact test exemption temperature from Fig UCS-66 Curve D = -43.9°F Fig UCS-66.1 MDMT reduction = 20.6°F, (coincident ratio = 0.7943) Rated MDMT of -64.5°F is limited to -55°F by UCS-66(b)(2)	UCS-66 governing thickness = 0.7105 in
3.	Material is impact test exempt per UG-20(f)	UCS-66 governing thickness = 0.7105 in
4.	Straight Flange governs MDMT	
5.	Material impact test exemption temperature from Fig UCS-66 Curve D = -43.9°F Fig UCS-66.1 MDMT reduction = 20.3°F, (coincident ratio = 0.7965) Rated MDMT of -64.2°F is limited to -55°F by UCS-66(b)(2)	UCS-66 governing thickness = 0.7105 in
6.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.103).	
7.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1029).	
8.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1181).	
9.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1043).	
10.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1045).	
11.	LWN rated MDMT per UCS-66(c)(4) Flange rated MDMT per UCS-66(b)(1)(b) = -44.4°F (Coincident ratio = 0.7558) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	
12.	LWN rated MDMT per UCS-66(c)(4) Flange rated MDMT per UCS-66(b)(1)(b) = -44.4°F (Coincident ratio = 0.7562) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

Radiography Summary

UG-116 Radiography							
Component	Longitudinal Seam		Top Circumferential Seam		Bottom Circumferential Seam		Mark
	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	
Closure	N/A	Seamless No RT	N/A	N/A	B	Spot UW-11(a)(5)(b) / Type 1	RT2
Shell	N/A	Seamless No RT	B	Spot UW-11(a)(5)(b) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	RT2
Bottom Head	N/A	Seamless No RT	B	Spot UW-11(a)(5)(b) / Type 1	N/A	N/A	RT2
Nozzle	Longitudinal Seam		Nozzle to Vessel Circumferential Seam		Nozzle free end Circumferential Seam		
Inlet (N1)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
Outlet (N2)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
Drain (Coalescer) (C2)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
Vent (C3)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
DPI (C4A)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
DPI (C4B)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
PI (C5)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
Drain (Sump) (C1)	N/A	Seamless No RT	D	N/A / Type 7	B	UW-11(a)(4) exempt / Type 1	N/A
Nozzle Flange	Longitudinal Seam		Flange Face		Nozzle to Flange Circumferential Seam		
ASME B16.5/16.47 flange attached to Inlet (N1)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
ASME B16.5/16.47 flange attached to Outlet (N2)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
UG-116(e) Required Marking: RT2							

Weight Summary

Weight (lb) Contributed by Vessel Elements										
Component	Metal New*	Metal Corroded	Insulation	Insulation Supports	Lining	Piping + Liquid	Operating Liquid		Test Liquid	
							New	Corroded	New	Corroded
Closure	110.8	101.6	0	0	0	0	49.9	51	49.9	51
Shell	1,119.2	1,036.5	0	0	0	0	831.9	843.9	831.9	843.9
Bottom Head	110	100.9	0	0	0	0	50.4	51.6	50.4	51.6
Skirt	444.1	444.1	0	0	0	0	0	0	0	0
Base Plate	50	50	0	0	0	0	0	0	0	0
TOTAL:	1,834.2	1,733.2	0	0	0	0	932.2	946.5	932.2	946.5
*Shells with attached nozzles have weight reduced by material cut out for opening.										

Weight (lb) Contributed by Attachments										
Component	Body Flanges		Nozzles & Flanges		Packed Beds	Ladders & Platforms	Trays	Tray Supports	Rings & Clips	Vertical Loads
	New	Corroded	New	Corroded						
Closure	0	0	0	0	0	0	0	0	0	952
Shell	0	0	473.2	462.2	0	0	0	0	0	89
Bottom Head	0	0	5.6	4.7	0	0	0	0	0	0
Skirt	0	0	0	0	0	0	0	0	0	20
TOTAL:	0	0	478.8	466.8	0	0	0	0	0	1,061

Vessel Totals		
	New	Corroded
Operating Weight (lb)	4,306	4,207
Empty Weight (lb)	3,374	3,261
Test Weight (lb)	4,306	4,207
Capacity** (US gal)	108	110
**The vessel capacity does not include volume of nozzle, piping or other attachments.		

Vessel Lift Condition	
Vessel Lift Weight, New (lb)	3,374
Center of Gravity from Datum (in)	37.9164

Settings Summary

COMPRESS 2016 Build 7600	
ASME Section VIII Division 1, 2015 Edition	
Units	U.S. Customary
Datum Line Location	3.00" from bottom seam
Vessel Design Mode	Get Thickness from Pressure
Minimum thickness	0.0625" per UG-16(b)
Design for cold shut down only	No
Design for lethal service (full radiography required)	No
Design nozzles for	Design P only
Corrosion weight loss	100% of theoretical loss
UG-23 Stress Increase	1.20
Skirt/legs stress increase	1.0
Minimum nozzle projection	1"
Juncture calculations for $\alpha > 30$ only	No
Preheat P-No 1 Materials $> 1.25"$ and $\leq 1.50"$ thick	Yes
UG-37(a) shell tr calculation considers longitudinal stress	No
Cylindrical shells made from pipe are entered as minimum thickness	No
Nozzles made from pipe are entered as minimum thickness	No
ASME B16.9 fittings are entered as minimum thickness	No
Butt welds	Tapered per Figure UCS-66.3(a)
Disallow Appendix 1-5, 1-8 calculations under 15 psi	No
Hydro/Pneumatic Test	
Shop Hydrotest at user defined pressure	1,430 psi
Test liquid specific gravity	1.00
Maximum stress during test	90% of yield
Required Marking - UG-116	
UG-116(e) Radiography	RT2
UG-116(f) Postweld heat treatment	None
Code Cases/Interpretations	
Use Code Case 2547	No
Use Code Case 2695	No
Apply interpretation VIII-1-83-66	No
Apply interpretation VIII-1-86-175	Yes

Apply interpretation VIII-1-01-37	Yes
Apply interpretation VIII-1-01-150	No
Apply interpretation VIII-1-07-50	No
No UCS-66.1 MDMT reduction	No
No UCS-68(c) MDMT reduction	No
Disallow UG-20(f) exemptions	No
UG-22 Loadings	
UG-22(a) Internal or External Design Pressure	Yes
UG-22(b) Weight of the vessel and normal contents under operating or test conditions	Yes
UG-22(c) Superimposed static reactions from weight of attached equipment (external loads)	Yes
UG-22(d)(2) Vessel supports such as lugs, rings, skirts, saddles and legs	Yes
UG-22(f) Wind reactions	Yes
UG-22(f) Seismic reactions	Yes
UG-22(j) Test pressure and coincident static head acting during the test:	Yes
Note: UG-22(b),(c) and (f) loads only considered when supports are present.	

License Information	
Company Name	KMI Fabricators
License	Commercial
License Key ID	31538
Support Expires	May 12, 2017

Test Report

Vertical shop test based on user defined pressure

Gauge pressure at 60°F = 1,430 psi

Vertical shop test					
Identifier	Local test pressure (psi)	Test liquid static head (psi)	Stress during test (psi)	Allowable test stress (psi)	Stress excessive?
Closure	1,430.24	0.24	17,436	34,200	No
Straight Flange on Closure	1,430.24	0.24	18,345	34,200	No
Shell	1,433.272	3.272	19,242	36,000	No
Straight Flange on Bottom Head	1,433.345	3.345	18,385	34,200	No
Bottom Head	1,433.513	3.513	17,476	34,200	No
DPI (C4A)	1,431.302	1.302	19,286	54,000	No
DPI (C4B)	1,432.854	2.854	19,307	54,000	No
Drain (Coalescer) (C2)	1,432.43	2.43	19,711	54,000	No
Drain (Sump) (C1)	1,433.615	3.615	18,546	51,300	No
Inlet (N1)	1,432.334	2.334	21,617	54,000	No
Outlet (N2)	1,432.984	2.984	21,627	54,000	No
PI (C5)	1,431.302	1.302	19,286	54,000	No
Vent (C3)	1,430.476	0.476	19,763	54,000	No
(1) P_L stresses at nozzle openings have been estimated using the method described in PVP-Vol. 399, pages 77-82. (2) $1.5 \times 0.9 \times S_y$ used as the basis for the maximum local primary membrane stress at the nozzle intersection P_L .					

The field test condition has not been investigated.

The test temperature of 60 °F is warmer than the minimum recommended temperature of 10 °F so the brittle fracture provision of UG-99(h) has been met.

Thickness Summary

Component Data								
Component Identifier	Material	Diameter (in)	Length (in)	Nominal t (in)	Design t (in)	Total Corrosion (in)	Joint E	Load
Closure	SA-516 70	20 OD	5.3438	0.6875*	0.5823	0.0625	1.00	Internal
Straight Flange on Closure	SA-516 70	20 OD	2	0.75	0.6008	0.0625	1.00	Internal
Shell	SA-106 C Smls pipe	20 OD	84	0.812	0.6023	0.0625	1.00	Internal
Straight Flange on Bottom Head	SA-516 70	20 OD	2	0.75	0.6023	0.0625	1.00	Internal
Bottom Head	SA-516 70	20 OD	5.3438	0.6875*	0.5838	0.0625	1.00	Internal
Skirt	SA-53 E/B Wld pipe	20 OD	68.63	0.375	0.0273	0	0.55	Seismic
*Head minimum thickness after forming								

Definitions	
Nominal t	Vessel wall nominal thickness
Design t	Required vessel thickness due to governing loading + corrosion
Joint E	Longitudinal seam joint efficiency
Load	
Internal	Circumferential stress due to internal pressure governs
External	External pressure governs
Wind	Combined longitudinal stress of pressure + weight + wind governs
Seismic	Combined longitudinal stress of pressure + weight + seismic governs

Wind Code

Building Code: ASCE 7-10		
Elevation of base above grade		0.00 ft
Increase effective outer diameter by		0.00 ft
Wind Force Coefficient, C_f		0.7000
Risk Category (Table 1.5-1)		III
Basic Wind Speed, V		120.00 mph
Exposure category		C
Wind Directionality Factor, K_d		0.9500
Topographic Factor, K_{zt}		1.0000
Enforce min. loading of 16 psf		Yes
Vessel Characteristics		
Height, h		13.6117 ft
Minimum Diameter, b	Operating, Corroded	1.6667 ft
	Empty, Corroded	1.6667 ft
Fundamental Frequency, n_1	Operating, Corroded	11.0240 Hz
	Empty, Corroded	12.3433 Hz
	Vacuum, Corroded	11.0240 Hz
Damping coefficient, β	Operating, Corroded	0.0249
	Empty, Corroded	0.0200
	Vacuum, Corroded	0.0249

[Table Lookup Values](#)

2.4.1 Basic Load Combinations for Allowable Stress Design	
Load combinations considered in accordance with ASCE section 2.4.1:	
5.	$D + P + P_s + 0.6W$
7.	$0.6D + P + P_s + 0.6W$
Parameter Description	
D	= Dead load
P	= Internal or external pressure load
P_s	= Static head load
W	= Wind load

Wind Deflection Reports:

[Operating, Corroded](#)

[Empty, Corroded](#)

[Vacuum, Corroded](#)

[Wind Pressure Calculations](#)

Wind Deflection Report: Operating, Corroded								
Component	Elevation of Bottom above Base (in)	Effective OD (ft)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Platform Wind Shear at Bottom (lb _f)	Total Wind Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)	Deflection at Top (in)
Closure	155.9964	1.67	29.0	*	0	10	3	0.0042
Shell	71.9964	1.67	28.8	0.1014	0	142	536	0.0039
Bottom Head (top)	68.63	1.67	29.0	*	0	147	577	0.0012
Skirt	0	1.67	29.0	0.0537	0	255	1,735	0.0011
*Moment of Inertia I varies over the length of the component								

Wind Deflection Report: Empty, Corroded								
Component	Elevation of Bottom above Base (in)	Effective OD (ft)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Platform Wind Shear at Bottom (lb _f)	Total Wind Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)	Deflection at Top (in)
Closure	155.9964	1.67	29.4	*	0	10	3	0.0041
Shell	71.9964	1.67	29.2	0.1014	0	142	536	0.0039
Bottom Head (top)	68.63	1.67	29.4	*	0	147	577	0.0012
Skirt	0	1.67	29.4	0.0537	0	255	1,735	0.0011
*Moment of Inertia I varies over the length of the component								

Wind Deflection Report: Vacuum, Corroded								
Component	Elevation of Bottom above Base (in)	Effective OD (ft)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Platform Wind Shear at Bottom (lb _f)	Total Wind Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)	Deflection at Top (in)
Closure	155.9964	1.67	29.0	*	0	10	3	0.0042
Shell	71.9964	1.67	28.8	0.1014	0	142	536	0.0039
Bottom Head (top)	68.63	1.67	29.0	*	0	147	577	0.0012
Skirt	0	1.67	29.0	0.0537	0	255	1,735	0.0011
*Moment of Inertia I varies over the length of the component								

Wind Pressure (WP) Calculations

[Gust Factor \(G_f\) Calculations](#)

$$\begin{aligned}
 K_z &= 2.01 * (Z/Z_g)^{2/\alpha} \\
 &= 2.01 * (Z/900.00)^{0.2105} \\
 q_z &= 0.00256 * K_z * K_{zt} * K_d * \underline{V}^2 \\
 &= 0.00256 * K_z * 1.0000 * 0.9500 * 120.0000^2 \\
 &= 35.0208 * K_z \\
 WP &= 0.6 * q_z * \underline{G} * \underline{C}_f \text{ (Minimum 16 lb/ft}^2\text{)} \\
 &= 0.6 * q_z * \underline{G} * 0.7000 \text{ (Minimum 16 lb/ft}^2\text{)}
 \end{aligned}$$

Design Wind Pressures							
Height Z (')	Kz	qz (psf)	WP (psf)				
			Operating	Empty	Hydrotest New	Hydrotest Corroded	Vacuum
15.0	0.8489	29.73	11.31	11.31	N.A.	N.A.	11.31
Design Wind Force determined from: F = Pressure * Af , where Af is the projected area.							

Gust Factor Calculations

[Operating, Corroded](#)
[Empty, Corroded](#)
[Vacuum, Corroded](#)

Gust Factor Calculations: Operating, Corroded

Vessel is considered a rigid structure as $n_1 = 11.0240 \text{ Hz} \geq 1 \text{ Hz}$.

$$\begin{aligned}
 z^- &= \max (0.60 * h, z_{min}) \\
 &= \max (0.60 * 13.6117, 15.0000) \\
 &= 15.0000 \\
 I_z^- &= c * (33 / z^-)^{1/6} \\
 &= 0.2000 * (33 / 15.0000)^{1/6} \\
 &= 0.2281 \\
 L_z^- &= l * (z^- / 33)^{ep} \\
 &= 500.0000 * (15.0000 / 33)^{0.2000} \\
 &= 427.0566 \\
 Q &= \text{Sqr}(1 / (1 + 0.63 * ((h + h) / L_z^-)^{0.63})) \\
 &= \text{Sqr}(1 / (1 + 0.63 * ((1.6667 + 13.6117) / 427.0566)^{0.63})) \\
 &= 0.9635 \\
 G &= 0.925 * (1 + 1.7 * g_Q * I_z^- * Q) / (1 + 1.7 * g_v * I_z^-) \\
 &= 0.925 * (1 + 1.7 * 3.40 * 0.2281 * 0.9635) / (1 + 1.7 * 3.40 * 0.2281) \\
 &= 0.9058
 \end{aligned}$$

Gust Factor Calculations: Empty, Corroded

Vessel is considered a rigid structure as $n_1 = 12.3433 \text{ Hz} \geq 1 \text{ Hz}$.

$$\begin{aligned}
 z^- &= \max (0.60 * h, z_{min}) \\
 &= \max (0.60 * 13.6117, 15.0000) \\
 &= 15.0000 \\
 I_z^- &= c * (33 / z^-)^{1/6} \\
 &= 0.2000 * (33 / 15.0000)^{1/6} \\
 &= 0.2281 \\
 L_z^- &= l * (z^- / 33)^{ep} \\
 &= 500.0000 * (15.0000 / 33)^{0.2000} \\
 &= 427.0566
 \end{aligned}$$

$$\begin{aligned}
Q &= \text{Sqr}(1 / (1 + 0.63 * ((b + h) / L_z)^{0.63})) \\
&= \text{Sqr}(1 / (1 + 0.63 * ((1.6667 + 13.6117) / 427.0566)^{0.63})) \\
&= 0.9635 \\
G &= 0.925 * (1 + 1.7 * g_Q * I_z^- * Q) / (1 + 1.7 * g_v * I_z^-) \\
&= 0.925 * (1 + 1.7 * 3.40 * 0.2281 * 0.9635) / (1 + 1.7 * 3.40 * 0.2281) \\
&= 0.9058
\end{aligned}$$

Gust Factor Calculations: Vacuum, Corroded

Vessel is considered a rigid structure as $n_1 = 11.0240 \text{ Hz} \geq 1 \text{ Hz}$.

$$\begin{aligned}
z^- &= \max(0.60 * h, z_{\min}) \\
&= \max(0.60 * 13.6117, 15.0000) \\
&= 15.0000 \\
I_z^- &= c * (33 / z^-)^{1/6} \\
&= 0.2000 * (33 / 15.0000)^{1/6} \\
&= 0.2281 \\
L_z^- &= l * (z^- / 33)^{ep} \\
&= 500.0000 * (15.0000 / 33)^{0.2000} \\
&= 427.0566 \\
Q &= \text{Sqr}(1 / (1 + 0.63 * ((b + h) / L_z)^{0.63})) \\
&= \text{Sqr}(1 / (1 + 0.63 * ((1.6667 + 13.6117) / 427.0566)^{0.63})) \\
&= 0.9635 \\
G &= 0.925 * (1 + 1.7 * g_Q * I_z^- * Q) / (1 + 1.7 * g_v * I_z^-) \\
&= 0.925 * (1 + 1.7 * 3.40 * 0.2281 * 0.9635) / (1 + 1.7 * 3.40 * 0.2281) \\
&= 0.9058
\end{aligned}$$

Table Lookup Values	
$\alpha = 9.5000, z_g = 900.00 \text{ ft}$	[Table 26.9-1, page 256]
$c = 0.2000, l = 500.0000, ep = 0.2000$	[Table 26.9-1, page 256]
$a^- = 0.1538, b^- = 0.6500$	[Table 26.9-1, page 256]
$z_{\min} = 15.0000 \text{ ft}$	[Table 26.9-1, page 256]
$g_Q = 3.40$	[26.9.4 page 254]
$g_v = 3.40$	[26.9.4 page 254]

Seismic Code

Building Code: ASCE 7-10 ground supported		
Site Class		D
Importance Factor, I_e		1.2500
Spectral Response Acceleration at short period (% g), S_s		100.00%
Spectral Response Acceleration at period of 1 sec (% g), S_1		40.00%
Response Modification Coefficient from Table 15.4-2, R		3.0000
Acceleration-based Site Coefficient, F_a		1.1000
Velocity-based Site Coefficient, F_v		1.6000
Long-period Transition Period, T_L		12.0000
Redundancy factor, ρ		1.0000
Risk Category (Table 1.5-1)		III
User Defined Vertical Accelerations Considered		No
Vessel Characteristics		
Height		13.6117 ft
Weight	Operating, Corroded	4,207 lb
	Empty, Corroded	3,261 lb
	Vacuum, Corroded	4,207 lb
Period of Vibration Calculation		
Fundamental Period, T	Operating, Corroded	0.091 sec (f = 11.0 Hz)
	Empty, Corroded	0.081 sec (f = 12.3 Hz)
	Vacuum, Corroded	0.091 sec (f = 11.0 Hz)

The fundamental period of vibration T (above) is calculated using the Rayleigh method of approximation

$T = 2 * \pi * \text{Sqr}(\{\text{Sum}(W_i * y_i^2)\} / \{g * \text{Sum}(W_i * y_i)\})$, where

W_i is the weight of the i^{th} lumped mass, and
 y_i is its deflection when the system is treated as a cantilever beam.

12.4.2.3 Basic Load Combinations for Allowable Stress Design			
Load combinations considered in accordance with ASCE section 2.4.1:			
5.	$D + P + P_s + 0.7E$	$= (1.0 + 0.14S_{DS})D + P + P_s + 0.7\rho Q_E$	
8.	$0.6D + P + P_s + 0.7E$	$= (0.6 - 0.14S_{DS})D + P + P_s + 0.7\rho Q_E$	
Parameter description			
D	= Dead load		
P	= Internal or external pressure load		
P_s	= Static head load		
E	= Seismic load	$= E_h \text{ +/- } E_v$	$= \rho Q_E \text{ +/- } 0.2S_{DS}D$

Seismic Shear Reports:

[Operating, Corroded](#)

[Empty, Corroded](#)

[Vacuum, Corroded](#)

[Base Shear Calculations](#)

Seismic Shear Report: Operating, Corroded					
Component	Elevation of Bottom above Base (in)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Seismic Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)
Closure	155.9964	29.0	*	341	193
Shell	71.9964	28.8	0.1014	849	4,397
Bottom Head (top)	68.63	29.0	*	859	4,636
Skirt	0	29.0	0.0537	900	9,705
*Moment of Inertia I varies over the length of the component					

Seismic Shear Report: Empty, Corroded					
Component	Elevation of Bottom above Base (in)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Seismic Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)
Closure	155.9964	29.4	*	327	190
Shell	71.9964	29.2	0.1014	653	3,590
Bottom Head (top)	68.63	29.4	*	659	3,774
Skirt	0	29.4	0.0537	697	7,685
*Moment of Inertia I varies over the length of the component					

Seismic Shear Report: Vacuum, Corroded					
Component	Elevation of Bottom above Base (in)	Elastic Modulus E (10 ⁶ psi)	Inertia I (ft ⁴)	Seismic Shear at Bottom (lb _f)	Bending Moment at Bottom (lb _f -ft)
Closure	155.9964	29.0	*	341	193
Shell	71.9964	28.8	0.1014	849	4,397
Bottom Head (top)	68.63	29.0	*	859	4,636
Skirt	0	29.0	0.0537	900	9,705
*Moment of Inertia I varies over the length of the component					

11.4.3: Maximum considered earthquake spectral response acceleration

The maximum considered earthquake spectral response acceleration at short period, S_{MS}

$$S_{MS} = F_a * S_s = 1.1000 * 100.00 / 100 = 1.1000$$

The maximum considered earthquake spectral response acceleration at 1 s period, S_{MI}

$$S_{MI} = F_v * S_1 = 1.6000 * 40.00 / 100 = 0.6400$$

11.4.4: Design spectral response acceleration parameters

Design earthquake spectral response acceleration at short period, S_{DS}

$$S_{DS} = 2 / 3 * S_{MS} = 2 / 3 * 1.1000 = 0.7333$$

Design earthquake spectral response acceleration at 1 s period, S_{DI}

$$S_{DI} = 2 / 3 * S_{MI} = 2 / 3 * 0.6400 = 0.4267$$

11.6 Seismic Design Category

The Risk Category is III.

From Table 11.6-1, the Seismic Design Category based on $S_{DS} = 0.7333$ is D.

From Table 11.6-2, the Seismic Design Category based on $S_{DI} = 0.4267$ is D.

This vessel is assigned to Seismic Design Category D.

12.4.2.3: Seismic Load Combinations: Vertical Term

Factor is applied to dead load.

$$\begin{aligned} \text{Compressive Side:} &= 1.0 + 0.14 * S_{DS} \\ &= 1.0 + 0.14 * 0.7333 \\ &= 1.1027 \end{aligned}$$

$$\begin{aligned} \text{Tensile Side:} &= 0.6 - 0.14 * S_{DS} \\ &= 0.6 - 0.14 * 0.7333 \\ &= 0.4973 \end{aligned}$$

Base Shear Calculations

[Operating, Corroded](#)

[Empty, Corroded](#)

[Vacuum, Corroded](#)

Base Shear Calculations: Operating, Corroded

Paragraph 15.4.4: Period Determination

Fundamental Period is taken from the Rayleigh method listed previously in this report.

$$T = 0.0907 \text{ sec.}$$

12.8.1: Calculation of Seismic Response Coefficient

C_s is the value computed below, bounded by $C_{s\text{Min}}$ and $C_{s\text{Max}}$:

$C_{s\text{Min}}$ is calculated with equation 15.4-1 and shall not be less than 0.03; in addition, if $S_1 \geq 0.6g$, $C_{s\text{Min}}$ shall not be less than eqn 15.4-2.

