

UOP RUSSELL LLC
Tulsa, Oklahoma

JOB NO: J-447	TAG NO: V-404	DATE: 11/29/2010
CLIENT: UOP Russell	S.O./P.O. NO:	BY: JRG
SUBJECT: 60 MMscfd Cryo Plant	SERVICE: Product Surge Tank	

PRESSURE VESSELS

MECHANICAL DESIGN	PROCESS DESIGN
Type (vertical, horizontal, tower) Horizontal	Operating Pressure (psia) 265
Diameter: (inch) 109.346 OD	Operating Temperature (°F) 36 to 120
S/S Length (ft-inch) 65' - 5" OAL	Vapor Flow (Lb/Hr) ----
CL Vessel Height (ft-inch) 5'-0"	Vapor Density (Lb/cf) ----
Design Pressure (psig) 400	Liquid Flow (Lb/Hr) 39,570
Design Temperature (°F) 200	Liquid Density (Lb/cf) 30.84
MDMT (°F) @ Pressure (psig) -20 @ 400	Liquid Residence Time (Hr) >2.6 @ 85%
Corrosion Allowance (inch) 0.0625	
Radiography RT-2 min.	
PWHT Req'd? No	
Wind / Seismic Code ASCE 7-10 / ASCE 7-10	
Wind Code Cf=0.7, V=120 mph, Exp. C, Cat. III	
Seismic Code Site D, I=1.25, S_s=100%, S₁=40%	
Insulation 1" C	
Fireproof No	
Code ASME VIII, Div I	
Code Stamp Req'd Yes	
Sandblast / Paint SSPC-SP6 / TRCo Std ENG-36c (Note 2)	
Ladder / Platform Clips Req'd? No	
Pipe Supports Req'd? No	
	MIST PAD
	Req'd : No Diameter: _____
	Overall Thk: _____ Pad Thk: _____
	Removable: _____ Grid Matl: _____
	Wire Diameter: _____ Mesh Matl: _____
	MATERIAL SPECIFICATIONS
	Shell SA- 516-70N
	Head SA- 612N
	Nozzle Necks SA- 106B
	Flanges SA- 105
	Couplings SA- 105
	Studs SA- 193-B7
	Nuts SA- 194-2H
	Wear Plate / Saddle SA- 516-70 / 36

NOZZLES

SERVICE	MK	QTY	SIZE	RATING	FACE & TYPE	NOZZLE APPURTENANCES
Inlet	A	1	6."	300	RF FLG	
Liquid Outlet	B	1	6."	300	RF FLG	Vortex Breaker
Equalization	C	1	6."	300	RF FLG	
LI	D	2	3."	300	RF FLG	
Manway	E	1	18."	300	RF FLG	
Drain	F	1	2."	300	RF FLG	
TI	G	1	.75"	6000	CPLG	
PSV	H	1	6."	300	RF FLG	Flush Inside w/ 0.125 Radius
Pump Spillback	J	1	3."	300	RF FLG	
Seal Flush Connection	K	1	.75"	6000	CPLG	

INTERNALS AND APPURTENANCES

PACKING	Size (in.)	Type	Bed Height (ft.)	PLATFORMS	Quantity	Angle / Area		DOME	BOOT
Top				Access:		(deg)	Diameter (in):		
Middle				Stepoff:		(deg)	Length (in):		
Bottom				Other:		(Sq.Ft.)	with flanges		
TRAYS	Quantity	No. of Passes	Weldins by:	Platepack Length (inch):			Qty Break Flg Pairs:		
				Total Ladder Length (ft):			Qty of Hat Trays:		
NOTES: 1) See scope of supply for oversizing mist pads.							Weir Plate:	No	
▲ 2) Use TRCo Painting System 3							Wave Baffle:	No	
							Nat'l Board Req'd:	Yes	
REVISION		3	4	5	▲ 6		Charcoal Bed Height (ft):		
ENGINEER/DATE		HMG 11/26/12	TN 6/28/13	TKF 7/12/13	TKF 08/19/13		Qty Catalyst bed Supports:		
ISSUED FOR		Revised	Revised	Revised	Revised				



Data Book

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136
Tel: 539-664-4800

109.346" O.D. x 65'-5" OAL
Product Surge Tank

Tag Number: V-404

P.O. Number: 4500754186

Project: J447XX

BWFS Job # 2491

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039



Manufacturing Data Book

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*4 Oct
31 May 17*



Manufacturing Data Book

Section 1

Data Reports

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136

P.O. Number: 4500754186

Project: J447XX

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039

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 BWFS INDUSTRIES, LLC. 5637 ETHELINE HOUSTON TEXAS 77039 USA
(Name and address of manufacturer)

2. Manufactured for UOP Russell, 7050 South Yale Ave., Suite 210, Tulsa, Ok. 74136
(Name and address of purchaser)

3. Location of installation Catoosa, Oklahoma, 74015
(Name and address)

4. Type: Horizontal 2491 - 2491 Rev.4 14730 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 Edition / -
(Edition and Addenda, if applicable (Date)) (Code Case numbers) (Special Service per UG-120 (d))

6. Shell SA-516-70N 1.1875" .0625" 106.971" I.D. 65'-5" S/S
Material spec. number, grade) Nominal thickness (Corr. allow) (Inner diameter) [Length (overall)]

Body Flanges on Shell

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

7. Seams: 6 Dbl. Type 1 UW-11(a) 100% - - 2 Sngl. / 5 Dbl. Type 1 UW-11(a)(5)(b) 85% 6
[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-516-70N (b) Material SA-516-70N
(Spec. number, grade) (Spec. number, grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	End	.8670"	.0625"	-	-	2:1	-	53.6875"	-	Concave
(b)	End	.8420"	.0625"	-	-	2:1	-	53.6875"	-	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)	-	-	-	-	-	-	-	-	-	-	-	-
(b)	-	-	-	-	-	-	-	-	-	-	-	-

9. MAWP 400 PSI - PSI at max temp. 200°F -°F
(Internal) (External) (Internal) (External)

Min. design metal temp. -20 °F at 400 PSI Hydro. ~~proof~~ or ~~comb.~~ test press. 523
 Proof Test -

10. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain ect.)	No.	Diameter Or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Inlet	1	6" 300#	RFWN	SA-106-B	SA-105	.432"	.0625"	SA-516-70	UW-16.1(c)	Type 1	Shell
Liquid Outlet	1	6" 300#	RFWN	SA-106-B	SA-105	.432"	.0625"	SA-516-70	UW-16.1(c)	Type 1	Shell
Equalization	1	6" 300#	RFWN	SA-106-B	SA-105	.432"	.0625"	SA-516-70	UW-16.1(c)	Type 1	Shell
LI	2	3" 300#	RFWN	SA-106-B	SA-105	.438"	.0625"	SA-516-70	UW-16.1(c)	Type 1	Shell
*Manway w/ Blind	1	18" 300#	RFWN	SA-106-B	SA-105	.500"	.0625"	SA-516-70N	UW-16.1(c)	Type 1	Shell
Drain	1	2" 300#	RFWN	SA-106-B	SA-105	.344"	.0625"	-	UW-16.1(c)	Type 1	Shell

11. Supports: Skirt No Lugs - Legs - Others Saddles Attached Shell / Welded
(Yes or No) (No.) (No.) (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:

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

PSV by Customer per UG-125(a). See attached Form U-4. Impact test exempt per UCS-66.

* (24) SA-193-B7, 1-1/4" X 7-3/4" Lg, w/ (2) SA-194-2H each.

FORM U-1A (Back)

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 26,717 expires 7/13/2018

Date 5/8/17 Co. Name BWFS INDUSTRIES, LLC. (Manufacturer) Signed [Signature] (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by BWFS INDUSTRIES, LLC. at 5637 ETHELINE HOUSTON, TEXAS 77039 USA
I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by OneCIS Insurance Co. of Lynn, MA

have inspected the component described in this Manufacturer's Data Report on 5/8/2017, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 5-8-2017 Signed [Signature] (Authorized Inspector) Commissions NB 14610 AI R [National Board (incl endorsements)]

[Signature]
31-May-17

1 OCT 31-May 77



Manufacturing Data Book

Section 2

Name Plate Copies

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136

P.O. Number: 4500754186

Project: J447XX

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039



U
W
RT-2



14730

CERTIFIED BY

BWFS INDUSTRIES LLC
HOUSTON, TEXAS, USA
TEL (281) 590-9391

M.A.W.P.

400

PSIAT

200

°F

M.A.E.W.P.

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PSIAT

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°F

M.D.M.T.

-20

°FAT

400

PSI

SERIAL NO.

2491

YEAR BUILT

2017

109.346" O.D. X 65'-5" OAL X 1" HEADS X 1-3/16" SHELL

PRODUCT SURGE TANK

CORROSION ALLOWANCE; 1/16"

HYDROTESTED AT 523 PSI ON 5/8/2017

BWFS
INDUSTRIES LLC



Handwritten signature



Manufacturing Data Book

Section 3

ASME Code Calculations

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136

P.O. Number: 4500754186

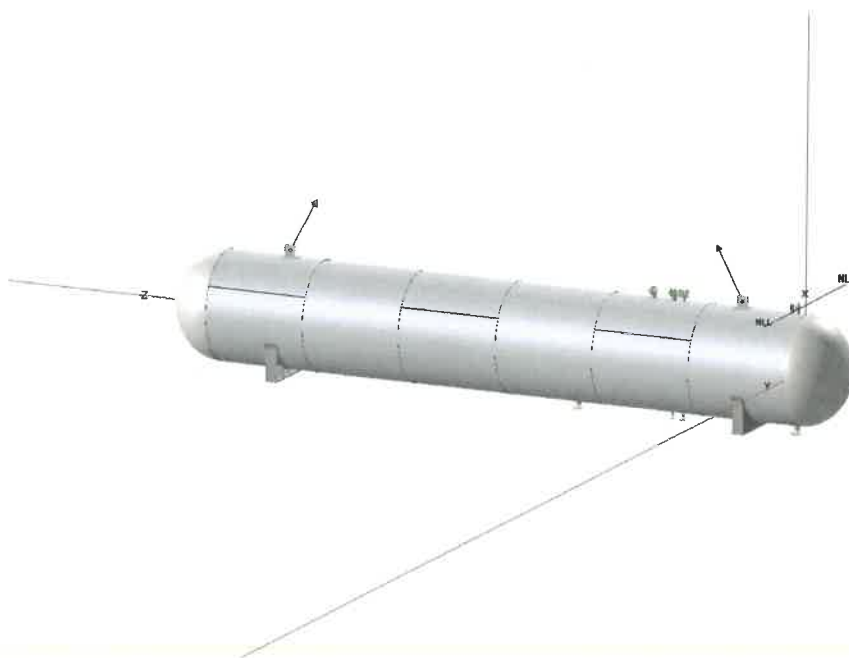
Project: J447XX

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039

BWFS Industries, LLC

Houston, TX, USA

www.bwfsindustries.com



COMPRESS Pressure Vessel Design Calculations

Item: 109.346" O.D. x 65'-5" OAL PRODUCT SURGE TANK
Vessel No: 2491

Engineering Approval:  Date: 5-4-17

Authorized Inspector:  Date: 5-8-2017

Vessel Tag#: V-404
Customer: UOP RUSSELL LLC
Project: S447XX
Plant Location: CATOOSA Oklahoma 74015
P.O.#: 4500754186



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<u>18" 300# MANWAY (E)</u>	36/92
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<u>6" 300# (A)</u>	42/92
<u>Cylinder #2</u>	45/92
<u>2" 300# DRAIN (F)</u>	47/92
<u>3" 300# (D1)</u>	50/92
<u>3" 300# (D2)</u>	53/92
<u>6" 300# (C)</u>	56/92
<u>6" 300# (H)</u>	59/92
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<u>Wind Code</u>	91/92
<u>Vertical Load #1</u>	92/92

Deficiencies Summary

No deficiencies found.

Nozzle Schedule

Specifications									
Nozzle mark	Identifier	Size	Materials		Impact Tested	Normalized	Fine Grain	Flange	Blind
A	6" 300#	NPS 6 Sch 80 (XS)	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 6 Class 300 WN A105	No
			Pad	SA-516 70	No	No	No		
B	6" 300#	NPS 6 Sch 80 (XS)	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 6 Class 300 WN A105	No
			Pad	SA-516 70	No	No	No		
C	6" 300#	NPS 6 Sch 80 (XS)	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 6 Class 300 WN A105	No
			Pad	SA-516 70	No	No	No		
D1	3" 300#	NPS 3 Sch 160	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 3 Class 300 WN A105	No
			Pad	SA-516 70	No	No	No		
D2	3" 300#	NPS 3 Sch 160	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 3 Class 300 WN A105	No
			Pad	SA-516 70	No	No	No		
E	18" 300# MANWAY	NPS 18 XS	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 18 Class 300 WN A105	NPS 18 Class 300 A105
			Pad	SA-516 70	No	Yes	No		
F	2" 300# DRAIN	NPS 2 Sch 160	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 2 Class 300 WN A105	No
G	3/4" 6000# CPLG	NPS 0.75 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
H	6" 300#	NPS 6 Sch 80 (XS)	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 6 Class 300 WN A105	No
			Pad	SA-516 70	No	No	No		
J	3" 300#	NPS 3 Sch 160	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 3 Class 300 WN A105	No
			Pad	SA-516 70	No	No	No		
K	3/4" 6000# CPLG	NPS 0.75 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No

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)		
A	6.625	0.432	0.3514	Yes	Yes	1.1875	1.1588		2.75	1	0.0625	100.9
B	6.625	0.432	0.3514	Yes	Yes	1.1875	1.1588		2.75	1	0.0625	100.9
C	6.625	0.432	0.3514	Yes	Yes	1.1875	1.1482		2.75	1	0.0625	102.9
D1	3.5	0.438	0.2874	Yes	Yes	1.1875	1.1588		2	0.875	0.0625	103.2
D2	3.5	0.438	0.2874	Yes	Yes	1.1875	1.1482		2	0.875	0.0625	105.3
E	18	0.5	0.3049	Yes	Yes	1.1875	1.1535		7	1.25	0.0625	103.3
F	2.375	0.344	0.2254	Yes	Yes	1.1875	N/A		N/A	N/A	0.0625	Exempt
G	1.75	0.35	0.125	Yes	Yes	1.1875	N/A		N/A	N/A	0.0625	Exempt
H	6.625	0.432	0.3514	Yes	Yes	1.1875	1.1482		2.75	1	0.0625	102.9
J	3.5	0.438	0.2874	Yes	Yes	1.1875	1.1482		2	0.875	0.0625	105.3
K	1.75	0.35	0.125	Yes	Yes	1.1875	N/A		N/A	N/A	0.0625	Exempt

Definitions	
tn	Nozzle thickness
Req tn	Nozzle thickness required per UG-45/UG-16 Increased for pipe to account for 12.5% pipe thickness tolerance
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

Pressure Summary

Component Summary								
Identifier	P Design (psi)	T Design (°F)	MAWP (psi)	MAP (psi)	MDMT (°F)	MDMT Exemption		Impact Tested
Hemi Head #1	400	200	563.06	613.86	-55	Note 1		No
Cylinder #6	400	200	410.71	438.21	-25.1	Note 2		No
Cylinder #5	400	200	410.71	438.21	-25.1	Note 2		No
Cylinder #4	400	200	410.71	438.21	-25.1	Note 2		No
Cylinder #3	400	200	410.71	438.21	-25.1	Note 2		No
Cylinder #2	400	200	410.71	438.21	-25.1	Note 2		No
Cylinder #1	400	200	410.71	438.21	-25.1	Note 2		No
Hemi Head #2	400	200	563.06	613.86	-55	Note 1		No
Saddle #1	400	200	401.85	N/A	N/A	N/A		N/A
6" 300# (A)	400	200	401.85	422.71	-20	Nozzle	Note 3	No
						Pad	Note 4	No
6" 300# (B)	400	200	401.85	422.71	-20	Nozzle	Note 3	No
						Pad	Note 4	No
6" 300# (C)	400	200	405.8	422.71	-20	Nozzle	Note 5	No
						Pad	Note 4	No
3" 300# (D1)	400	200	406.43	438.2	-20	Nozzle	Note 6	No
						Pad	Note 7	No
3" 300# (D2)	400	200	410.37	438.2	-20	Nozzle	Note 8	No
						Pad	Note 7	No
18" 300# MANWAY (E)	400	200	406.66	425.04	-25.6	Nozzle	Note 9	No
						Pad	Note 10	No
2" 300# DRAIN (F)	400	200	410.67	438.2	-55	Note 11		No
3/4" 6000# CPLG (G)	400	200	412.64	438.2	-155	Note 12		No
6" 300# (H)	400	200	405.8	422.71	-20	Nozzle	Note 5	No
						Pad	Note 4	No
3" 300# (J)	400	200	410.37	438.2	-20	Nozzle	Note 8	No
						Pad	Note 7	No
3/4" 6000# CPLG (K)	400	200	414.61	438.2	-155	Note 13		No

Chamber Summary	
Design MDMT	-20 °F
Rated MDMT	-20 °F @ 401.85 psi
MAWP hot & corroded	401.85 psi @ 200 °F
MAP cold & new	422.71 psi @ 70 °F
(1) This pressure chamber is not designed for external pressure.	

Notes for MDMT Rating		
Note #	Exemption	Details
1.	Material impact test exemption temperature from Fig UCS-66 Curve D = -37.44°F Fig UCS-66.1 MDMT reduction = 28.3°F, (coincident ratio = 0.7173) Rated MDMT of -65.74°F is limited to -55°F by UCS-66(b)(2)	UCS-66 governing thickness = 0.83 in
2.	Material impact test exemption temperature from Fig UCS-66 Curve D = -23°F Fig UCS-66.1 MDMT reduction = 2.1°F, (coincident ratio = 0.9788)	UCS-66 governing thickness = 1.1875 in
3.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.2248).	
4.	Pad is impact test exempt per UG-20(f)	UCS-66 governing thickness = 1 in.
5.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.2225).	
6.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1033).	
7.	Pad is impact test exempt per UG-20(f)	UCS-66 governing thickness = 0.875 in.
8.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1022).	
9.	Nozzle impact test exemption temperature from Fig UCS-66 Curve B = -13°F Fig UCS-66.1 MDMT reduction = 48.9°F, (coincident ratio = 0.5474) Rated MDMT of -61.9°F is limited to -55°F by UCS-66(b)(2)	UCS-66 governing thickness = 0.4375 in.
10.	Pad impact test exemption temperature from Fig UCS-66 Curve D = -23°F Fig UCS-66.1 MDMT reduction = 2.6°F, (coincident ratio = 0.9742)	UCS-66 governing thickness = 1.1875 in.
11.	Flange rating governs: Flange rated MDMT per UCS-66(b)(1)(b) = -55°F (Coincident ratio = 0.5492) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	
12.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.0418).	
13.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.0416).	

Revision History

Revisions			
No.	Date	Operator	Notes
0	1/ 5/2017	S.Rice	New vessel created ASME Section VIII Division 1 [COMPRESS 2015 Build 7510]

Settings Summary

COMPRESS 2016 Build 7600	
ASME Section VIII Division 1, 2015 Edition	
Units	U.S. Customary
Datum Line Location	0.00" from right 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	6"
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	Yes
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 Pressure	1.3 times vessel MAWP
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	Yes
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	Yes
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:	No
Note: UG-22(b),(c) and (f) loads only considered when supports are present.	

License Information	
Company Name	BWFS Industries LLC
License	Commercial
License Key ID	31138
Support Expires	July 28, 2017

Radiography Summary

UG-116 Radiography							
Component	Longitudinal Seam		Left Circumferential Seam		Right Circumferential Seam		Mark
	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	
Hemi Head #1	N/A	Seamless No RT	N/A	N/A	A	Full UW-11(a) / Type 1	RT1 SPOT
Cylinder #6	A	Full UW-11(a) / Type 1	A	Full UW-11(a) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	RT2
Cylinder #5	A	Full UW-11(a) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	RT2
Cylinder #4	A	Full UW-11(a) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	RT2
Cylinder #3	A	Full UW-11(a) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	RT2
Cylinder #2	A	Full UW-11(a) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	RT2
Cylinder #1	A	Full UW-11(a) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	A	Full UW-11(a) / Type 1	RT2
Hemi Head #2	N/A	Seamless No RT	A	Full UW-11(a) / Type 1	N/A	N/A	RT1 SPOT
Nozzle	Longitudinal Seam		Nozzle to Vessel Circumferential Seam		Nozzle free end Circumferential Seam		
18" 300# MANWAY (E)	N/A	Seamless No RT	D	N/A / Type 7	C	Spot UW-11(a)(5)(b) / Type 1	RT2
6" 300# (A)	N/A	Seamless No RT	D	N/A / Type 7	C	UW-11(a)(4) exempt / Type 1	N/A
3/4" 6000# CPLG (G)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
6" 300# (C)	N/A	Seamless No RT	D	N/A / Type 7	C	UW-11(a)(4) exempt / Type 1	N/A
6" 300# (H)	N/A	Seamless No RT	D	N/A / Type 7	C	UW-11(a)(4) exempt / Type 1	N/A
2" 300# DRAIN (F)	N/A	Seamless No RT	D	N/A / Type 7	C	UW-11(a)(4) exempt / Type 1	N/A
3" 300# (D1)	N/A	Seamless No RT	D	N/A / Type 7	C	UW-11(a)(4) exempt / Type 1	N/A
3" 300# (D2)	N/A	Seamless No RT	D	N/A / Type 7	C	UW-11(a)(4) exempt / Type 1	N/A
6" 300# (B)	N/A	Seamless No RT	D	N/A / Type 7	C	UW-11(a)(4) exempt / Type 1	N/A
3" 300# (J)	N/A	Seamless No RT	D	N/A / Type 7	C	UW-11(a)(4) exempt / Type 1	N/A
3/4" 6000# CPLG (K)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
Nozzle Flange	Longitudinal Seam		Flange Face		Nozzle to Flange Circumferential Seam		
ASME B16.5/16.47 flange attached to 18" 300# MANWAY (E)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	Spot UW-11(a)(5)(b) / Type 1	RT2
ASME B16.5/16.47 flange attached to 6" 300# (A)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(a)(4) exempt / Type 1	N/A
ASME B16.5/16.47 flange attached to 6" 300# (C)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(a)(4) exempt / Type 1	N/A
ASME B16.5/16.47 flange attached to 6" 300# (H)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(a)(4) exempt / Type 1	N/A
ASME B16.5/16.47 flange attached to 2" 300# DRAIN (F)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(a)(4) exempt / Type 1	N/A
ASME B16.5/16.47 flange attached to 3" 300# (D1)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(a)(4) exempt / Type 1	N/A
ASME B16.5/16.47 flange attached to 3" 300# (D2)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(a)(4) exempt / Type 1	N/A
ASME B16.5/16.47 flange attached to 6" 300# (B)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(a)(4) exempt / Type 1	N/A
ASME B16.5/16.47 flange attached to 3" 300# (J)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(a)(4) exempt / Type 1	N/A
UG-116(e) Required Marking: RT2							

Thickness Summary

Component Data								
Component Identifier	Material	Diameter (in)	Length (in)	Nominal t (in)	Design t (in)	Total Corrosion (in)	Joint E	Load
Hemi Head #1	SA-516 70	109 OD	54.5	0.83*	0.6106	0.0625	1.00	Internal
Cylinder #6	SA-516 70	109.346 OD	114.125	1.1875	1.1587	0.0625	1.00	Internal
Cylinder #5	SA-516 70	109.346 OD	114.125	1.1875	1.1587	0.0625	1.00	Internal
Cylinder #4	SA-516 70	109.346 OD	114.125	1.1875	1.1587	0.0625	1.00	Internal
Cylinder #3	SA-516 70	109.346 OD	114.125	1.1875	1.1587	0.0625	1.00	Internal
Cylinder #2	SA-516 70	109.346 OD	114.125	1.1875	1.1587	0.0625	1.00	Internal
Cylinder #1	SA-516 70	109.346 OD	114.125	1.1875	1.1587	0.0625	1.00	Internal
Hemi Head #2	SA-516 70	109 OD	54.5	0.83*	0.6106	0.0625	1.00	Internal
*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

Weight Summary

Weight (lb) Contributed by Vessel Elements											
Component	Metal New*	Metal Corroded	Insulation	Insulation Supports	Lining	Piping + Liquid	Operating Liquid		Test Liquid		Surface Area ft ²
							New	Corroded	New	Corroded	
Hemi Head #1	4,317.2	3,996.8	165	100	0	0	11,687.6	11,728.5	11,687.6	11,728.5	130
Cylinder #6	13,032	12,353.2	343.4	100	0	0	37,023.3	37,109.9	37,023.3	37,109.9	272
Cylinder #5	13,032	12,353.2	343.4	100	0	0	37,023.3	37,109.9	37,023.3	37,109.9	272
Cylinder #4	13,032	12,353.2	343.4	100	0	0	37,023.3	37,109.9	37,023.3	37,109.9	272
Cylinder #3	12,934.1	12,260.5	343.4	100	0	0	37,077.2	37,164.7	37,077.2	37,164.7	270
Cylinder #2	13,000.9	12,323.8	343.4	100	0	0	37,033.4	37,120.6	37,033.4	37,120.6	272
Cylinder #1	13,016.4	12,338.4	343.4	100	0	0	37,029.6	37,116.5	37,029.6	37,116.5	272
Hemi Head #2	4,317.2	3,996.8	165	100	0	0	11,687.6	11,728.5	11,687.6	11,728.5	130
Saddle #1	2,088	2,088	0	0	0	0	0	0	0	0	109
TOTAL:	88,769.9	84,063.9	2,390.5	800	0	0	245,585.3	246,188.4	245,585.3	246,188.4	1,999

*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	Trays	Tray Supports	Rings & Clips	Vertical Loads	Surface Area ft ²
	New	Corroded	New	Corroded						
Hemi Head #1	0	0	0	0	0	0	0	0	0	0
Cylinder #6	0	0	0	0	0	0	0	117.8	0	3
Cylinder #5	0	0	0	0	0	0	0	0	0	0
Cylinder #4	0	0	0	0	0	0	0	0	1	0
Cylinder #3	0	0	1,120.8	1,110.4	0	0	0	0	0	17
Cylinder #2	0	0	230.3	224	0	0	0	0	0	8
Cylinder #1	0	0	114.9	111.2	0	0	0	117.8	0	6
Hemi Head #2	0	0	0	0	0	0	0	0	0	0
TOTAL:	0	0	1,466	1,445.5	0	0	0	235.6	1	33

Vessel Totals		
	New	Corroded
Operating Weight (lb)	339,248	335,125
Empty Weight (lb)	93,663	88,937
Test Weight (lb)	336,858	332,734
Surface Area (ft ²)	2,032	-
Capacity** (US gal)	29,444	29,516
**The vessel capacity does not include volume of nozzle, piping or other attachments.		

Vessel Lift Condition	
Vessel Lift Weight, New (lb)	93,663
Center of Gravity from Datum (in)	340.6356

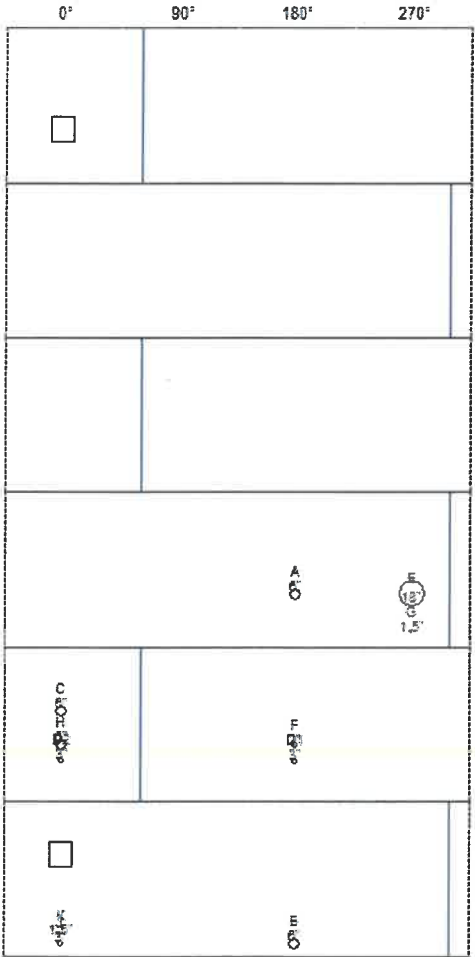
Long Seam Summary

Shell Long Seam Angles	
Component	Seam 1
Cylinder #6	60°
Cylinder #5	300°
Cylinder #4	60°
Cylinder #3	300°
Cylinder #2	60°
Cylinder #1	300°

Shell Plate Lengths		
Component	Starting Angle	Plate 1
Cylinder #6	60°	339.7899"
Cylinder #5	300°	339.7899"
Cylinder #4	60°	339.7899"
Cylinder #3	300°	339.7899"
Cylinder #2	60°	339.7899"
Cylinder #1	300°	339.7899"

Note

1) Plate Lengths use the circumference of the vessel based on the mid diameter of the components.



Shell Rollout

Hydrostatic Test

Horizontal shop hydrostatic test based on MAWP per UG-99(b)

Gauge pressure at 70 °F = $1.3 \times \text{MAWP} \times \text{LSR}$
 = $1.3 \times 401.85 \times 1$
 = 522.4 psi

Horizontal shop hydrostatic test				
Identifier	Local test pressure (psi)	Test liquid static head (psi)	UG-99(b) stress ratio	UG-99(b) pressure factor
Hemi Head #1 (1)	526.604	4.2	1	1.30
Cylinder #6	526.598	4.194	1	1.30
Cylinder #5	526.598	4.194	1	1.30
Cylinder #4	526.598	4.194	1	1.30
Cylinder #3	526.598	4.194	1	1.30
Cylinder #2	526.598	4.194	1	1.30
Cylinder #1	526.598	4.194	1	1.30
Hemi Head #2	526.604	4.2	1	1.30
18" 300# MANWAY (E)	524.974	2.57	1	1.30
2" 300# DRAIN (F)	526.93	4.526	1	1.30
3" 300# (D1)	526.93	4.526	1	1.30
3" 300# (D2)	522.693	0.289	1	1.30
3" 300# (J)	522.693	0.289	1	1.30
3/4" 6000# CPLG (G)	524.686	2.282	1	1.30
3/4" 6000# CPLG (K)	522.693	0.289	1	1.30
6" 300# (A)	526.93	4.526	1	1.30
6" 300# (B)	526.977	4.573	1	1.30
6" 300# (C)	522.693	0.289	1	1.30
6" 300# (H)	522.693	0.289	1	1.30
(1) Hemi Head #1 limits the UG-99(b) stress ratio. (2) The zero degree angular position is assumed to be up, and the test liquid height is assumed to the top-most flange.				

The field test condition has not been investigated.

The test temperature of 70 °F is warmer than the minimum recommended temperature of 10 °F so the brittle fracture provision of UG-99(h) has been met.

Bill of Materials

Heads / Covers						
Item #	Type	Material	Thk [in]	Dia. [in]	Wt. [lb] (ea.)	Qty
H1	Hemi Head	SA-516 70	0.83 (min.)	109 OD	4,317.2	2
H2	ASME B16.5/B16.47 Blind NPS 18 Class 300	A105	2.38	28 OD	463	1

Shells							
Item #	Type	Material	Thk [in]	Dia. [in]	Length [in]	Wt. [lb] (ea.)	Qty
S1	Cylinder	SA-516 70	1.1875	109.346 OD	114.1	13,032	6

Nozzles							
Item #	Type	Material	NPS	Thk [in]	Dia. [in]	Length [in]	Wt. [lb]
Noz1	Nozzle	SA-106 B Smls pipe	NPS 18 XS	0.5	18 OD	8	256.8
Noz2	Nozzle	SA-106 B Smls pipe	NPS 6 Sch 80 (XS)	0.432	6.625 OD	23	133
Noz3	Nozzle	SA-105	NPS 0.75 Class 6000 - threaded	0.35	1.75 OD	14.4	6.3
Noz4	Nozzle	SA-106 B Smls pipe	NPS 2 Sch 160	0.344	2.375 OD	6.5	4
Noz5	Nozzle	SA-106 B Smls pipe	NPS 3 Sch 160	0.438	3.5 OD	18.3	47.5

Flanges							
Item #	Type	Material	NPS	Dia. [in]	Wt. [lb] (ea.)	Qty	
AF1	ASME B16.5 Welding Neck - Class 300	A105	18	28 x 17	320	1	
AF2	ASME B16.5 Welding Neck - Class 300	A105	6	12.5 x 6.07	42	4	
AF3	ASME B16.5 Welding Neck - Class 300	A105	2.0	6.5 x 2.07	9	1	
AF4	ASME B16.5 Welding Neck - Class 300	A105	3.0	8.25 x 3.07	15	3	

Fasteners				
Item #	Description	Material	Length [in]	Qty
FB1	1-1/4" series 8 bolt	SA-193 B7 Bolt <= 2 1/2	6.5	24
FB2	3/4" series 8 bolt	SA-193 B7 Bolt <= 2 1/2	4.3	48
FB3	5/8" series 8 bolt	SA-193 B7 Bolt <= 2 1/2	3	8
FB4	3/4" series 8 bolt	SA-193 B7 Bolt <= 2 1/2	3.5	24
SB1	2-1/4" series 8 bolt	Saddle bolt material	-	4

All listed flange bolts require associated nuts and washers in accordance with Division 1, UCS-11.

Insulation				
Item #	Thk [in]	Density [lb/cu ft]	Wt. [lb]	Qty [ft²]
IN1	1	15	2,390.5	1,912.44

Plates				
Item #	Material	Thk [In]	Wt. [lb]	Qty [ft²]
Plate1	SA-516 70	1.25	227.6	5.59
Plate1 - Note: Applies to nozzle pad				
Plate2	SA-516 70	1	130.7	3.21
Plate2 - Note: Applies to nozzle pad				
Plate3	SA-516 70	0.875	37.5	0.92
Plate3 - Note: Applies to nozzle pad				
Plate4	SA-516 70	0.375	435.7	28.51
Plate4 - Note: Applies to saddle wear plate				
Plate5	Unspecified material	1.25	970.7	19.06
Plate5 - Note: Applies to saddle base plate				
Plate6	Unspecified material	0.5	681.6	33.45
Plate6 - Note: Applies to saddle web plate				
Plate7	SA-516 70	1.5	119.7	1.96
Plate7 - Note: Applies to lift lug plates				
Plate8	SA-516 70	0.75	107	3.5
Plate8 - Note: Applies to lift lug pad plates				

Liquid Level bounded by Hemi Head #2

ASME Section VIII Division 1, 2015 Edition	
Location from Center Line (in)	64
Operating Liquid Specific Gravity	1

Hemi Head #1

ASME Section VIII Division 1, 2015 Edition				
Component		Hemispherical Head		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Attached To		Cylinder #6		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	Yes	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		400	200	-20
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		4.25	117.7325	1
Test horizontal		4.2	116.3575	1
Dimensions				
Outer Diameter		109"		
Minimum Thickness		0.83"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		4,317.24		1,401.66
Corroded		3,996.75		1,406.56
Insulation				
		Thickness (in)	Density (lb/ft³)	Weight (lb)
Insulation		1	15	164.99
		Spacing(in)	Individual Weight (lb)	Total Weight (lb)
Insulation Supports		120	100	100
Radiography				
Category A joints - Long Seam		Seamless No RT		
Category A joints - Circ Seam		Full UW-11(a) 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)	0.6106"
Maximum allowable working pressure (MAWP)	563.06 psi
Maximum allowable pressure (MAP)	613.86 psi
Rated MDMT	-55 °F

UCS-66 Material Toughness Requirements	
Governing thickness, $t_g =$	0.83"
Exemption temperature from Fig UCS-66 Curve D =	-37.44 °F
$t_r = 54.5 * (1 - \exp(-406.1 / (2 * 20,000 * 1))) =$	0.5505"
Stress ratio = $t_r * E' / (t_n - c) = 0.5505 * 1 / (0.83 - 0.0625) =$	0.7173
Reduction in MDMT, T_R from Fig UCS-66.1 =	28.3 °F
MDMT = $\max[\text{MDMT} - T_R, -55] = \max[-37.44 - 28.3, -55] =$	-55 °F
Material is exempt from impact testing at the Design MDMT of -20 °F.	