$C_{s\text{Max}}$ calculated with 12.8-3 because $(T = 0.0907) \leq (T_L = 12.0000)$

$$C_s = S_{DS} / (R / I_e) = 0.7333 / (3.0000 / 1.2500) = 0.3056$$

$$C_{s\text{Min}} = \max (0.044 * S_{DS} * I_e, 0.03) = \max (0.044 * 0.7333 * 1.2500, 0.03) = 0.0403$$

$$C_{s\text{Max}} = S_{D+} / (T * (R / I_e)) = 0.4267 / (0.0907 * (3.0000 / 1.2500)) = 1.9598$$

$$C_s = 0.3056$$

12.8.1: Calculation of Base Shear

$$V = C_s * W$$

$$= 0.3056 * 4,207.4937$$

$$= 1,285.62 \text{ lb}$$

12.4.2.1 Seismic Load Combinations: Horizontal Seismic Load Effect, E_h

$$Q_E = V$$

$$E_h = 0.7 * \rho * Q_E \text{ (Only 70\% of seismic load considered as per Section 2.4.1)}$$

$$= 0.70 * 1.0000 * 1,285.62$$

$$= 899.94 \text{ lb}$$

Base Shear Calculations: Empty, Corroded

Paragraph 15.4.4: Period Determination

Fundamental Period is taken from the Rayleigh method listed previously in this report.

$$T = 0.0810 \text{ sec.}$$

12.8.1: Calculation of Seismic Response Coefficient

C_s is the value computed below, bounded by $C_{s\text{Min}}$ and $C_{s\text{Max}}$:

$C_{s\text{Min}}$ is calculated with equation 15.4-1 and shall not be less than 0.03; in addition, if $S_1 \geq 0.6g$, $C_{s\text{Min}}$ shall not be less than eqn 15.4-2.

$C_{s\text{Max}}$ calculated with 12.8-3 because $(T = 0.0810) \leq (T_L = 12.0000)$

$$C_s = S_{DS} / (R / I_e) = 0.7333 / (3.0000 / 1.2500) = 0.3056$$

$$C_{s\text{Min}} = \max (0.044 * S_{DS} * I_e, 0.03) = \max (0.044 * 0.7333 * 1.2500, 0.03) = 0.0403$$

$$C_{s\text{Max}} = S_{D+} / (T * (R / I_e)) = 0.4267 / (0.0810 * (3.0000 / 1.2500)) = 2.1944$$

$$C_s = 0.3056$$

12.8.1: Calculation of Base Shear

$$\begin{aligned}
 V &= C_s * \underline{W} \\
 &= 0.3056 * 3,261.0378 \\
 &= 996.43 \text{ lb}
 \end{aligned}$$

12.4.2.1 Seismic Load Combinations: Horizontal Seismic Load Effect, E_h

$$\begin{aligned}
 Q_E &= V \\
 E_h &= 0.7 * \rho * Q_E \text{ (Only 70\% of seismic load considered as per Section 2.4.1)} \\
 &= 0.70 * 1.0000 * 996.43 \\
 &= 697.50 \text{ lb}
 \end{aligned}$$

Base Shear Calculations: Vacuum, Corroded

Paragraph 15.4.4: Period Determination

Fundamental Period is taken from the Rayleigh method listed previously in this report.

$$T = 0.0907 \text{ sec.}$$

12.8.1: Calculation of Seismic Response Coefficient

C_s is the value computed below, bounded by $C_{s\text{Min}}$ and $C_{s\text{Max}}$:

$C_{s\text{Min}}$ is calculated with equation 15.4-1 and shall not be less than 0.03; in addition, if $S_1 \geq 0.6g$, $C_{s\text{Min}}$ shall not be less than eqn 15.4-2.

$C_{s\text{Max}}$ calculated with 12.8-3 because $(T = 0.0907) \leq (T_L = 12.0000)$

$$\begin{aligned}
 C_s &= \underline{S_{DS}} / (\underline{R} / \underline{I_e}) = 0.7333 / (3.0000 / 1.2500) = 0.3056 \\
 C_{s\text{Min}} &= \max (0.044 * \underline{S_{DS}} * \underline{I_e} , 0.03) = \max (0.044 * 0.7333 * 1.2500 , 0.03) = 0.0403 \\
 C_{s\text{Max}} &= \underline{S_{D1}} / (T * (\underline{R} / \underline{I_e})) = 0.4267 / (0.0907 * (3.0000 / 1.2500)) = 1.9598 \\
 C_s &= 0.3056
 \end{aligned}$$

12.8.1: Calculation of Base Shear

$$\begin{aligned}
 V &= C_s * \underline{W} \\
 &= 0.3056 * 4,207.4937 \\
 &= 1,285.62 \text{ lb}
 \end{aligned}$$

12.4.2.1 Seismic Load Combinations: Horizontal Seismic Load Effect, E_h

$$\begin{aligned}
 Q_E &= V \\
 E_h &= 0.7 * \rho * Q_E \text{ (Only 70\% of seismic load considered as per Section 2.4.1)} \\
 &= 0.70 * 1.0000 * 1,285.62 \\
 &= 899.94 \text{ lb}
 \end{aligned}$$

Shell

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-106 C Smls pipe (II-D p. 22, ln. 1)		
Pipe NPS and Schedule		NPS 20 Sch 60		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	No	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		1,100	150	-20
External		15	150	
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		3.27	90.7188	1
Test vertical		3.27	90.6563	1
Dimensions				
Outer Diameter		20"		
Length		84"		
Pipe Nominal Thickness		0.812"		
Pipe Minimum Thickness ¹		0.7105"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		1,119.2		96.44
Corroded		1,036.55		97.76
Radiography				
Longitudinal seam		Seamless No RT		
Top Circumferential seam		Spot UW-11(a)(5)(b) Type 1		
Bottom Circumferential seam		Spot UW-11(a)(5)(b) Type 1		

¹Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	$0.0625" + 0.0625" = 0.125"$
Design thickness due to internal pressure (t)	0.6023"
Design thickness due to external pressure (t_e)	0.1833"
Design thickness due to combined loadings + corrosion	0.3171"
Maximum allowable working pressure (MAWP)	1,327.21 psi
Maximum allowable pressure (MAP)	1,462.57 psi
Maximum allowable external pressure (MAEP)	599.26 psi
Rated MDMT	-20 °F

UCS-66 Material Toughness Requirements	
Governing thickness, $t_g =$	0.7105"
MDMT =	-20°F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20°F.	

Design thickness, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 t &= P \cdot R_o / (S \cdot E + 0.40 \cdot P) + \text{Corrosion} \\
 &= 1,103.27 \cdot 10 / (20,000 \cdot 1.00 + 0.40 \cdot 1,103.27) + 0.0625 \\
 &= \a href="#">0.6023"
 \end{aligned}$$

Maximum allowable working pressure, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) - P_s \\
 &= 20,000 \cdot 1.00 \cdot (0.812 \cdot 0.875 - 0.0625) / (10 - 0.40 \cdot (0.812 \cdot 0.875 - 0.0625)) - 3.27 \\
 &= \a href="#">1,327.21 \text{ psi}
 \end{aligned}$$

Maximum allowable pressure, (at 60 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) \\
 &= 20,000 \cdot 1.00 \cdot (0.812 \cdot 0.875) / (10 - 0.40 \cdot (0.812 \cdot 0.875)) \\
 &= \a href="#">1,462.57 \text{ psi}
 \end{aligned}$$

External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned}
 L / D_o &= 91.1458 / 20 = 4.5573 \\
 D_o / t &= 20 / 0.1208 = 165.6173
 \end{aligned}$$

From table G: A = 0.000130
 From table CS-2: B = 1,863.2016 psi

$$\begin{aligned}
 P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\
 &= 4 \cdot 1,863.2 / (3 \cdot (20 / 0.1208)) \\
 &= 15 \text{ psi}
 \end{aligned}$$

Design thickness for external pressure $P_a = 15$ psi

$$t_a = t + \text{Corrosion} = 0.1208 + 0.0625 = \underline{0.1833"}$$

Maximum Allowable External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned} L / D_o &= 91.1458 / 20 = 4.5573 \\ D_o / t &= 20 / (0.812 * 0.875 - 0.0625) = 30.8642 \end{aligned}$$

$$\text{From table G: } A = 0.001522$$

$$\text{From table CS-2: } B = 13,871.6537 \text{ psi}$$

$$\begin{aligned} P_a &= 4 * B / (3 * (D_o / t)) \\ &= 4 * 13,871.65 / (3 * (20 / (0.812 * 0.875 - 0.0625))) \\ &= \underline{599.26} \text{ psi} \end{aligned}$$

External Pressure + Weight + Wind Loading Check (Bergman, ASME paper 54-A-104)

$$\begin{aligned} P_v &= W / (2 * \pi * R_m) + M / (\pi * R_m^2) \\ &= 2,641.3 / (2 * \pi * 9.6253) + 6,433 / (\pi * 9.6253^2) \\ &= 65.776 \text{ lb/in} \end{aligned}$$

$$\begin{aligned} \alpha &= P_v / (P_e * D_o) \\ &= 65.776 / (15 * 20) \\ &= 0.2193 \end{aligned}$$

$$n = 2$$

$$\begin{aligned} m &= 1.23 / (L / D_o)^2 \\ &= 1.23 / (91.1458 / 20)^2 \\ &= 0.0592 \end{aligned}$$

$$\begin{aligned} \text{Ratio } P_e &= (n^2 - 1 + m + m * \alpha) / (n^2 - 1 + m) \\ &= (2^2 - 1 + 0.0592 + 0.0592 * 0.2193) / (2^2 - 1 + 0.0592) \\ &= 1.0042 \end{aligned}$$

$$\text{Ratio } P_e * P_e \leq \text{MAEP}$$

$$(1.0042 * 15 = 15.06) \leq 599.26$$

Cylinder design thickness is satisfactory.

External Pressure + Weight + Seismic Loading Check (Bergman, ASME paper 54-A-104)

$$\begin{aligned} P_v &= (1 + 0.14 * S_{DS}) * W / (2 * \pi * R_m) + M / (\pi * R_m^2) \\ &= 1.10 * 2,641.3 / (2 * \pi * 9.6253) + 52,762 / (\pi * 9.6253^2) \\ &= 229.4381 \text{ lb/in} \end{aligned}$$

$$\begin{aligned} \alpha &= P_v / (P_e * D_o) \\ &= 229.4381 / (15 * 20) \\ &= 0.7648 \end{aligned}$$

$$n = 2$$

$$\begin{aligned} m &= 1.23 / (L / D_o)^2 \\ &= 1.23 / (91.1458 / 20)^2 \\ &= 0.0592 \end{aligned}$$

$$\begin{aligned} \text{Ratio } P_e &= (n^2 - 1 + m + m * \alpha) / (n^2 - 1 + m) \\ &= (2^2 - 1 + 0.0592 + 0.0592 * 0.7648) / (2^2 - 1 + 0.0592) \\ &= 1.0148 \end{aligned}$$

$$\text{Ratio } P_e * P_e \leq \text{MAEP}$$

$$(1.0148 * 15 = 15.22) \leq 599.26$$

Cylinder design thickness is satisfactory.

Thickness Required Due to Pressure + External Loads								
Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S _t	S _c					
Operating, Hot & Corroded	1,100	20,000	17,319	150	0.0625	Wind	0.2465	0.2435
						Seismic	0.2546	0.2355
Operating, Hot & New	1,100	20,000	17,342	150	0	Wind	0.2448	0.2417
						Seismic	0.2531	0.2335
Hot Shut Down, Corroded	0	20,000	17,319	150	0.0625	Wind	0.0002	0.0032
						Seismic	0.0078	0.011
Hot Shut Down, New	0	20,000	17,342	150	0	Wind	0.0002	0.0033
						Seismic	0.008	0.0113
Empty, Corroded	0	20,000	17,319	70	0.0625	Wind	0.0002	0.0032
						Seismic	0.0062	0.0094
Empty, New	0	20,000	17,342	70	0	Wind	0.0002	0.0033
						Seismic	0.0064	0.0098
Vacuum	-15	20,000	17,319	150	0.0625	Wind	0.0035	0.0065
						Seismic	0.0044	0.0144
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	20,000	17,319	150	0.0625	Weight	0.0025	0.0025

Bottom Head

ASME Section VIII Division 1, 2015 Edition				
Component		Ellipsoidal Head		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Attached To		Shell		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	Yes	Yes	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		1,100	150	-20
External		15	150	
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		3.52	97.4375	1
Test vertical		3.51	97.3125	1
Dimensions				
Outer Diameter		20"		
Head Ratio		2		
Minimum Thickness		0.6875"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Length L _{sf}		2"		
Nominal Thickness t _{sf}		0.75"		
Weight and Capacity				
		Weight (lb) ¹		Capacity (US gal) ¹
New		110.03		5.99
Corroded		100.91		6.12
Radiography				
Category A joints		Seamless No RT		
Head to shell seam		Spot UW-11(a)(5)(b) Type 1		

¹ includes straight flange

Results Summary	
Governing condition	internal pressure
Minimum thickness per UG-16	$0.0625" + 0.0625" = 0.125"$
Design thickness due to internal pressure (t)	0.5838"
Design thickness due to external pressure (t_e)	0.1112"
Maximum allowable working pressure (MAWP)	1,332.67 psi
Maximum allowable pressure (MAP)	1,465.69 psi
Maximum allowable external pressure (MAEP)	633.25 psi
Straight Flange governs MDMT	-55°F

Factor K		
$K = (1/6) * [2 + (D / (2 * h))^2]$		
Corroded	$K = (1/6) * [2 + (18.75 / (2 * 4.7188))^2]$	0.9912
New	$K = (1/6) * [2 + (18.625 / (2 * 4.6563))^2]$	1

Design thickness for internal pressure, (Corroded at 150 ° F) Appendix 1-4(c)

$$\begin{aligned}
 t &= P * D_o * K / (2 * S * E + 2 * P * (K - 0.1)) + \text{Corrosion} \\
 &= 1,103.52 * 20 * 0.991199 / (2 * 20,000 * 1 + 2 * 1,103.52 * (0.991199 - 0.1)) + 0.0625 \\
 &= \a href="#">0.5838"
 \end{aligned}$$

Maximum allowable working pressure, (Corroded at 150 ° F) Appendix 1-4(c)

$$\begin{aligned}
 P &= 2 * S * E * t / (K * D_o - 2 * t * (K - 0.1)) - P_s \\
 &= 2 * 20,000 * 1 * 0.625 / (0.991199 * 20 - 2 * 0.625 * (0.991199 - 0.1)) - 3.52 \\
 &= \a href="#">1,332.67 \text{ psi}
 \end{aligned}$$

Maximum allowable pressure, (New at 60 ° F) Appendix 1-4(c)

$$\begin{aligned}
 P &= 2 * S * E * t / (K * D_o - 2 * t * (K - 0.1)) - P_s \\
 &= 2 * 20,000 * 1 * 0.6875 / (1 * 20 - 2 * 0.6875 * (1 - 0.1)) - 0 \\
 &= \a href="#">1,465.69 \text{ psi}
 \end{aligned}$$

Design thickness for external pressure, (Corroded at 150 ° F) UG-33(d)

Equivalent outside spherical radius (R_o)

$$\begin{aligned}
 R_o &= K_o * D_o \\
 &= 0.8421 * 20 \\
 &= 16.8421 \text{ in}
 \end{aligned}$$

$$\begin{aligned}
 A &= 0.125 / (R_o / t) \\
 &= 0.125 / (16.8421 / 0.048644) \\
 &= 0.000361
 \end{aligned}$$

From Table CS-2:

$$B = 5,193.4548 \text{ psi}$$

$$\begin{aligned}
 P_a &= B / (R_o / t) \\
 &= 5,193.4548 / (16.8421 / 0.0486) \\
 &= 15 \text{ psi}
 \end{aligned}$$

$$t = 0.0486" + \text{Corrosion} = 0.0486" + 0.0625" = 0.1111"$$

Check the external pressure per UG-33(a)(1) Appendix 1-4(c)

$$\begin{aligned} t &= 1.67 * P_e * D_o * K / (2 * S * E + 2 * 1.67 * P_e * (K - 0.1)) + \text{Corrosion} \\ &= 1.67 * 15 * 20 * 0.991199 / (2 * 20,000 * 1 + 2 * 1.67 * 15 * (0.991199 - 0.1)) + 0.0625 \\ &= 0.0749" \end{aligned}$$

The head external pressure design thickness (t_e) is [0.1111"](#).

Maximum Allowable External Pressure, (Corroded at 150 ° F) UG-33(d)

Equivalent outside spherical radius (R_o)

$$\begin{aligned} R_o &= K_o * D_o \\ &= 0.8421 * 20 \\ &= 16.8421 \text{ in} \end{aligned}$$

$$\begin{aligned} A &= 0.125 / (R_o / t) \\ &= 0.125 / (16.8421 / 0.625) \\ &= 0.004639 \end{aligned}$$

From Table CS-2:

$$B = 17,064.49 \text{ psi}$$

$$\begin{aligned} P_a &= B / (R_o / t) \\ &= 17,064.49 / (16.8421 / 0.625) \\ &= 633.2525 \text{ psi} \end{aligned}$$

Check the Maximum External Pressure, UG-33(a)(1) Appendix 1-4(c)

$$\begin{aligned} P &= 2 * S * E * t / ((K * D_o - 2 * t * (K - 0.1)) * 1.67) \\ &= 2 * 20,000 * 1 * 0.625 / ((0.991199 * 20 - 2 * 0.625 * (0.991199 - 0.1)) * 1.67) \\ &= 800.11 \text{ psi} \end{aligned}$$

The maximum allowable external pressure (MAEP) is [633.25](#) psi.

% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned} EFE &= (75 * t / R_f) * (1 - R_f / R_o) \\ &= (75 * 0.75 / 3.5413) * (1 - 3.5413 / \infty) \\ &= 15.8842\% \end{aligned}$$

The extreme fiber elongation exceeds 5 percent and the thickness exceeds 5/8 inch;. Heat treatment per UCS-56 is required if fabricated by cold forming.

Straight Flange on Bottom Head

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	Yes	Yes	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		1,100	150	-20
External		15	150	
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		3.35	92.7188	1
Test vertical		3.34	92.6563	1
Dimensions				
Outer Diameter		20"		
Length		2"		
Nominal Thickness		0.75"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		25.67		2.33
Corroded		23.61		2.36
Radiography				
Longitudinal seam		Seamless No RT		
Top Circumferential seam		Spot UW-11(a)(5)(b) Type 1		

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	$0.0625" + 0.0625" = 0.125"$
Design thickness due to internal pressure (t)	0.6023"
Design thickness due to external pressure (t_e)	0.1833"
Design thickness due to combined loadings + corrosion	0.3189"
Maximum allowable working pressure (MAWP)	1,410.53 psi
Maximum allowable pressure (MAP)	1,546.39 psi
Maximum allowable external pressure (MAEP)	653.49 psi
Rated MDMT	-55 °F

UCS-66 Material Toughness Requirements	
Governing thickness, $t_g =$	0.7105"
Exemption temperature from Fig UCS-66 Curve D =	-43.9°F
$t_r = 1,119.72 \times 10 / (20,000 \times 1 + 0.4 \times 1,119.72) =$	0.5476"
Stress ratio $= t_r \times E^* / (t_n - c) = 0.5476 \times 1 / (0.75 - 0.0625) =$	0.7965
Reduction in MDMT, T_R from Fig UCS-66.1 =	20.3°F
MDMT $= \max[\text{MDMT} - T_R, -55] = \max[-43.9 - 20.3, -55] =$	-55°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Design thickness, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 t &= P \times R_o / (S \times E + 0.40 \times P) + \text{Corrosion} \\
 &= 1,103.35 \times 10 / (20,000 \times 1.00 + 0.40 \times 1,103.35) + 0.0625 \\
 &= \text{0.6023"}
 \end{aligned}$$

Maximum allowable working pressure, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S \times E \times t / (R_o - 0.40 \times t) - P_s \\
 &= 20,000 \times 1.00 \times 0.6875 / (10 - 0.40 \times 0.6875) - 3.35 \\
 &= \text{1,410.53 psi}
 \end{aligned}$$

Maximum allowable pressure, (at 60 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S \times E \times t / (R_o - 0.40 \times t) \\
 &= 20,000 \times 1.00 \times 0.75 / (10 - 0.40 \times 0.75) \\
 &= \text{1,546.39 psi}
 \end{aligned}$$

External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned}
 L / D_o &= 91.1458 / 20 = 4.5573 \\
 D_o / t &= 20 / 0.1208 = 165.6173
 \end{aligned}$$

$$\begin{aligned}
 \text{From table G: } A &= 0.000130 \\
 \text{From table CS-2: } B &= 1,863.2016 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 P_a &= 4*B / (3*(D_o / t)) \\
 &= 4*1,863.2 / (3*(20 / 0.1208)) \\
 &= 15 \text{ psi}
 \end{aligned}$$

Design thickness for external pressure $P_a = 15$ psi

$$t_a = t + \text{Corrosion} = 0.1208 + 0.0625 = \underline{0.1833"}$$

Maximum Allowable External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned}
 L / D_o &= 91.1458 / 20 = 4.5573 \\
 D_o / t &= 20 / 0.6875 = 29.0909
 \end{aligned}$$

From table G: $A = 0.001675$

From table CS-2: $B = 14,258.0447 \text{ psi}$

$$\begin{aligned}
 P_a &= 4*B / (3*(D_o / t)) \\
 &= 4*14,258.04 / (3*(20 / 0.6875)) \\
 &= \underline{653.49} \text{ psi}
 \end{aligned}$$

% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 EFE &= (50*t / R_f)*(1 - R_f / R_o) \\
 &= (50*0.75 / 9.625)*(1 - 9.625 / \infty) \\
 &= 3.8961\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

Thickness Required Due to Pressure + External Loads								
Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S _t	S _c					
Operating, Hot & Corroded	1,100	20,000	17,334	150	0.0625	Wind	0.2482	0.2451
						Seismic	0.2564	0.2369
Operating, Hot & New	1,100	20,000	17,355	150	0	Wind	0.2465	0.2433
						Seismic	0.255	0.2349
Hot Shut Down, Corroded	0	20,000	17,334	150	0.0625	Wind	0.0002	0.0032
						Seismic	0.008	0.0113
Hot Shut Down, New	0	20,000	17,355	150	0	Wind	0.0002	0.0033
						Seismic	0.0082	0.0116
Empty, Corroded	0	20,000	17,334	70	0.0625	Wind	0.0002	0.0032
						Seismic	0.0064	0.0096
Empty, New	0	20,000	17,355	70	0	Wind	0.0002	0.0033
						Seismic	0.0066	0.0099
Vacuum	-15	20,000	17,334	150	0.0625	Wind	0.0035	0.0066
						Seismic	0.0046	0.0146
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	20,000	17,334	150	0.0625	Weight	0.0025	0.0025

Skirt

ASME Section VIII Division 1, 2015 Edition		
Component		Support Skirt
Material		SA-53 E/B Wld pipe (II-D p. 14, ln. 12)
Skirt is Attached To		Bottom Head
Skirt Attachment Offset		3.3664" down from the top seam
Design Temperature		
Internal		150°F
External		150°F
Dimensions		
Inner Diameter	Top	19.25"
	Bottom	19.25"
Length (includes base ring thickness)		68.63"
Nominal Thickness		0.375"
Corrosion	Inner	0"
	Outer	0"
Weight		
New		444.14 lb
Corroded		444.14 lb
Joint Efficiency		
Top		0.55
Bottom		0.8

Skirt design thickness, largest of the following + corrosion = 0.0273 in

The governing condition is due to seismic, compressive stress at the base, operating & new.

The skirt thickness of 0.3281 in is adequate.