Design thickness, (at 200 °F) Appendix 1-3

$$\begin{aligned}
 t &= R_o * (1 - \exp[-0.5 * P / (S * E)]) + \text{Corrosion} \\
 &= 54.5 * (1 - \exp[-0.5 * 404.25 / (20,000 * 1.00)]) + 0.0625 \\
 &= \text{0.6106"}
 \end{aligned}$$

Maximum allowable working pressure, (at 200 °F) Appendix 1-3

$$\begin{aligned}
 P &= 2 * S * E * \ln(R_o / (R_o - t)) - P_s \\
 &= 2 * 20,000 * 1.00 * \ln(54.5 / (54.5 - 0.7675)) - 4.25 \\
 &= \text{563.06 psi}
 \end{aligned}$$

Maximum allowable pressure, (at 70 °F) Appendix 1-3

$$\begin{aligned}
 P &= 2 * S * E * \ln(R_o / (R_o - t)) \\
 &= 2 * 20,000 * 1.00 * \ln(54.5 / (54.5 - 0.83)) \\
 &= \text{613.86 psi}
 \end{aligned}$$

% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 EFE &= (75 * t / R_t) * (1 - R_t / R_o) \\
 &= (75 * 0.83 / 54.085) * (1 - 54.085 / \infty) \\
 &= 1.151\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

Cylinder #6

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, In. 37)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	Yes	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		400	200	-20
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		4.24	117.548	1
Test horizontal		4.19	116.173	1
Dimensions				
Outer Diameter		109.346"		
Length		114.125"		
Nominal Thickness		1.1875"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		13,032.01		4,440.08
Corroded		12,353.25		4,450.46
Insulation				
		Thickness (in)	Density (lb/ft³)	Weight (lb)
Insulation		1	15	343.43
		Spacing(in)	Individual Weight (lb)	Total Weight (lb)
Insulation Supports		120	100	100
Radiography				
Longitudinal seam		Full UW-11(a) Type 1		
Left Circumferential seam		Full UW-11(a) Type 1		
Right 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)	1.1587"
Maximum allowable working pressure (MAWP)	410.71 psi
Maximum allowable pressure (MAP)	438.21 psi
Rated MDMT	-25.1 °F

UCS-66 Material Toughness Requirements	
Governing thickness, $t_g =$	1.1875"
Exemption temperature from Fig UCS-66 Curve D =	-23 °F
$t_r = 406.09 \times 54.673 / (20,000 \times 1 + 0.4 \times 406.09) =$	1.1012"
Stress ratio = $t_r E' / (t_n - c) = 1.1012 \times 1 / (1.1875 - 0.0625) =$	0.9788
Reduction in MDMT, T_R from Fig UCS-66.1 =	2.1 °F
MDMT = $\max[\text{MDMT} - T_R, -55] = \max[-23 - 2.1, -55] =$	-25.1 °F
Material is exempt from impact testing at the Design MDMT of -20 °F.	

Design thickness, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 t &= P R_o / (S E + 0.40 P) + \text{Corrosion} \\
 &= 404.24 \times 54.673 / (20,000 \times 1.00 + 0.40 \times 404.24) + 0.0625 \\
 &= \underline{1.1587"}
 \end{aligned}$$

Maximum allowable working pressure, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 P &= S E t / (R_o - 0.40 t) - P_s \\
 &= 20,000 \times 1.00 \times 1.125 / (54.673 - 0.40 \times 1.125) - 4.24 \\
 &= \underline{410.71 \text{ psi}}
 \end{aligned}$$

Maximum allowable pressure, (at 70 °F) Appendix 1-1

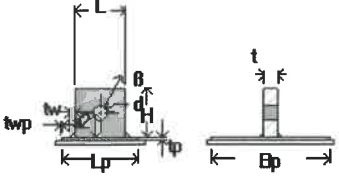
$$\begin{aligned}
 P &= S E t / (R_o - 0.40 t) \\
 &= 20,000 \times 1.00 \times 1.1875 / (54.673 - 0.40 \times 1.1875) \\
 &= \underline{438.21 \text{ psi}}
 \end{aligned}$$

% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 EFE &= (50 t / R_f) (1 - R_f / R_o) \\
 &= (50 \times 1.1875 / 54.0793) (1 - 54.0793 / \infty) \\
 &= 1.0979\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

Lifting Lug #2

Geometry Inputs	
	
Attached To	Cylinder #6
Material	SA-516 70
Orientation	Longitudinal
Distance of Lift Point From Datum	609.6875"
Angular Position	0°
Length, L	12"
Height, H	11.75"
Thickness, t	1.5"
Hole Diameter, d	3.375"
Pin Diameter, Dp	3.25"
Load Eccentricity, a ₁	0"
Distance from Load to Shell or Pad, a ₂	5.75"
Load Angle Normal to Vessel, β	-30°
Load Angle from Vertical, φ	-30°
Welds	
Size, t _w	1.25"
Reinforcement Pad	
Width, B _p	14"
Length, L _p	18"
Thickness, t _p	0.75"
Weld Size, t _{wp}	0.5"

Intermediate Values	
Load Factor	2.0000
Vessel Weight (new, incl. Load Factor), W	187,326 lb
Lug Weight (new), W_{lug}	117.8 lb
Distance from Center of Gravity to this lug, x_1	269.0519"
Distance from Center of Gravity to second lug, x_2	265.6356"
Allowable Stress, Tensile, σ_t	22,800 psi
Allowable Stress, Shear, σ_s	15,200 psi
Allowable Stress, Bearing, σ_p	34,200 psi
Allowable Stress, Bending, σ_b	25,080 psi
Allowable Stress, Weld Shear, $\tau_{allowable}$	15,200 psi
Allowable Stress set to 1/3 Sy per ASME B30.20	No

Summary Values	
Required Lift Pin Diameter, d_{reqd}	<u>2.1215"</u>
Required Lug Thickness, t_{reqd}	<u>0.9668"</u>
Lug Stress Ratio, σ_{ratio}	<u>0.57</u>
Weld Shear Stress Ratio, τ_{ratio}	<u>0.62</u>
Lug Design	Acceptable
Local Stresses WRC 107	Acceptable

Lift Forces

$$\begin{aligned}
 F_r &= \text{force on vessel at lug} \\
 F_r &= [W / \cos(\phi_1)] * (1 - x_1 / (x_1 + x_2)) \\
 &= (187,326) / \cos(-30) * (1 - 269.0519 / (269.0519 + 265.6356)) \\
 &= \underline{107,462 \text{ lb}}
 \end{aligned}$$

where ' x_1 ' is the distance between this lug and the center of gravity

' x_2 ' is the distance between the second lift lug and the center of gravity

Lug Pin Diameter - Shear stress

$$\begin{aligned}
 d_{reqd} &= (2 * F_r / (\pi * \sigma_s))^{0.5} \\
 &= (2 * 107,462 / (\pi * 15,200))^{0.5} = \underline{2.1215"}
 \end{aligned}$$

$$d_{reqd} / D_p = 2.1215 / 3.25 = 0.65 \quad \text{Acceptable}$$

$$\begin{aligned}
 \sigma &= F_r / A \\
 &= F_r / (2 * (0.25 * \pi * D_p^2)) \\
 &= 107,462 / (2 * (0.25 * \pi * 3.25^2)) = 6,477 \text{ psi}
 \end{aligned}$$

$$\sigma / \sigma_s = 6,477 / 15,200 = 0.43 \quad \text{Acceptable}$$

Lug Thickness - Tensile stress

$$\begin{aligned}
 t_{reqd} &= F_r / ((L - d) * \sigma_t) \\
 &= 107,462 / ((12 - 3.375) * 22,800) = 0.5465"
 \end{aligned}$$

$$t_{\text{reqd}} / t = 0.5465 / 1.5 = 0.36 \quad \text{Acceptable}$$

$$\begin{aligned} \sigma &= F_r / A \\ &= F_r / ((L - d) * t) \\ &= 107,462 / ((12 - 3.375) * 1.5) = 8,306 \text{ psi} \end{aligned}$$

$$\sigma / \sigma_t = 8,306 / 22,800 = 0.36 \quad \text{Acceptable}$$

Lug Thickness - Bearing stress

$$\begin{aligned} t_{\text{reqd}} &= F_v / (D_p * \sigma_p) \\ &= 107,462 / (3.25 * 34,200) = \underline{0.9668"} \end{aligned}$$

$$t_{\text{reqd}} / t = 0.9668 / 1.5 = 0.64 \quad \text{Acceptable}$$

$$\begin{aligned} \sigma &= F_v / A_{\text{bearing}} \\ &= F_v / (D_p * t) \\ &= 107,462 / (3.25 * (1.5)) = 22,043 \text{ psi} \end{aligned}$$

$$\sigma / \sigma_p = 22,043 / 34,200 = 0.64 \quad \text{Acceptable}$$

Lug Thickness - Shear stress

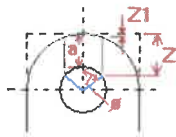
$$\begin{aligned} t_{\text{reqd}} &= [F_v / \sigma_s] / (2 * L_{\text{shear}}) \\ &= (107,462 / 15,200) / (2 * 4.9587) = \underline{0.7129"} \end{aligned}$$

$$t_{\text{reqd}} / t = 0.7129 / 1.5 = 0.48 \quad \text{Acceptable}$$

$$\begin{aligned} \tau &= F_v / A_{\text{shear}} \\ &= F_v / (2 * t * L_{\text{shear}}) \\ &= 107,462 / (2 * 1.5 * 4.9587) = 7,224 \text{ psi} \end{aligned}$$

$$\tau / \sigma_s = 7,224 / 15,200 = 0.48 \quad \text{Acceptable}$$

Shear stress length (per Pressure Vessel and Stacks, A. Keith Escoe)



$$\begin{aligned} \phi &= 55 * D_p / d \\ &= 55 * 3.25 / 3.375 \\ &= 52.963^\circ \\ L_{\text{shear}} &= (H - a_2 - 0.5 * d) + 0.5 * D_p * (1 - \cos(\phi)) \\ &= (11.75 - 5.75 - 0.5 * 3.375) + 0.5 * 3.25 * (1 - \cos(52.963)) \\ &= 4.9587" \end{aligned}$$

Lug Plate Stress

Lug stress tensile + bending during lift:

$$\begin{aligned}
 \sigma_{\text{ratio}} &= [F_{\text{ten}} / (A_{\text{ten}} \cdot \sigma_t)] + [M_{\text{bend}} / (Z_{\text{bend}} \cdot \sigma_b)] \leq 1 \\
 &= [(F_r \cdot \cos(\beta)) / (t \cdot L \cdot \sigma_t)] + [(6 \cdot \text{abs}(F_r \cdot \sin(\beta) \cdot \text{Hght} - F_r \cdot \cos(\beta) \cdot a_1)) / (t \cdot L^2 \cdot \sigma_b)] \leq 1 \\
 &= 107,462 \cdot \cos(-30.0) / (1.5 \cdot 12 \cdot 22,800) + 6 \cdot \text{abs}(107,462 \cdot \sin(-30.0) \cdot 5.75 - 107,462 \cdot \cos(-30.0) \cdot 0) / \\
 &\quad (1.5 \cdot 12^2 \cdot 25,080) \\
 &= \underline{0.57} \quad \text{Acceptable}
 \end{aligned}$$

Weld Stress**Weld stress, tensile, bending and shear during lift:****Direct shear:**Shear stress at lift angle -30.00°; lift force = 107,462 lb_f

$$\begin{aligned}
 A_{\text{weld}} &= 2 \cdot (0.707) \cdot t_w \cdot (L + t) \\
 &= 2 \cdot (0.707) \cdot 1.25 \cdot (12 + 1.5) = 23.8612 \text{ in}^2
 \end{aligned}$$

$$\begin{aligned}
 \tau_t &= F_{\text{lug}} \cdot \cos(\beta) / A_{\text{weld}} \\
 &= 107,462 \cdot \cos(-30.0) / 23.8612 = 3,900 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_s &= F_{\text{lug}} \cdot \sin(\beta) / A_{\text{weld}} \\
 &= 107,462 \cdot \sin(-30.0) / 23.8612 = -2,252 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_b &= M \cdot c / I \\
 &= 3 \cdot (F_{\text{lug}} \cdot \sin(\beta) \cdot \text{Hght} - F_{\text{lug}} \cdot \cos(\beta) \cdot a_1) / (0.707 \cdot h \cdot L \cdot (3 \cdot t + L)) \\
 &= 3 \cdot \text{abs}(107,462 \cdot \sin(-30.0) \cdot 5.75 - 107,462 \cdot \cos(-30.0) \cdot 0) / \\
 &\quad (174.9825) \\
 &= 5,297 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_{\text{ratio}} &= \text{sqr}((\tau_t + \tau_b)^2 + \tau_s^2) / \tau_{\text{allowable}} \leq 1 \\
 &= \text{sqr}((3,900 + 5,297)^2 + (-2,252)^2) / 15,200 \\
 &= \underline{0.62} \quad \text{Acceptable}
 \end{aligned}$$

Pad Weld Stress, tensile, bending and shear during lift:**Direct shear:**Shear stress at lift angle -30.00°; lift force = 107,462 lb_f

$$\begin{aligned}
 A_{\text{weld}} &= 2 \cdot (0.707) \cdot t_{\text{wp}} \cdot (L_p + B_p) \\
 &= 2 \cdot (0.707) \cdot 0.5 \cdot (18 + 14) = 22.624 \text{ in}^2
 \end{aligned}$$

$$\begin{aligned}
 \tau_t &= F_{\text{lug}} \cdot \cos(\beta) / A_{\text{weld}} \\
 &= 107,462 \cdot \cos(-30.0) / 22.624 = 4,114 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_s &= F_{\text{lug}} \cdot \sin(\beta) / A_{\text{weld}} \\
 &= 107,462 \cdot \sin(-30.0) / 22.624 = -2,375 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_b &= M * c / I \\
 &= 3 * (F_{lug} * \sin(\beta) * H_{ght} - F_{lug} * \cos(\beta) * a_1) / (0.707 * h_p * L_p * (3 * W_p + L_p)) \\
 &= 3 * \text{abs}(107,462 * \sin(-30.0) * 6.5 - 107,462 * \cos(-30.0) * (0)) / (381.7800) \\
 &= 2,744 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_{ratio} &= \text{sqr}(\tau_t + \tau_b)^2 + \tau_s^2 / \tau_{allowable} \leq 1 \\
 &= \text{sqr}((4,114 + 2,744)^2 + (-2,375)^2) / 15,200 \\
 &= 0.48 \quad \text{Acceptable}
 \end{aligned}$$

WRC 107 Analysis

Geometry	
Height (radial)	11.75"
Width (circumferential)	1.5"
Length	12"
Fillet Weld Size:	1.25"
Located On	Cylinder #6 (603.6875" from right end)
Location Angle	0.00°
Reinforcement Pad	
Thickness	0.75"
Width	14"
Length	18"
Weld Size	0.5"

Applied Loads	
Radial load, P_r	-93,064.55 lb _f
Circumferential moment, M_c	0 lb _f -in
Circumferential shear, V_c	0 lb _f
Longitudinal moment, M_L	-349,250.5 lb _f -in
Longitudinal shear, V_L	-53,730.84 lb _f
Torsion moment, M_t	0 lb _f -in
Internal pressure, P	0 psi
Mean shell radius, R_m	54.0793"
Design factor	3

Maximum stresses due to the applied loads at the lug edge

$$\gamma = R_m / T = 54.0793 / 1.9375 = 27.9119$$

$$C_1 = 2, C_2 = 7.25 \text{ in}$$

$$\text{Local circumferential pressure stress} = P * R_i / T = 0 \text{ psi}$$

$$\text{Local longitudinal pressure stress} = P * R_i / (2 * T) = 0 \text{ psi}$$

Maximum combined stress ($P_L + P_b + Q$) = 36,662 psi
Allowable combined stress ($P_L + P_b + Q$) = $\pm 3 \cdot S = \pm 60,000$ psi

The maximum combined stress ($P_L + P_b + Q$) is within allowable limits.

Maximum local primary membrane stress (P_L) = 5,686 psi
Allowable local primary membrane stress (P_L) = $\pm 1.5 \cdot S = \pm 30,000$ psi

The maximum local primary membrane stress (P_L) is within allowable limits.

Stresses at the lug edge per WRC Bulletin 107										
Figure	value	β	A_u	A_l	B_u	B_l	C_u	C_l	D_u	D_l
3C*	4.4796	0.103	0	0	0	0	3,979	3,979	3,979	3,979
4C*	5.1314	0.084	4,558	4,558	4,558	4,558	0	0	0	0
1C	0.1882	0.0623	0	0	0	0	27,994	-27,994	27,994	-27,994
2C-1	0.1497	0.0623	22,268	-22,268	22,268	-22,268	0	0	0	0
3A*	0.3742	0.0568	0	0	0	0	0	0	0	0
1A	0.1045	0.0718	0	0	0	0	0	0	0	0
3B*	2.3064	0.0873	1,128	1,128	-1,128	-1,128	0	0	0	0
1B-1	0.0543	0.078	7,183	-7,183	-7,183	7,183	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total circumferential stress			35,137	-23,765	18,515	-11,655	31,973	-24,015	31,973	-24,015
Primary membrane circumferential stress*			5,686	5,686	3,430	3,430	3,979	3,979	3,979	3,979
3C*	4.7711	0.084	4,238	4,238	4,238	4,238	0	0	0	0
4C*	4.9749	0.103	0	0	0	0	4,419	4,419	4,419	4,419
1C-1	0.1624	0.0874	24,157	-24,157	24,157	-24,157	0	0	0	0
2C	0.1195	0.0874	0	0	0	0	17,775	-17,775	17,775	-17,775
4A*	0.4833	0.0568	0	0	0	0	0	0	0	0
2A	0.0571	0.0975	0	0	0	0	0	0	0	0
4B*	0.6258	0.0873	527	527	-527	-527	0	0	0	0
2B-1	0.0786	0.1048	7,740	-7,740	-7,740	7,740	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total longitudinal stress			36,662	-27,132	20,128	-12,706	22,194	-13,356	22,194	-13,356
Primary membrane longitudinal stress*			4,765	4,765	3,711	3,711	4,419	4,419	4,419	4,419
Shear from M_t			0	0	0	0	0	0	0	0
Circ shear from V_c			0	0	0	0	0	0	0	0
Long shear from V_L			0	0	0	0	956	956	-956	-956
Total Shear stress			0	0	0	0	956	956	-956	-956
Combined stress (P_L+P_b+Q)			36,662	-27,132	20,128	-12,706	32,066	-24,100	32,066	-24,100
* denotes primary stress.										

Maximum stresses due to the applied loads at the pad edge

$$\gamma = R_m / T = 54.0793 / 1.1875 = 45.5404$$

$$C_1 = 7.5, C_2 = 9.5 \text{ in}$$

$$\text{Local circumferential pressure stress} = P \cdot R_i / T = 0 \text{ psi}$$

$$\text{Local longitudinal pressure stress} = P \cdot R_i / (2 \cdot T) = 0 \text{ psi}$$

$$\text{Maximum combined stress } (P_L + P_b + Q) = 46,326 \text{ psi}$$

$$\text{Allowable combined stress } (P_L + P_b + Q) = \pm 3 \cdot S = \pm 60,000 \text{ psi}$$

The maximum combined stress ($P_L + P_b + Q$) is within allowable limits.

$$\text{Maximum local primary membrane stress } (P_L) = 12,597 \text{ psi}$$

$$\text{Allowable local primary membrane stress } (P_L) = \pm 1.5 \cdot S = \pm 30,000 \text{ psi}$$

The maximum local primary membrane stress (P_L) is within allowable limits.

Stresses at the pad edge per WRC Bulletin 107										
Figure	value	β	A_u	A_l	B_u	B_l	C_u	C_l	D_u	D_l
3C*	4.5695	0.1771	0	0	0	0	6,622	6,622	6,622	6,622
4C*	6.8225	0.1648	9,887	9,887	9,887	9,887	0	0	0	0
1C	0.0847	0.1508	0	0	0	0	33,539	-33,539	33,539	-33,539
2C-1	0.0503	0.1508	19,918	-19,918	19,918	-19,918	0	0	0	0
3A*	1.7968	0.1501	0	0	0	0	0	0	0	0
1A	0.0802	0.166	0	0	0	0	0	0	0	0
3B*	4.9858	0.1624	2,710	2,710	-2,710	-2,710	0	0	0	0
1B-1	0.0313	0.1592	5,404	-5,404	-5,404	5,404	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total circumferential stress			37,919	-12,725	21,691	-7,337	40,161	-26,917	40,161	-26,917
Primary membrane circumferential stress*			12,597	12,597	7,177	7,177	6,622	6,622	6,622	6,622
3C*	4.9111	0.1648	7,117	7,117	7,117	7,117	0	0	0	0
4C*	6.6239	0.1771	0	0	0	0	9,599	9,599	9,599	9,599
1C-1	0.0792	0.167	31,361	-31,361	31,361	-31,361	0	0	0	0
2C	0.0464	0.167	0	0	0	0	18,373	-18,373	18,373	-18,373
4A*	3.1083	0.1501	0	0	0	0	0	0	0	0
2A	0.0388	0.1825	0	0	0	0	0	0	0	0
4B*	1.8196	0.1624	1,170	1,170	-1,170	-1,170	0	0	0	0
2B-1	0.0426	0.1753	6,678	-6,678	-6,678	6,678	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total longitudinal stress			46,326	-29,752	30,630	-18,736	27,972	-8,774	27,972	-8,774
Primary membrane longitudinal stress*			8,287	8,287	5,947	5,947	9,599	9,599	9,599	9,599
Shear from M_t			0	0	0	0	0	0	0	0
Circ shear from V_c			0	0	0	0	0	0	0	0
Long shear from V_L			0	0	0	0	1,191	1,191	-1,191	-1,191
Total Shear stress			0	0	0	0	1,191	1,191	-1,191	-1,191
Combined stress (P_L+P_D+Q)			46,326	-29,752	30,630	-18,736	40,276	-26,995	40,276	-26,995
* denotes primary stress.										

Cylinder #5

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	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		400	200	-20
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		4.24	117.548	1
Test horizontal		4.19	116.173	1
Dimensions				
Outer Diameter		109.346"		
Length		114.125"		
Nominal Thickness		1.1875"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		13,032.01		4,440.08
Corroded		12,353.25		4,450.46
Insulation				
		Thickness (in)	Density (lb/ft³)	Weight (lb)
Insulation		1	15	343.43
		Spacing(in)	Individual Weight (lb)	Total Weight (lb)
Insulation Supports		120	100	100
Radiography				
Longitudinal seam		Full UW-11(a) Type 1		
Left Circumferential seam		Spot UW-11(a)(5)(b) Type 1		
Right 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)	1.1587"
Maximum allowable working pressure (MAWP)	410.71 psi
Maximum allowable pressure (MAP)	438.21 psi
Rated MDMT	-25.1 °F

UCS-66 Material Toughness Requirements	
Governing thickness, t_g =	1.1875"
Exemption temperature from Fig UCS-66 Curve D =	-23 °F
$t_r = 406.09 * 54.673 / (20,000 * 1 + 0.4 * 406.09) =$	1.1012"
Stress ratio = $t_r * E' / (t_n - c) = 1.1012 * 1 / (1.1875 - 0.0625) =$	0.9788
Reduction in MDMT, T_R from Fig UCS-66.1 =	2.1 °F
MDMT = max[MDMT - T_R , -55] = max[-23 - 2.1 , -55] =	-25.1 °F
Material is exempt from impact testing at the Design MDMT of -20 °F.	

Design thickness, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 t &= P * R_o / (S * E + 0.40 * P) + \text{Corrosion} \\
 &= 404.24 * 54.673 / (20,000 * 1.00 + 0.40 * 404.24) + 0.0625 \\
 &= \underline{1.1587"}
 \end{aligned}$$

Maximum allowable working pressure, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 P &= S * E * t / (R_o - 0.40 * t) - P_s \\
 &= 20,000 * 1.00 * 1.125 / (54.673 - 0.40 * 1.125) - 4.24 \\
 &= \underline{410.71} \text{ psi}
 \end{aligned}$$

Maximum allowable pressure, (at 70 °F) Appendix 1-1

$$\begin{aligned}
 P &= S * E * t / (R_o - 0.40 * t) \\
 &= 20,000 * 1.00 * 1.1875 / (54.673 - 0.40 * 1.1875) \\
 &= \underline{438.21} \text{ psi}
 \end{aligned}$$

% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 EFE &= (50 * t / R_t) * (1 - R_t / R_o) \\
 &= (50 * 1.1875 / 54.0793) * (1 - 54.0793 / \infty) \\
 &= 1.0979\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

Cylinder #4

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, In. 37)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	Yes	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		400	200	-20
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		4.24	117.548	1
Test horizontal		4.19	116.173	1
Dimensions				
Outer Diameter		109.346"		
Length		114.125"		
Nominal Thickness		1.1875"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)	Capacity (US gal)	
New		13,032.01	4,440.08	
Corroded		12,353.25	4,450.46	
Insulation				
		Thickness (in)	Density (lb/ft³)	Weight (lb)
Insulation		1	15	343.43
		Spacing(in)	Individual Weight (lb)	Total Weight (lb)
Insulation Supports		120	100	100
Radiography				
Longitudinal seam		Full UW-11(a) Type 1		
Left Circumferential seam		Spot UW-11(a)(5)(b) Type 1		
Right 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)	1.1587"
Maximum allowable working pressure (MAWP)	410.71 psi
Maximum allowable pressure (MAP)	438.21 psi
Rated MDMT	-25.1 °F

UCS-66 Material Toughness Requirements	
Governing thickness, t_g =	1.1875"
Exemption temperature from Fig UCS-66 Curve D =	-23 °F
$t_r = 406.09 \times 54.673 / (20,000 \times 1 + 0.4 \times 406.09) =$	1.1012"
Stress ratio = $t_r \times E' / (t_g - c) = 1.1012 \times 1 / (1.1875 - 0.0625) =$	0.9788
Reduction in MDMT, T_R from Fig UCS-66.1 =	2.1 °F
MDMT = max[MDMT - T_R , -55] = max[-23 - 2.1 , -55] =	-25.1 °F
Material is exempt from impact testing at the Design MDMT of -20 °F.	

Design thickness, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 t &= P \cdot R_o / (S \cdot E + 0.40 \cdot P) + \text{Corrosion} \\
 &= 404.24 \times 54.673 / (20,000 \times 1.00 + 0.40 \times 404.24) + 0.0625 \\
 &= \underline{1.1587"}
 \end{aligned}$$

Maximum allowable working pressure, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) - P_s \\
 &= 20,000 \times 1.00 \times 1.125 / (54.673 - 0.40 \times 1.125) - 4.24 \\
 &= \underline{410.71} \text{ psi}
 \end{aligned}$$

Maximum allowable pressure, (at 70 °F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) \\
 &= 20,000 \times 1.00 \times 1.1875 / (54.673 - 0.40 \times 1.1875) \\
 &= \underline{438.21} \text{ psi}
 \end{aligned}$$

% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 EFE &= (50 \cdot t / R_f) \cdot (1 - R_f / R_o) \\
 &= (50 \times 1.1875 / 54.0793) \cdot (1 - 54.0793 / \infty) \\
 &= 1.0979\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

Cylinder #3

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	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		400	200	-20
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		4.24	117.548	1
Test horizontal		4.19	116.173	1
Dimensions				
Outer Diameter		109.346"		
Length		114.125"		
Nominal Thickness		1.1875"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)	Capacity (US gal)	
New		12,934.1	4,440.08	
Corroded		12,260.49	4,450.46	
Insulation				
		Thickness (in)	Density (lb/ft³)	Weight (lb)
Insulation		1	15	343.43
		Spacing(in)	Individual Weight (lb)	Total Weight (lb)
Insulation Supports		120	100	100
Radiography				
Longitudinal seam		Full UW-11(a) Type 1		
Left Circumferential seam		Spot UW-11(a)(5)(b) Type 1		
Right 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)	1.1587"
Maximum allowable working pressure (MAWP)	410.71 psi
Maximum allowable pressure (MAP)	438.21 psi
Rated MDMT	-25.1 °F

UCS-66 Material Toughness Requirements	
Governing thickness, t_g =	1.1875"
Exemption temperature from Fig UCS-66 Curve D =	-23 °F
$t_r = 406.09 \times 54.673 / (20,000 \times 1 + 0.4 \times 406.09) =$	1.1012"
Stress ratio = $t_r \times E' / (t_n - c) = 1.1012 \times 1 / (1.1875 - 0.0625) =$	0.9788
Reduction in MDMT, T_R from Fig UCS-66.1 =	2.1 °F
MDMT = max[MDMT - T_R , -55] = max[-23 - 2.1 , -55] =	-25.1 °F
Material is exempt from impact testing at the Design MDMT of -20 °F.	

Design thickness, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 t &= P \times R_o / (S \times E + 0.40 \times P) + \text{Corrosion} \\
 &= 404.24 \times 54.673 / (20,000 \times 1.00 + 0.40 \times 404.24) + 0.0625 \\
 &= \underline{1.1587"}
 \end{aligned}$$

Maximum allowable working pressure, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 P &= S \times E \times t / (R_o - 0.40 \times t) - P_s \\
 &= 20,000 \times 1.00 \times 1.125 / (54.673 - 0.40 \times 1.125) - 4.24 \\
 &= \underline{410.71 \text{ psi}}
 \end{aligned}$$

Maximum allowable pressure, (at 70 °F) Appendix 1-1

$$\begin{aligned}
 P &= S \times E \times t / (R_o - 0.40 \times t) \\
 &= 20,000 \times 1.00 \times 1.1875 / (54.673 - 0.40 \times 1.1875) \\
 &= \underline{438.21 \text{ psi}}
 \end{aligned}$$

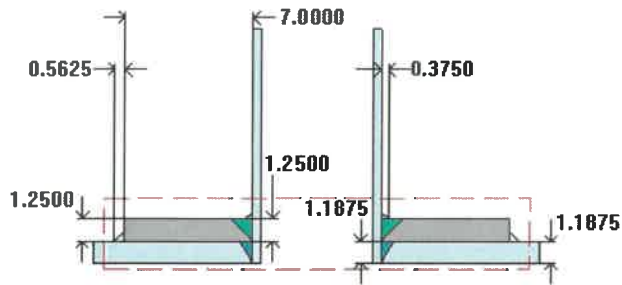
% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 EFE &= (50 \times t / R_i) \times (1 - R_i / R_o) \\
 &= (50 \times 1.1875 / 54.0793) \times (1 - 54.0793 / \infty) \\
 &= 1.0979\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

18" 300# MANWAY (E)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation	
Located on	Cylinder #3
Orientation	270°
Nozzle center line offset to datum line	267.75"
End of nozzle to shell center	67"
Passes through a Category A joint	No
Nozzle	
Description	NPS 18 XS
Access opening	Yes
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 15)
Inside diameter, new	17"
Pipe nominal wall thickness	0.5"
Pipe minimum wall thickness ¹	0.4375"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	6.077"
Projection available outside vessel to flange face, L _f	12.327"
Local vessel minimum thickness	1.1875"
Liquid static head included	2.31 psi
Longitudinal joint efficiency	1
Reinforcing Pad	
Material specification	SA-516 70 (II-D p. 18, ln. 37) (normalized)
Diameter, D _p	32"
Thickness, t _e	1.25"
Is split	No
Welds	
Inner fillet, Leg ₄₁	0.375"

Outer fillet, Leg₄₂	0.5625"
Nozzle to vessel groove weld	1.1875"
Pad groove weld	1.25"

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

ASME B16.5-2013 Flange	
Description	NPS 18 Class 300 WN A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	Yes
Rated MDMT	-55°F
Liquid static head	2.31 psi
MAWP rating	680 psi @ 200°F
MAP rating	740 psi @ 70°F
Hydrotest rating	1,125 psi @ 70°F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(a)(5)(b) Type 1
Bore diameter, B (specified by purchaser)	17"
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55°F (Coincident ratio = 0.5462)	
Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements Nozzle	
Governing thickness, t_g =	0.4375"
Exemption temperature from Fig UCS-66 Curve B =	-13°F
$t_r = 404.16 \cdot 8.5625 / (17,100 \cdot 1 - 0.6 \cdot 404.16) =$	0.2053"
Stress ratio = $t_r \cdot E' / (t_n - c) = 0.2053 \cdot 1 / (0.4375 - 0.0625) =$	0.5474
Reduction in MDMT, T_R from Fig UCS-66.1 =	48.9°F
MDMT = $\max[\text{MDMT} - T_R, -55] = \max[-13 - 48.9, -55] =$	-55°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

UCS-66 Material Toughness Requirements Pad	
Governing thickness, t_g =	1.1875"
Exemption temperature from Fig UCS-66 Curve D =	-23°F
$t_r = 404.16 \cdot 54.673 / (20,000 \cdot 1 + 0.4 \cdot 404.16) =$	1.096"
Stress ratio = $t_r \cdot E' / (t_n - c) = 1.096 \cdot 1 / (1.1875 - 0.0625) =$	0.9742
Reduction in MDMT, T_R from Fig UCS-66.1 =	2.6°F
MDMT = $\max[\text{MDMT} - T_R, -55] = \max[-23 - 2.6, -55] =$	-25.6°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

Available reinforcement per UG-37 governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 408.97 psi @ 200 °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}
19.1306	19.1309	0.2737	0.9206	--	17.5	0.4366	0.2703	0.4375

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
377,378.98	377,144	421,558.72	37,648.81	1,082,684.32	393,976.81	747,856.13

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

Reinforcement Calculations for MAP

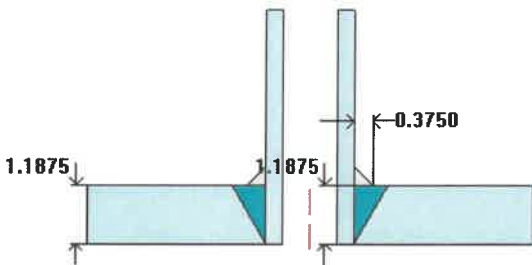
Available reinforcement per UG-37 governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 425.04 psi @ 70 °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}
19.7531	19.7534	0.5963	1.2205	--	17.5	0.4366	0.2145	0.4375

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
383,740.95	383,142	441,609.75	47,120.25	1,108,838.08	403,448.25	774,009.89

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

3/4" 6000# CPLG (G)

ASME Section VIII Division 1, 2015 Edition	
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	Cylinder #3
Orientation	270°
Nozzle center line offset to datum line	240"
End of nozzle to shell center	60.673"
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}	6"
Local vessel minimum thickness	1.1875"
Liquid static head included	2.31 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg ₄₁	0.375"
Nozzle to vessel groove weld	1.1875"

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 404.16 \times 0.5875 / (20,000 \times 1 - 0.6 \times 404.16) =$	0.012"
Stress ratio $= t_r \times E' / (t_n - c) = 0.012 \times 1 / (0.35 - 0.0625) =$	0.0418
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 MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 414.95 psi @ 200 °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 MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 438.21 psi @ 70 °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)							0.0625	0.35

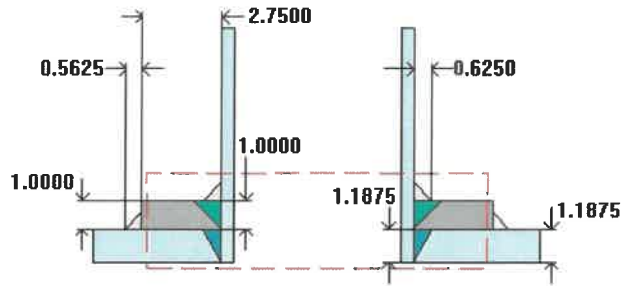
UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.245	0.2625	weld size is adequate

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

6" 300# (A)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation

Located on	Cylinder #3
Orientation	180°
Nozzle center line offset to datum line	267.75"
End of nozzle to shell center	62.6875"
Passes through a Category A joint	No

Nozzle

Description	NPS 6 Sch 80 (XS)
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, In. 15)
Inside diameter, new	5.761"
Pipe nominal wall thickness	0.432"
Pipe minimum wall thickness ¹	0.378"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	4.1345"
Projection available outside vessel to flange face, L _f	8.0145"
Local vessel minimum thickness	1.1875"
Liquid static head included	4.28 psi
Longitudinal joint efficiency	1

Reinforcing Pad

Material specification	SA-516 70 (II-D p. 18, In. 37)
Diameter, D _p	12.125"
Thickness, t _e	1"
Is split	No

Welds

Inner fillet, Leg ₄₁	0.625"
---------------------------------	--------

Outer fillet, Leg ₄₂	0.5625"
Nozzle to vessel groove weld	1.1875"
Pad groove weld	1"

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

ASME B16.5-2013 Flange	
Description	NPS 6 Class 300 WN A105
Bolt Material	SA-193 B7 Bolt ≤ 2 1/2 (II-D p. 344, In. 31)
Blind included	No
Rated MDMT	-55°F
Liquid static head	4.57 psi
MAWP rating	680 psi @ 200°F
MAP rating	740 psi @ 70°F
Hydrotest rating	1,125 psi @ 70°F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(a)(5)(b) Type 1
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55°F (Coincident ratio = 0.5492)	
Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 406.13 \times 2.943 / (17,100 \times 1 - 0.6 \times 406.13) =$	0.0709"
Stress ratio = $t_r \times E' / (t_n - c) = 0.0709 \times 1 / (0.378 - 0.0625) =$	0.2248
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.	