Results Summary							
Loading	Condition	Tensile or Compressive Side	Governing Skirt Location	Temperature (°F)	Allowable Stress (psi)	Calculated Stress/E (psi)	Required thickness (in)
Wind	operating, corroded	Tensile	bottom	150	17,176.47	94.58	0.0021
		Compressive			17,176.47	363.38	0.0079
	operating, new	Tensile	bottom	150	17,176.47	91.31	0.002
		Compressive			17,176.47	367.59	0.008
	empty, corroded	Tensile	bottom	60	17,176.47	125.28	0.0027
		Compressive			17,176.47	322.44	0.007
	empty, new	Tensile	bottom	60	17,176.47	121.55	0.0027
		Compressive			17,176.47	327.27	0.0071
	test, new	Tensile	bottom	60	17,176.47	-109.09	0.0024
		Compressive				185.48	0.004
	vacuum, corroded	Tensile	bottom	150	17,176.47	94.58	0.0021
		Compressive			17,176.47	363.38	0.0079
Seismic	operating, corroded	Tensile	bottom	150	17,176.47	1,171.58	0.0256
		Compressive			17,176.47	1,224.97	0.0267
	operating, new	Tensile	bottom	150	17,176.47	1,196.7	0.0261
		Compressive			17,176.47	1,251.91	0.0273
	empty, corroded	Tensile	bottom	60	17,176.47	929.87	0.0203
		Compressive			17,176.47	966.11	0.0211
	empty, new	Tensile	bottom	60	17,176.47	958.62	0.0209
		Compressive			17,176.47	996.93	0.0218
	vacuum, corroded	Tensile	bottom	150	17,176.47	1,171.58	0.0256
		Compressive			17,176.47	1,224.97	0.0267

Loading due to seismic, operating & new

Tensile side

Required thickness, tensile stress at base:

$$\begin{aligned}
 t &= -(0.6 - 0.14 \cdot S_{DS}) \cdot W / (\pi \cdot D \cdot S_t \cdot E) + 48 \cdot M / (\pi \cdot D^2 \cdot S_t \cdot E) \\
 &= -(0.6 - 0.14 \cdot 0.7333) \cdot 4,256.19 / (\pi \cdot 19.625 \cdot 17,176 \cdot 0.8) + 48 \cdot 9,915.2 / (\pi \cdot 19.625^2 \cdot 17,176 \cdot 0.8) \\
 &= 0.0261 \text{ in}
 \end{aligned}$$

Required thickness, tensile stress at the top:

$$\begin{aligned}
 t &= -(0.6 - 0.14 \cdot S_{DS}) \cdot W_t / (\pi \cdot D_t \cdot S_t \cdot E) + 48 \cdot M_t / (\pi \cdot D_t^2 \cdot S_t \cdot E) \\
 &= -(0.6 - 0.14 \cdot 0.7333) \cdot 3,792.05 / (\pi \cdot 19.625 \cdot 17,176 \cdot 0.55) + 48 \cdot 4,734 / (\pi \cdot 19.625^2 \cdot 17,176 \cdot 0.55) \\
 &= 0.0166 \text{ in}
 \end{aligned}$$

Compressive side

Required thickness, compressive stress at base:

$$\begin{aligned}t &= (1 + 0.14*S_{DS})*W / (\pi*D*S_c*E_c) + 48*M / (\pi*D^2*S_c*E_c) \\&= (1 + 0.14*0.7333)*4,256.19 / (\pi*19.625*17,176*1) + 48*9,915.2 / (\pi*19.625^2*17,176*1) \\&= 0.0273 \text{ in}\end{aligned}$$

Required thickness, compressive stress at the top:

$$\begin{aligned}t &= (1 + 0.14*S_{DS})*W_t / (\pi*D_t*S_c*E_c) + 48*M_t / (\pi*D_t^2*S_c*E_c) \\&= (1 + 0.14*0.7333)*3,792.05 / (\pi*19.625*17,176*1) + 48*4,734 / (\pi*19.625^2*17,176*1) \\&= 0.0149 \text{ in}\end{aligned}$$

Base Plate

Inputs	
Base configuration	single base plate without gussets
Base plate material	SA-36
Base plate allowable stress, S_p	16,600 psi
Foundation compressive strength	1,658 psi
Concrete ultimate 28-day strength	3,000 psi
Bolt circle, BC	22"
Base plate inner diameter, D_i	18"
Base plate outer diameter, D_o	25"
Base plate thickness, t_b	0.75"
Anchor Bolts	
Material	CS
Allowable stress, S_b	20,000 psi
Bolt size and type	0.75" series 8 threaded
Number of bolts, N	4
Corrosion allowance (applied to root radius)	0"
Anchor bolt clearance	0.125"
Bolt root area (corroded), A_b	0.3 in ²
Diameter of anchor bolt holes, d_b	0.875"
Initial bolt preload	0% (0 psi)
Bolt at 0°	No

Results Summary							
Load	Vessel condition	Base V (lb _f)	Base M (lb _f -ft)	W (lb)	Required bolt area (in ²)	t _r Base (in)	Foundation bearing stress (psi)
Wind	operating, corroded	254.7	1,735.1	4,207.5	0.0158	0.2032	36.54
Wind	operating, new	254.7	1,734.6	4,306.2	0.015	0.2043	36.96
Wind	empty, corroded	254.7	1,735.1	3,261	0.0229	0.2314	47.41
Wind	empty, new	254.7	1,734.6	3,374	0.022	0.2314	47.39
Wind	test, new	91.5	13	4,306.6	0	0.1447	18.54
Wind	vacuum, corroded	254.7	1,735.1	4,207.5	0.0158	0.2032	36.54
Seismic	operating, corroded	899.9	9,705.1	4,207.5	0.2385	0.5185	238.05
Seismic	operating, new	921	9,915.2	4,306.2	0.2436	0.5242	243.28
Seismic	empty, corroded	697.5	7,684.8	3,261	0.1893	0.4606	187.8
Seismic	empty, new	721.7	7,925.2	3,374	0.1952	0.4679	193.79
Seismic	vacuum, corroded	899.9	9,705.1	4,207.5	0.2385	0.5185	238.05

Anchor bolt load (governing)

$$\begin{aligned}
 P &= -(0.6 - 0.14 \cdot S_{DS}) \cdot W / N + 48 \cdot M / (N \cdot BC) \\
 &= -(0.6 - 0.14 \cdot 0.7333) \cdot 4,306.19 / 4 + 48 \cdot 9,915.2 / (4 \cdot 22) \\
 &= 4,872.87 \text{ lb}_f
 \end{aligned}$$

$$\text{Required area per bolt} = P / S_b = \text{0.2436} \text{ in}^2$$

The area provided (0.302 in²) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, governing)

Base plate width, t_c: 3.5 in
Average base plate diameter, d: 21.5 in
Base plate elastic modulus, E_s: 29.0E+06 psi
Base plate yield stress, S_y: 36,000 psi

$$E_c = 57,000 \cdot \text{Sqr}(3,000) = 3,122,019 \text{ psi}$$

$$n = E_s / E_c = 29.0E+06 / 3,122,019 = 9.2889$$

$$\begin{aligned}
 t_s &= (N \cdot A_b) / (\pi \cdot d) \\
 &= (4 \cdot 0.302) / (\pi \cdot 21.5) \\
 &= 0.0179 \text{ in}
 \end{aligned}$$

From table 12.4 for k = 0.168197:

$$\begin{aligned}
 K_1 &= 2.7316, K_2 = 1.1128 \\
 L_1 &= 7.1357, L_2 = 13.7423, L_3 = 2.8765
 \end{aligned}$$

Total tensile force on bolting

$$T = (12 \cdot M - (0.6 - 0.14 \cdot S_{DS}) \cdot W \cdot (L_1 + L_3)) / (L_2 + L_3)$$

$$= (12 * 9,915.2 - (0.6 - 0.14 * 0.7333) * 4,306.19 * (7.1357 + 2.8765)) / (13.7423 + 2.8765)$$

$$= 5,869.22 \text{ lb}_f$$

Tensile stress in bolts use the larger of f_s or bolt preload = 0 psi

$$f_s = T / (t_s * (d / 2) * K_1)$$

$$= 5,869.22 / (0.0179 * (21.5 / 2) * 2.7316)$$

$$= 11,176 \text{ psi}$$

Total compressive load on foundation

$$C_c = T + (1 + 0.14 * S_{DS}) * W + \text{Bolt Preload}$$

$$= 5,869.22 + (1 + 0.14 * 0.7333) * 4,306.19 + 0$$

$$= 10,617.51 \text{ lb}_f$$

Foundation bearing stress

$$f_c = C_c / (((t_c - t_s) + n * t_s) * (d / 2) * K_2)$$

$$= 10,617.51 / (((3.5 - 0.0179) + 9.2889 * 0.0179) * (21.5 / 2) * 1.1128)$$

$$= 243 \text{ psi}$$

As $f_c \leq 1,658 \text{ psi}$ the base plate width is satisfactory.

$$k = 1 / (1 + f_s / (n * f_c))$$

$$= 1 / (1 + 11,176 / (9.2889 * 243))$$

$$= 0.168197$$

Base plate required thickness (governing)

$$t_r = (3 * f_c * L^2 / S_p)^{0.5}$$

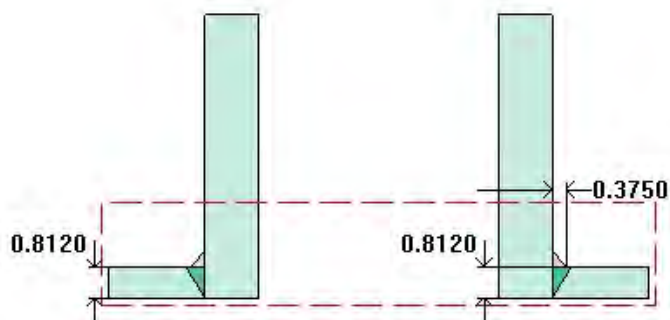
$$= (3 * 243 * 2.5^2 / 16,600)^{0.5}$$

$$= 0.5242 \text{ in}$$

The base plate thickness is satisfactory.

Inlet (N1)

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Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	270°
Nozzle center line offset to datum line	27"
End of nozzle to shell center	20"
Passes through a Category A joint	No

Nozzle

Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23) (normalized)
Inside diameter, new	8"
Nominal wall thickness	1.375"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	7.56"
Projection available outside vessel to flange face, L _f	10"
Local vessel minimum thickness	0.7105"
Liquid static head included	2.34 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
Nozzle to vessel groove weld	0.812"

ASME B16.5-2013 Flange	
Description	NPS 8 Class 600 LWN A105 N
Bolt Material	SA-193 B7 Bolt $\leq 2\frac{1}{2}$ (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-44.4°F
Liquid static head	2.19 psi
Consider External Loads on Flange MAWP Rating	No
MAWP rating	1,420 psi @ 150°F
MAP rating	1,480 psi @ 60°F
Hydrotest rating	2,225 psi @ 60°F
PWHT performed	No
Impact Tested	No
Gasket	
Description	Flexitallic Spiral Wound CG 304 S.S.
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -44.4°F (Coincident ratio = 0.7558) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements	
LWN rated MDMT per UCS-66(c)(4) =	-44.4°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,102.34 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A _{required}	A _{available}	A ₁	A ₂	A ₃	A ₅	A _{welds}	t _{req}	t _{min}
4.3817	4.5261	0.8834	3.5021	--	--	0.1406	0.3819	1.375

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

WRC 107												
Load Case	P (psi)	P _r (lb _f)	M _c (lb _f -in)	V _c (lb _f)	M _L (lb _f -in)	V _L (lb _f)	M _t (lb _f -in)	Max Comb Stress (psi)	Allow Comb Stress (psi)	Max Local Primary Stress (psi)	Allow Local Primary Stress (psi)	Over stressed
Load case 1	1,102.34	2,400	49,740	2,970	74,640	2,970	119,280	26,615	60,000	20,566	30,000	No
Load case 1 (Hot Shut Down)	0	2,400	49,740	2,970	74,640	2,970	119,280	-13,648	60,000	-3,654	30,000	No

Reinforcement Calculations for External Pressure

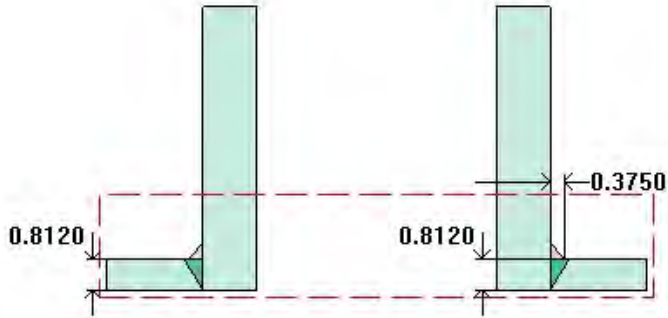
UG-37 Area Calculation Summary (in ²)								UG-45 Summary (in)	
For P _e = 15 psi @ 150 °F The opening is adequately reinforced								The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}	
0.4906	8.5609	4.2838	4.1365	--	--	0.1406	0.125	1.375	

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Outlet (N2)

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Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	90°
Nozzle center line offset to datum line	9"
End of nozzle to shell center	20"
Passes through a Category A joint	No

Nozzle

Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23) (normalized)
Inside diameter, new	8"
Nominal wall thickness	1.375"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	7.56"
Projection available outside vessel to flange face, L _f	10"
Local vessel minimum thickness	0.7105"
Liquid static head included	2.99 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
Nozzle to vessel groove weld	0.812"

ASME B16.5-2013 Flange	
Description	NPS 8 Class 600 LWN A105 N
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-44.4°F
Liquid static head	2.84 psi
Consider External Loads on Flange MAWP Rating	No
MAWP rating	1,420 psi @ 150°F
MAP rating	1,480 psi @ 60°F
Hydrotest rating	2,225 psi @ 60°F
PWHT performed	No
Impact Tested	No
Gasket	
Description	Flexitallic Spiral Wound CG 304 S.S.
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -44.4°F (Coincident ratio = 0.7562) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements	
LWN rated MDMT per UCS-66(c)(4) =	-44.4°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,102.99 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
4.3842	4.5232	0.8808	3.5018	--	--	0.1406	0.3819	1.375

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(1)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

WRC 107												
Load Case	P (psi)	P _r (lb _f)	M _c (lb _f -in)	V _c (lb _f)	M _L (lb _f -in)	V _L (lb _f)	M _t (lb _f -in)	Max Comb Stress (psi)	Allow Comb Stress (psi)	Max Local Primary Stress (psi)	Allow Local Primary Stress (psi)	Over stressed
Load case 1	1,102.99	2,400	49,740	2,970	74,640	2,970	119,280	26,625	60,000	20,578	30,000	No
Load case 1 (Hot Shut Down)	0	2,400	49,740	2,970	74,640	2,970	119,280	-13,648	60,000	-3,654	30,000	No

Reinforcement Calculations for External Pressure

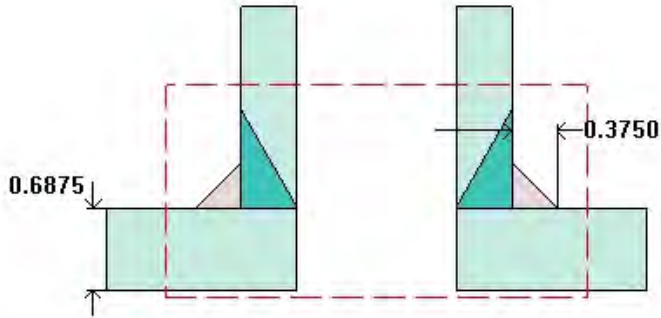
UG-37 Area Calculation Summary (in ²)								UG-45 Summary (in)	
For P _e = 15 psi @ 150 °F The opening is adequately reinforced								The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}	
0.4906	8.5609	4.2838	4.1365	--	--	0.1406	0.125	1.375	

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

Drain (Sump) (C1)

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Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Bottom Head
Orientation	0°
End of nozzle to datum line	-12.5"
Calculated as hillside	No
Distance to head center, R	0"
Passes through a Category A joint	No

Nozzle

Description	NPS 1 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.315"
Nominal wall thickness	0.4675"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.1902"
Local vessel minimum thickness	0.6875"
Liquid static head included	3.59 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,119.97 * 0.72 / (20,000 * 1 - 0.6 * 1,119.97) =$	0.0417"
Stress ratio = $t_r * E^* / (t_n - c) = 0.0417 * 1 / (0.4675 - 0.0625) =$	0.103
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,103.59 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.4675

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P _e = 15 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.4675

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Nozzle Pipe (C1)

ASME Section VIII Division 1, 2015 Edition				
Component		Nozzle Pipe		
Material		SA-106 B Smls pipe (II-D p. 14, ln. 15)		
Pipe NPS and Schedule		NPS 1 Sch 160		
Attached To		Drain (Sump) (C1)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	No	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		1,100	150	-20
External		15	150	
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		4.12	114.2188	1
Test vertical		4.23	117.1563	1
Dimensions				
Outer Diameter		1.315"		
Length		17"		
Pipe Nominal Thickness		0.25"		
Pipe Minimum Thickness ¹		0.2188"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		4.02		0.04
Corroded		3.2		0.05
Radiography				
Longitudinal seam		Seamless No RT		
Left Circumferential seam		Spot UW-11(a)(5)(b) Type 1		
Right Circumferential seam		Spot UW-11(a)(5)(b) Type 1		

¹Pipe minimum thickness = nominal thickness times pipe tolerance factor of 0.875.

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	$0.0625" + 0.0625" = 0.125"$
Design thickness due to internal pressure (t)	0.1039"
Design thickness due to external pressure (t_e)	0.075"
Maximum allowable working pressure (MAWP)	4,486.42 psi
Maximum allowable pressure (MAP)	6,917.21 psi
Maximum allowable external pressure (MAEP)	3,042.51 psi
Rated MDMT	-155 °F

UCS-66 Material Toughness Requirements	
Impact test exempt per UCS-66(d) (NPS 4 or smaller pipe) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Design thickness, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 t &= P \cdot R_o / (S \cdot E + 0.40 \cdot P) + \text{Corrosion} \\
 &= 1,104.12 \cdot 0.6575 / (17,100 \cdot 1.00 + 0.40 \cdot 1,104.12) + 0.0625 \\
 &= \underline{0.1039"}
 \end{aligned}$$

Maximum allowable working pressure, (at 150 ° F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) - P_s \\
 &= 17,100 \cdot 1.00 \cdot (0.25 \cdot 0.875 - 0.0625) / (0.6575 - 0.40 \cdot (0.25 \cdot 0.875 - 0.0625)) - 4.12 \\
 &= \underline{4,486.42 \text{ psi}}
 \end{aligned}$$

Maximum allowable pressure, (at 60 ° F) Appendix 1-2

$$\begin{aligned}
 P &= S \cdot E \cdot \ln(R_o / (R_o - t)) \\
 &= 17,100 \cdot 1.00 \cdot \ln(0.6575 / (0.6575 - (0.25 \cdot 0.875))) \\
 &= \underline{6,917.21 \text{ psi}}
 \end{aligned}$$

External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned}
 L / D_o &= 19.1902 / 1.315 = 14.5933 \\
 D_o / t &= 1.315 / 0.0125 = 105.1813
 \end{aligned}$$

$$\begin{aligned}
 \text{From table G: } A &= 0.000105 \\
 \text{From table CS-2: } B &= 1,508.5888 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 P_a &= 4 \cdot B / (3 \cdot (D_o / t)) \\
 &= 4 \cdot 1,508.59 / (3 \cdot (1.315 / 0.0125)) \\
 &= 19.12 \text{ psi}
 \end{aligned}$$

Design thickness for external pressure $P_a = 19.12 \text{ psi}$

$$t_a = t + \text{Corrosion} = 0.0125 + 0.0625 = \underline{0.075"}$$

Maximum Allowable External Pressure, (Corroded & at 150 ° F) UG-28(c)

$$\begin{aligned} L / D_o &= 19.1902 / 1.315 &= 14.5933 \\ D_o / t &= 1.315 / (0.25 \times 0.875 - 0.0625) &= 8.4160 \end{aligned}$$

From table G: $A = 0.016165$

From table CS-2: $B = 17,490.7297 \text{ psi}$

$$S_y = 2 \times B_{(sy)} = 2 \times 17,600 = 35,200 \text{ psi}$$

$$S_1 = 2 \times S_e = 2 \times 17,100 = 34,200 \text{ psi}$$

$$S_2 = 0.90 \times S_y = 0.90 \times 35,200 = 31,680 \text{ psi}$$

$$S = \min(S_1, S_2) = \min(34,200, 31,680) = 31,680 \text{ psi}$$

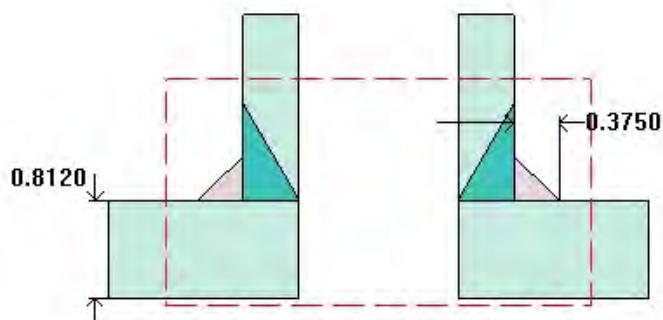
$$\begin{aligned} P_{a1} &= [2.167 / (D_o / t) - 0.08333] \times B - P_{se} \\ &= [2.167 / 8.4160 - 0.08333] \times 17,491 - 4.12 \\ &= 3,042.51 \text{ psi} \end{aligned}$$

$$\begin{aligned} P_{a2} &= (2 \times S / (D_o / t)) \times [1 - 1 / (D_o / t)] - P_{se} \\ &= (2 \times 31,680 / 8.416) \times [1 - 1 / 8.416] - 4.12 \\ &= 6,629.85 \text{ psi} \end{aligned}$$

$$\text{Maximum Allowable External Pressure} = \min(P_{a1}, P_{a2}) = \underline{3,042.51} \text{ psi}$$

Drain (Coalescer) (C2)

ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	135°
Nozzle center line offset to datum line	21"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

Nozzle

Description	NPS 1 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.315"
Nominal wall thickness	0.4675"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.375"
Local vessel minimum thickness	0.7105"
Liquid static head included	2.43 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,118.81 * 0.72 / (20,000 * 1 - 0.6 * 1,118.81) =$	0.0417"
Stress ratio = $t_r * E^* / (t_n - c) = 0.0417 * 1 / (0.4675 - 0.0625) =$	0.1029
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,102.43 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.4675

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P _e = 15 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.4675

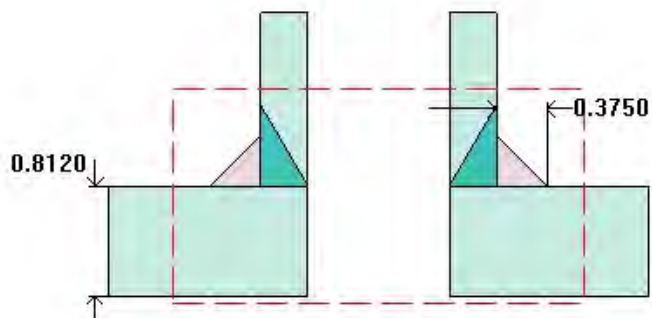
UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Vent (C3)

ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	225°
Nozzle center line offset to datum line	75"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

Nozzle

Description	NPS 0.75 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.05"
Nominal wall thickness	0.35"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.375"
Local vessel minimum thickness	0.7105"
Liquid static head included	0.48 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,116.85 * 0.5875 / (20,000 * 1 - 0.6 * 1,116.85) =$	0.0339"
Stress ratio $= t_r * E^* / (t_n - c) = 0.0339 * 1 / (0.35 - 0.0625) =$	0.1181
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,100.48 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.35

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.2012	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For $P_e = 15 \text{ psi @ } 150 \text{ }^\circ\text{F}$							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.35

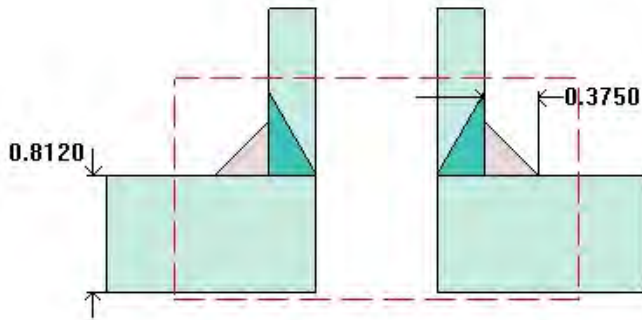
UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.2012	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

DPI (C4A)

ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	90°
Nozzle center line offset to datum line	52"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

Nozzle

Description	NPS 0.5 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	0.84"
Nominal wall thickness	0.33"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.375"
Local vessel minimum thickness	0.7105"
Liquid static head included	1.3 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,117.68 * 0.4825 / (20,000 * 1 - 0.6 * 1,117.68) =$	0.0279"
Stress ratio $= t_r * E^* / (t_n - c) = 0.0279 * 1 / (0.33 - 0.0625) =$	0.1043
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,101.3 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

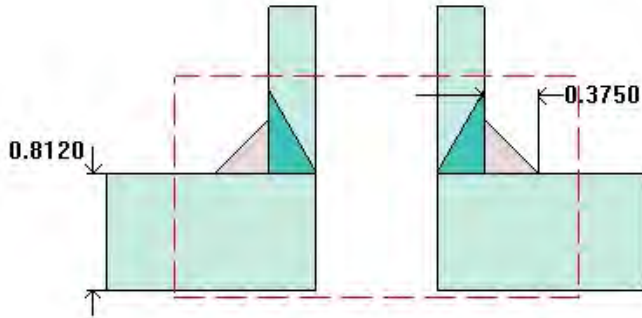
UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For $P_e = 15 \text{ psi @ } 150 \text{ }^\circ\text{F}$							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	180°
Nozzle center line offset to datum line	9"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

Nozzle

Description	NPS 0.5 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	0.84"
Nominal wall thickness	0.33"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.375"
Local vessel minimum thickness	0.7105"
Liquid static head included	2.86 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,119.23 * 0.4825 / (20,000 * 1 - 0.6 * 1,119.23) =$	0.0279"
Stress ratio $= t_r * E^* / (t_n - c) = 0.0279 * 1 / (0.33 - 0.0625) =$	0.1045
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,102.86 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

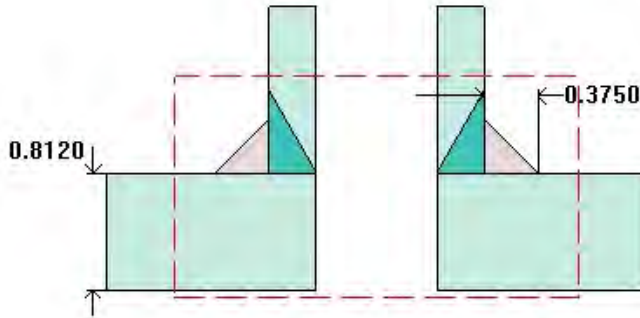
UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For $P_e = 15 \text{ psi @ } 150 \text{ }^\circ\text{F}$							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

ASME Section VIII Division 1, 2015 Edition



Note: round inside edges per UG-76(c)

Location and Orientation

Located on	Shell
Orientation	180°
Nozzle center line offset to datum line	52"
End of nozzle to shell center	12.375"
Passes through a Category A joint	No

Nozzle

Description	NPS 0.5 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	0.84"
Nominal wall thickness	0.33"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	2.375"
Local vessel minimum thickness	0.7105"
Liquid static head included	1.3 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg ₄₁	0.375"
---------------------------------	--------

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 1,117.68 * 0.4825 / (20,000 * 1 - 0.6 * 1,117.68) =$	0.0279"
Stress ratio $= t_r * E^* / (t_n - c) = 0.0279 * 1 / (0.33 - 0.0625) =$	0.1043
Stress ratio ≤ 0.35 , MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 1,101.3 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)

Reinforcement Calculations for External Pressure

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For $P_e = 15 \text{ psi @ } 150 \text{ }^\circ\text{F}$							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.125	0.33

UG-41 Weld Failure Path Analysis Summary
Weld strength calculations are not required for external pressure

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.1872	0.2625	weld size is adequate

This opening does not require reinforcement per UG-36(c)(3)(a)



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165053

SECTION 4

MATERIAL TEST REPORTS AND/OR MATERIAL CERTIFICATIONS

KMI FAB
S/O 165053
Date 2-8-17
Item # 1

FSDA206D



INSPECTION CERTIFICATE
CERTIFICATO DI COLLAUDO
(UNI EN 10204 3.1 / ISO 10474 3.1.B)

Number / Numero: **01/14/14320**
Page / Pagina: **1 / 6**
Date / Data: December 20, 2014

Dalmine S.p.A. - Dalmine plant
Piazza Coduri 6 Luglio 1944, 1
24044 Dalmine (BG) - Italy
+39 035 560 111 fax

Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.		Customer's Order Item / Rifer. Ordine Cliente - Item: HR055166		Customer's Reference / Posizione Cliente:		Manufacturer's Works Order N° / Conferma-Prestazione: 1232079/005	
Manufacture Process / Processo di fabbricazione:		Product Type / Tipo di prodotto: SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS) TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)		Surface / Superficie: See note nr.3 Vedi nota nr.3		Ends / Estremità: BEVEL API 5L / ISO 3183 CT4:8825 SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825	
Standard or Specification / Norme o specifica: See note nr.1 Vedi nota nr.1		Steel Grade / Grado dell'Acciaio: See note nr.2 Vedi nota nr.2		Quantity / Quantità: 4Pcs/Pz		Nominal Weight / Peso nominale: 166.68 lb/ft 247.90 Kg/m	
Dimensions / Dimensioni: ø 20.000" O.D. x 0.312" W.T. ø 508mm O.D. x 20.62mm W.T.	Schedule / Scheda: 60	Length / Lunghezza: 37.999 ft + 42.001 ft 11582 mm ÷ 12802 mm	Weight / Peso: 163.75 ft 49.91 mt		27374,7 lb 12417 kg		

DELIVERY NOTES / AVVISI DI SPEDIZIONE

Delivery Notes Avvisi di spedizione Job number: 0031105304 / 000050 Shipping note: 97290165 - 18/12/2014 Address: PO BOX 581270	Delivery Notes Avvisi di spedizione Town: 74158 TULSA Country: USA
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TENSILE TEST / PROVA DI TRAZIONE

Heat N° Colata N°	Sample N° Prova N°	Specimen condition Condizioni della provetta				Specimen dimensions Dimensioni della provetta		Test temp. Temp. di prova	Y.S.		U.T.S.	Elongation / Allungamento			
		Ls	Sc	Type Tipo	Ort	Size Dimensioni	Area Area		Min	Max		Lo	Min.	Min.	Obl.
945033	L1468	B	AM	Cs	L	12.64	125.50	+20	530.00	771.00	773.00	cal.	mm	%	%
945535	L1471	B	AM	Ss	L	37.84 x 20.27	767.90	+20	574.00	773.00	773.00	2"	50.8	23.0%	34.1%
												2"	50.8	30.0%	46.3%

AM: As manufactured / Come laminato	Lo: Initial length / Lunghezza iniziale	Obl: Obtained / Ottenuto	Ss: Strip specimen / Rettangolare
B: Body / Corpo	Ls: Location of sample / Ubicazione provetta	Ort: Orientation / Orientamento	U.T.S: Ultimate Tensile Strength / Rottura
Cs: Cylindrical specimen / Cilindrica	Max: Maximum / Massimo	Req: Required / Richiesto	Y.S: Yield Strength / Snervamento
L: Longitudinal / Longitudinale	Min: Minimum / Minimo	Sc: Specimen condition / Condizioni Provetta	

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trade-mark green colored "Tenaris" is stamped. In case the owner of the original certificate would release a copy of it, he must attest its conformity to the original one taking upon himself the responsibility for any unlawful or not allowed use. Any alteration and/or falsification will be subjected to the law.

Questo certificato è emesso da un sistema computerizzato ed è valido con firma elettronica. Il certificato originale riporta il marchio "Tenaris" in colore verde. Il possessore dell'originale, qualora rilasci copia, deve attestare a suo nome la conformità all'originale, assumendosi ogni responsabilità per usi illeciti o non consentiti. Qualunque alterazione o falsificazione sarà perseguita a norma di legge.

FOR03171



[IN: 15] | TY023201-1 | FSDA2060

20' shell

S/O 165053



INSPECTION CERTIFICATE
CERTIFICATO DI COLLAUDO
(UNI EN 10204 3.1 / ISO 10474 3.1.B)

Number / Numero:
01/14/14320

Page / Pagina:
2 / 6

Date / Data: December 20, 2014

Dalmine S.p.A. - Dalmine plant
Piazza Caduti 6 Luglio 1944, 1
24044 Dalmine (BG) - Italy
+39 035 560 111 tel

Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.		Customer's Order Item / Rifer. Ordine Cliente - Item HR055166		Customer's Reference / Posizione Cliente:		Manufacturer's Works Order N° / Conformità-Posizione 1232079/005	
Manufacture Process / Processo di fabbricazione:		Product Type / Tipo di prodotto: SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS) TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)				Surface / Superficie: See note nr.3 Vedi nota nr.3	
Standard or Specification / Norme o specifica: See note nr.1 Vedi nota nr.1		Steel Grade / Grado dell'Acciaio: See note nr.2 Vedi nota nr.2				Ends / Estremità: BEVEL API 5L / ISO 3183 CT4:8825 SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825	
Dimensions / Dimensioni: ø 20.000" O.D. x 0.812" W.T. ø 508mm O.D. x 20.62mm W.T.		Schedule / Scheda: 60		Length / Lunghezza: 37.999 ft ÷ 42.001 ft 11582 mm ÷ 12802 mm		Quantity / Quantità: 4Pcs/Pz 163,75 ft 49.91 mt	
				27374,7 lb 12417 kg		Nominal Weight / Peso nominale: 166.58 lb/ft 247.90 Kg/m	

CHEMICAL COMPOSITION / COMPOSIZIONE CHIMICA

		Composition % / Composizione %													
		x 100							x 1000						
		C	Mn	Si	Ni	Cr	Mo	Cu	Ce LF	F1	F2	P	S	Ti	Nb
Heat N° Colata N°	Sample N° Prova N°	H	Max	Min	Max	Min	Max	Min	Max	Min	Max	Max	Min	Max	Max
		P	Min	Max	Min	Max	Min	Max	Min	Max	Min	Min	Max	Min	Min
945633		H	12	116	26	10	12	8	13	38	50	9.1	14	2	21
945633	L1468	P	12	115	25	10	12	8	13	38	49	7.8	13	2	18
945633	L1469	P	12	114	25	10	12	8	13	38	49	7.8	13	2	18
945635		H	12	120	20	11	16	8	14	40	56	9.3	17	2	23
945635	L1471	P	12	119	19	11	16	8	14	40	55	8	16	2	20
945635	L1472	P	13	120	19	12	17	8	15	41	58	8.1	17	3	21

Ce LF: G+Mn/5+(Cr+Mo+V)/5+(Ni+Cu)/15

F2: (Nb+V)

Max: Maximum / Massimo

P: Product / Prodotto

F1: (V+Ni+Cr+Mo+Cu)

H: Heat / Colata

Min: Minimum / Minimo

SUPERFICIAL HARDNESS / DUREZZA SUPERFICIALE

Heat N° Colata N°	Sample N° Prova N°	Ls	Sc	External / Esterna Scale / Scala: HRB	
				Req. Min:	Req. Max: 100.0
945633	L1468	B	AM	79.0	

Heat N° Colata N°	Sample N° Prova N°	Ls	Sc	External / Esterna Scale / Scala: HRB	
				Req. Min:	Req. Max: 100.0
945635	L1471	B	AM	83.0	

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FOR03171

[10352] [945635] [LN: 15] [TY023201-1] [FSDA2060]





INSPECTION CERTIFICATE
CERTIFICATO DI COLLAUDO
(UNI EN 10204 3.1 / ISO 10474 3.1.B)

Number / Numero:
01/14/14320

Page / Pagina:
3 / 6

Date / Data: December 20, 2014

Dalmine S.p.A. - Dalmine plant
Piazza Caduti 5 Luglio 1944 1
24044 Dalmine (BG) - Italy
+39 035 560 111 tel

Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.

Customer's Order Item / Rifer. Ordine Cliente - Item
HR055166

Customer's Reference / Posizione Cliente:

Manufacturer's Works Order N° / Conferma-Posizione:
1232079/005

Manufacture Process / Processo di fabbricazione:

Product Type / Tipo di prodotto:

SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS)
TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)

Surface / Superficie:

See note nr.3
Vedi nota nr.3

Standard or Specification / Nome o specifica:

See note nr.1
Vedi nota nr.1

Steel Grade / Grado dell'Acciaio:

See note nr.2
Vedi nota nr.2

Ends / Estremità:

BEVEL API 5L / ISO 3183 CT4:8825
SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825

Dimensions / Dimensioni:

20.000" O.D. x 0.812" W.T.
508mm O.D. x 20.62mm W.T.

Schedule / Scheda:

60

Length / Lunghezza:

37.999 ft ± 42.001 ft
11582 mm ± 12802 mm

Quantity / Quantità: 4Pcs/Pz

163,75 ft 27374,7 lb
49,91 mt 12417 kg

Nominal Weight / Peso nominale:

166.58 lb/ft
247.90 Kg/m

SUPERFICIAL HARDNESS / DUREZZA SUPERFICIALE

AM: As manufactured / Come laminato

B: Body / Corpo

Ls: Location of sample / Ubicazione provetta

Sc: Specimen condition / Condizioni Provetta

FLATTENING TEST / PROVA DI SCHIACCIAMENTO

Standard / Norma:

Heat N° Colata N°	Sample N° Prova N°	Zone Zona	Sc	Test Frequency Frequenza prova	Result Esito
945633	L1467	E1	AM	pipes of the lot	Good/Buono

Standard / Norma:

Heat N° Colata N°	Sample N° Prova N°	Zone Zona	Sc	Test Frequency Frequenza prova	Result Esito
945635	L1470	E1	AM	pipes of the lot	Good/Buono

AM: As manufactured / Come laminato

E1 / E2: Ends of Sampling / Estremità della

provetta

Sc: Specimen condition / Condizioni Provetta

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FOR03171



10352 | 945635 | TY023201-1 | FSDA2060



INSPECTION CERTIFICATE
CERTIFICATO DI COLLAUDO
(UNI EN 10204 3.1 / ISO 10474 3.1.B)

Number / Numero: **01/14/14320**
Page / Pagina: **4 / 6**
Date / Data: **December 20, 2014**

Dalmine S.p.A. - Dalmine plant
Piazza Caduti 6 Luglio 1944, 1
24044 Dalmine (BG) - Italy
+39 035 560 111 tel

Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.		Customer's Order Item / Rifer. Ordine Cliente - Item: HR055166	Customer's Reference / Posizione Cliente:	Manufacturer's Works Order N° / Conferma-Posizione:
Manufacture Process / Processo di fabbricazione:		Product Type / Tipo di prodotto: SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS) TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)		Manufacturer's Works Order N° / Conferma-Posizione: 1232079/005
Standard or Specification / Norme o specifiche: See note nr.1 Vedi nota nr.1		Steel Grade / Grado dell'Acciaio: See note nr.2 Vedi nota nr.2		Surface / Superficie: See note nr.3 Vedi nota nr.3
Dimensions / Dimensioni: ø 20.000" O.D. x 0.812" W.T. ø 508mm O.D. x 20.62mm W.T.	Schedule / Schedule: 60	Length / Lunghezza: 37.999 ft ÷ 42.001 ft 11582 mm ÷ 12802 mm	Quantity / Quantità: 4Pcs/Pz 163,75 ft 49.91 mt	Ends / Estremità: BEVEL API 5L / ISO 3183 CT4:8825 SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825
			27374,7 lb 12417 kg	Nominal Weight / Peso nominale: 166.58 lb/ft 247.90 Kg/m

HYDROSTATIC TEST / PROVA IDRAULICA

Pressure / Pressione		Time / Tempo	Results / Risultato
Unit / Unità	Value / Valore	Seconds / Secondi	
psi	2,970	5	Satisfactory / Soddisfacente

SUPPLEMENTARY INFORMATION / INFORMAZIONI SUPPLEMENTARI

STANDARD EDITIONS EDIZIONI NORME	
Standard:API 5L Year:2012 Revision:Ed... Revision year:45th	Norma:API 5L Anno:2012 Revisione:Ed... Anno della revisione:45th
Standard:ASTM A53/A106 Year:2010	Norma:ASTM A53/A106 Anno:2010
Standard:ASME SA53/SA106 Year:2013	Norma:ASME SA53/SA106 Anno:2013
Standard:NACE MR0175/ISO 15156 Year:2009	Norma:NACE MR0175/ISO 15156 Anno:2009
Standard:NACE MR0103 Year:2012	Norma:NACE MR0103 Anno:2012

PRODUCT DESCRIPTION NOTES NOTE DI DESCRIZIONE DEL PRODOTTO	
Note 1 is the full description of the 'Standard or specification' ACC. TO THE NORM API 5L PSL1 45TH ED. A/SA 106/53,IPS SPEC.1,NACE MR01.75/01.03 + TEMP TQ NO.1 20013058/4.1 V.4	La nota 1 è la descrizione completa delle 'Norme o specifiche' NORMA API 5L PSL1 45A EDIZ., A/SA 106/53,IPS SPEC.1,NACE MR01.75/01.03 + TEMP TQ NO.1 20013058/4.1 V.4
Note 2 is the full description of the 'Steel grade' STEEL GR. X42 PSL1 GR.B PSL1,GR.B/C A/SA 106,GR. B A/SA 53	La nota 2 è la descrizione completa del 'Grado acciaio' ACCIAIO GR. X42 PSL1 GR.B PSL1,GR.B/C A/SA 106,GR. B A/SA 53
Note 3 is the full description of the 'Surface' BARE INSIDE, EXTERNALLY PROTECTED BY VARNISH, SUITABLE FOR COATING,	La nota 3 è la descrizione completa della 'Superficie' GREZZI INTERNAMENTE, OLEATI ESTERNAMENTE ATTI AL RIVESTIMENTO

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FOR03171

[LN: 15] | TY023201-1 | FSDA2060 | 945635 | 10352 | 165053





INSPECTION CERTIFICATE
CERTIFICATO DI COLLAUDO
(UNI EN 10204 3.1 / ISO 10474 3.1.B)

Number / Numero:
01/14/14320

Page / Pagina:
5 / 6

Date / Data: December 20, 2014

Dalmine S.p.A. - Dalmine plant:
Piazza Caduti 6 Luglio 1944, 1
24044 Dalmine (BG) - Italy
+39 035 560 111 fax

Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.		Customer's Order Item / Rifer. Ordine Cliente - Item:	Customer's Reference / Posizione Cliente:	Manufacturer's Works Order N° / Conferma Posizione:
Manufacture Process / Processo di fabbricazione:		Product Type / Tipo di prodotto:	1232079/005	
		SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS) TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)	Surface / Superficie: See note nr.3 Vedi nota nr.3	
Standard or Specification / Norme o specifiche: See note nr.1 Vedi nota nr.1		Steel Grade / Grado dell'Acciaio: See note nr.2 Vedi nota nr.2	Ends / Estremità: BEVEL API 5L / ISO 3183 CT4:8825 SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825	
Dimensions / Dimensioni: ø 20.000" O.D. x 0.812" W.T. ø 508mm O.D. x 20.62mm W.T.	Schedule / Scheda: 60	Length / Lunghezza: 37.999 ft ÷ 42.001 ft 11582 mm ÷ 12802 mm	Quantity / Quantità: 4Pcs/Pz 163,75 lb 49.91 mt 27374,7 lb 12417 kg	Nominal Weight / Peso nominale: 166.58 lb/ft 247.90 Kg/m

SUPPLEMENTARY INFORMATION / INFORMAZIONI SUPPLEMENTARI

Supplementary Information Informazioni supplementari	
AFTER INSPECTION OPERATION, THE MATERIAL HAS NOT A RESIDUAL MAGNETISM GREATER THAN 20 GAUSS HARDNESS HRC 22 MAX, ACCORDING TO NACE MR-01-75/ISO 15156 HARDNESS HBW 225 MAX, ACCORDING TO NACE MR-01-03 COUNTRY OF MELT: TENARIS DALMINE (ITALY) SEAMLESS HOT FINISHED PIPES VISUAL AND DIMENSIONAL CONTROL HAS BEEN CARRIED OUT WITH SATISFACTORY RESULT STEEL IS FULLY KILLED AND PRODUCED BY ELECTRIC FURNACE TO A FINE GRAIN PRACTICE THE PRODUCT SUPPLIED IS IN COMPLIANCE WITH THE REQUIREMENTS OF THE ORDER. MANUFACTURED BY TENARIS DALMINE NO WELD REPAIR, MERCURY AND RADIATION FREE Tenaris IT identification number for MTC: 56v(D)/H	DOPO LE OPERAZIONI DI CONTROLLO, IL MATERIALE NON PRESENTA UN MAGNETISMO RESIDUO SUPERIORE A 20 GAUSS DUREZZA HRC 22 MAX, IN ACCORDO ALLA SPEC. NACE MR-01-75/ISO 15156 DUREZZA HBW 225 MAX, IN ACCORDO ALLA SPEC. NACE MR-01-03 PAESE FUSIONE ACCIAIO: TENARIS DALMINE (ITALIA) TUBI SENZA SALDATURA FINITI A CALDO IL CONTROLLO VISIVO E DIMENSIONALE HA DATO ESITO SODDISFACENTE L'ACCIAIO E' DI TIPO CALMATO, A GRANO FINE, PRODOTTO AL FORNO ELETTRICO IL MATERIALE FORNITO E' IN ACCORDO AI REQUISITI DELL'ORDINE. FABBRICATO DA TENARIS DALMINE NON RIPARATO MEDIANTE SALDATURA, ESENTE DA MERCURIO E RADIAZIONI Numero identificativo Tenaris IT per MTC: 56v(D)/H

MARKING / MARCATURA

Marking Marcatura	
STENCILING _T SPEC 5L 0038.1 _API_ DATA 20 0.812 B-X42 PSL 1 SMLS ASTM ASME A SA 106 B/C PSI:2970 ASTM ASME A SA 53 B S HEAT: _C OLATA FT _FT LBS _LBS NR_ _NR	VERNICIATURA _T SPEC 5L 0038.1 _API_ DATA 20 0.812 B-X42 PSL 1 SMLS ASTM ASME A SA 106 B/C PSI:2970 ASTM ASME A SA 53 B S HEAT: _C OLATA FT _FT LBS _LBS NR_ _NR
LEGEND _T = TENARIS Logo	LEGENDA _T = Logo TENARIS

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FOR03171

[IN: 15] | TY023201-1 | FSDA2060 | 945635 | 10352 | 304165053





INSPECTION CERTIFICATE
CERTIFICATO DI COLLAUDO
(UNI EN 10204 3.1 / ISO 10474 3.1.B)

Number / Numero:
01/14/14320

Page / Pagina:
6 / 6

Date / Data: December 20, 2014

Dalmine S.p.A. - Dalmine plant
Piazza Caduti 6 Luglio 1944, 1
24044 Dalmine (BG) - Italy
+39 035 560 1111

Customer / Cliente: INDUSTRIAL PIPING SPECIALISTS, INC.

Customer's Order Item / Rifer. Ordine Cliente - Item
HR055166

Customer's Reference / Posizione Cliente:

Manufacturer's Works Order N° / Conferma Posizione:
1232079/005

Manufacture Process / Processo di fabbricazione:

Product Type / Tipo di prodotto:

SEAMLESS LINE PIPES (WITH EXTRA REQUIREMENTS)
TUBI S.S. LINE PIPE (CON RICHIESTE SUPPLEMENTARI)

Surface / Superficie:

See note nr.3

Vedi nota nr.3

Standard or Specification / Norme o specifica:

See note nr.1

Vedi nota nr.1

Steel Grade / Grado dell'Acciaio:

See note nr.2

Vedi nota nr.2

Ends / Estremità:

BEVEL API 5L / ISO 3183 CT4:8825

SMUSSATI SECONDO API 5L / ISO 3183 CT4:8825

Dimensions / Dimensioni:

ø 20.000" O.D. x 0.812" W.T.

ø 508mm O.D. x 20.62mm W.T.

Schedule / Scheda:

60

Length / Lunghezza:

37.999 ft + 42.001 ft

11582 mm + 12802 mm

Quantity / Quantità: 4Pcs/Pz

163,75 ft

49.91 mt

27374,7 lb

12417 kg

Nominal Weight / Peso nominale:

166.58 lb/ft

247.90 Kg/m

MARKING / MARCATURA

Marking
Marcatura

_API = API Logo

_DATA = Marking Date

_FT = Pipe/Tube Length in feet

_LBS = Pipe/Tube Weight in pounds

_NR = Pipe/Tube Identifier

_API = Logo API

_DATA = Data di marcatura

_FT = Lunghezza del tubo in piedi

_LBS = Peso del tubo in libbre

_NR = Identificativo numerico del tubo

This is to certify that the product described here has been manufactured, sampled, tested, and inspected in accordance with purchaser order requirements. This certificate is not a declaration of origin nor may it be used as a declaration of origin.

Si certifica che il prodotto descritto è stato prodotto, provato, testato e controllato in conformità ai requisiti dell'ordine del cliente. Questo certificato non è una dichiarazione d'origine e non può essere usato come tale.