UCS-66 Material Toughness Requirements Pad	
Governing thickness, $t_g =$	1"
MDMT =	-20°F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

Available reinforcement per UG-37 governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in ²)	UG-45 Summary (in)
For P = 406.13 psi @ 200 °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}
6.6001	6.6004	0.1371	0.9823	--	5.147	0.334	0.3075	0.378

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
129,560.58	129,266	148,450.63	40,542.51	381,782.9	143,482.51	278,259.21

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.4375	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

Reinforcement Calculations for MAP

Available reinforcement per UG-37 governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 422.71 psi @ 70 °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}
6.7449	6.745	0.2346	1.2794	--	4.897	0.334	0.245	0.378

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
130,821.29	130,208	155,294.13	49,812.6	391,408.94	147,752.6	287,885.24

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.4375	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

Cylinder #2

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	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		400	200	-20
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		4.24	117.548	1
Test horizontal		4.19	116.173	1
Dimensions				
Outer Diameter		109.346"		
Length		114.125"		
Nominal Thickness		1.1875"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)	Capacity (US gal)	
New		13,000.88	4,440.08	
Corroded		12,323.76	4,450.46	
Insulation				
		Thickness (in)	Density (lb/ft³)	Weight (lb)
Insulation		1	15	343.43
		Spacing(in)	Individual Weight (lb)	Total Weight (lb)
Insulation Supports		120	100	100
Radiography				
Longitudinal seam		Full UW-11(a) Type 1		
Left Circumferential seam		Spot UW-11(a)(5)(b) Type 1		
Right 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)	1.1587"
Maximum allowable working pressure (MAWP)	410.71 psi
Maximum allowable pressure (MAP)	438.21 psi
Rated MDMT	-25.1 °F

UCS-66 Material Toughness Requirements	
Governing thickness, $t_g =$	1.1875"
Exemption temperature from Fig UCS-66 Curve D =	-23 °F
$t_r = 406.09 \times 54.673 / (20,000 \times 1 + 0.4 \times 406.09) =$	1.1012"
Stress ratio = $t_r E' / (t_n - c) = 1.1012 \times 1 / (1.1875 - 0.0625) =$	0.9788
Reduction in MDMT, T_R from Fig UCS-66.1 =	2.1 °F
MDMT = max[MDMT - T_R , -55] = max[-23 - 2.1 , -55] =	-25.1 °F
Material is exempt from impact testing at the Design MDMT of -20 °F.	

Design thickness, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 t &= P \cdot R_o / (S \cdot E + 0.40 \cdot P) + \text{Corrosion} \\
 &= 404.24 \times 54.673 / (20,000 \times 1.00 + 0.40 \times 404.24) + 0.0625 \\
 &= \underline{1.1587"}
 \end{aligned}$$

Maximum allowable working pressure, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) - P_s \\
 &= 20,000 \times 1.00 \times 1.125 / (54.673 - 0.40 \times 1.125) - 4.24 \\
 &= \underline{410.71} \text{ psi}
 \end{aligned}$$

Maximum allowable pressure, (at 70 °F) Appendix 1-1

$$\begin{aligned}
 P &= S \cdot E \cdot t / (R_o - 0.40 \cdot t) \\
 &= 20,000 \times 1.00 \times 1.1875 / (54.673 - 0.40 \times 1.1875) \\
 &= \underline{438.21} \text{ psi}
 \end{aligned}$$

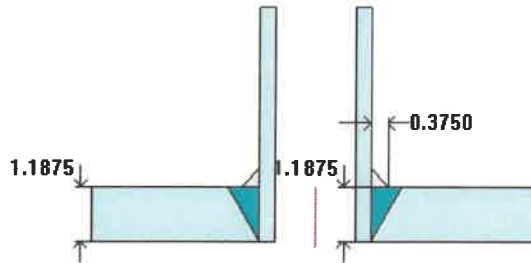
% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 EFE &= (50 \cdot t / R_t) \cdot (1 - R_t / R_o) \\
 &= (50 \times 1.1875 / 54.0793) \cdot (1 - 54.0793 / \infty) \\
 &= 1.0979\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

2" 300# DRAIN (F)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation	
Located on	Cylinder #2
Orientation	180°
Nozzle center line offset to datum line	156"
End of nozzle to shell center	62.6875"
Passes through a Category A joint	No
Nozzle	
Description	NPS 2 Sch 160
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 15)
Inside diameter, new	1.687"
Pipe nominal wall thickness	0.344"
Pipe minimum wall thickness ¹	0.301"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	5.2645"
Projection available outside vessel to flange face, L _f	8.0145"
Local vessel minimum thickness	1.1875"
Liquid static head included	4.28 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg ₄₁	0.375"
Nozzle to vessel groove weld	1.1875"

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

ASME B16.5-2013 Flange	
Description	NPS 2 Class 300 WN A105
Bolt Material	SA-193 B7 Bolt $\leq 2 \frac{1}{2}$ (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-55°F
Liquid static head	4.57 psi
MAWP rating	680 psi @ 200°F
MAP rating	740 psi @ 70°F
Hydrotest rating	1,125 psi @ 70°F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(a)(5)(b) Type 1
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55°F (Coincident ratio = 0.5492) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 406.13 \cdot 0.906 / (17,100 \cdot 1 - 0.6 \cdot 406.13) =$	0.0218"
Stress ratio = $t_r \cdot E' / (t_n - c) = 0.0218 \cdot 1 / (0.301 - 0.0625) =$	0.0915
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 MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 414.95 psi @ 200 °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)							0.1973	0.301

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)	0.197	0.2625	weld size is adequate

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

Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 438.21 psi @ 70 °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)							0.1348	0.301

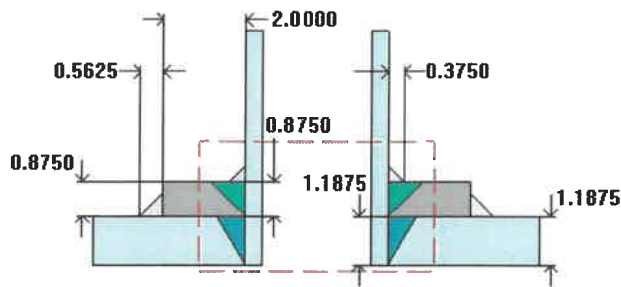
UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.2408	0.2625	weld size is adequate

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

3" 300# (D1)

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

Location and Orientation

Located on	Cylinder #2
Orientation	180°
Nozzle center line offset to datum line	144"
End of nozzle to shell center	62.6875"
Passes through a Category A joint	No

Nozzle

Description	NPS 3 Sch 160
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 15)
Inside diameter, new	2.624"
Pipe nominal wall thickness	0.438"
Pipe minimum wall thickness ¹	0.3833"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	4.8945"
Projection available outside vessel to flange face, L _f	8.0145"
Local vessel minimum thickness	1.1875"
Liquid static head included	4.28 psi
Longitudinal joint efficiency	1

Reinforcing Pad

Material specification	SA-516 70 (II-D p. 18, ln. 37)
Diameter, D _p	7.5"
Thickness, t _e	0.875"
Is split	No

Welds

Inner fillet, Leg ₄₁	0.375"
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Outer fillet, Leg₄₂	0.5625"
Nozzle to vessel groove weld	1.1875"
Pad groove weld	0.875"

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

ASME B16.5-2013 Flange	
Description	NPS 3 Class 300 WN A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, In. 31)
Blind included	No
Rated MDMT	-55 °F
Liquid static head	4.57 psi
MAWP rating	680 psi @ 200 °F
MAP rating	740 psi @ 70 °F
Hydrotest rating	1,125 psi @ 70 °F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(a)(5)(b) Type 1
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55 °F (Coincident ratio = 0.5492) Bolts rated MDMT per Fig UCS-66 note (c) = -55 °F	

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 406.13 * 1.3745 / (17,100 * 1 - 0.6 * 406.13) =$	0.0331"
$\text{Stress ratio} = t_r * E' / (t_n - c) = 0.0331 * 1 / (0.3833 - 0.0625) =$	0.1033
$\text{Stress ratio} \leq 0.35, \text{MDMT per UCS-66(b)(3)} =$	-155 °F
Material is exempt from impact testing at the Design MDMT of -20 °F.	

UCS-66 Material Toughness Requirements Pad	
Governing thickness, $t_g =$	0.875"
MDMT =	-20 °F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20 °F.	

Reinforcement Calculations for MAWP

Available reinforcement per UG-37 governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in ²)	UG-45 Summary (in)
For P = 410.71 psi @ 200 °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}
3.1825	3.1827	0.033	1.0607	--	1.9688	0.1202	0.2515	0.3833

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
63,136.99	62,993	87,002.56	38,065.36	180,009.23	77,440.36	156,480.77

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

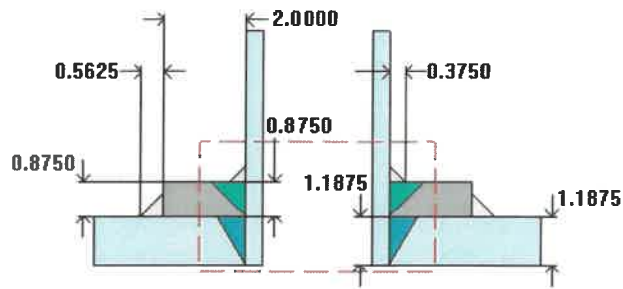
UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 438.21 psi @ 70 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
3.2668	3.5589	--	1.3606	--	2.0781	0.1202	0.189	0.3833

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
65,336.32	71,178.5	90,159.6	47,404.28	185,094.69	88,966.78	161,566.22

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

3" 300# (D2)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation

Located on	Cylinder #2
Orientation	0°
Nozzle center line offset to datum line	144"
End of nozzle to shell center	62.6875"
Passes through a Category A joint	No

Nozzle

Description	NPS 3 Sch 160
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 15)
Inside diameter, new	2.624"
Pipe nominal wall thickness	0.438"
Pipe minimum wall thickness ¹	0.3833"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	4.8945"
Projection available outside vessel to flange face, L _f	8.0145"
Local vessel minimum thickness	1.1875"
Liquid static head included	0.34 psi
Longitudinal joint efficiency	1

Reinforcing Pad

Material specification	SA-516 70 (II-D p. 18, ln. 37)
Diameter, D _p	7.5"
Thickness, t _e	0.875"
Is split	No

Welds

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

Outer fillet, Leg₄₂	0.5625"
Nozzle to vessel groove weld	1.1875"
Pad groove weld	0.875"

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

ASME B16.5-2013 Flange	
Description	NPS 3 Class 300 WN A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-55°F
Liquid static head	0.05 psi
MAWP rating	680 psi @ 200°F
MAP rating	740 psi @ 70°F
Hydrotest rating	1,125 psi @ 70°F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(a)(5)(b) Type 1
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55°F (Coincident ratio = 0.5431)	
Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 402.19 \times 1.3745 / (17,100 \times 1 - 0.6 \times 402.19) =$	0.0328"
$\text{Stress ratio} = t_r \times E' / (t_n - c) = 0.0328 \times 1 / (0.3833 - 0.0625) =$	0.1022
$\text{Stress ratio} \leq 0.35$, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

UCS-66 Material Toughness Requirements Pad	
Governing thickness, $t_g =$	0.875"
MDMT =	-20°F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

Available reinforcement per UG-37 governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in ²)	UG-45 Summary (in)
For P = 410.71 psi @ 200 °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}
3.1825	3.1827	0.033	1.0607	--	1.9688	0.1202	0.2515	0.3833

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
63,136.99	62,993	87,002.56	38,065.36	180,009.23	77,440.36	156,480.77

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

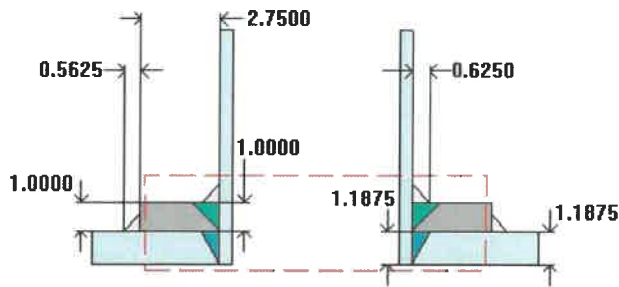
UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 438.21 psi @ 70 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}
3.2668	3.5589	--	1.3606	--	2.0781	0.1202	0.189	0.3833

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
65,336.32	71,178.5	90,159.6	47,404.28	185,094.69	88,966.78	161,566.22

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

6" 300# (C)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation

Located on	Cylinder #2
Orientation	0°
Nozzle center line offset to datum line	180"
End of nozzle to shell center	62.6875"
Passes through a Category A joint	No

Nozzle

Description	NPS 6 Sch 80 (XS)
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 15)
Inside diameter, new	5.761"
Pipe nominal wall thickness	0.432"
Pipe minimum wall thickness ¹	0.378"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	4.1345"
Projection available outside vessel to flange face, L _f	8.0145"
Local vessel minimum thickness	1.1875"
Liquid static head included	0.34 psi
Longitudinal joint efficiency	1

Reinforcing Pad

Material specification	SA-516 70 (II-D p. 18, ln. 37)
Diameter, D _p	12.125"
Thickness, t _e	1"
Is split	No

Welds

Inner fillet, Leg ₄₁	0.625"
---------------------------------	--------

Outer fillet, Leg₄₂	0.5625"
Nozzle to vessel groove weld	1.1875"
Pad groove weld	1"

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

ASME B16.5-2013 Flange	
Description	NPS 6 Class 300 WN A105
Bolt Material	SA-193 B7 Bolt ≤ 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-55°F
Liquid static head	0.05 psi
MAWP rating	680 psi @ 200°F
MAP rating	740 psi @ 70°F
Hydrotest rating	1,125 psi @ 70°F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(a)(5)(b) Type 1
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55°F (Coincident ratio = 0.5431) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 402.19 \times 2.943 / (17,100 \times 1 - 0.6 \times 402.19) =$	0.0702"
Stress ratio = $t_r \times E' / (t_n - c) = 0.0702 \times 1 / (0.378 - 0.0625) =$	0.2225
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.	

UCS-66 Material Toughness Requirements Pad	
Governing thickness, $t_p =$	1"
MDMT =	-20°F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

Available reinforcement per UG-37 governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in ²)	UG-45 Summary (in)
For P = 406.14 psi @ 200 °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}
6.6003	6.6003	0.137	0.9823	--	5.147	0.334	0.3075	0.378

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
129,564.73	129,266	148,450.63	40,542.51	381,782.9	143,482.51	278,259.21

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.4375	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

Reinforcement Calculations for MAP

Available reinforcement per UG-37 governs the MAP of this nozzle.

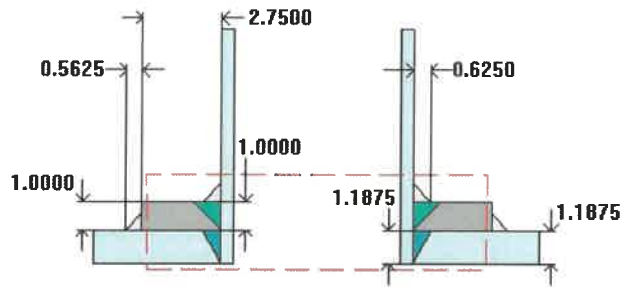
UG-37 Area Calculation Summary (in ²)								UG-45 Summary (in)	
For P = 422.71 psi @ 70 °F The opening is adequately reinforced								The nozzle passes UG-45	
A required	A available	A ₁	A ₂	A ₃	A ₅	A welds	t _{req}	t _{min}	
6.7449	6.745	0.2346	1.2794	--	4.897	0.334	0.245	0.378	

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
130,821.29	130,208	155,294.13	49,812.6	391,408.94	147,752.6	287,885.24

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.4375	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

6" 300# (H)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation

Located on	Cylinder #2
Orientation	0°
Nozzle center line offset to datum line	156"
End of nozzle to shell center	62.6875"
Passes through a Category A joint	No

Nozzle

Description	NPS 6 Sch 80 (XS)
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 15)
Inside diameter, new	5.761"
Pipe nominal wall thickness	0.432"
Pipe minimum wall thickness ¹	0.378"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	4.1345"
Projection available outside vessel to flange face, L _f	8.0145"
Local vessel minimum thickness	1.1875"
Liquid static head included	0.34 psi
Longitudinal joint efficiency	1

Reinforcing Pad

Material specification	SA-516 70 (II-D p. 18, ln. 37)
Diameter, D _p	12.125"
Thickness, t _e	1"
Is split	No

Welds

Inner fillet, Leg ₄₁	0.625"
---------------------------------	--------

Outer fillet, Leg ₄₂	0.5625"
Nozzle to vessel groove weld	1.1875"
Pad groove weld	1"

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

ASME B16.5-2013 Flange	
Description	NPS 6 Class 300 WN A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-55 °F
Liquid static head	0.05 psi
MAWP rating	680 psi @ 200 °F
MAP rating	740 psi @ 70 °F
Hydrotest rating	1,125 psi @ 70 °F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(a)(5)(b) Type 1
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55 °F (Coincident ratio = 0.5431)	
Bolts rated MDMT per Fig UCS-66 note (c) = -55 °F	

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 402.19 \times 2.943 / (17,100 \times 1 - 0.6 \times 402.19) =$	0.0702"
Stress ratio = $t_r \times E' / (t_n - c) = 0.0702 \times 1 / (0.378 - 0.0625) =$	0.2225
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.	