CUSTOMER THIRD PARTY

INSPECTION COMPANY
COMPAGNIA D'ISPEZIONE

TENARIS QUALITY DEPARTMENT SIGNATURE

Signature

QUALITY CERTIFICATION DEPT.
UFFICIO CERTIFICAZIONE QUALITÀ
SIGOLI Gianluca

Signature

CHIEF OF QUALITY CERTIFICATION DEPT.
RESPONSABILE DELL'UFFICIO CERTIFICAZIONE QUALITÀ
RAVANELLI Pietro

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FOR03171



165053



BAKER TANKHEAD

INCORPORATED

BAKER TANKHEAD, INC.
P.O. BOX 77021
10405 NORTH FREEWAY
FORT WORTH, TX 76177
United States of America
Ph: 866-232-8030
Fax: 817-847-7244

Cert # 93563

Material Certification

Date :7-Dec-16

To:

KMI FABRICATORS, INC.
410 BOYD ROAD
MINERAL WELLS, TX 76067

Ship To:

ERBY ATKINS
KMI FABRICATORS, INC.
410 BOYD ROAD
MINERAL WELLS, TX 76067

Phone: 940-325-7841

Fax: 940-325-3765

Phone: 940-325-7841

Fax: 940-325-3765

Job #	Customer PO	Qty	Code/Lot	Material	Mill*	Heat No*	SLab/Pc No*
169084		1	AAX	20 X 3/4 E HP PFS INV	* See Mill Test Report		
10349		1	AKC	20 X 3/4 E HP PFS INV			
20 X 3/4 E HP PFS 20"OD X 3/4"NOM 2:1 ELLIP .6875"MIN - SA516-70 - 2"SF 6 5/8"IOH 5' 2 13/16"OSC 30 DEG OS BEVEL W/ 1/16"LD 26 1/2"DIA - 118# NORMALIZED IN HOT FORMING DOMESTIC MATERIAL CUSTOMER 165052 & CUSTOMER 165053							
* The items listed above were formed in strict accordance with all applicable requirements of the ASME Boiler and Pressure Vessel Code Section VIII, Div. 1.							
* We hereby certify that these parts comply with tolerances of UG-81 of ASME Section VIII, Div. 1.							
* We hereby certify that these heads were heated to 1650 degree F min, held for one hour per inch of thickness, hot formed and still air cooled.							
KMI FAB S/O 165053 Date 2-8-17 Item # 2							

1 of 2

1 of 2

PO#46280 (1pc) 120X480X3/4" SA516-70 code: AKC
SSAB Rec'd (1pc) PO#46308 2-20-15
Test Certificate

12400 Highway 43 North, Axis, Alabama 36505, US

Form TC1: Revision 2: Date 23 Apr 2014

Customer: DELTA STEEL, INC. 5599 SAN FELIPE-STE 600 P.O BOX 2289 HOUSTON TX 77252				Customer P.O.No.: DFW-241171				Mill Order No. 41-418312-09				Shipping Manifest: AR198414									
Product Description: ASTM A516-70(10)/ASME SA516-70(13) A20 520.1 CEV.43MAX;TEST NORM 1650+/-25F 1HR;NACE MR0175 ANNEX A2.1.2 COMPLIANT								Ship Date: 13 Jan 15 Cert Date: 13 Jan 15				Cert No: 081490844 (Page 1 of 1)									
Size: 0.750 X 120.0 X 480.0 (IN)																					
Tested Pieces:				Tensiles:				Charpy Impact Tests													
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir	Hardness	Abs. Energy(FTLB) 1 2 3 Avg				% Shear 1 2 3 Avg				Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tst %Shr
W5A509	B47	0.748 (DISCRT)	L 51\	74\	74\		24\	T	AKC												
W5A509	B47*	0.748 (DISCRT)	L 52\	74\			26\	T													
W5A509	B48	0.748 (DISCRT)	L 51	74			26	T													
W5A509	B48*	0.748 (DISCRT)	L 51	74			29	T													
Chemical Analysis																					
Heat Id	C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	Cev					
W5A509	.18\	1.05\	.009\	.002\	.24\	.030	.029	.31\	.15\	.13\	.03\	.001\	.005\	.009\	.0001	.42					
																	ORGN USA				
KILLED STEEL MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT. KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15 RESULTS OF TESTS PERFORMED ON NORMALIZED TEST COUPONS ARE LABELED ABOVE WITH * MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT 100% MELTED AND MANUFACTURED IN THE USA. PRODUCTS SHIPPED: W5A509 B48 PCS: 4, LBS: 49008 W5A509 B47 PCS: 4, LBS: 49008																					
Robert Panice 2-17-14																					
(*) Cust Part #:																	WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION				
																	Justin Ward +1 251 662 4400 SENIOR METALLURGIST - PRODUCT				

DELTA STEEL, INC.
BAKER TANK HEAD, INC.
Heat No. W5A509 Slab No. B47
Doc No. 107576 Indexed 15-Jan-15 by aiaja

PO/Rei: 46280 /
B/L: DFW-36927 W/O: DFW-284564-1

Certificate of Mill Test Results

17-Feb-15
Page 1 of 1

2 for

2011
ZH551

165053

NATIONAL OILWELL SERVICES

Process & Flow Technology
10906 FM 2920
Tomball, TX 77375
Telephone: (281) 351-2222
Facsimile: (281) 351-6557

S/O# 165053

CUSTOMER: KMI FABRICATORS, INC.

P.O.# 10350

S.O.#: 1531971

PER YOUR INSTRUCTIONS, WE ARE ENCLOSING THE FOLLOWING DOCUMENTS:

_____	COPIES OF APPROVED DRAWINGS
_____	COPIES OF CERTIFIED DIM. DRAWINGS
X	COPIES OF PARTIAL DATA REPORT
X	COPIES OF MILL TEST REPORTS
_____	(ONE COPY ON CAP & ONE COPY ON HUB)
_____	COPIES OF SPARE PARTS LIST
_____	COPIES OF WELDING INSTRUCTIONS
_____	COPIES OF MAINTENANCE & OPERATIONS INSTRUCTIONS
_____	COPIES OF ASME CERTIFICATIONS
_____	COPIES OF DOT CERTIFICATIONS
_____	COPIES OF NACE CERTIFICATIONS
_____	COPIES OF API CERTIFICATIONS
_____	COPIES OF NDE CERTIFICATIONS

13 pages

KMI FAB
S/O 165053
Date 2-8-17
Item # 3

[illegible]

SO No 1531971-2

PO No 10350

FORM U-2A MANUFACTURER'S PARTIAL DATA REPORT (ALTERNATE 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 NATIONAL OILWELL VARCO 10906 FM 2920 TOMBALL, TEXAS 77375
(Name and address of Manufacturer)2. Manufactured for KMI FABRICATORS INC. 410 BOYD ROAD MINERAL WELLS, TX 76067
(Name and address of Purchaser)3. Location of Installation UNKNOWN
(Name and address)4. Type: (2) 20" CLOSURES ZH550 THRU ZH551 N/A
(Description of vessel part (shell, two-piece head, tube bundle)) (Mfg.'s Serial No.) (CRN)N/A 1531971-2R1 NATIONAL OILWELL VARCO 2017
(National Board Number) (Drawing Number) (Drawing prepared by:) (Year Built)5. ASME Code, Section VIII, Div. 1 2015 EDITION N/A N/A
(Edition and Addenda (Date)) (Code Case No.) (Special service per UG-120(d))6. Shell (a) No. of course(s) 1 (b) Overall length (ft. and in.): 1-00.

Course(s)			Material	Thickness, in.		Long Joint (Cat. A)			Circum. Joint (Cat. A, B, & C)			Heat Treatment	
No.	Diameter, in	Length, ft+in	Spec/Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp., F	Time
1	18.376	1-00.	SA 350 LF2	0.812	0.063	S	NONE	1	S	NONE	1	N/A	N/A
			CLASS 1										

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
N/A												

7. Heads: (a) SA 516-70 N (b) N/A
(Mat'l Spec. no., Grade or Type)(H.T. - Time and Temp.) (Mat'l Spec. no., Grade or Type)(H.T. - Time and Temp.)

(Mat'l Spec. No., Grade or Type)(H.T. - Time and Temp.)										(Mat'l Spec. no., Grade or Type)(H.T. - Time and Temp.)					
	Location (Top, Bottom Ends)	Thickness, in.		Radius, in.		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A			
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None.	Effc.	
(a)	TOP	0.673	0.063	-----	-----	2:1	-----	-----	-----			X	S	NONE	1
(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)	N/A											

8. MAWP 1100 PSI @ max temp. = 150 °F. Min Design Metal Temp -20 °F at 1100 PSI
internal external internal external9. Impact test Yes - CAP, HUB, & FITTING At a test temp of -51 & -50 & -50 °F
(Indicate yes or no and the component(s) impact tested)10. Hydro., pneu., or comb. Test pressure SEE REMARKS Proof Test: N/A11. Nozzles, inspection, and safety valve openings: UG-125(a) At PSIG

Purpose (Inlet, Outlet, Drain, etc.)	No.	Dia. or Size, in.	Flange Type	Material		Nozzle Thickness, in		Reinforcement Material	How Attached		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
SEE REMARKS											
OUTLET	1	1/2" NPT	TH'D	SA 350 LF2 CL1		0.500	0.063	INHERENT	*WELDED		HEAD
PAV	1	1/2" NPT	TH'D	SA 350 LF2 CL1		N/A	N/A	INHERENT	INT THD		SHELL

12. Identification of part(s)							
Name of Part	Qty.	Line No.	Mfg's. Identification No.	Mfg's. Dwg No.	CRN	National Board No.	Year
N/A							

13. Supports: Skirt --- Lugs --- Legs --- Others --- Attached ---
(Yes or No) (Number) (Number) (Describe) (Where and How)14. Remarks: THIS TEMPERATURE APPLICABLE TO CLOSURE METAL COMPONENTS ONLY. ACTUAL SERVICE
TEMPERATURE IS DETERMINED BY TEMPERATURE LIMITATIONS OF O-RING MATERIAL.
UG-120,c,2 DESIGN & CALCULATION BY NATIONAL OILWELL VARCO.
CLOSURE ASSEMBLY IS NOT HYDROSTATICALLY TESTED, PRESSURE ALERT VALVE FURNISHED.
*Fig. UW-16.1(x-2).

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. 10052 Expires: July 16, 2017

Date: 01/22/17 Name: NATIONAL OILWELL VARCO

(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 The Hartford Steam Boiler Inspection and Insurance Company of CONNECTICUT have inspected the pressure vessel part described in this Manufacturer's Data Report on 01-20, 2017, 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: 01/20/2017

Signed:

(Authorized Inspector)

Commissions: NB 14370A/15

(National Board (incl. endorsements))

Tank Head Manufacturing Complex
10703 Sheldon Road
Houston, TX 77044

UNI-FORM
COMPONENTS CO.

(281) 456-9310
(800) 231-3272 toll-free
(281) 456-0245 fax

MATERIAL CERTIFICATION

Packlist No.		Customer ID	
PL-82914		RMENSY	
Customer PO No.		UGC Job No.	Date Cert. Originated
7317449		127779	12/8/2016

Sold To:
R&M ENERGY SYSTEM
NATIONAL OILWELL VARCO LP
10906 FM 2920

Ship To:
R&M ENERGY SYSTEM
NATIONAL OILWELL VARCO LP
10906 FM 2920

TOMBALL TX 77375

TOMBALL TX 77375

In Order Qty	Ship Qty	B/O Qty	Part Description
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1 2 2 0 HEAD 2:1ELIP, 21.313 ID X 2 SA 516-70
Unit of Measure: EA

Code: 3T325 / HEAT/SLAB: 414212 / 345002-01 / GRADE: SA516-70 Size: 2 X 96 X 480 MILL: DILLINGER

3T325

part # H60270

matl # 2060F

MILL TEST REPORTS ATTACHED

The chemical and physical properties as indicated on the attached report are the results of the Mill Tests of the raw material used in the manufacture of these products and are certified to meet only the minimum requirements of the ASME and/or ASTM specifications for the material.

1. We hereby certify that these heads were hot formed at the required normalizing temperature and air cooled, in accordance with all applicable specifications.
2. We hereby certify that these heads comply with tolerances of UG-81 of ASME Section VIII, Div. 1.
3. Materials listed above are NACE MR-0175:2015 compliant

Approved for Manufacture
by [Signature]
Date 12/9/16

WE HEREBY CERTIFY THAT THIS REPORT COVERING THE ABOVE AND ATTACHED INFORMATION IS TRUE AND CORRECT AS SHOWN AND CONTAINED IN OUR RECORDS.

[Signature]
Quality Control

[Signature]

QM-System: Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1 AS PER ISO 10474:2013 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 5483199-23.12.14	A08/ Manufacturer's order/ A03 Certificate No. 398993-001	Sheet 1/...
A05 Established inspecting body DF	A05 Purchaser UNI-FORM, HOUSTON, TX Final receiver UNI-FORM, HOUSTON, TX	A07.1 No. 34453A A07.2 No.	B01 Product HEAVY PLATES	
B02/ Steel design. SA516-70/SA516-60 B03 Any suppl. ASME-III:2013 requirements				

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
			INCH						
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414430	352001-01	11250X096SA51670 3T311
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414430	352001-02	11250X096SA51670 3T312
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414430	352002-01	11250X096SA51670 3T313
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414430	352002-02	11250X096SA51670 3T314
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414432	351244-01	11250X096SA51670 3T315
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414432	352003-01	11250X096SA51670 3T316
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414432	352003-02	11250X096SA51670 3T317
01	1	1,1250 x	96,00000 x	480,00000	6669	N	414432	352369-02	11250X096SA51670 3T318
**	8				53352				
03	1	2,0000 x	79,00000 x	316,00000	6423	N	414208	349077-01	20000X079SA51670 3T319
03	1	2,0000 x	79,00000 x	316,00000	6423	N	414208	349077-02	20000X079SA51670 3T320
03	1	2,0000 x	79,00000 x	316,00000	6423	N	414210	349078-01	20000X079SA51670 3T321
03	1	2,0000 x	79,00000 x	316,00000	6423	N	414210	349078-02	20000X079SA51670 3T322
**	4				25692				
04	1	2,0000 x	96,00000 x	480,00000	11855	N	414208	345003-01	20000X096SA51670 3T323
04	1	2,0000 x	96,00000 x	480,00000	11855	N	414212	345001-01	20000X096SA51670 3T324
04	1	2,0000 x	96,00000 x	480,00000	11855	N	414212	345002-01	20000X096SA51670 3T325
04	1	2,0000 x	96,00000 x	480,00000	11855	N	414212	345004-01	20000X096SA51670 3T326
**	4				47420				
05	1	2,5000 x	79,00000 x	316,00000	8028	N	414207	349079-01	25000X079SA51670 3T327
05	1	2,5000 x	79,00000 x	316,00000	8028	N	414207	349079-02	25000X079SA51670 3T328
05	1	2,5000 x	79,00000 x	316,00000	8028	N	414207	349081-01	25000X079SA51670 3T329
05	1	2,5000 x	79,00000 x	316,00000	8028	N	414207	349081-02	25000X079SA51670 3T330

A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 POISSONNET Test House Manager	Dillinger France Port 3032 3032 rue du Comte Jean - CS 56317 F-59379 Dunkerque Cedex 1 - FRANCE Service Qualité-Essais Date 24.12.14	A01 CD 1
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 Manufacturer's mark

QM-System: Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

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A05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX Final receiver UNI-FORM, HOUSTON, TX	A07.1 No. 34453A A07.2 No.	B01 Product HEAVY PLATES	
B02/ Steel design. SA516-70/SA516-60				
B03 Any suppl. ASME-III:2013 requirements				

B01-B99 Description of the product

B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width INCH	B11 Length	B12 Theoretical mass KG	B04 Product delivery condition	B07.2 Heat No.	B07.1 Rolled plate No./ Test No.	A09 Purchaser article number
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414216	347285-01	36250X076SA515703T350
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414216	347286-01	36250X076SA515703T351
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	345298-01	36250X076SA515703T352
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347278-01	36250X076SA515703T353
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347281-01	36250X076SA515703T354
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347282-01	36250X076SA515703T355
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347287-01	36250X076SA515703T356
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347288-01	36250X076SA515703T357
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	347289-01	36250X076SA515703T358
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	348091-01	36250X076SA515703T359
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414218	348096-01	36250X076SA515703T360
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414219	347283-01	36250X076SA515703T361
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414219	347284-01	36250X076SA515703T362
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414219	348093-01	36250X076SA515703T363
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414219	348094-01	36250X076SA515703T364
11	1	3,6250 x	76,00000 x	304,00000	10774	N	414219	348095-01	36250X076SA515703T365
**	17				183158				
***	55				508978				

B04 Product delivery condition

ITEM NO.: 01,03-05,08-11

N: HT: 1670 GR.F +27 -27 GR.F

SOAKING TIME TO ATTAIN THE TARGET TEMPERATURE OVER THE WHOLE SECTION: 1-1,75 MIN/MM (25-45 MIN/INCH)

COOLING IN STILL AIR

A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 POISSONNET Test House Manager	Dillinger France Port 3032 3032 rue du Comte Jean - CS 56317 F-59379 Dunkerque Cedex 1 - FRANCE Service Qualité-Essais Date 24.12.14	A01
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 Manufacturer's
 mark

CD 1

QM-System; Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

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A05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX	A07.1 No. 34453A	B01 Product HEAVY PLATES			
Final receiver UNI-FORM, HOUSTON, TX		A07.2 No.				
B02/ Steel design. SA516-70/SA516-60						
B03 Any suppl. ASME-IIA:2013 requirements						

— B06 Marking of the product —
ITEM NO.: 01,03-05,08-11
STEEL DESIGNATION SA516 70 60 MT LTV
HEAT NO. / TRADEMARK / ROLLED PLATE NO.-TEST NO.

— B07-B99 Further information about the product —
ITEM NO.: 01,03-05,08-11
THICKNESS REDUCTION RATIO $\geq 3,0$ IS FULFILLED (CF. A/SA20 PAR. 5.3)

C10-C29 Tensile test										C14-C15	
B14 Item No.	B07.2 Heat No.	B07.1 Ref.plate/ Test No.	B05 Reference (heat) treatment	C01 C01	C02/ Temp. GRF	C03 RT	C10 KSI RP02	C11	C12 RM	A % LO=2IN	A % LO=8IN
01	414430	352001		K1	QO	RT	52,6		75,1		30
01	414430	352002		K1	QO	RT	53,2		75,1		29
01	414432	351244		K1	QO	RT	48,7		73,8		29
01	414432	352003		K1	QO	RT	53,4		74,7		30
01	414432	352369		K1	QO	RT	52,3		74,5		31
03	414208	349077		K1	QV	RT	52,9		77,3	39	
03	414210	349078		K1	QV	RT	50,9		75,3	40	
04	414208	345003		K1	QV	RT	50,6		75,1	37	
04	414212	345001		K1	QV	RT	52,1		76,7	37	
04	414212	345002		K1	QV	RT	52,3		76,0	38	
04	414212	345004		K1	QV	RT	53,4		77,4	39	
05	414207	349079		K1	QV	RT	50,3		75,1	39	
05	414207	349081		K1	QV	RT	50,6		75,3	40	
05	414207	349082		K1	QV	RT	51,0		75,1	41	
05	414207	349083		K1	QV	RT	49,7		75,1	38	

A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 POISSONNET Test House Manager	Dillinger France Port 3032 3032 rue du Comte Jean - CS 56317 F-59379 Dunkerque Cedex 1 - FRANCE Service Qualité-Essais Date 24.12.14	A01 CD 1
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QM-System: Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

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A05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX Final receiver UNI-FORM, HOUSTON, TX	A07.1 No. 34453A A07.2 No.	B01 Product HEAVY PLATES	
B02/ Steel design. SA516-70/SA516-60				
B03 Any suppl. ASME-IIA:2013 requirements				

C10-C29 Tensile test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01 C02/ C01 Temp. GR.F	C03 KSI RP02	C10 RT	C11 47,3	C12 RM 74,5	C13 74,2	A % 40	A % 37	C14-C15
1.1	414219	348094		K1 QV	RT							
1.1	414219	348095		K1 QV	RT							

C40-C49 Impact test

B14 Item No.	B07.2 Heat No.	B07.1 Rol.plate/ Test No.	B05 Reference (heat) treatment	C01 C02/ C01 Temp. GR.F	C03 Width of test piece	C41 Type of test piece	C40 Testing method	C45 Energy	C45 AV 8	C42 Individual values AV=FT,LBF	C43 Mean value
01	414430	352001		K1 LV	-51	CHP-V			AV 8	273 268 260	267
01	414430	352002		K1 LV	-51	CHP-V			AV 8	285 270 276	277
01	414432	351244		K1 LV	-51	CHP-V			AV 8	288 268 150	235
01	414432	352003		K1 LV	-51	CHP-V			AV 8	275 297 288	287
01	414432	352369		K1 LV	-51	CHP-V			AV 8	268 279 276	274
03	414208	349077		K1 LV	-51	CHP-V			AV 8	234 221 227	227
03	414210	349078		K1 LV	-51	CHP-V			AV 8	266 242 277	262
04	414208	345003		K1 LV	-51	CHP-V			AV 8	218 209 212	213
04	414212	345001		K1 LV	-51	CHP-V			AV 8	215 219 217	217
04	414212	345002		K1 LV	-51	CHP-V			AV 8	204 112 114	143
04	414212	345004		K1 LV	-51	CHP-V			AV 8	223 144 221	196
05	414207	349079		K1 LV	-51	CHP-V			AV 8	206 226 177	203
05	414207	349081		K1 LV	-51	CHP-V			AV 8	219 226 179	208
05	414207	349082		K1 LV	-51	CHP-V			AV 8	112 178 258	183
05	414207	349083		K1 LV	-51	CHP-V			AV 8	202 221 215	213
05	414529	345358		K1 LV	-51	CHP-V			AV 8	218 226 233	226
05	414529	345360		K1 LV	-51	CHP-V			AV 8	184 221 257	221
05	414529	345361		K1 LV	-51	CHP-V			AV 8	168 134 248	183

A04	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 POISSONNET Test House Manager	Dillinger France Port 3032 3032 rue du Comte Jean - CS 56317 F-59379 Dunkerque Cedex 1 - FRANCE Service Qualité-Essais Date 24.12.14	A01
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QM-System: Certification as per ISO 9001

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A05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX Final receiver UNI-FORM, HOUSTON, TX	A07.1 No. 34453A A07.2 No.		B01 Product HEAVY PLATES
B02/ Steel design. SA516-70/SA516-60				
B03 Any suppl. ASME-III:2013 requirements				

C70-C99 Chemical composition % - Heat analysis

B07.2 Heat	C70	C	SI	MN	P	S	CU	MO	NI	CR	V	NB	TI	B	O
414207	Y	0,163	0,384	1,47	0,005	0,0009	0,037	0,016	0,045	0,026	0,001	0,001	0,003	0,0005	0,0012
414208	Y	0,170	0,375	1,46	0,005	0,0008	0,024	0,008	0,032	0,020	0,001	0,001	0,003	0,0002	0,0007
414210	Y	0,163	0,378	1,47	0,005	0,0006	0,035	0,011	0,055	0,031	0,001	0,001	0,002	0,0002	0,0006
414212	Y	0,168	0,376	1,46	0,005	0,0007	0,028	0,013	0,034	0,027	0,001	0,001	0,002	0,0002	0,0004
414214	Y	0,159	0,381	1,48	0,006	0,0011	0,033	0,009	0,045	0,028	0,001	0,001	0,002	0,0002	0,0004
414216	Y	0,162	0,378	1,46	0,006	0,0008	0,038	0,018	0,052	0,038	0,001	0,001	0,002	0,0002	0,0005
414218	Y	0,160	0,361	1,46	0,006	0,0007	0,035	0,014	0,036	0,045	0,001	0,001	0,002	0,0002	0,0008
414219	Y	0,161	0,380	1,46	0,006	0,0006	0,036	0,009	0,040	0,028	0,001	0,001	0,002	0,0001	0,0007
414430	Y	0,140	0,376	1,46	0,006	0,0008	0,031	0,013	0,046	0,032	0,001	0,001	0,002	0,0001	0,0012
414432	Y	0,138	0,378	1,46	0,007	0,0008	0,027	0,011	0,042	0,037	0,001	0,001	0,002	0,0001	0,0005
414529	Y	0,159	0,380	1,46	0,007	0,0007	0,062	0,011	0,063	0,024	0,001	0,001	0,003	0,0001	0,0012

B07.2 Heat	C70	AL-T
414207	Y	0,034
414208	Y	0,031
414210	Y	0,033
414212	Y	0,033
414214	Y	0,035
414216	Y	0,034
414218	Y	0,040
414219	Y	0,035
414430	Y	0,033
414432	Y	0,035
414529	Y	0,046

 Manufacturer's mark	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 POISSONNET Test House Manager	Dillinger France Port 3032 3032 rue du Comte Jean - CS 56317 F-59379 Dunkerque Cedex 1 - FRANCE Service Qualité-Essais Date 24.12.14	A01 CD 1
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QIM-System: Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1 AS PER ISO 10474:2013 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No./ Date of dispatch 5483199-23.12.14	A08/ Manufacturer's order/ A03 Certificate No. 398993-001	Sheet 9/...
A05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX Final receiver UNI-FORM, HOUSTON, TX	A07.1 No. 34453A A07.2 No.	B01 Product HEAVY PLATES	
B02 Steel design. SA516-70/SA516-60				
B03 Any suppl. ASME-IIA:2013 requirements				

C94 Heat analysis Carbon equivalent / Alloying restrictions

B07.2

Heat

414207	FO-02=	0,42	FO-55=	0,12	FO-78=	0,04
414208	FO-02=	0,42	FO-55=	0,08	FO-78=	0,03
414210	FO-02=	0,42	FO-55=	0,13	FO-78=	0,04
414212	FO-02=	0,42	FO-55=	0,10	FO-78=	0,04
414214	FO-02=	0,42	FO-55=	0,12	FO-78=	0,04
414216	FO-02=	0,42	FO-55=	0,15	FO-78=	0,06
414218	FO-02=	0,42	FO-55=	0,13	FO-78=	0,06
414219	FO-02=	0,42	FO-55=	0,11	FO-78=	0,04
414430	FO-02=	0,40	FO-55=	0,12	FO-78=	0,05
414432	FO-02=	0,40	FO-55=	0,12	FO-78=	0,05
414529	FO-02=	0,42	FO-55=	0,16	FO-78=	0,04

C95 Ladle treatment

ITEM NO.: 01,03-05,08-11

HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL

C95 Further information about ladle treatment

ITEM NO.: 01,03-05,08-11

CALCIUM TREATED

ITEM NO.: 01,03-05,08-11

MELTED IN GERMANY BY -AG DER DILLINGER HUETTENWERKE, DILLINGEN/SAAR-

C70-C99 Further information about heat analysis

ITEM NO.: 01,03-05,08-11

CA & O: VALUES INFORMATIVE.

A04



Manufacturer's
mark

Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance
with the terms of order.

[Signature]

POISSONNET
Test House Manager

Dillinger France
Port 3032
3032 rue du Comte Jean - CS 56317
F-59379 Dunkerque Cedex 1 - FRANCE
Service Qualité-Essais

Date 24.12.14

CD 1

A01

QM-System: Certification as per ISO 9001

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.de/certificate)

A02 INSPECTION CERTIFICATE 3.1 AS PER EN 10204:2004 INSPECTION CERTIFICATE 3.1 AS PER ISO 10474:2013 MATERIAL TEST REPORT (MTR)		A10 Advice of dispatch No/ Date of dispatch 5483199-23.12.14	A08/ Manufacturer's order/ A03 Certificate No. 398993-001	Sheet 10
A05 Established inspecting body DF	A06 Purchaser UNI-FORM, HOUSTON, TX A07.1 No. 34453A Final receiver UNI-FORM, HOUSTON, TX A07.2 No.	B01 Product HEAVY PLATES		
302/ Steel design. SA516-70/SA516-60				
303 Any suppl. ASME-IIA:2013 requirements				

———— C94 Carbon equivalent formula / Alloying restrictions ————

FO-02 = $C + (Mn/6) + (Cr+Mo+V)/5 + (Ni+Cu)/15$
FO-55 = $Cu+Mo+Ni+Cr$
FO-78 = $Cr+Mo$

———— D01 Marking and identification, surface appearance, shape and dimensional properties ————

ITEM NO.: 01,03-05,08-11
EXAMINATION OF MARKING, SURFACE, SHAPE AND DIMENSIONS: THE RESULTS MEET THE REQUIREMENTS.
SURFACE AS PER ASME-SA20
THICKNESS AS PER ASME-SA20
LENGTH AND WIDTH AS PER ASME-SA20 ✓
FLATNESS AS PER ASME-SA20

———— D02 Non-destructive tests - Ultrasonic testing ————

ITEM NO.: 01,03-05,08-11
UT-SPECIFICATION : ASME-SA578 (M) LEVEL C SUPPLEMENTARY REQUIREMENTS S1 ✓
SCANNING PLAN BODY : 100% OF PLATE SURFACE
PERSONNEL QUALIFICATION : LEVEL 2 IN ACC. TO EN 473 / ISO 9712 AND SNT-TC-1A
THE TEST RESULTS MEET THE REQUIREMENTS OF THE ORDER.

A04  Manufacturer's mark	Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.	 POISSONNET Test House Manager	Dillinger France Port 3032 3032 rue du Comte Jean - CS 56317 F-59379 Dunkerque Cedex 1 - FRANCE Service Qualité-Essais Date 24.12.14	A01 CD 1
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Reg. Nr.: 10537



TÜV nach AD 2000 W 0 / TRD 100 / PED 97/23EC Annex I - Bureau Veritas
DET NORSKE VERITAS - Germanischer Lloyd - Lloyd's Register of Shipping
URZAD DOZURU TECHNICZNEGO, UDT-Polen, American Bureau of Shipping
Russian Maritime Register of Shipping, RMRS

Herstellerzeichen
Manufacturer's stamp



ORIGINAL

Abnahmeprüfzeugnis

EN 10 204 3.1

Inspection certificate

Kunde Customer	NATIONAL OILWELL VARCO 10906 FM 2920 TOMBALL/TEXAS 77375 USA		
Kd. Bestell Nr. Cust. Order no.	7317446	Position Item	4
Bezeichnung Designation	20" 150/600 Ring Forging	unsere Ref. Job no./Certificate no.	56093D12
Kd. Material Cust. Material	SA 105/SA 350 LF2 Cl. 1 / A694 F48	Anzahl Quantity	4
Lieferzustand condition of delivery	unmachined	Charge Nr. Heat no.	J0417
Kd. Zeichn. Nr. Cust. Drawing	Stock Ring Forging Rev. 3	Probe Nr. Test no.	50247
Artikel No. Part no	H61533	Dimension Dimension	FS d 559/466 x 305 mm
Kd. Spezifikation Cust. Specification	ASME Sect. II Part A SA105: 2013 Ed./ ASME Sect. II Part A SA 350 LF2-Cl. 1: 2013 Ed. - ASTM A694-F48: 08		
Stempelung Marking	56093D12 - SA 105/SA 350 LF2 Cl. 1 / A694 F48 - J0417 - 3144 - Stock Ring Forging (3) - H61533 - ST 50247 QI - item:4		

Wärmebehandlung / Heat treatment: 900°C/3h/water/600°C/5h/air
watertemperature before quenching: 26°C after quenching: 29°C

Chemische Zusammensetzung gem. Hersteller / Chemical composition acc. to manufacturer:

Heat no.	C	Si	Mn	P	S	Cr	Mo
J0417	0.19	0.20	0.95	0.009	0.004	0.11	0.02
ESB	Ni	V	Al	Cu	N	Ti	Nb
	0.11	0.004	0.034	0.18	0.0055	0.001	0.003
	Co	W	Sn	Ca	B	H	As
	0.011	0.006	0.009	0.0009	0.0003	0.00010	0.008
	Sb	CE1	Ni+Cr+Mo+Cu	Cr+Mo			
	0.002	0.394	0.420	0.13			

Melting practices: VD, E

Product analysis

Heat no.	C	Si	Mn	P	S	Cr	Mo
J0417	0.21	0.21	0.94	0.011	0.005	0.10	0.024
	Ni	V	Cu	Nb	CE1	Ni+Cr+Mo+Cu	Cr+Mo
	0.12	<0.010	0.19	<0.010	0.4141	0.4340	0.124

Mech. Werkstoffprüfung / Mechanical testing

Zugversuch / tensile test

ASTM A370-12a

Kerbschlagbiegeversuch / Impact test

ASTM A370-12a

	ReH Yield strength MPa	Rp 0,2 % MPa	Rp 1 % MPa	Rm Tensile strength MPa	A 4 d El. %	Z ROA %	A _v Joule Charpy-V -46 °C	Probenlage Orientation of specimen
Sollwerte/ Requirements	min. 330	min.	min.	485-655	min. 22	inf.	single 16 average 20	
50247	386			547	33	76	166/131/152	tangentiel ¼ T

Härteprüfung / Hardness test:
ASTM E 10 :2012

Sollwerte/ Requirements :
Resultate/ Results :

145 - 187 HBW

170, 168, 166, 169, 171, 167, 172, 170, 168, 166,
168, 170, 168, 171, 168, 167, 173, 171, 167, 169,
171, 166, 168, 169, 172 HBW

Visuelle Prüfung / Visual Inspection
Masskontrolle / dimension

in Ordnung / accepted
in Ordnung / accepted

Es wird bestätigt, dass die Lieferung den Vereinbarungen bei der Bestellannahme entspricht.
We confirm that the test results are in acc. to the order.

Approved for Manufacture

by

Date

Beilagen / Enclosure: 2 heat treatment charts

Hedingen, 30. September 2014/sk

Werksachverständige / Inspector:

FO 62-09

SCHMIEDWERK STOOS AG

Seite 1 von 1

Maienbrunnenstrasse 8 CH-8908 Hedingen Tel. 043 322 62 00 Fax 043 322 62 01 www.stoos.com e-mail: info@stoos.com

NOV HEAT CODE #

10703

50th 165053



[| 10352 | | B091AN] | [LN: 24] | TY023201-3 | D860RFLN14 |

Material Test Report

an **AFGlobal** Company

FVC Heat Nbr: **B091AN**

Forged Vessel Connections

An AFGlobal Company

2525 De Soto, Houston, TX 77091

ISO 9001:2008 Certified

Sales: (713) 868-4421 Fax: (713) 455-8366

Industrial Piping	00011500	PO: TP443725	Sales Order: 140511	Line: 9
P.O. Box 581270		Item Code: LWN080600140A002A1	Qty: 1	
Tulsa, OK 74158-1270		Item Desc: LWN, SA105N, 600#, 8"x14", RF		
Spec: ASME SA105N: 2013 Edition				

Element	(%wt)	Ladle	Product	EPCRA	CAS#	Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.18				Cb	Columbium (N)	0.004			
Mn	Manganese	1.19		✓	7439-96-5	Sn	Tin	0.007			
P	Phosphorous	0.009				B	Boron	0.0002			
S	Sulphur	0.002				Ti	Titanium	0.003		✓	7440-02-0
Si	Silicon	0.20				Al	Aluminum	0.033			
Cu	Copper	0.19		✓	7440-50-8	Ca	Calcium	0.0004			
Ni	Nickel	0.13		✓	7440-02-0	N	Nitrogen	0.007			
Cr	Chromium	0.09		✓	7440-47-3	As	Arsenic	0.005		✓	7440-38-2
Mo	Molybdenum	0.045				Sb	Antimony	0.001		✓	7440-36-0
V	Vanadium	0.015				CE	C+Mn/6+(Cr+M	0.44			

Mechanical Testing					Heat Treat	
Test Lab	AMF 55215	Heat Treatment	Normalized			
BHN (QTC)	149 - 149					
Elg (%)	35.00		Other			
RA (%)	73.00	MHC	76167			
Tensile (ksi)	74.330	Production Method	EAF			
Yield (ksi)	48.385	VD	YES			
		Reduction Ratio (Mill) x:1	3.7:1			
		Made to Fine Grain Practice	YES			

CE=C+(Mn/6)+((Cr+Mo+V)/5)+((Ni+Cu)/15)
 PRODUCT COMPLIANT TO NACE MR0175 AND NACE MR0103 LATEST EDITION.
 YIELD STRENGTH CALCULATED AT 0.2% OFFSET.

FVC STANDARD MANUFACTURING PRACTICES:

- 1) FLANGE DIMENSIONS & BOLTING COMPLY - ASME B16.5. 2013 EDITION
- 2) SELF-REINFORCING NOZZLES COMPLY WITH SPECIFICATION OF SECTION VIII DIV. 1 OR DIV. 2 PER CUSTOMER DESIGN/FVC DESIGN.
- 3) MATERIAL SPECIFICATION COMPLIES WITH ASME SECT. II PART A.
- 4) ALL FVC MATERIAL MANUFACTURED PER FINE GRAIN PRACTICE.
- 5) ALL FVC MATERIAL CERTIFIED PER EN 10204 Type 3.1 UNLESS OTHERWISE SPECIFIED.
- 6) CERTIFICATE OF INSURANCE AVAILABLE UPON REQUEST.
- 7) PRODUCT FREE OF MERCURY CONTAMINATION.

KMI FAB

S/O 165053

Date 2-8-17

Item # 4

The recording of false, fictitious, or fraudulent statement or entries on this document may be punishable as a felony under federal statute.

EPCRA Supplier Notification: This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with a checkmark in the "EPCRA" column and a Chemical Abstract Services (CAS) registry number is provided for each such chemical in addition to the percent by weight of the chemical present in this product. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Certification No.: 1145059

Certification Date: 10/9/2014

Issued By: Cynthia Madrid

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

Cynthia Madrid

Cynthia Madrid - QA Analyst

50# 165053

FVC
an **AFGlobal** Company**Material Test Report**FVC Heat Nbr: **A285DAN**

Forged Vessel Connections

An AFGlobal Company

2525 De Soto, Houston, TX 77091

ISO 9001:2008 Certified

Sales: (713) 868-4421 Fax: (713) 455-8366

Industrial Piping	00011500	PO: HP232569	Sales Order: 150716	Line: 39
P.O. Box 581270		Item Code: LWN080600140A002A1	Qty: 2	
Tulsa, OK 74158-1270		Item Desc: LWN, SA105N, 600#, 8"x14", RF		
Spec: ASME SA105N: 2015 Edition				

Element	(%wt)	Ladle	Product	EPCRA	CAS#	Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.14				V	Vanadium	0.07			
Mn	Manganese	1.28		✓	7439-96-5	Cb	Columbium (N)	0.012			
P	Phosphorous	0.012				Sn	Tin	0.007			
S	Sulphur	0.00				B	Boron	0.0002			
Si	Silicon	0.25				Ti	Titanium	0.002		✓	7440-02-0
Cu	Copper	0.16		✓	7440-50-8	Al	Aluminum	0.030			
Ni	Nickel	0.14		✓	7440-02-0	Ca	Calcium	0.0020			
Cr	Chromium	0.14		✓	7440-47-3	N	Nitrogen	0.0089			
Mo	Molybdenum	0.100				CE	C+Mn/6+(Cr+M	0.449			

Mechanical Testing						Heat Treat					
Test Lab	AFG 60101					Heat Treatment	Normalized				
BHN (QTC)	156										
Elg (%)	29.00						Other				
RA (%)	61.00					MHC	227W637				
Tensile (ksi)	76.248					Production Method	EF				
Yield (ksi)	50.132					VD	YES				
						Made to Fine Grain Practice	YES				

CE=C+(Mn/6)+((Cr+Mo+V)/5)+((Ni+Cu)/15)
 PRODUCT COMPLIANT TO NACE MR0175 AND NACE MR0103 LATEST EDITION.
 YIELD STRENGTH CALCULATED AT 0.2% OFFSET.

FVC STANDARD MANUFACTURING PRACTICES:

- 1) FLANGE DIMENSIONS & BOLTING COMPLY - ASME B16.5. 2015 EDITION
- 2) SELF-REINFORCING NOZZLES COMPLY WITH SPECIFICATION OF SECTION VIII DIV. 1 OR DIV. 2 PER CUSTOMER DESIGN/FVC DESIGN.
- 3) MATERIAL SPECIFICATION COMPLIES WITH ASME SECT. II PART A.
- 4) ALL FVC MATERIAL MANUFACTURED PER FINE GRAIN PRACTICE.
- 5) ALL FVC MATERIAL CERTIFIED PER EN 10204 Type 3.1 UNLESS OTHERWISE SPECIFIED.
- 6) CERTIFICATE OF INSURANCE AVAILABLE UPON REQUEST.
- 7) PRODUCT FREE OF MERCURY CONTAMINATION.
- 8) ALL FVC MATERIAL MANUFACTURED UNDER ISO 9001:2008 QUALITY MANAGEMENT SYSTEM.

KMI FAB

S/O 165053

Date 2-8-17

Item # 4

The recording of false, fictitious, or fraudulent statement or entries on this document may be punishable as a felony under federal statute.

EPCRA Supplier Notification: This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with a checkmark in the "EPCRA" column and a Chemical Abstract Services (CAS) registry number is provided for each such chemical in addition to the percent by weight of the chemical present in this product. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Certification No.: 1236290

Certification Date: 1/21/2016

Issued By: Ana Robles

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



Ana Robles - QA Technician

50-165053

Coupling



[10352] [A2K] [LN: 18] TY023201-1 D16TCPLT
/ 19/2016 10:35 9188359681

PAGE 01/01

12-16-14

16Dec14 7:9

TEST CERTIFICATE

No: 1 112992

KREHER STEEL COMPANY, LLC.
1550 NORTH 25TH AVENUE
MELROSE PARK, IL 60160
Tel: 788-345-8180 Fax: 708-345-8293

P/O No 3213
Rel
S/O No 1 272430-001
B/L No 1 219587-002
Inv No
Shp 16Dec14
Inv

Sold To: (7811)
PRODUCTION MANUFACTURING CO., INC..
5909 EAST 13TH STREET
TULSA OK 74112

Ship To: (1)
PRODUCTION MANUFACTURING CO., INC..
5909 EAST 13TH STREET
TULSA OK 74112

Tel: 918-836-3585 Fax: 918-835-9681

CERTIFICATE of ANALYSIS and TESTS

Cert. No: 1 112992
16Dec14

Part No
TURN & POLISH ROUNDS A105
2.2500 X 17'R/L

2 1/4 Ø SA105
A2K

0

CONFORMS TO ASTM A105 & ASME SA105
HEAT NUMBER A142612
Cu .12, V .003 AND Cb/Nb .001
LOT NUMBER 163361 WEIGHT 3220
TENSILE 73,200
YIELD 43,900
ELONGATION 22 %
REDUCTION OF AREA 40 %
HARDNESS 151--150 AT SURFACE
MADE IN THE USA

Heat Number
A142612

*** Chemical Analysis ***
C=0.1900 Mn=0.9200 P=0.0090 S=0.0210 Si=0.2100 Cu=0.1200
Ni=0.1000 Cr=0.1400 Mo=0.0400 Al=0.0360 Cb=0.0010 V=0.0030
B=<.0004> Ca=<.0012> W=<.0> Ti=<.001> Fe=<.002> Co=<.005>
As=<.004> Sb=<.002>

I hereby certify that this data is correct as
contained in the records of this company.
I hereby certify that no mercury came in contact
with or no weld repair was done to this product
while in our possession.

[Signature]

PRODUCTION MFG, TULSA, OKLA
CUSTOMER TPS
P.O.# Kim
ITEM 1-6000 Couplet
HEAT CODE A2K

KMI FAB
S/O 165053
Date 2-8-17
Item # 5

50# 165053



[10352 | | TTP] [LN: 19] TY023201-1 | D.756TCPLT |

Phoenix Group Group - Certified Mill Test Report

Page 1 of 1



Phoenix * Capitol * Camco CapProducts

Certified Mill Test Report

Heat Code: TTP

Heat Number: 121991

Item: 12305607; 3/4 6M THD COUPLET

Material: ASTM A105-2011a / ASME SA105-2010 Edition

Chemistry Properties

C	Mn	P	S	Si	Cu	Cr
0.2000	0.9200	0.0060	0.0290	0.2400	0.1900	0.1110
Ni	Mo	V	Co	Al	Cb	N
0.0680	0.0220	0.0340		0.0010	0.0020	
Pb	Sn	Ta	Ti	C Eq. Long		
				0.4039		

Additional Chemical Properties

Mechanical Properties

Tensile(PSI)	Yield(PSI)	Elong. % in 2 in. or 4D	Reduction	HBW	HBW 2
78800	55800	26%	45	162	150

Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Avg.	Test Temp.

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements. We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

KMI FAB

S/O 165053

Date 2-8-17

Item # 6

6

50# 165053



[10352 | 74FJ] [LN: 20] TY023201-1 | D.56TCPLT |

Capitol Manufacturing
1125 Capitol Avenue
Crowley, LA 70526

Phoenix * Capitol * Camco
CapProducts

Commanding a Higher Standardsm

Certified Mill Test Report

Printed: 9/15/2016

Customer

INDUSTRIAL PIPING SPECIALISTS

P.O. BOX 581270

TULSA, OK 74158

Certified: 09/25/2015

P.O. TP519240

Tag

Heat No 145117

Heat Code 74FJ

Phoenix Order # 1229129

Material ASTM A105-2011a / ASME SA105-2010 Edition

Part Number

12305605

Description

1/2 6M THD COUPLET

Chemical Properties

C	Mn	P	S	Si	Cu	Ni	Cr
0.2000	0.9500	0.0120	0.0210	0.2200	0.1900	0.0630	0.0990

C Eq. Long

0.4056

Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0150	0.0380								

Additional Chemical Properties

Cr + Cu + Ni

0.3520

Mechanical Properties

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
83,100	58,700	24.0%	47.0%	165	165

Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Average	Test Temp.
N/A	N/A	N/A	N/A	N/A

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements.

We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

KMI FAB

S/O

Date

Item #

165053
2-8-17
7

Tube sheet

NUCOR
PLATE MILL

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

Mill Test Report

Page 7

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

NUCOR
It's Our Nature

Issuing Date : 11/09/2016 B/L No. : 457293 Load No. : 465391 Our Order No. : 141569/4 Cust. Order No. : MUS-247109
Vehicle No: TTPX 806104 Sold To: METALS USA - SOUTH CENTRAL 2800 N 43RD ST E MUSKOGEE, OK 74403 Shp To: METALS USA - PLATES AND SHAPES TRACK 747 MUSKOGEE, OK 74401
Specification: 1.0000" x 96.000" x 480.000"
ASTM A516 70/65/60-10(2015)/ASME SA516-70/65/60 PVQ 2013/2015
Normalized Plate NACE MR0175 Annex 2.1.2, MR0103 (2010) Section 2.1.2 (2015) 13.1.1, 13.1.2) Compliant

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm	J	X			
6506641	0.19	1.04	0.010	0.001	0.19	0.19	0.08	0.09	0.03	0.031	0.006	0.002	0.002	0.0069	0.0010	0.0001	0.008	0.41	0.27	#####	#####			
Plate Serial No			Pieces	Tons	Tensile Test				Heat Treat				Charpy Impacts										Temp °F	Size
					Dir.	Yield (psi)	Tensile (psi)	Elong. % in 2"	Elong. % in 8"	Norm °F	Time (min)	Temper °F	Time (min)	Absorbed Energy (Ft-lbs)					Shear (%)					
6506641-05			3	19.60	T	46,500	73,400	54.6		1650	41													
												H-L	112.3	109.4	107.9	109.9	15					-50 10mm		

NACE MR0175 ANNEX 2.1.2 COMPLIANT
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 (#010940) by SRI Quality System Registrar (#0985-09). 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. Depretis
T. A. Depretis, Metallurgist

11/10/2016 8:35:36 AM

KMI FAB
SIO 165053
Date 2-8-17
Item # 8



P/O No. : MIP00035
L/C No. : HU20110829001

ISSUED DATE : 2014.09.05

COMMODITY : E.R.W. STEEL PIPE
API 5L X-42 PSL1/API 5LB/
SPECIFICATION : ASTM A53B/ASME SA 53B

INSPECTION CERTIFICATE



주식회사 휴스틸

HUSTEEL Co., Ltd.

HEAD OFFICE : SHINAN B/D 15F, 943-19, DAECHE-DONG,
KANGNAM-GU, SEOUL, KOREA
DAEBUL PLANT : 3RO, DAEBUL INDUSTRIAL COMPLEX, SAMHO-EUP,
YEONGAM-GUN, JEOLLANAM-DO, KOREA

CERTIFICATE No. : 140905-315

MANUFACTURED No. : 2014-08-203

SUPPLIER : HUSTEEL CO., LTD.

CUSTOMER : HUSTEEL USA INC.

NO.	HEAT_NO	QUAN- TITY	TYPE	NOMINAL SIZE	ORDER SIZE			WEIGHT lb/ft	TENSILE TEST					CHEMICAL COMPOSITION(%)																
					O.D. Inch	W.T. Inch	LENGTH ft		DIR.	TS PSI	YS %	EL %	YR %	WTS PSI	DIV	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	CEQ	PCM
		PCS	*1	*2	*3	*4	*5	*6	*7	*8	*9	*10	*11	*12	*13	*14	*15	*16	*17	*18	*19	*20	*21	*22	*23	*24	*25	*26		
07	N13101	20	BPEB	20	20.000	0.250	42	52.78	T	68,455	56,272	38	82	73,096	H	7	1	77	12	5	12	10	20	TR	10	150	10			
08	N16664	17	BPEB	20	20.000	0.250	42	52.78	T	67,440	55,257	40	82	71,355	P	7	2	80	13	6	13	9	24	32	10	191	7			
09	N18421	43	BPEB	20	20.000	0.250	42	52.78	T	67,440	55,692	40	83	71,936	H	6	1	79	13	6	13	9	23	29	8	180	7			
															P	7	1	76	13	3	14	10	20	TR	10	160	10			
															P	7	2	78	14	4	15	11	25	31	13	205	8			
															P	7	2	78	14	4	15	10	25	25	13	205	8			
															H	7	1	74	14	5	15	10	20	TR	TR	140	10			
															P	7	2	77	16	5	18	13	32	27	13	199	8			
															P	7	2	77	16	5	17	12	32	22	13	202	9			
NO.	HYDROSTATIC TEST		HEAT TREATMENT	ZINC COATING TEST	THREADS	HARDNESS TEST	IMPACT TEST	*13 N · D · T (UT)		FLATTENING OR BEND TEST		VISUAL & DIMENSION		METALLOGRAPHIC TEST		RESIDUAL MAGNETISM														
	TP	H.T	RESULT	WZC	CST	TPI	ETL			GOOD		GOOD		GOOD		GOOD														
	PSI	sec		g/m ²	TIMES	Inch				FLANGE TEST		REVERSE FLATTENING TEST		CRUSH TEST																
	*9		*10	*11		*12		HV		DIV		Energy (Ind, J)		SIZE																
07	950	10	GOOD	930																										
08	950	10	GOOD	930																										
09	950	10	GOOD	930																										
NOTE	*1. Type of Pipe Ends																													
	BPE		Black Plain Ends		GPE		Galvanized Plain Ends																							
	BPEB		BPE Bevelled		GPEB		GPE Bevelled																							
	BTE		Black Threaded Ends		GTE		Galvanized Threaded Ends																							
	BTC		Black Threaded & Coupled		GTC		Galvanized Threaded & Coupled																							
	*2. O.D. : Outside Diameter, W.T. : Wall Thickness																													
	*3. Direction - L : Longitudinal, T : Transverse																													
	*4. Tensile Test - TS : Tensile Strength, YS : Yield Strength, YR : Yield Ratio, EL : Elongation, WTS : Weld tensile strength, Gauge Length : 2 inch, Y.P method : 0.5% Underload																													
	*5. H : Heat analysis, P : Product analysis																													
	*6. -2 : x1/100, -3 : x1/1000, -4 : x1/10000, -5 : x1/100000, Tr : Trace																													
	*7. B : Base Metal, W : Weld Line, H : Heat Affected Zone																													
	*8. Specimen Size - A:10x10mm, B:10x7.5mm, C:10x6mm, D:10x5.0mm, Direction: Transverse																													
	*9. TP : Tensile Pressure, H.T : Holding Time																													
	*10. Heat Treatment : Seam Normalizing																													
	*11. WZC : Weight of Zinc Coating, CST : Copper Sulphate Test																													
	*12. TPI : Threads per Inch, ETL : Effective length of threads																													
	*13. NDT : UT, Reference Standard : 3.2 & Drilled Hole																													
SURVEYOR		WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE AND TESTED IN ACCORDANCE WITH THE ORDER AND ABOVE SPECIFICATION THIS CERTIFICATE IS ISSUED ACCORDING TO EN 10204 3.1(ISO 10474 3.1 B)															MANAGER OF QA TEAM													

HMC C-30-05-(21)

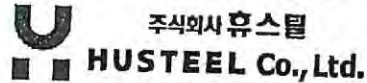
본 검사증명서에 영기된 규격용도 외 사용시 안전상 문제가 발생할 수 있으며, 검사증명서 위·변조시 사문서 위조(형법231조)로 불이익을 당하실 수 있습니다.