UCS-66 Material Toughness Requirements Pad	
Governing thickness, $t_g =$	1"
MDMT =	-20 °F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20 °F.	

Reinforcement Calculations for MAWP

Available reinforcement per UG-37 governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in ²)	UG-45 Summary (in)
For P = 406.14 psi @ 200 °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}
6.6003	6.6003	0.137	0.9823	--	5.147	0.334	0.3075	0.378

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
129,564.73	129,266	148,450.63	40,542.51	381,782.9	143,482.51	278,259.21

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.4375	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

Reinforcement Calculations for MAP

Available reinforcement per UG-37 governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in ²)								UG-45 Summary (in)	
For P = 422.71 psi @ 70 °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}	
6.7449	6.745	0.2346	1.2794	--	4.897	0.334	0.245	0.378	

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
130,821.29	130,208	155,294.13	49,812.6	391,408.94	147,752.6	287,885.24

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.4375	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

Cylinder #1

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, In. 37)		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	Yes	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		400	200	-20
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		4.24	117.548	1
Test horizontal		4.19	116.173	1
Dimensions				
Outer Diameter		109.346"		
Length		114.125"		
Nominal Thickness		1.1875"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		13,016.38		4,440.08
Corroded		12,338.44		4,450.46
Insulation				
		Thickness (in)	Density (lb/ft³)	Weight (lb)
Insulation		1	15	343.43
		Spacing(in)	Individual Weight (lb)	Total Weight (lb)
Insulation Supports		120	100	100
Radiography				
Longitudinal seam		Full UW-11(a) Type 1		
Left Circumferential seam		Spot UW-11(a)(5)(b) Type 1		
Right Circumferential seam		Full UW-11(a) 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)	1.1587"
Maximum allowable working pressure (MAWP)	410.71 psi
Maximum allowable pressure (MAP)	438.21 psi
Rated MDMT	-25.1 °F

UCS-66 Material Toughness Requirements	
Governing thickness, $t_g =$	1.1875"
Exemption temperature from Fig UCS-66 Curve D =	-23 °F
$t_r = 406.09 * 54.673 / (20,000 * 1 + 0.4 * 406.09) =$	1.1012"
Stress ratio = $t_r * E' / (t_g - c) = 1.1012 * 1 / (1.1875 - 0.0625) =$	0.9788
Reduction in MDMT, T_R from Fig UCS-66.1 =	2.1 °F
MDMT = $\max[\text{MDMT} - T_R, -55] = \max[-23 - 2.1, -55] =$	-25.1 °F
Material is exempt from impact testing at the Design MDMT of -20 °F.	

Design thickness, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 t &= P * R_o / (S * E + 0.40 * P) + \text{Corrosion} \\
 &= 404.24 * 54.673 / (20,000 * 1.00 + 0.40 * 404.24) + 0.0625 \\
 &= \underline{1.1587"}
 \end{aligned}$$

Maximum allowable working pressure, (at 200 °F) Appendix 1-1

$$\begin{aligned}
 P &= S * E * t / (R_o - 0.40 * t) - P_s \\
 &= 20,000 * 1.00 * 1.125 / (54.673 - 0.40 * 1.125) - 4.24 \\
 &= \underline{410.71} \text{ psi}
 \end{aligned}$$

Maximum allowable pressure, (at 70 °F) Appendix 1-1

$$\begin{aligned}
 P &= S * E * t / (R_o - 0.40 * t) \\
 &= 20,000 * 1.00 * 1.1875 / (54.673 - 0.40 * 1.1875) \\
 &= \underline{438.21} \text{ psi}
 \end{aligned}$$

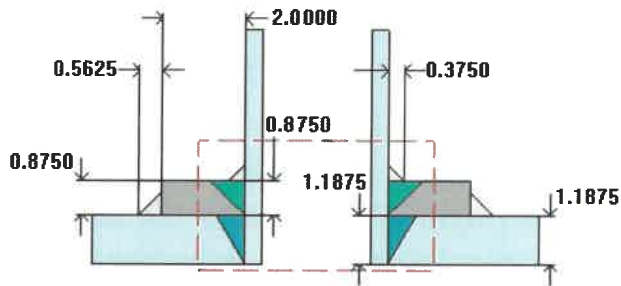
% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 EFE &= (50 * t / R_f) * (1 - R_f / R_o) \\
 &= (50 * 1.1875 / 54.0793) * (1 - 54.0793 / \infty) \\
 &= 1.0979\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

3" 300# (J)

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

Location and Orientation

Located on	Cylinder #1
Orientation	0°
Nozzle center line offset to datum line	9"
End of nozzle to shell center	62.6875"
Passes through a Category A joint	No

Nozzle

Description	NPS 3 Sch 160
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 15)
Inside diameter, new	2.624"
Pipe nominal wall thickness	0.438"
Pipe minimum wall thickness ¹	0.3833"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	4.8945"
Projection available outside vessel to flange face, L _f	8.0145"
Local vessel minimum thickness	1.1875"
Liquid static head included	0.34 psi
Longitudinal joint efficiency	1

Reinforcing Pad

Material specification	SA-516 70 (II-D p. 18, ln. 37)
Diameter, D _p	7.5"
Thickness, t _e	0.875"
Is split	No

Welds

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

Outer fillet, Leg₄₂	0.5625"
Nozzle to vessel groove weld	1.1875"
Pad groove weld	0.875"

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

ASME B16.5-2013 Flange	
Description	NPS 3 Class 300 WN A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-55 °F
Liquid static head	0.05 psi
MAWP rating	680 psi @ 200 °F
MAP rating	740 psi @ 70 °F
Hydrotest rating	1,125 psi @ 70 °F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(a)(5)(b) Type 1
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55 °F (Coincident ratio = 0.5431) Bolts rated MDMT per Fig UCS-66 note (c) = -55 °F	

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 402.19 \times 1.3745 / (17,100 \times 1 - 0.6 \times 402.19) =$	0.0328"
Stress ratio = $t_r \times E^* / (t_n - c) = 0.0328 \times 1 / (0.3833 - 0.0625) =$	0.1022
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.	

UCS-66 Material Toughness Requirements Pad	
Governing thickness, $t_g =$	0.875"
MDMT =	-20 °F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20 °F.	

Reinforcement Calculations for MAWP

Available reinforcement per UG-37 governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in ²)	UG-45 Summary (in)
For P = 410.71 psi @ 200 °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}
3.1825	3.1827	0.033	1.0607	--	1.9688	0.1202	0.2515	0.3833

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
63,136.99	62,993	87,002.56	38,065.36	180,009.23	77,440.36	156,480.77

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

Reinforcement Calculations for MAP

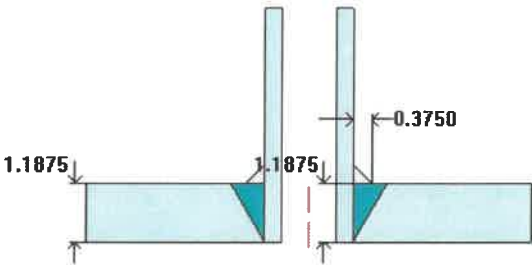
The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 438.21 psi @ 70 °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}
3.2668	3.5589	--	1.3606	--	2.0781	0.1202	0.189	0.3833

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
65,336.32	71,178.5	90,159.6	47,404.28	185,094.69	88,966.78	161,566.22

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.2625	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

3/4" 6000# CPLG (K)

ASME Section VIII Division 1, 2015 Edition	
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	Cylinder #1
Orientation	0°
Nozzle center line offset to datum line	15"
End of nozzle to shell center	60.673"
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}	6"
Local vessel minimum thickness	1.1875"
Liquid static head included	0.34 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg ₄₁	0.375"
Nozzle to vessel groove weld	1.1875"

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 402.19 \times 0.5875 / (20,000 \times 1 - 0.6 \times 402.19) =$	0.012"
Stress ratio = $t_r \times E^* / (t_n - c) = 0.012 \times 1 / (0.35 - 0.0625) =$	0.0416
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 MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 414.95 psi @ 200 °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 MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 438.21 psi @ 70 °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)							0.0625	0.35

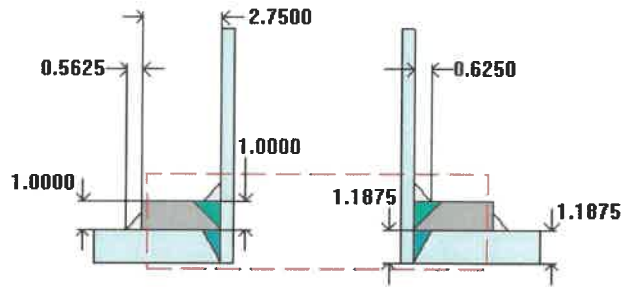
UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg ₄₁)	0.245	0.2625	weld size is adequate

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

6" 300# (B)

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

Location and Orientation

Located on	Cylinder #1
Orientation	180°
Nozzle center line offset to datum line	9"
End of nozzle to shell center	64"
Passes through a Category A joint	No

Nozzle

Description	NPS 6 Sch 80 (XS)
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 15)
Inside diameter, new	5.761"
Pipe nominal wall thickness	0.432"
Pipe minimum wall thickness ¹	0.378"
Corrosion allowance	0.0625"
Projection available outside vessel, L _{pr}	5.447"
Projection available outside vessel to flange face, L _f	9.327"
Local vessel minimum thickness	1.1875"
Liquid static head included	4.28 psi
Longitudinal joint efficiency	1

Reinforcing Pad

Material specification	SA-516 70 (II-D p. 18, ln. 37)
Diameter, D _p	12.125"
Thickness, t _p	1"
Is split	No

Welds

Inner fillet, Leg ₄₁	0.625"
---------------------------------	--------

Outer fillet, Leg ₄₂	0.5625"
Nozzle to vessel groove weld	1.1875"
Pad groove weld	1"

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

ASME B16.5-2013 Flange	
Description	NPS 6 Class 300 WN A105
Bolt Material	SA-193 B7 Bolt ≤ 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-55°F
Liquid static head	4.62 psi
MAWP rating	680 psi @ 200°F
MAP rating	740 psi @ 70°F
Hydrotest rating	1,125 psi @ 70°F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(a)(5)(b) Type 1
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -55°F (Coincident ratio = 0.5493)	
Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements Nozzle	
$t_r = 406.13 \times 2.943 / (17,100 \times 1 - 0.6 \times 406.13) =$	0.0709"
Stress ratio = $t_r \times E' / (t_n - c) = 0.0709 \times 1 / (0.378 - 0.0625) =$	0.2248
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.	

UCS-66 Material Toughness Requirements Pad	
Governing thickness, $t_g =$	1"
MDMT =	-20°F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

Available reinforcement per UG-37 governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in ²)	UG-45 Summary (in)
For P = 406.13 psi @ 200 °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}
6.6001	6.6004	0.1371	0.9823	--	5.147	0.334	0.3075	0.378

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
129,560.58	129,266	148,450.63	40,542.51	381,782.9	143,482.51	278,259.21

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.4375	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

Reinforcement Calculations for MAP

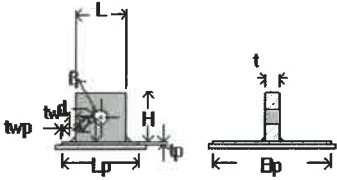
Available reinforcement per UG-37 governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in ²)							UG-45 Summary (in)	
For P = 422.71 psi @ 70 °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}
6.7449	6.745	0.2346	1.2794	--	4.897	0.334	0.245	0.378

UG-41 Weld Failure Path Analysis Summary (lb _f)						
All failure paths are stronger than the applicable weld loads						
Weld load W	Weld load W ₁₋₁	Path 1-1 strength	Weld load W ₂₋₂	Path 2-2 strength	Weld load W ₃₋₃	Path 3-3 strength
130,821.29	130,208	155,294.13	49,812.6	391,408.94	147,752.6	287,885.24

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to pad fillet (Leg ₄₁)	0.25	0.4375	weld size is adequate
Pad to shell fillet (Leg ₄₂)	0.375	0.3938	weld size is adequate

Lifting Lug #1

Geometry Inputs	
	
Attached To	Cylinder #1
Material	SA-516 70
Orientation	Longitudinal
Distance of Lift Point From Datum	75"
Angular Position	0°
Length, L	12"
Height, H	11.75"
Thickness, t	1.5"
Hole Diameter, d	3.375"
Pin Diameter, Dp	3.25"
Load Eccentricity, a_1	0"
Distance from Load to Shell or Pad, a_2	5.75"
Load Angle Normal to Vessel, β	30°
Load Angle from Vertical, ϕ	30°
Welds	
Size, t_w	1.25"
Reinforcement Pad	
Width, B_p	14"
Length, L_p	18"
Thickness, t_p	0.75"
Weld Size, t_{wp}	0.5"

Intermediate Values	
Load Factor	2.0000
Vessel Weight (new, incl. Load Factor), W	187,326 lb
Lug Weight (new), W_{lug}	117.8 lb
Distance from Center of Gravity to this lug, x_1	265.6356"
Distance from Center of Gravity to second lug, x_2	269.0519"
Allowable Stress, Tensile, σ_t	22,800 psi
Allowable Stress, Shear, σ_s	15,200 psi
Allowable Stress, Bearing, σ_p	34,200 psi
Allowable Stress, Bending, σ_b	25,080 psi
Allowable Stress, Weld Shear, $\tau_{allowable}$	15,200 psi
Allowable Stress set to 1/3 Sy per ASME B30.20	No

Summary Values	
Required Lift Pin Diameter, d_{reqd}	<u>2.1351"</u>
Required Lug Thickness, t_{reqd}	<u>0.9793"</u>
Lug Stress Ratio, σ_{ratio}	<u>0.58</u>
Weld Shear Stress Ratio, τ_{ratio}	<u>0.63</u>
Lug Design	Acceptable
Local Stresses WRC 107	Acceptable

Lift Forces

$$\begin{aligned}
 F_r &= \text{force on vessel at lug} \\
 F_r &= [W / \cos(\phi_1)] * (1 - x_1 / (x_1 + x_2)) \\
 &= (187,326) / \cos(30) * (1 - 265.6356 / (265.6356 + \\
 &\quad 269.0519)) \\
 &= \underline{108,844 \text{ lb}}
 \end{aligned}$$

where ' x_1 ' is the distance between this lug and the center of gravity

' x_2 ' is the distance between the second lift lug and the center of gravity

Lug Pin Diameter - Shear stress

$$\begin{aligned}
 d_{reqd} &= (2 * F_r / (\pi * \sigma_s))^{0.5} \\
 &= (2 * 108,844 / (\pi * 15,200))^{0.5} = \underline{2.1351"}
 \end{aligned}$$

$$d_{reqd} / D_p = 2.1351 / 3.25 = 0.66 \quad \text{Acceptable}$$

$$\begin{aligned}
 \sigma &= F_r / A \\
 &= F_r / (2 * (0.25 * \pi * D_p^2)) \\
 &= 108,844 / (2 * (0.25 * \pi * 3.25^2)) = 6,560 \text{ psi}
 \end{aligned}$$

$$\sigma / \sigma_s = 6,560 / 15,200 = 0.43 \quad \text{Acceptable}$$

Lug Thickness - Tensile stress

$$\begin{aligned}
 t_{reqd} &= F_r / ((L - d) * \sigma_t) \\
 &= 108,844 / ((12 - 3.375) * 22,800) = 0.5535"
 \end{aligned}$$

$$t_{\text{reqd}} / t = 0.5535 / 1.5 = 0.37 \quad \text{Acceptable}$$

$$\begin{aligned} \sigma &= F_r / A \\ &= F_r / ((L - d) * t) \\ &= 108,844 / ((12 - 3.375) * 1.5) = 8,413 \text{ psi} \end{aligned}$$

$$\sigma / \sigma_t = 8,413 / 22,800 = 0.37 \quad \text{Acceptable}$$

Lug Thickness - Bearing stress

$$\begin{aligned} t_{\text{reqd}} &= F_v / (D_p * \sigma_p) \\ &= 108,844 / (3.25 * 34,200) = \underline{0.9793"} \end{aligned}$$

$$t_{\text{reqd}} / t = 0.9793 / 1.5 = 0.65 \quad \text{Acceptable}$$

$$\begin{aligned} \sigma &= F_v / A_{\text{bearing}} \\ &= F_v / (D_p * t) \\ &= 108,844 / (3.25 * (1.5)) = 22,327 \text{ psi} \end{aligned}$$

$$\sigma / \sigma_p = 22,327 / 34,200 = 0.65 \quad \text{Acceptable}$$

Lug Thickness - Shear stress

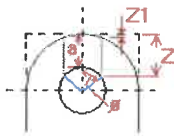
$$\begin{aligned} t_{\text{reqd}} &= [F_v / \sigma_s] / (2 * L_{\text{shear}}) \\ &= (108,844 / 15,200) / (2 * 4.9587) = \underline{0.722"} \end{aligned}$$

$$t_{\text{reqd}} / t = 0.722 / 1.5 = 0.48 \quad \text{Acceptable}$$

$$\begin{aligned} \tau &= F_v / A_{\text{shear}} \\ &= F_v / (2 * t * L_{\text{shear}}) \\ &= 108,844 / (2 * 1.5 * 4.9587) = 7,317 \text{ psi} \end{aligned}$$

$$\tau / \sigma_s = 7,317 / 15,200 = 0.48 \quad \text{Acceptable}$$

Shear stress length (per Pressure Vessel and Stacks, A. Keith Escoe)



$$\begin{aligned} \phi &= 55 * D_p / d \\ &= 55 * 3.25 / 3.375 \\ &= 52.963^\circ \\ L_{\text{shear}} &= (H - a2 - 0.5 * d) + 0.5 * D_p * (1 - \cos(\phi)) \\ &= (11.75 - 5.75 - 0.5 * 3.375) + 0.5 * 3.25 * (1 - \cos(52.963)) \\ &= 4.9587" \end{aligned}$$