P/O No. : MIP00035
L/C No. : HU20110829001

ISSUED DATE : 2014.09.05

COMMODITY : E.R.W. STEEL PIPE
API 5L X-42 PSL1/API 5LB/
SPECIFICATION : ASTM A53B/ASME SA 53B

INSPECTION CERTIFICATE



HEAD OFFICE : SHINAN B/D 15F, 943-19, DAECHI-DONG,
KANGNAM-GU, SEOUL, KOREA
DAEBUL PLANT : 3RO, DAEBUL INDUSTRIAL COMPLEX, SAMHO-EUP,
YEONGAM-GUN, JEOLLANAM-DO, KOREA

CERTIFICATE No. : 140905-315

MANUFACTURED No. : 2014-08-203

SUPPLIER : HUSTEEL CO., LTD.

CUSTOMER : HUSTEEL USA INC.

NO.	HEAT_NO	QUAN- TITY	TYPE	NOMINAL SIZE	ORDER SIZE			WEIGHT lb/ft	TENSILE TEST						CHEMICAL COMPOSITION(%)																	
		PCS			O.D inch	WT inch	LENGTH ft		DIR.	TS	YS	EL %	YR %	WTS	DIV	C	SI	Mn	P	S	Cu	NI	Cr	Mo	V	Nb	Ti	B	CEQ	PCM		
*1	*2		*3	*4		PSI	*5	*6																								
13	N17333	36	BPEB	24	24.000	0.250	42	63.47	T	66,714	57,287	41	86	70,775	H	6	1	74	16	6	11	10	20	TR	10	150	10					
14	N17338	89	BPEB	24	24.000	0.250	42	63.47	T	66,279	54,097	40	82	72,081	P	5	1	75	15	5	13	8	22	10	7	168	9					
															P	5	1	75	15	4	12	8	22	10	7	171	8					
															H	6	1	76	16	7	15	10	30	TR	10	150	10					
15	M98433	10	BPEB	24	24.000	0.375	42	94.71	T	75,416	59,753	40	79	79,187	P	6	1	76	17	7	14	10	30	21	10	205	6					
															P	6	1	76	17	7	13	9	30	13	9	198	6					
															H	6	15	98	13	2	13	10	20	TR	10	330	20					
															P	6	16	102	15	2	13	10	22	21	9	373	15					
															P	6	16	101	15	2	12	10	20	16	7	362	15					

NO.	HYDROSTATIC TEST			HEAT TREATMENT	ZINC COATING TEST		THREADS		HARDNESS TEST	IMPACT TEST				*13 N - D - T (UT)	FLATTENING OR BEND TEST	VISUAL& DIMENSION	METALLOGRAPHIC TEST	RESIDUAL MAGNETISM
	TP	H.T	RESULT		WZC	CST	TPI	ETL		(0) °C								
	PSI	sec																
	°C	g/m²																
*9				*10	*11	*12		HV	DIV *7	Energy (Ind, J)	SIZE *8	FLANGE TEST	REVERSE FLATTENING TEST	GOOD	GOOD	GOOD		
13	790	10	GOOD	930														

- Latest edition per API 5L(45th,2013) ASTM(2012) ASME SA 53B(2013)
- HARDNESS MAX 22 HRC AS PER NACE MR 0175 / ISO 15156

*1. Type of Pipe Ends

BPE	Black Plain Ends	GPE	Galvanized Plain Ends
BPEB	BPE Beveled	GPEB	GPE Beveled
BTE	Black Threaded Ends	GTE	Galvanized Threaded Ends
BTC	Black Threaded & Coupled	GTC	Galvanized Threaded & Coupled

- *2. O.D : Outside Diameter, W.T : Wall Thickness
- *3. Direction: L : Longitudinal, T : Transverse
- *4. Tensile Test -TS : Tensile Strength, YS : Yield Strength, YR : Yield Ratio, EL : Elongation, WTS : Weld tensile strength, Gauge Length : 2 Inch, Y.P method : 0.5% Underload
- *5. H : Heat analysis, P : Product analysis
- *6. -2 : x1/100, -3 : x1/1000, -4 : x1/10000, -5 : x1/100000, Tr : Trace
- *7. B : Base Metal, W : Weld Line, H : Heat Affected Zone
- *8. Specimen Size -A:10x10mm, B:10x7.5mm, C:10x6.5mm, D:10x5.0mm, Direction: Transverse
- *9. T.P : Testing Pressure, H.T : Holding Time
- *10. Heat Treatment : Seam Normalizing
- *11. WZC : Weight of Zinc Coating, CST : Copper Sulphate Test
- *12. TPI : Threads per inch, ETL : Effective length of threads
- *13. NDT : UT, Reference Standard : 3.2 E Drilled Hole

SURVEYOR

WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE AND TESTED IN ACCORDANCE WITH THE ORDER AND ABOVE SPECIFICATION
THIS CERTIFICATE IS ISSUED ACCORDING TO EN 10204 3.1(ISO 10474 3.1 B)

MANAGER OF QA TEAM

HMC C-30-05-(21)

본 검사증명서에 명기된 규격용도 외 사용시 안전상 문제가 발생할 수 있으며, 검사증명서 위·변조시 사문서 위조(형법231조)로 불이익을 당하실 수 있습니다.

P/O No. : MIP00035
L/C No. : HU20110829001

ISSUED DATE : 2014.09.05

COMMODITY : E.R.W. STEEL PIPE

API 5L X-42 PSL1/API 5LB/

SPECIFICATION : ASTM A53B/ASME SA 53B

INSPECTION CERTIFICATE



주식회사 휴스틸

HUSTEEL Co., Ltd.

HEAD OFFICE : SHINAN B/D 15F, 943-19, DAECHI-DONG,

KANGNAM-GU, SEOUL, KOREA

DAEBUL PLANT : 3RO, DAEBUL INDUSTRIAL COMPLEX, SAMHO-EUP,
YEONGAM-GUN, JEOLLANAM-DO, KOREA

CERTIFICATE No. : 1409Q5-315

MANUFACTURED No. : 2014-08-203

SUPPLIER : HUSTEEL CO., LTD.

CUSTOMER : HUSTEEL USA INC.

NO.	HEAT_NO	QUAN- TITY	TYPE	NOMINAL SIZE	ORDER SIZE			WEIGHT	TENSILE TEST						CHEMICAL COMPOSITION(%)																				
					O.D	WT	LENGTH		DIR.	TS	YS	EL	YR	WTS	DIV	C	SI	Mn	P	S	Cu	NI	Cr	Mo	V	Nb	Ti	B	CEQ	PCM					
					inch	inch	ft																								lb/ft	PSI	%	%	PSI
16	680050	74	BPEB	24	24.000	0.375	42	94.71	T	77,012	58,883	39	76	79,187	H	7	18	107	15	2	10	10	20	30	10	210	80								
17	592974	11	BPEB	24	24.000	0.375	42	94.71	T	81,508	64,684	37	79	80,492	P	7	21	108	16	2	7	10	26	33	11	259	77								
18	595028	8	BPEB	24	24.000	0.500	42	125.61	T	70,340	49,601	44	71	75,416	H	9	18	109	18	2	10	10	20	10	210	90									
															P	6	19	110	16	2	6	8	15	27	16	253	82								
															P	6	19	109	16	2	6	7	13	17	13	243	81								
															H	15	1	83	15	2	10	10	10	10	10	10	10								
															P	14	2	86	15	2	8	8	15	18	8	21	8								
															P	15	2	86	15	2	8	7	15	15	7	16	7								
NO.	HYDROSTATIC TEST			HEAT TREATMENT	ZINC COATING TEST		THREADS		HARDNESS TEST	IMPACT TEST		*13 N · D · T (UT)		FLATTENING OR BEND TEST	VISUAL & DIMENSION	METALLOGRAPHIC TEST	RESIDUAL MAGNETISM																		
	T.P	H.T	RESULT	°C	WZC	CST	TPI	ETL			(°) °C																								
	PSI	sec			g/m²	TIMES		inch	HV	DIV	Energy (J)	SIZE																							
	*9			*10	*11		*12			*7		*8																							
16	1190	10	GOOD	950																															
17	1190	10	GOOD	950																															
18	1580	10	GOOD	950																															
- Latest edition per API 5L(45th,2013) ASTM(2012) ASME SA 53B(2013) - HARDNESS MAX 22 HRC AS PER NACE MR 0175/ ISO 15156																																			
NOTE	*1. Type of Pipe Ends																																		
	BPE Black Plain Ends				GPE Galvanized Plain Ends																														
	BPEB BPE Bevelled				GPEB GPE Bevelled																														
	BTE Black Threaded Ends				GTE Galvanized Threaded Ends																														
	BTC Black Threaded & Coupled				GTC Galvanized Threaded & Coupled																														
*2. O.D : Outside Diameter, W.T : Wall Thickness *3. Direction : L : Longitudinal, T : Transverse *4. Tensile Test : TS : Tensile Strength, YS : Yield Strength, YR : Yield Ratio, EL : Elongation, WTS : Weld tensile strength, Gauge Length : 2 inch, Y.P method : 0.5% Underload *5. H : Heat analysis, P : Product analysis *6. -2 : x1/100, -3 : x1/1000, -4 : x1/10000, -5 : x1/100000, Tr : Trace *7. B : Base Metal, W : Weld Line, H : Heat Affected Zone *8. Specimen Size : A:10x10mm, B:10x7.5mm, C:10x6.5mm, D:10x5.0mm, Direction: Transverse *9. T.P : Testing Pressure, H.T : Holding Time *10. Heat Treatment : Seam Normalizing *11. WZC : Weight of Zinc Coating, CST : Copper Sulphate Test *12. TPI : Threads per inch, ETL : Effective length of threads *13. NDT : UT, Reference Standard 3.2C Drilled Hole																																			
SURVEYOR		WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE AND TESTED IN ACCORDANCE WITH THE ORDER AND ABOVE SPECIFICATION THIS CERTIFICATE IS ISSUED ACCORDING TO EN 10204 3.1(ISO 10474 3.1 B)														MANAGER OF Q.A TEAM																			

HMC C-30-05-(21)

본 검사증명서에 영기된 규격용도 외 사용시 안전상 문제가 발생할 수 있으며, 검사증명서 위·변조시 사문서 위조(형법231조)로 불이익을 당하실 수 있습니다.

PAGE : 6 / 7

P/O No. : MIP00035
L/C No. : HU20110829001

ISSUED DATE : 2014.09.05

COMMODITY : E.R.W. STEEL PIPE
API 5L X-42 PSL1/API 5LB/

SPECIFICATION : ASTM A53B/ASME SA 53B

INSPECTION CERTIFICATE



주식회사 휴스틸

HUSTEEL Co., Ltd.

HEAD OFFICE : SHINAN B/D 15F, 943-19, DAECHE-DONG,
KANGNAM-GU, SEOUL, KOREA

DAEBUL PLANT : 3RO, DAEBUL INDUSTRIAL COMPLEX, SAMHO-EUP,
YEONGAM-GUN, JEOLLANAM-DO, KOREA

CERTIFICATE No. : 140905-315

MANUFACTURED No. : 2014-08-203

SUPPLIER : HUSTEEL CO., LTD.

CUSTOMER : HUSTEEL USA INC.

TEONGAM-GUN, JEOLLANAM-DO, KOREA										CUSTOMER										: HUSTEEL USA INC.											
NO.	HEAT_NO	QUAN- TITY	TYPE	NOMINAL SIZE	ORDER SIZE			WEIGHT	TENSILE TEST						CHEMICAL COMPOSITION(%)																
		PCS			*1	O.D	W.T		LENGTH	DIR.	TS	YS	EL	YR	WTS	DIV	C	SI	Mn	P	S	Cu	NI	Cr	Mo	V	Nb	Ti	B	CEQ	PCM
						inch	inch		ft		PSI	%	%	PSI	-2		-3					-4				-5	-3				
					*2		lb/ft	*3	*4				PSI	*5	*6																
19	489394	21	BPEB	24	24.000	0.500	42	125.61	T	70,340	49,456	45	70	74,836	H	16	TR	85	14	2	10	10	10	20	10	10	10				
															P	14	2	85	15	2	8	8	14	16	7	16	7				
															P	14	2	85	15	2	8	8	13	14	6	11	7				

NO.	HYDROSTATIC TEST			HEAT TREATMENT	ZINC COATING TEST		THREADS		HARDNESS TEST	IMPACT TEST			*13 N · D · T (UT)	FLATTENING OR BEND TEST	VISUAL& DIMENSION	METALLOGRAPHIC TEST	RESIDUAL MAGNETISM	
	T.P	H.T	RESULT		WZC	CST	TPI	ETL		(0) °C								
	PSI	sec			°C	g/m²		TIMES		Inch	DIV	Energy (Ind. J)						SIZE
	*9	*10			*11	*12		HV		*7								*8
19	1580	10	GOOD	950														
- Latest edition per API 5L(45th,2013) ASTM(2012) ASME SA 53B(2013) - HARDNESS MAX 22 HRC AS PER NACE MR 0175 / ISO 15156																		

NOTE	*1. Type of Pipe Ends			
	BPE	Black Plain Ends	GPE	Galvanized Plain Ends
	BPEB	BPE Bevelled	GPEB	GPE Bevelled
	BTE	Black Threaded Ends	GTE	Galvanized Threaded Ends

- *2. O.D : Outside Diameter, W.T : Wall Thickness *3. Direction- L : Longitudinal, T : Transverse
*4. Tensile Test -TS : Tensile Strength, YS : Yield Strength, YR : Yield Ratio, EL : Elongation, WTS : Weld tensile strength, Gauge Length : 2 inch, Y.P method : 0.5% Underload
*5. H : Heat analysis, P : Product analysis *6. -2 : x1/100, -3 : x1/1000, -4 : x1/10000, -5 : x1/100000, Tr : Trace *7. B : Base Metal, W : Weld Line, H : Heat Affected Zone
*8. Specimen Size A:10x10mm, B:10x7.5mm, C:10x6.5mm, D:10x5.0mm, Direction: Transverse *9. T.P : Testing Pressure, H.T : Holding Time *10. Heat Treatment See: Normalizing
*11. WZC : Weight of Zinc Coating, CST : Copper Sulphate Test *12. TPI : Threads per inch, ETL : Effective length of threads *13. NDT : UT, Reference Standard 3.2C Drilled Hole

SURVEYOR

WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE AND TESTED IN ACCORDANCE WITH THE ORDER AND ABOVE SPECIFICATION
THIS CERTIFICATE IS ISSUED ACCORDING TO EN 10204 3.1(ISO 10474 3.1 B)

MANAGER OF QA TEAM

HMC C-30-05-(21)

본 검사증명서에 명기된 규격용도 외 사용시 안전상 문제가 발생할 수 있으며, 검사증명서 위·변조시 사문서 위조(형법231조)로 불이익을 당하실 수 있습니다.
2014.09.05

PAGE : 7 / 7

[10352] [LN: 16] [TY023201-2] [FERWU20STD]



KMI

SSAB

12400 Highway 43 North, Axis, Alabama 36505, US

3/4 x 40 x 121 1/2

Test Certificate

Form TC1: Revision 2: Date 23 Apr 2014

Customer: METALS USA PLATES & SHAPES-SOUTHCENTRAL P.O. BOX 3528 101 EAST ILLINOIS ENID OK 73702				Customer P.O.No.: MUS-245345				Mill Order No. 41-458113-05				Shipping Manifest: AR222006																		
				Product Description: ASME SA516-70/SA516-65/SA516-60(15) ASTM A516-70/A516-65/A516-60(10/15) LCVN 15/12 FT.LBS @ -60F/A673-P NORMALIZED								Ship Date: 23 Mar 16 Cert Date: 23 Mar 16				Cert No: 081549355 (Page 1 of 1)														
				Size: 0.750 X 120.0 X 480.0 (IN)																										
Tested Pieces:				Tensiles:				Charpy Impact Tests																						
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir	Hardness	Abs. Energy(FTLB) 1 2 3 Avg				% Shear 1 2 3 Avg				Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr									
W6C510	F33	0.750 (DISCRT)	C 50	73			29	T		106	80	103	96				-60F	L	10.											
Heat Id				Chemical Analysis																ORGN										
				C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	Cev											
W6C510				.19	1.03	.012	.001	.23	.027	.026	.23	.12	.13	.03	.001	.004	.009	.0001	.42		USA									
KILLED STEEL MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT. KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15 NACE MR0175(09) ANNEX A2.1.2 COMPLIANT MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT 100% MELTED AND MANUFACTURED IN THE USA. NORMALIZED PLATES. HEATED AT 1665F FOR 31 MINUTES. TEST COUPONS TAKEN FROM HEAT TREATED PLATE. PRODUCTS SHIPPED: W6C510 F33 6650740 PCES: 1, LBS: 12252 W6C510 F33 6650741 PCES: 1, LBS: 12252																														
(P)										Cust Part #:										WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION Justin Ward SENIOR METALLURGIST - PRODUCT										

KMI FAB
S/O 165053
Date 2-8-17
Item # 10



Phoenix * Capitol * Camco CapProducts

Certified Mill Test Report

Heat Code: ADOB

Heat Number: 031794

Item: 2.1.0900.134: MEDIUM LIFTING LUG

Material: ASTM A105-2011a / ASME SA105-2010 Edition

Chemistry Properties

C	Mn	P	S	Si	Cu	Cr
0.2000	0.9200	0.0080	0.0370	0.2200	0.3700	0.0700
Ni	Mo	V	Co	Al	Cb	N
0.0900	0.0300	0.0240				
Pb	Sn	Ta	Ti	C Eq. Long		
				0.4088		

Additional Chemical Properties

Mechanical Properties

Tensile(PSI)	Yield(PSI)	Elong. % in 2 in. or 4D	Reduction	HBW	HBW 2
76000	48800	30%	65	152	156

Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Avg.	Test Temp.

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements. We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

KMI FAB
S/O 165053
Date 2-8-17
Item # 14



10308 | RFQ | 1015378774 | | [LN: 4] | TY022731-1 | FSVAT1160 |
voestalpine Tubulars GmbH & Co KG

Alpinstrasse 17
8652 Kindberg-Aumühl
T. +43(0)3865/22 15-0
F. +43(0)3865/2216-532
www.vatubulars.com

Legal Structure: Limited Partnership
Location: Kindberg/Austria
Company Registry Number 165400k
Commercial Court of Leoben
DPR 0592684, VAT Nr. ATU 43630406

General Partner: voestalpine Tubulars GmbH
Legal Structure: Limited Liability Company
Location: Linz, Company Registry Number 1069337
Commercial Court of Linz

FSVAT 1160

INSPECTION - CERTIFICATE 3.1

(according to EN 10204)

ABNAHMEPRUEFZEUGNIS 3.1

(gem. EN 10204)

No. 119903

CERTIFICAT DE CONTROLE DES PRODUITS PAR L'USINE 3.1

(selon EN 10204)

Hersteller: voestalpine Tubulars GmbH & Co KG, Austria
Manufacturer:
Producteur:

Besteller: VOEST-ALPINE TUBULAR CORPORATION
Purchaser: USA-77077 HOUSTON, TEXAS
Archeteur: INDUSTRIAL PIPING
SPECIALISTS. INC.
TULSA OK 74158-1270, US

Pruefgegenstand: Line Pipe
Object of tests: LP-USA-01
Epreuve: LINEPIPE-01.0
non upset ends (API 5 D + 5 L) - non upset
UV coating

Werkstoff: GRADE B
Material:
Matières:

Anforderungen: Grade B acc. to ASTM A 53 / A 53M-2012
Requirements: ASME SA 53-2015
Exigence: Grade B acc. to ASTM A 106 / A 106M-2015,
ASME SA 106-2015
Grade B acc. to API 5 L, 45.edt.-2012 (PSL1)
NACE MR 0175 / ISO 15156-2009
NACE MR 0103-2012
LINEPIPE-01.0; LP-USA-01

Ausführung: NU, PLAIN END, PE,
Condition:
Cond. de livraison:

Wärmebehandlung: AS ROLLED
Heat treatment:
Traitement de chaleur:

Coupl.die stamped:
Coupl.paint stencilling:

Colour coding: Fully painted: Bands:
Tube die stamped:

Tube paint stencilling: va SPEC 5L-0033 "API" 04.2016 1.315" 0.250" B PSL1 SMLS TESTED 2500 PSI Length ft Heat No. A/SA 53
GRADE B S A/SA 106 GRADE B SCHED.160 PO No.: HR066557 Made in Austria

Colour coding: Fully painted: Bands: purple

Label: PO No.: HR066557, DAT Port of Houston

Remarks: *) SI units have been converted to US customary units

Auftrags-Nr.: 20850 / 3
Our works order No.:
No usine:

Bestellnr.: HR066557/VATC PO#
Your order No.: 602604

No de la commande:

Zeichen des Lieferwerks: va
Marking of producer:
Marque du fabricant:

Erschmelzungsart: BOF
Melting process: fully killed, produced to
Procédé d'élaboration: fine grain practice

Kindberg, 18.04.2016

Page 1 of 4

No. 119903

Abnahmeprüfzeugnis wurde digital signiert und ist ohne
Originalunterschrift gültig/
Inspection certificate has been signed digitally and is
valid without an original signature

voestalpine Tubulars GmbH & Co KG
Qualitätsstelle / Quality Department

WEITZER

Abnahmebeauftragter
authorized inspection representative
représentant autorisé du contrôle

voestalpine

ONE STEP AHEAD.

KMI FAB

S/O 165053
Date 2-8-17
Item # 16

16



[10308 | REF | 1015378774] | [LN: 4] | TY022731-1 | FSVAT1160 |
voestalpine Tubulars GmbH & Co KG

Umfang der Lieferung / Volume of delivery / Contenu de la livraison:

Versandanzeige: Dispatch advice No. Avis d'expédition:	Pos.: Pos.:	Abmessung: Dimension: Dimension:	Bundnr.: Bundle No.: Nombre Fret:	Stückzahl: Number Of: Pièces:	Länge: Length: Longueur:	Gewicht: Weight: Poids:	Los: Lot: Lot:	Schmelze: Heat: Soufflage:
	3	1,315 in x 0,250 in; 2,84 lbs/ft SCHED.160	1-8	894	19 792.075ft	25 209.50kg		

Volume of delivery

Heat	Lot	Remark
1015378774	206455	AD 01

Test results

- 1 Biegeversuch/Bend test: bestanden/passed
- 2 Dimensionskontrolle/ Dimensional inspection: bestanden/passed
- 3 Streuflussprüfung gem. ASTM E 570 / Flux leakage testing acc. ASTM E 570 (N 12,5 longitudinal, type and size of reference indicator used): bestanden/passed
- 4 Visuelle Inspektion/ Visual inspection: bestanden/passed
- 5 Wasserinnendruckversuch/Hydrostatic test: 2500 PSI (duration min. 5 sec.) bestanden/passed

Test remarks

Wir bestätigen, dass die gelieferten Erzeugnisse den Anforderungen der Bestellung entsprechen.
We hereby certify that the goods delivered are in compliance with the requirements of the order.

Kindberg, 18.04.2016

Page 2 of 4

No. 119903

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Qualitätsstelle / Quality Department

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authorized inspection representative
représentant autorisé du contrôle

voestalpine

ONE STEP AHEAD.



| 10308 | REF | 1015378774 | | [LN: 4] | TY022731-1 | FSVAT1160 |
voestalpine Tubulars GmbH & Co KG

Tensile testing

Lot No	Test Type	Heat treatment	Temp	Specimen			Yield	Tensile	Elong.Reduct	Rt/Rm
				[°C]	No.	Type	Dimension [mm]	Strength	Strength	in area
							[PSI]	[PSI]	[%]	[%]
Requ. from 35 534							60 180	30.00		
Requ. to										
206455	AD 01	Standard	as rolled	20	1	Full Section 33.40 x 6.35	Rt0.50 47 572	65 847	50.40	0.72
206455	AD 01	Standard	as rolled	20	2	Full Section 33.40 x 6.35	Rt0.50 45 977	64 686	52.10	0.71
206455	AD 01	Standard	as rolled	20	3	Full Section 33.40 x 6.35	Rt0.50 46 702	64 977	49.20	0.72
yield strength: Gr B: 35500 PSI										
tensile strength: Gr. B: 60200 PSI										

Hardness testing

Lot No	Test Type		Heat treatment	Specimen		Test Method	Hardness Number		Mean Hardness Number		Variation
				No.	Location		from	to	from	to	
Requ.:											99.50
206455	AC01	Standard	as rolled	1	Body	HRB	74.70	75.60	74.97	75.50	0.53

Kindberg, 18.04.2016

Page 3 of 4

No. 119903

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voestalpine

ONE STEP AHEAD.



[10308 | RFQ | 1015378774] | [LN: 4] | TY022731-1 | FSVAT1160 |

voestalpine Tubulars GmbH & Co KG

Chemical test results

Product analysis

C	Si	Mn	P	S	Cr	Ni	Cu	Al	Ti	Mo	V	Sn	B	N2	Nb	Ca	CEQ
max. Requ.																	
0.2300		1.0600	0.0300	0.0300	0.4000	0.4000	0.4000				0.1500	0.0800					0.4000

min. Requ.

0.0000 0.1000 0.2900

1015378774

0.1557 0.1953 0.7289 0.0146 0.0073 0.0260 0.0212 0.0230 0.0288 0.0009 0.0036 0.0018 0.0013 0.0002 0.0059 0.0000 0.0022 0.2664

Chemical test results

Product analysis

C	Si	Mn	P	S	Cr	Ni	Cu	Al	Ti	Mo	V	Sn	B	N2	Nb	Ca	CEQ
Lot No.	206455	AD 01	1	Standard	Heat No.	1015378774											
0.1545	0.1737	0.6971	0.0137	0.0072	0.0233	0.0215	0.0242	0.0233	0.0012	0.0041	0.0033	0.0019	0.0002	0.0067	0.0007	0.0000	0.2799

Lot No. 206455 AD 01 2 Standard Heat No. 1015378774

0.1539 0.1665 0.6953 0.0107 0.0067 0.0237 0.0232 0.0291 0.0236 0.0013 0.0042 0.0032 0.0022 0.0002 0.0063 0.0007 0.0000 0.2795

Lot No. 206455 AD 01 3 Standard Heat No. 1015378774

0.1522 0.1790 0.7090 0.0114 0.0075 0.0244 0.0227 0.0297 0.0263 0.0016 0.0044 0.0041 0.0025 0.0002 0.0061 0.0013 0.0000 0.2804

Lot No. 206455 AD 01 4 Standard Heat No. 1015378774

0.1590 0.1867 0.7181 0.0146 0.0071 0.0241 0.0211 0.0252 0.0254 0.0015 0.0042 0.0041 0.0022 0.0002 0.0066 0.0013 0.0000 0.2883

Lot No. 206455 AD 01 5 Standard Heat No. 1015378774

0.1524 0.1837 0.7065 0.0146 0.0069 0.0269 0.0215 0.0247 0.0248 0.0014 0.0040 0.0039 0.0023 0.0002 0.0060 0.0011 0.0000 0.2802

Lot No. 206455 AD 01 6 Standard Heat No. 1015378774

0.1535 0.1828 0.7042 0.0145 0.0071 0.0267 0.0213 0.0248 0.0246 0.0014 0.0039 0.0038 0.0022 0.0002 0.0055 0.0010 0.0000 0.2808

Kindberg, 18.04.2016

Page 4 of 4

No. 119903

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voestalpine Tubulars GmbH & Co KG
Qualitätsstelle / Quality Department

WEITZER

Abnahmebeauftragter
authorized inspection representative
représentant autorisé du contrôle

voestalpine

ONE STEP AHEAD.

30# 165053



[| 10352 | | 138VVV] | [LN: 14] | TY023201-1 | D13S90 |



Capitol Manufacturing
1125 Capitol Avenue
Crowley, LA 70526

Phoenix * Capitol * Camco
CapProducts

Commanding a Higher Standardsm

Certified Mill Test Report

Printed: 3/14/2016

Customer

INDUSTRIAL PIPING SPECIALISTS

P.O. BOX 581270

TULSA, OK 74158

Certified: 03/11/2016

P.O. HP235613

Tag

Heat No 166142

Heat Code 138VVV

Phoenix Order # 1187112

Material ASTM A105-2014 / ASME SA105-2015 Edition

Part Number

12400110

Description

1 90 FS 3M SW ELL

Chemical Properties

C	Mn	P	S	Si	Cu	Ni	Cr	C Eq. Long	
0.2100	0.9100	0.0080	0.0230	0.2300	0.1600	0.0930	0.1410	0.4199	
Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0330	0.0330								

Additional Chemical Properties

Cr + Cu + Ni

0.3940

Mechanical Properties

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
88,000	59,500	26.0%	64.0%	179	179

Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Average
N/A	N/A	N/A	N/A

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements.

We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

KMI FAB

S/O

Date

Item #

165053

2-8-17

17

50# 165053



[10352 | 413DD] [LN: 21] TY023201-1 D13TCO



Capitol Manufacturing
1125 Capitol Avenue
Crowley, LA 70526

Phoenix * Capitol * Camco
CapProducts

Commanding a Higher Standard_{sm}

Certified Mill Test Report

Printed: 9/30/2016

Certified: 07/13/2016

Customer

P.O. CP170450

INDUSTRIAL PIPING SPECIALISTS

Tag

Heat No 166339

P.O. BOX 581270

Heat Code 413DD

TULSA, OK 74158

Phoenix Order # 1232832

Material ASTM A105-2014 / ASME SA105-2015 Edition

Part Number

12202010

Description

1 FS 3M THD COUPLING

Chemical Properties

C	Mn	P	S	Si	Cu	Ni	Cr	C Eq. Long	
0.2000	0.9200	0.0050	0.0220	0.2400	0.1700	0.0730	0.1130	0.4029	
Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0180	0.0360								

Additional Chemical Properties

					Cr + Cu + Ni	
					0.3560	

Mechanical Properties

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
71,500	42,500	31.0%	64.0%	143	143

Charpy Minimum Impact - ft/lbs

Test 1	Test 2	Test 3	Average	Test Temp.
N/A	N/A	N/A	N/A	N/A

We hereby certify that these parts were manufactured, sampled, tested, and inspected in accordance with the product specifications stated and were found to meet the requirements.

We further certify that this material was inspected using independent inspectors conforming to the requirements of EN 10204 3.1. These products meet the requirements of the latest editions of NACE MR0175, NACE MR0103, and ISO 15156. No weld repair has been performed on these products. This material was not exposed to mercury or any other metal alloy that is liquid at ambient temperatures during processing or while in our possession.

Meets ASME SA-181-70 2013 Edition. Manufactured in the USA.

KMI FAB

S/O

Date

Item #

165053
2-8-17
18

165053		INDEX OF MATERIAL CERTIFICATION		
ITEM	QTY	DESCRIPTION	HEAT NUMBERS	MATERIAL
1	1	SHELL, PIPE, 20" SCH 60 (0.812" NOM) SMLS x 84" LG	945635	SA-106-C
2	1	HEAD, 20" OD x 3/4" NOM, 2: 1 ELLIP. W/ 2" S.F. (HOT FORMED)	AKC	SA-516- 70 N
3	1	CLOSURE, 20" OD 600# ANSI FIG. 500 R & M VERTICAL W/DAVIT	ZH551	CS
4	2	FLANGE, 8" 600# RFLWN x 14" LG	B091AN, A285DAN	SA-105 N
5	2	COUP-O-LET, 1" 6000#	A2K	SA-105
6	1	COUP-O-LET, 3/4" 6000#	TTP	SA-105
7	3	COUP-O-LET, 1/2" 6000#	74FJ	SA-105
8	1	PLATE, TUBESHEET, 18 1/8" OD x 1" THK (SEE DETAIL)	6506641	SA-516- 70 N
9	1	SKIRT, PIPE, 20" SCH 20 (.375") X 69"LG	N13597	SA-53-B/1-6-B
10	1	PLATE (BASE) 25" OD x 18" ID x 3/4" THK	W6C510	SA-516- 70 N
14	2	LIFTING LUGS, PHOENIX SERIES 2-899-MLL	ADOB	A105
16	1	PIPE, DRAIN, 1" SCH 160 SMLS	1015378774	SA-106-B
17	1	ELBOW, 1" 3000# 90° SOCKETWELD	138VVV	SA-105
18	1	COUPLING, FULL, 1" 3000# THREADED	413DD	SA-105



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165053

SECTION 5
NDE REPORTS

[illegible]

2-7-17



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165053

SECTION 6

PROCESS CONTROL SHEETS (TRAVELERS)

KMI FABRICATORS, LLC STANDARD INSPECTION CHECKLIST FOR PRESSURE VESSELS FOR PRESSURE VESSELS ASME SECTION VIII, DIVISION 1	CUSTOMER: UOP RUSSELL KMI PROJECT: Q160140R1 PO: 44500749401	JOB/SERIAL NO. 165053 TAG: F-446	MODEL NO. GE1307L025V 20"OD X 7' 0" S/S	PAGE 1 OF 2 165053
---	--	---	--	--

NO	CHECKLIST ATTRIBUTES/TESTS TO BE VERIFIED		MFG		AI WITNESS		QA AUDIT/NDE		CI
			HP	INIT/DATE	HP	INIT/DATE	HP	INIT/DATE	
1.	MATERIAL TRACEABILITY	VERIFY THAT MATERIAL TRACEABILITY HAS BEEN CONFIRMED BY QA AND THAT MATERIAL IS IDENTIFIED WITH HEAT/QC NUMBERS. REVIEW MTR'S	X	1-8-17 mw			X	1/31/17	
2.	JOINT FIT UP (SHELL SEAMS)	VERIFY WELD JOINT FITUP IN ACCORDANCE WITH APPROVED DRAWINGS FOR ALL SEAMS ON THE VESSEL AND SUMP	X						
3.	LAYOUT	VERIFY NOZZLE/COUPLING OPENINGS IN VESSEL IS PROPERLY LOCATED PER DRAWING.	X						
4.	NOZZLES	VERIFY NOZZLES/COUPLINGS FITUP IN ACCORDANCE WITH APPROVED DRAWINGS, VERIFY NOZZLES INSTALLED PLUMB/LEVEL	X						
5.	OPEN END/ INTERNALS	VERIFY INTERNALS ARE INSTALLED IN ACCORDANCE WITH DIMENSIONS, CONFIGURATION, ORIENTATION SHOWN ON DRAWING.	1 ST STAGE	X	2-1-17 mw	X	2-1-17		
		2 ND STAGE*	N/A		N/A				
6.	WELDING INSPECTION	VESSEL ☒ SUMP ☐ A.I. HOLD POINT							
		VISUALLY EXAMINE COMPLETED WELDMENTS IN ACCORDANCE WITH APPROVED DRAWINGS. INSPECT ALL ACCESSIBLE WELDS (FILLET, GROOVE, etc.-INTERNAL & EXTERNAL). DIRECT VISUAL EXAMINATION VERIFY THAT WELDS ARE STAMPED WITH WELDERS'S SYMBOL (S) & THAT SYMBOLS ARE RECORDED ON INSPECTION COPY OF DRAWINGS	VERIFY WELD SURFACE QUALITY VERIFY LENGTH/TYPE SIZE/LOCATION	X	2-6-17 mw			X	2-6-17 Barnes
7.	DIMENSIONS & CONFIGURATION VERIFICATION	A) VERIFY FINAL CONFIGURATION OF VESSEL (INCLUDING CLOSURE, DAVIT, SUMP, VESSEL SUPPORTS, etc.) COMPLIES WITH DIMENSIONS AND ORIENTATIONS SHOWN ON DRAWING.		X					
		B) VERIFY HEAT /QC NUMBERS AND BOLT MARKINGS REMAIN VISIBLE AND LEGIBLE AND THAT NO MATERIAL HAS BEEN SUBSTITUTED WITHOUT ENG. APPROVAL: RECORD HEAT/QC NUMBERS ON INSPECTION COPY OF VESSEL DRAWING.		X					
		C) VERIFY THAT NOZZLES/COUPLINGS ARE INSTALLED PLUMB/LEVEL WITH FLANGE BOLTHOLES STRADDLING VESSEL CENTERLINE.		X					
		D) VERIFY THAT VESSEL SHELL ROUNDNESS COMPLIES WITH ASME VIII UG80		X					
		E) VERIFY THAT MATERIAL TYPES INSTALLED IN VESSEL CONFORM TO REQUIREMENTS OF BILL OF MATERIAL/ENG. DATA SHEET/JOB PICK LIST.		X					
		F) VERIFY THAT BASE METAL IS FREE OF DAMAGE (DENTS, GOUGES, etc.).		X					

APPROVED WPS (USE CURRENT REVISION)		1047A ☒	1064 ☐	1071 ☐	OTHER WPS ☐	* WHERE APPLICABLE
HEAT TREAT: YES ☐ NO ☒		LEGEND: HP = HOLD INSPECTION POINT AI = AUTHORIZED INSPECTOR CI = CUSTOMER INSPECTOR				
APPROVED BY QUALITY ASSURANCE: <i>Barnes</i>		DATE: 1-17-17				

KMI FABRICATORS, INC.
STANDARD INSPECTION CHECKLIST FOR PRESSURE VESSELS

JOB NO.: 165053
TAG: F-446

PROJECT: Q160140R1

165053

Page
2 of 2

NO	CHECKLIST ATTRIBUTES/TESTS TO BE VERIFIED (CON'T FROM PG 1)		MFG		AI WITNESS		QA AUDIT/NDE		CP
			HP	INIT/DATE	HP	INIT/DATE	HP	INIT/DATE	
8.	NONDESTRUCTIVE EXAMINATION (CONTACT QA TO PERFORM/VERIFY NDE)	MAGNETIC PARTICLE INSPECTION	N/A						
		LIQUID PENETRANT INSPECTION	N/A						
		ULTRASONIC INSPECTION (SUBCONTRACT)	N/A						
		BRINELL HARDNESS TESTING ☐ OTHER ☐	N/A						
		RT (SUBCONTRACT) RT1 ☐ RT2 ☒ RT3 ☐ RT4 ☐ RADIOGRAPH ☐ USE TYPE _____ FILM	X	HB 2/7/17					
9.	PRESSURE TEST	A) PERFORM REINFORCING PAD LEAK TEST IAW SPECIFICATION DATA SHEET	N/A		N/A				
		B) PERFORM HYDROSTATIC TEST IAW SPECIFICATION DATA SHEET 1430 PSIG for 15 minutes	X	TO 2-8-17	X	2-8-17	X	HB 2/8/17	
10.	NAMEPLATE	VERIFY NAMEPLATE (CODE OR NON-CODE) AND CUSTOMER NAMEPLATE WHEN REQUIRED IS ATTACHED PER DRAWING (AFTER HYDRO/PRIOR TO SHIPPING)	X	2-21-17	X		X		
11.	DAVIT TEST	PERFORM DAVIT TEST	X	2-21-17					
12.	COATINGS	A) VERIFY BLAST CLEANING IN ACCORDANCE WITH PAINT SPECIFICATION							
		B) VERIFY COATINGS APPLICATION IS ACCORDANCE WITH PAINT SPEC AND SPEC DATA SHEET	X	2-21-17					
13.	INTERNAL CLEANING	VERIFY INTERNAL CLEANING IN ACCORDANCE WITH SPECIFICATION DATA SHEET	X	2-21-17					
14.	ELEMENTS	VERIFY FILTER MEDIA (ELEMENTS, REPACK, etc.) IS INSTALLED PER DRAWING	N/A						
15.	AUXILIARY EQUIPMENT	VERIFY AUXILIARY EQUIPMENT (PIPING, VALVES, etc.) IS INSTALLED FOR TRIAL FIT (WHEN REQUIRED) IN ACCORDANCE WITH THE DRAWINGS	N/A						
16.	BOLT TORQUING	VERIFY THAT ALL PERMANENT BOLTING IS INSTALLED AND TORQUED	X	2-21-17					
17.	PREPARATION FOR SHIPMENT	VERIFY THAT SHIPPING PREPARATIONS ARE COMPLETE, IN ACCORDANCE WITH THE REQUIREMENTS OF THE SPECIFICATION DATA SHEET AND DRAWINGS.	X	2-21-17			X	HB 2/22/17	

OTHER REQUIREMENTS

NOTES: Use TRCo Painting System 3 per the Specification Data Sheet.

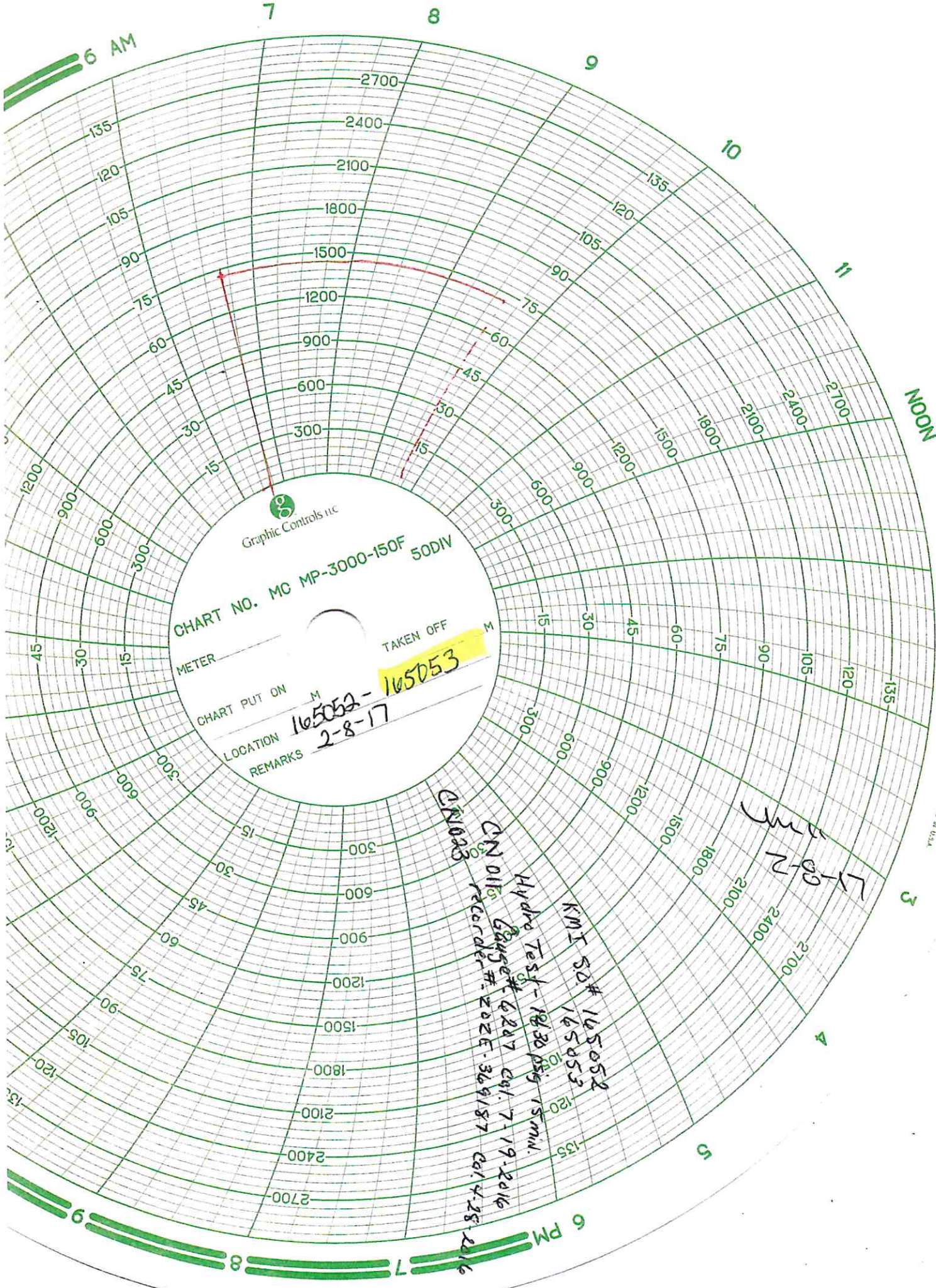


410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165053

SECTION 7

HYDROSTATIC / PRESSURE TEST RECORDS



Graphic Controls Inc
CHART NO. MC MP-3000-150F 50DIV
METER
CHART PUT ON
LOCATION
REMARKS
TAKEN OFF
M

165052-165053
2-8-17

CN 0115
Hydro Test - 1830 psi 15 min.
Gauge # 6247 Cal. 7-19-2016
Recorder # 2026-369187 Cal. 4-28-2016
KMI SO # 165052 165053

165052
165053



PRESS. — TEMP. — GAUGE — REC. — PK/DeadWt. —

SERIAL NUMBER 16207 MODEL McDaniel's RANGE 0.3000 ACCURACY 5%

CALIBRATION

CALIBRATED IN Vertical POSITION. AMBIENT TEMPERATURE 70°

DATE OF CALIBRATION 7-19-16 INSPECTOR Z. Sjo



P.O. BOX 7172
FORT WORTH, TEXAS 76111
(817) 532-2534
FAX (817) 532-2513

SERIAL NUMBER 202F-36A187 MODEL Barton RANGE 0-3200 ACCURACY 1%

CN23

CALIBRATION

CALIBRATED IN Vertical POSITION. AMBIENT TEMPERATURE 70°

THIS IS TO CERTIFY THAT THIS INSTRUMENT HAS BEEN INSPECTED AND TESTED AGAINST
PRESSURE STANDARD T155 T16004
TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS TECHNOLOGY.
TRACEABILITY REFERENCE P8003
SPECIAL CONDITIONS:

DATE OF CALIBRATION 4-28-16 INSPECTOR [Signature]



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165053

SECTION 8

NAMEPLATE FASCIMILE



PENTAIR

Filtration & Process

936-788-1000

www.pentairseparations.com

InterSep® ID No.

GI2004H08

Replacement Element No.

GE1307L025V



6566

CERTIFIED BY



KMI FABRICATORS, INC.

410 BOYD RD.

MINERAL WELLS, TX 76067



1100 PSI AT 150 °F

MAWP

-20 °F AT 1100 PSI

MDMT

RT-2

SERIAL NO.

165053

YR. BLT.

2017

CORR. ALLOWANCE

.0625"

EXT. PRESS.

XXX

PSI AT

XX

°F

MOL SIEVE DUST

FILTER

TAG: F-446

CERTIFIED BY



KMI FABRICATORS, INC.

410 BOYD RD.
MINERAL WELLS, TX 76067



1100 PSI AT 150 °F

MAWP

-20 °F AT 1100 PSI

MDMT

RT-2

SERIAL NO. 165053

YR. BLT. 2017

CORR. ALLOWANCE

.0625

EXT. PRESS. ~~XXX~~ PSI AT ~~XX~~ °F

100 L SIEVE DUST

FILTER

TAG: F-446



PENTAIR

Filtration & Process

936-788-1000

www.pentairseparations.com

InterSep® ID No.

GI2004H08

Replacement Element No.

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410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

165053

SECTION 9
PAINT REPORT

165053

PRESS-O-FILM™

No. _____

Reading _____

Gage less 2.0 mils

or 50 microns

COARSE (.8-2.0 mils) or (20 to 50 microns)

TESTEX

NEWARK, DE 19715

USA



410 BOYD ROAD
MINERAL WELLS, TEXAS 76067
PHONE: 940-325-7841
FAX: 940-325-3765

PAINT LOG

Description of Item: MOL SIEVE DUST FILTER

Serial No. 165053 Note: Use TRCo Painting System 3

1. Date of Blasting	2-15-2017	Type of Sand:	2
2. Atmospheric Temp.	73	°F	
3. Surface Temp.	74	°F	
4. Wet Bulb Temp.	55	°F, Dry Bulb Temp.	74 °F
5. Dew Point	40	°F, Humidity	61 °F
6. Surface Preparation Quality			
7. Blast Profile	2	SSPC-SP 6 Commercial Blast	MILS
8. Method of Checking Profile	TEXTEX PROFILE Comparator		
9. Date of Prime Coat	2-15-2017		
10. Atmospheric Temp.	74	°F	
11. Surface Temp.	76	°F	
12. Wet Bult Temp.	55	°F, Dry Bulb Temp.	74 °F
13. Dew Point	40	°F, Air Quality	good Humidity 61
14. Product Name	Sherwin Williams Macropoxy 646 (B58-600)	Batch No.	XM3476FM
15. Cure Time	24 Hrs. Dry Film Thk.	MILS (AVG.)	
16. Date of Intermediate Coat	2-16-2017		
17. Atmospheric Temp.	85	°F	
18. Surface Temp.	89	°F	
19. Wet Bult Temp.	61	°F, Dry Bulb Temp.	85 °F
20. Dew Point	48	°F, Air Quality	good Humidity 63
21. Product Name	Sherwin Williams Macropoxy 646 (B58-600)	Batch No.	XM3476FM
22. Cure Time	24 Hrs. Dry Film Thk.	MILS (AVG.)	
23. Date of Intermediate Coat	2-17-2017		
24. Atmospheric Temp.	88	°F	
25. Surface Temp.	90	°F	
26. Wet Bult Temp.	59	°F, Dry Bulb Temp.	88 °F
27. Dew Point	44	°F, Air Quality	good Humidity 58
28. Product Name	Sherwin Williams Hi-Solids Polyurethan B65 Series/B60V30	Batch No.	XM3166650
29. Cure Time	24 Hrs. Dry Film Thk.	10-11 MILS (AVG.)	

THE ABOVE INFORMATION CERTIFIED CORRECT BY KMI FABRICATORS, INC

BY: Jay CappsDATE: 2-21-17