Lug Plate Stress

Lug stress tensile + bending during lift:

$$\begin{aligned}
 \sigma_{\text{ratio}} &= [F_{\text{ten}} / (A_{\text{ten}} \cdot \sigma_t)] + [M_{\text{bend}} / (Z_{\text{bend}} \cdot \sigma_b)] \leq 1 \\
 &= [(F_r \cdot \cos(\beta)) / (t \cdot L \cdot \sigma_t)] + [(6 \cdot \text{abs}(F_r \cdot \sin(\beta) \cdot \text{Hght} - F_r \cdot \cos(\beta) \cdot a_1)) / (t \cdot L^2 \cdot \sigma_b)] \leq 1 \\
 &= 108,844 \cdot \cos(30.0) / (1.5 \cdot 12 \cdot 22,800) + 6 \cdot \text{abs}(108,844 \cdot \sin(30.0) \cdot 5.75 - 108,844 \cdot \cos(30.0) \cdot 0) / (1.5 \cdot 12^2 \cdot 25,080) \\
 &= \underline{0.58} \quad \text{Acceptable}
 \end{aligned}$$

Weld Stress**Weld stress, tensile, bending and shear during lift:****Direct shear:**Shear stress at lift angle 30.00°; lift force = 108,844 lb_f

$$\begin{aligned}
 A_{\text{weld}} &= 2 \cdot (0.707) \cdot t_w \cdot (L + t) \\
 &= 2 \cdot (0.707) \cdot 1.25 \cdot (12 + 1.5) = 23.8612 \text{ in}^2
 \end{aligned}$$

$$\begin{aligned}
 \tau_t &= F_{\text{lug}} \cdot \cos(\beta) / A_{\text{weld}} \\
 &= 108,844 \cdot \cos(30.0) / 23.8612 = 3,950 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_s &= F_{\text{lug}} \cdot \sin(\beta) / A_{\text{weld}} \\
 &= 108,844 \cdot \sin(30.0) / 23.8612 = 2,281 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_b &= M \cdot c / I \\
 &= 3 \cdot (F_{\text{lug}} \cdot \sin(\beta) \cdot \text{Hght} - F_{\text{lug}} \cdot \cos(\beta) \cdot a_1) / (0.707 \cdot h \cdot L \cdot (3 \cdot t + L)) \\
 &= 3 \cdot \text{abs}(108,844 \cdot \sin(30.0) \cdot 5.75 - 108,844 \cdot \cos(30.0) \cdot 0) / (174.9825) \\
 &= 5,365 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_{\text{ratio}} &= \text{sqr}(\tau_t + \tau_b)^2 + \tau_s^2 / \tau_{\text{allowable}} \leq 1 \\
 &= \text{sqr}((3,950 + 5,365)^2 + (2,281)^2) / 15,200 \\
 &= \underline{0.63} \quad \text{Acceptable}
 \end{aligned}$$

Pad Weld Stress, tensile, bending and shear during lift:**Direct shear:**Shear stress at lift angle 30.00°; lift force = 108,844 lb_f

$$\begin{aligned}
 A_{\text{weld}} &= 2 \cdot (0.707) \cdot t_{\text{wp}} \cdot (L_p + B_p) \\
 &= 2 \cdot (0.707) \cdot 0.5 \cdot (18 + 14) = 22.624 \text{ in}^2
 \end{aligned}$$

$$\begin{aligned}
 \tau_t &= F_{\text{lug}} \cdot \cos(\beta) / A_{\text{weld}} \\
 &= 108,844 \cdot \cos(30.0) / 22.624 = 4,166 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_s &= F_{\text{lug}} \cdot \sin(\beta) / A_{\text{weld}} \\
 &= 108,844 \cdot \sin(30.0) / 22.624 = 2,405 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_b &= M * c / I \\
 &= 3 * (F_{lug} * \sin(\beta) * H_{ght} - F_{lug} * \cos(\beta) * a_1) / \\
 &\quad (0.707 * h_p * L_p * (3 * W_p + L_p)) \\
 &= 3 * \text{abs}(108,844 * \sin(30.0) * 6.5 - \\
 &\quad 108,844 * \cos(30.0) * (0)) / (381.7800) \\
 &= 2,780 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \tau_{ratio} &= \text{sqr}((\tau_l + \tau_b)^2 + \tau_s^2) / \tau_{allowable} \leq 1 \\
 &= \text{sqr}((4,166 + 2,780)^2 + (2,405)^2) / 15,200 \\
 &= 0.48
 \end{aligned}$$

Acceptable

WRC 107 Analysis

Geometry	
Height (radial)	11.75"
Width (circumferential)	1.5"
Length	12"
Fillet Weld Size:	1.25"
Located On	Cylinder #1 (69" from right end)
Location Angle	0.00°
Reinforcement Pad	
Thickness	0.75"
Width	14"
Length	18"
Weld Size	0.5"

Applied Loads	
Radial load, P_r	-94,261.44 lb _f
Circumferential moment, M_c	0 lb _f -in
Circumferential shear, V_c	0 lb _f
Longitudinal moment, M_L	353,742.1 lb _f -in
Longitudinal shear, V_L	54,421.87 lb _f
Torsion moment, M_t	0 lb _f -in
Internal pressure, P	0 psi
Mean shell radius, R_m	54.0793"
Design factor	3

Maximum stresses due to the applied loads at the lug edge

$$\gamma = R_m / T = 54.0793 / 1.9375 = 27.9119$$

$$C_1 = 2, C_2 = 7.25 \text{ in}$$

$$\text{Local circumferential pressure stress} = P * R_i / T = 0 \text{ psi}$$

Local longitudinal pressure stress = $P \cdot R_i / (2 \cdot T) = 0$ psi

Maximum combined stress ($P_L + P_b + Q$) = 37,132 psi

Allowable combined stress ($P_L + P_b + Q$) = $\pm 3 \cdot S = \pm 60,000$ psi

The maximum combined stress ($P_L + P_b + Q$) is within allowable limits.

Maximum local primary membrane stress (P_L) = 5,759 psi

Allowable local primary membrane stress (P_L) = $\pm 1.5 \cdot S = \pm 30,000$ psi

The maximum local primary membrane stress (P_L) is within allowable limits.

Stresses at the lug edge per WRC Bulletin 107										
Figure	value	β	A_u	A_l	B_u	B_l	C_u	C_l	D_u	D_l
3C*	4.4796	0.103	0	0	0	0	4,030	4,030	4,030	4,030
4C*	5.1314	0.084	4,616	4,616	4,616	4,616	0	0	0	0
1C	0.1882	0.0623	0	0	0	0	28,354	-28,354	28,354	-28,354
2C-1	0.1497	0.0623	22,554	-22,554	22,554	-22,554	0	0	0	0
3A*	0.3742	0.0568	0	0	0	0	0	0	0	0
1A	0.1045	0.0718	0	0	0	0	0	0	0	0
3B*	2.3064	0.0873	-1,143	-1,143	1,143	1,143	0	0	0	0
1B-1	0.0543	0.078	-7,275	7,275	7,275	-7,275	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total circumferential stress			18,752	-11,806	35,588	-24,070	32,384	-24,324	32,384	-24,324
Primary membrane circumferential stress*			3,473	3,473	5,759	5,759	4,030	4,030	4,030	4,030
3C*	4.7711	0.084	4,292	4,292	4,292	4,292	0	0	0	0
4C*	4.9749	0.103	0	0	0	0	4,476	4,476	4,476	4,476
1C-1	0.1624	0.0874	24,467	-24,467	24,467	-24,467	0	0	0	0
2C	0.1195	0.0874	0	0	0	0	18,004	-18,004	18,004	-18,004
4A*	0.4833	0.0568	0	0	0	0	0	0	0	0
2A	0.0571	0.0975	0	0	0	0	0	0	0	0
4B*	0.6258	0.0873	-534	-534	534	534	0	0	0	0
2B-1	0.0786	0.1048	-7,839	7,839	7,839	-7,839	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total longitudinal stress			20,386	-12,870	37,132	-27,480	22,480	-13,528	22,480	-13,528
Primary membrane longitudinal stress*			3,758	3,758	4,826	4,826	4,476	4,476	4,476	4,476
Shear from M_t			0	0	0	0	0	0	0	0
Circ shear from V_c			0	0	0	0	0	0	0	0
Long shear from V_L			0	0	0	0	-969	-969	969	969
Total Shear stress			0	0	0	0	-969	-969	969	969
Combined stress (P_L+P_b+Q)			20,386	-12,870	37,132	-27,480	32,478	-24,410	32,478	-24,410
* denotes primary stress.										

Maximum stresses due to the applied loads at the pad edge

$$\gamma = R_m / T = 54.0793 / 1.1875 = 45.5404$$

$$C_1 = 7.5, C_2 = 9.5 \text{ in}$$

$$\text{Local circumferential pressure stress} = P \cdot R_i / T = 0 \text{ psi}$$

$$\text{Local longitudinal pressure stress} = P \cdot R_i / (2 \cdot T) = 0 \text{ psi}$$

$$\text{Maximum combined stress } (P_L + P_b + Q) = 46,923 \text{ psi}$$

$$\text{Allowable combined stress } (P_L + P_b + Q) = \pm 3 \cdot S = \pm 60,000 \text{ psi}$$

The maximum combined stress ($P_L + P_b + Q$) is within allowable limits.

$$\text{Maximum local primary membrane stress } (P_L) = 12,759 \text{ psi}$$

$$\text{Allowable local primary membrane stress } (P_L) = \pm 1.5 \cdot S = \pm 30,000 \text{ psi}$$

The maximum local primary membrane stress (P_L) is within allowable limits.

Stresses at the pad edge per WRC Bulletin 107										
Figure	value	β	A_u	A_l	B_u	B_l	C_u	C_l	D_u	D_l
3C*	4.5695	0.1771	0	0	0	0	6,707	6,707	6,707	6,707
4C*	6.8225	0.1648	10,014	10,014	10,014	10,014	0	0	0	0
1C	0.0847	0.1508	0	0	0	0	33,970	-33,970	33,970	-33,970
2C-1	0.0503	0.1508	20,174	-20,174	20,174	-20,174	0	0	0	0
3A*	1.7968	0.1501	0	0	0	0	0	0	0	0
1A	0.0802	0.166	0	0	0	0	0	0	0	0
3B*	4.9858	0.1624	-2,745	-2,745	2,745	2,745	0	0	0	0
1B-1	0.0313	0.1592	-5,473	5,473	5,473	-5,473	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total circumferential stress			21,970	-7,432	38,406	-12,888	40,677	-27,263	40,677	-27,263
Primary membrane circumferential stress*			7,269	7,269	12,759	12,759	6,707	6,707	6,707	6,707
3C*	4.9111	0.1648	7,209	7,209	7,209	7,209	0	0	0	0
4C*	6.6239	0.1771	0	0	0	0	9,723	9,723	9,723	9,723
1C-1	0.0792	0.167	31,765	-31,765	31,765	-31,765	0	0	0	0
2C	0.0464	0.167	0	0	0	0	18,610	-18,610	18,610	-18,610
4A*	3.1083	0.1501	0	0	0	0	0	0	0	0
2A	0.0388	0.1825	0	0	0	0	0	0	0	0
4B*	1.8196	0.1624	-1,185	-1,185	1,185	1,185	0	0	0	0
2B-1	0.0426	0.1753	-6,764	6,764	6,764	-6,764	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total longitudinal stress			31,025	-18,977	46,923	-30,135	28,333	-8,887	28,333	-8,887
Primary membrane longitudinal stress*			6,024	6,024	8,394	8,394	9,723	9,723	9,723	9,723
Shear from M_t			0	0	0	0	0	0	0	0
Circ shear from V_c			0	0	0	0	0	0	0	0
Long shear from V_L			0	0	0	0	-1,206	-1,206	1,206	1,206
Total Shear stress			0	0	0	0	-1,206	-1,206	1,206	1,206
Combined stress (P_L+P_b+Q)			31,025	-18,977	46,923	-30,135	40,794	-27,342	40,794	-27,342
* denotes primary stress.										

Hemi Head #2

ASME Section VIII Division 1, 2015 Edition				
Component		Hemispherical Head		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Attached To		Cylinder #1		
Impact Tested	Normalized	Fine Grain Practice	PWHT	Optimize MDMT/ Find MAWP
No	Yes	No	No	No
		Design Pressure (psi)	Design Temperature (°F)	Design MDMT (°F)
Internal		400	200	-20
Static Liquid Head				
Condition		P _s (psi)	H _s (in)	SG
Operating		4.25	117.7325	1
Test horizontal		4.2	116.3575	1
Dimensions				
Outer Diameter		109"		
Minimum Thickness		0.83"		
Corrosion	Inner	0.0625"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		Capacity (US gal)
New		4,317.24		1,401.66
Corroded		3,996.75		1,406.56
Insulation				
		Thickness (in)	Density (lb/ft³)	Weight (lb)
Insulation		1	15	164.99
		Spacing(in)	Individual Weight (lb)	Total Weight (lb)
Insulation Supports		120	100	100
Radiography				
Category A joints - Long Seam		Seamless No RT		
Category A joints - Circ Seam		Full UW-11(a) 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)	<u>0.6106"</u>
Maximum allowable working pressure (MAWP)	<u>563.06 psi</u>
Maximum allowable pressure (MAP)	<u>613.86 psi</u>
Rated MDMT	-55 °F

UCS-66 Material Toughness Requirements	
Governing thickness, $t_g =$	0.83"
Exemption temperature from Fig UCS-66 Curve D =	-37.44 °F
$t_r = 54.5 \cdot (1 - \exp(-406.1 / (2 \cdot 20,000 \cdot 1))) =$	0.5505"
Stress ratio = $t_r \cdot E' / (t_n - c) = 0.5505 \cdot 1 / (0.83 - 0.0625) =$	0.7173
Reduction in MDMT, T_R from Fig UCS-66.1 =	28.3 °F
MDMT = $\max[\text{MDMT} - T_R, -55] = \max[-37.44 - 28.3, -55] =$	-55 °F
Material is exempt from impact testing at the Design MDMT of -20 °F.	

Design thickness, (at 200 °F) Appendix 1-3

$$\begin{aligned}
 t &= R_o \cdot (1 - \exp[-0.5 \cdot P / (S \cdot E)]) + \text{Corrosion} \\
 &= 54.5 \cdot (1 - \exp[-0.5 \cdot 404.25 / (20,000 \cdot 1.00)]) + 0.0625 \\
 &= \underline{0.6106"}
 \end{aligned}$$

Maximum allowable working pressure, (at 200 °F) Appendix 1-3

$$\begin{aligned}
 P &= 2 \cdot S \cdot E \cdot \ln(R_o / (R_o - t)) - P_s \\
 &= 2 \cdot 20,000 \cdot 1.00 \cdot \ln(54.5 / (54.5 - 0.7675)) - 4.25 \\
 &= \underline{563.06 \text{ psi}}
 \end{aligned}$$

Maximum allowable pressure, (at 70 °F) Appendix 1-3

$$\begin{aligned}
 P &= 2 \cdot S \cdot E \cdot \ln(R_o / (R_o - t)) \\
 &= 2 \cdot 20,000 \cdot 1.00 \cdot \ln(54.5 / (54.5 - 0.83)) \\
 &= \underline{613.86 \text{ psi}}
 \end{aligned}$$

% Extreme fiber elongation - UCS-79(d)

$$\begin{aligned}
 \text{EFE} &= (75 \cdot t / R_f) \cdot (1 - R_f / R_o) \\
 &= (75 \cdot 0.83 / 54.085) \cdot (1 - 54.085 / \infty) \\
 &= 1.151\%
 \end{aligned}$$

The extreme fiber elongation does not exceed 5%.

Saddle #1

ASME Section VIII Division 1, 2015 Edition		
Saddle Material		
Saddle Construction	Web at edge of rib	
Welded to Vessel	Yes	
Saddle Allowable Stress, S_s	20,000 psi	
Saddle Yield Stress, S_y	38,000 psi	
Foundation Allowable Stress	1,350 psi	
Design Pressure	Left Saddle	Right Saddle
Operating	406.09 psi	
Test	526.6 psi	
Dimensions		
Right saddle distance to datum	57.5625"	
Tangent To Tangent Length, L	684.75"	
Saddle separation, L_s	552"	
Vessel Radius, R	54.673"	
Tangent Distance Left, A_l	75.1875"	
Tangent Distance Right, A_r	57.5625"	
Saddle Height, H_s	60"	
Saddle Contact Angle, θ	121 °	
Web Plate Thickness, t_s	0.5"	
Base Plate Length, E	98"	
Base Plate Width, F	14"	
Base Plate Thickness, t_b	1.25"	
Number of Stiffening Ribs, n	6	
Largest Stiffening Rib Spacing, d_i	19.3"	
Stiffening Rib Thickness, t_w	0.5"	
Saddle Width, b	12"	
Reinforcing Plate		
Thickness, t_p	0.375"	
Width, W_p	16"	
Contact Angle, θ_w	134 °	
Bolting		
Material		
Bolt Allowable Shear	13,200 psi	
Description	2.25" series 8 threaded	
Corrosion on root	0"	
Anchor Bolts per Saddle	2	

Base coefficient of friction, μ	0.45	
Weight		
	Operating, Corroded	Hydrotest
Weight on Left Saddle	171,575 lb	172,453 lb
Weight on Right Saddle	161,462 lb	162,317 lb
Weight of Saddle Pair	2,088 lb	

Notes
(1) Saddle calculations are based on the method presented in "Stresses in Large Cylindrical Pressure Vessels on Two Saddle Supports" by L.P. Zick.

Stress Summary										
Load	Condition	Saddle	Bending + pressure between saddles (psi)				Bending + pressure at the saddle (psi)			
			S ₁ (+)	allow (+)	S ₁ (-)	allow (-)	S ₂ (+)	allow (+)	S ₂ (-)	allow (-)
Seismic	Operating	Right Saddle	11,853	20,400	<u>2,188</u>	18,880	11,429	24,000	1,764	18,880
		Left Saddle					12,282	24,000	2,617	18,880
Wind	Operating	Right Saddle	11,242	20,400	1,577	18,880	11,135	24,000	1,470	18,880
		Left Saddle					11,846	24,000	2,181	18,880
	Test	Right Saddle	13,324	29,070	1,465	18,880	13,261	34,200	1,402	18,880
		Left Saddle					13,938	34,200	2,079	18,880
Weight	Operating	Right Saddle	<u>11,182</u>	17,000	1,517	15,734	11,135	20,000	1,470	15,734
		Left Saddle					<u>11,846</u>	20,000	<u>2,181</u>	15,734

Stress Summary										
Load	Condition	Saddle	Tangential shear (psi)		Circumferential stress (psi)		Stress over saddle (psi)		Splitting (psi)	
			S ₃	allow	S ₄ (horns)	allow (+/-)	S ₅	allow	S ₆	allow
Seismic	Operating	Right Saddle	3,478	16,000	-16,492	30,000	8,032	17,400	6,091	13,333
		Left Saddle	3,578	16,000	-17,525	30,000	8,535	17,400	6,473	13,333
Wind	Operating	Right Saddle	2,400	16,000	-11,885	30,000	5,788	17,400	4,390	13,333
		Left Saddle	2,451	16,000	-12,622	30,000	6,147	17,400	4,662	13,333
	Test	Right Saddle	2,210	27,360	-10,504	34,200	5,336	34,200	4,300	34,200
		Left Saddle	2,254	27,360	-11,158	34,200	5,668	34,200	4,567	34,200
Weight	Operating	Right Saddle	2,279	16,000	-11,431	30,000	5,567	17,400	4,222	13,333
		Left Saddle	2,324	16,000	-12,147	30,000	5,916	17,400	4,487	13,333

Seismic base shear on vessel	
Vessel is assumed to be a rigid structure.	
Method of seismic analysis	ASCE 7-10 ground supported
Vertical seismic accelerations considered	Yes
Force Multiplier	0.3333
Minimum Weight Multiplier	0.2
Importance factor, I _e	1.25
Site Class	D
Short period spectral response acceleration as percent of g, S _s	100
From Table 11.4-1, F _a	1.1
Risk Category (Table 1.5-1)	III
Equations	
$S_{MS} = F_a * S_s$	
$S_{DS} = (2 / 3) * S_{MS}$	
$F_p = 0.3 * S_{DS} * W * I_e * 0.7$	
Results	
$S_{MS} = 1.1 * 1$	1.1
$S_{DS} = (2 / 3) * 1.1$	0.7333
Seismic Design Category (Section 11.6)	D
$F_p = 0.3 * 0.7333 * 333,037 * 1.25 * 0.7$	64,109.62 lb _f

Saddle reactions due to weight + seismic			
V_v = vertical seismic force acting on the saddle			
V = horizontal seismic shear acting on the saddle (worst case if not slotted)			
Seismic longitudinal reaction, Q_l			
Seismic transverse reaction, Q_t			
Equations			
$Q_l = V \cdot H_s / L_s + V_v$			
$Q_t = V \cdot H_s / (R_o \cdot \sin(\theta / 2)) + V_v$			
$Q = W + \max[Q_t, Q_l]$			
Results			
Operating	Right Saddle	$Q_l = 64,109.62 \cdot 60 / 552 + 32,292.4$	39,260.84 lb _f
		$Q_t = 31,081.44 \cdot 60 / (54.673 \cdot \sin(121 / 2)) + 32,292.4$	71,483.06 lb _f
		$Q = 161,462 + \max[71,483.06, 39,260.84]$	232,945.06 lb _f
	Left Saddle	$Q_l = 64,109.62 \cdot 60 / 552 + 34,315$	41,283.44 lb _f
		$Q_t = 33,028.19 \cdot 60 / (54.673 \cdot \sin(121 / 2)) + 34,315$	75,960.33 lb _f
		$Q = 171,575 + \max[75,960.33, 41,283.44]$	247,535.33 lb _f

Saddle reactions due to weight + wind			
Wind longitudinal reaction, Q_l			
Wind transverse reaction, Q_t			
Wind pressure, P_w			20.5127 psf
Equations			
$V_{wt} = P_w * G * (C_{f(shell)} * (\text{Projected shell area}) + C_{f(saddle)} * (\text{Projected saddle area}))$			
$V_{we} = P_w * G * (C_{f(shell)} * \pi * R_o^2 / 144 + C_{f(saddle)} * (\text{Projected saddle area}))$			
$Q_t = V_{wt} * H_s / (R_o * \sin(\theta / 2))$			
$Q_l = V_{we} * H_s / L_s$			
$Q = W + \max[Q_t, Q_l]$			
Results			
Operating	Right Saddle	$V_{wt} = 20.51 * 0.85 * (0.8 * 363.2173 + 2 * 0.4439)$	5,081.87 lb _f
		$V_{we} = 20.51 * 0.85 * (0.5 * \pi * 67.673^2 / 144 + 2 * 10.0146)$	1,220.25 lb _f
		$Q_t = 5,081.87 * 60 / (54.673 * \sin(121 / 2))$	6,407.75 lb _f
		$Q_l = 1,220.25 * 60 / 552$	132.64 lb _f
		$Q = 161,462 + \max[6,407.75, 132.64]$	167,869.75 lb _f
	Left Saddle	$V_{wt} = 20.51 * 0.85 * (0.8 * 379.7831 + 2 * 0.4439)$	5,312.95 lb _f
		$V_{we} = 20.51 * 0.85 * (0.5 * \pi * 67.673^2 / 144 + 2 * 10.0146)$	1,220.25 lb _f
		$Q_t = 5,312.95 * 60 / (54.673 * \sin(121 / 2))$	6,699.11 lb _f
		$Q_l = 1,220.25 * 60 / 552$	132.64 lb _f
		$Q = 171,575 + \max[6,699.11, 132.64]$	178,274.11 lb _f
Test	Right Saddle	$V_{wt} = 6.77 * 0.85 * (0.8 * 363.2173 + 2 * 0.4439)$	1,677.02 lb _f
		$V_{we} = 6.77 * 0.85 * (0.5 * \pi * 67.673^2 / 144 + 2 * 10.0146)$	402.68 lb _f
		$Q_t = 1,677.02 * 60 / (54.673 * \sin(121 / 2))$	2,114.56 lb _f
		$Q_l = 402.68 * 60 / 552$	43.77 lb _f
		$Q = 162,317 + \max[2,114.56, 43.77]$	164,431.56 lb _f
	Left Saddle	$V_{wt} = 6.77 * 0.85 * (0.8 * 379.7831 + 2 * 0.4439)$	1,753.27 lb _f
		$V_{we} = 6.77 * 0.85 * (0.5 * \pi * 67.673^2 / 144 + 2 * 10.0146)$	402.68 lb _f
		$Q_t = 1,753.27 * 60 / (54.673 * \sin(121 / 2))$	2,210.71 lb _f
		$Q_l = 402.68 * 60 / 552$	43.77 lb _f
		$Q = 172,453 + \max[2,210.71, 43.77]$	174,663.71 lb _f

Longitudinal stress between saddles (Weight, Operating, right saddle loading and geometry govern)

$$S_l = \pm 3 * K_1 * Q * (L / 12) / (\pi * R^2 * t)$$

$$= 3 * 0.5679 * 161,462 * (684.75 / 12) / (\pi * 54.1105^2 * 1.125)$$

$$= 1,517 \text{ psi}$$

$$S_p = P * R / (2 * t)$$

$$= 406.09 * 53.548 / (2 * 1.125)$$

$$= 9,665 \text{ psi}$$

$$\text{Maximum tensile stress } S_{lt} = S_l + S_p = 11,182 \text{ psi}$$

Maximum compressive stress (shut down) $S_{1c} = S_1 = 1,517$ psi

Tensile stress is acceptable ($\leq 1 \cdot S \cdot E = 17,000$ psi)

Compressive stress is acceptable ($\leq 1 \cdot S_c = 15,734$ psi)

Longitudinal stress at the left saddle (Weight, Operating)

$$\begin{aligned} L_e &= 2 \cdot (\text{Left head depth}) / 3 + L + 2 \cdot (\text{Right head depth}) / 3 \\ &= 2 \cdot 54.5 / 3 + 684.75 + 2 \cdot 54.5 / 3 \\ &= 757.4167 \text{ in} \end{aligned}$$

$$w = W_t / L_e = 333,037 / 757.4167 = 439.7 \text{ lb/in}$$

Bending moment at the left saddle:

$$\begin{aligned} M_q &= w \cdot (2 \cdot H \cdot A_f / 3 + A_f^2 / 2 - (R^2 - H^2) / 4) \\ &= 439.7 \cdot (2 \cdot 54.5 \cdot 75.1875 / 3 + 75.1875^2 / 2 - (54.673^2 - 54.5^2) / 4) \\ &= 2,441,955.6 \text{ lb}_f\text{-in} \end{aligned}$$

$$\begin{aligned} S_2 &= \pm M_q \cdot K_1' / (\pi \cdot R^2 \cdot t) \\ &= 2,441,955.6 \cdot 9.2422 / (\pi \cdot 54.1105^2 \cdot 1.125) \\ &= 2,181 \text{ psi} \end{aligned}$$

$$\begin{aligned} S_p &= P \cdot R / (2 \cdot t) \\ &= 406.09 \cdot 53.548 / (2 \cdot 1.125) \\ &= 9,665 \text{ psi} \end{aligned}$$

Maximum tensile stress $S_{2t} = S_2 + S_p = 11,846$ psi

Maximum compressive stress (shut down) $S_{2c} = S_2 = 2,181$ psi

Tensile stress is acceptable ($\leq 1 \cdot S = 20,000$ psi)

Compressive stress is acceptable ($\leq 1 \cdot S_c = 15,734$ psi)

Tangential shear stress in the shell (left saddle, Seismic, Operating)

$$\begin{aligned} Q_{\text{shear}} &= Q - w \cdot (a + 2 \cdot H / 3) \\ &= 247,535.33 - 527.64 \cdot (75.1875 + 2 \cdot 54.5 / 3) \\ &= 188,692.32 \text{ lb}_f \end{aligned}$$

$$\begin{aligned} S_3 &= K_{2.2} \cdot Q_{\text{shear}} / (R \cdot t) \\ &= 1.1544 \cdot 188,692.32 / (54.1105 \cdot 1.125) \\ &= 3,578 \text{ psi} \end{aligned}$$

Tangential shear stress is acceptable ($\leq 0.8 \cdot S = 16,000$ psi)

Circumferential stress at the left saddle horns (Seismic, Operating)

$$\begin{aligned} S_4 &= -Q / (4 \cdot t \cdot (b + 1.56 \cdot \text{Sqr}(R_o \cdot t))) - 3 \cdot K_3 \cdot Q / (2 \cdot t^2) \\ &= -247,535.33 / (4 \cdot 1.125 \cdot (12 + 1.56 \cdot \text{Sqr}(54.673 \cdot 1.125))) - 3 \cdot 0.052 \cdot 247,535.33 / (2 \cdot 1.125^2) \\ &= -17,525 \text{ psi} \end{aligned}$$

Circumferential stress at saddle horns is acceptable ($\leq 1.5 \cdot S_a = 30,000$ psi)

Ring compression in shell over left saddle (Seismic, Operating)

$$\begin{aligned} S_5 &= K_5 \cdot Q / ((t + t_o) \cdot (t_s + 1.56 \cdot \text{Sqr}(R_o \cdot t_o))) \\ &= 0.7565 \cdot 247,535.33 / ((1.125 + 0.375) \cdot (0.5 + 1.56 \cdot \text{Sqr}(54.673 \cdot 1.5))) \\ &= 8,535 \text{ psi} \end{aligned}$$

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 17,400$ psi)

Saddle splitting load (left, Seismic, Operating)

Area resisting splitting force = Web area + wear plate area

$$\begin{aligned} A_e &= H_{eff} * t_s + t_p * W_p \\ &= 3.702 * 0.5 + 0.375 * 16 \\ &= 7.851 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} S_e &= K_8 * Q / A_e \\ &= 0.2053 * 247,535.33 / 7.851 \\ &= \underline{6.473} \text{ psi} \end{aligned}$$

Stress in saddle is acceptable ($\leq (2/3) * S_s = 13,333 \text{ psi}$)

Shear stress in anchor bolting, one end slotted

Maximum seismic or wind base shear = 64,109.62 lb_f

Thermal expansion base shear = $W * \mu = 172,619 * 0.45 = 77,678.55 \text{ lb}_f$
Corroded root area for a 2.25" series 8 threaded bolt = 3.423 in² (2 per saddle)

Bolt shear stress = $77,678.55 / (3.423 * 1 * 2) = 11,347 \text{ psi}$

Anchor bolt stress is acceptable ($\leq 13,200 \text{ psi}$)

Shear stress in anchor bolting, transverse

Maximum seismic or wind base shear = 64,109.62 lb_f
Corroded root area for a 2.25" series 8 threaded bolt = 3.423 in² (2 per saddle)

Bolt shear stress = $64,109.62 / (3.423 * 2 * 2) = 4,682 \text{ psi}$

Anchor bolt stress is acceptable ($\leq 13,200 \text{ psi}$)

Web plate buckling check (Escoe pg 251)

Allowable compressive stress S_c is the lesser of 20,000 or 22,517 psi: (20,000)

$$\begin{aligned} S_c &= K_1 * \pi^2 * E / (12 * (1 - 0.3^2) * (d_i / t_s)^2) \\ &= 1.28 * \pi^2 * 29E+06 / (12 * (1 - 0.3^2) * (19.3 / 0.5)^2) \\ &= 22,517 \text{ psi} \end{aligned}$$

Allowable compressive load on the saddle

$$\begin{aligned} b_e &= d_i * t_s / (d_i * t_s + 2 * t_w * (b - 1)) \\ &= 19.3 * 0.5 / (19.3 * 0.5 + 2 * 0.5 * (12 - 1)) \\ &= 0.4673 \end{aligned}$$

$$\begin{aligned} F_b &= n * (A_s + 2 * b_e * t_s) * S_c \\ &= 6 * (5.75 + 2 * 0.4673 * 0.5) * 20,000 \\ &= 746,077.48 \text{ lb}_f \end{aligned}$$

Saddle loading of 248,579.33 lb_f is $\leq F_b$; satisfactory.

Primary bending + axial stress in the saddle due to end loads (assumes one saddle slotted)

$$\begin{aligned} \sigma_b &= V * (H_s - x_o) * y / I + Q / A \\ &= 64,109.62 * (60 - 45.0647) * 7.6912 / 782.39 + 247,535.33 / 82.085 \\ &= 12,428 \text{ psi} \end{aligned}$$

The primary bending + axial stress in the saddle $\leq 20,000 \text{ psi}$; satisfactory.

Secondary bending + axial stress in the saddle due to end loads (includes thermal expansion, assumes one saddle slotted)

$$\begin{aligned} \sigma_b &= V * (H_s - x_o) * y / I + Q / A \\ &= 141,788.17 * (60 - 45.0647) * 7.6912 / 782.39 + 247,535.33 / 82.085 \end{aligned}$$

2491-Cal_r0

1/5/2017

= 23,833 psi

The secondary bending + axial stress in the saddle $< 2 \cdot S_y = 76,000$ psi; satisfactory.

Saddle base plate thickness check (Roark sixth edition, Table 26, case 7a)

where $a = 19.3$, $b = 13.5$ in

$$\begin{aligned} t_b &= (\beta_1 \cdot q \cdot b^2 / (1.5 \cdot S_a))^{0.5} \\ &= (1.1952 \cdot 181 \cdot 13.5^2 / (1.5 \cdot 20,000))^{0.5} \\ &= 1.147 \text{ in} \end{aligned}$$

The base plate thickness of 1.25 in is adequate.

Foundation bearing check

$$\begin{aligned} S_f &= Q_{\max} / (F \cdot E) \\ &= 248,579.33 / (14 \cdot 98) \\ &= 181 \text{ psi} \end{aligned}$$

Concrete bearing stress $\leq 1,350$ psi ; satisfactory.

Seismic Code

Seismic calculations are reported in the saddle report.

Wind Code

Building Code: ASCE 7-10	
Elevation of base above grade	0.00 ft
Increase effective outer diameter by	2.00 ft
Wind Force Coefficient, Cf	0.8000
Risk Category (Table 1.5-1)	III
Basic Wind Speed, V	120.0000 mph
Exposure category	C
Wind Directionality Factor, Kd	0.9500
Topographic Factor, Kzt	1.1500
Enforce minimum design load of 16 psf per ASCE 29.8:	Yes

Wind Pressure (WP) Calculations

$$\begin{aligned}
 K_z &= 2.01 * (Z/z_g)^{2/\alpha} \\
 &= 2.01 * (15.00 / 900.00)^{0.2105} \\
 &= 0.8489
 \end{aligned}$$

$$\begin{aligned}
 q_z &= 0.00256 * K_z * K_{zt} * K_d * V^2 \\
 &= 0.00256 * 0.8489 * 1.1500 * 0.9500 * 120.0000^2 \\
 &= 34.1879 \text{ psf}
 \end{aligned}$$

$$\begin{aligned}
 q_z &= 0.6 * \max (34.1879, 16.0000) \\
 &= 20.5127 \text{ psf}
 \end{aligned}$$

Note: The 0.6 factor is the wind load combination factor from Section 2.4.1.

Table Lookup Values	
$\alpha = 9.5000$, $z_g = 900.00$ ft	[Table 26.9-1, page 256]

Shear calculations are reported in the saddle report.

Vertical Load #1

ASME Section VIII Division 1, 2015 Edition	
Inputs	
Load Orientation	Vertical Load
Position from datum	392.5"
Direction Angle	0.00°
Magnitude of Force	1 lb
Loading Conditions	
Present When Operating	Yes
Included in Vessel Lift Weight	Yes
Present When Vessel is Empty	Yes
Present During Test	Yes



Manufacturing Data Book

Section 4

Inspection Reports

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136

P.O. Number: 4500754186

Project: J447XX

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039

BWFS
INSPECTION CHECKLIST
(Standard Design)

S/O No 2491-17-C Design Pressure 400 PSIG Design Temp 200 °F

Dwg No 2491 Rev No 3 Calcs Reviewed by * CS 5-8-17
(AI Initial & Date)

Shell Thickness 1.1875" Shell Material SA-516-70N

OD/ID x Length 109.346" O.D. X 65'-5" SEAM/SEAM

Head Thickness 1.00" Head Material SA-516-70N Head Shape 2:1

Heat Treat Required Yes No X
Magnetic Particle Examination Required Yes No X
Liquid Penetrant Examination Required Yes No X

MT or PT by N/A Date N/A Results N/A

Serial No.	Nat'l Bd No.	Head Heat No.	Shell Heat No.	Welder Stamp	Radiographics - No. of Film & Results	
2491	14730	11357412	7500117 7500117	5C	RT-2	
		11357411	7500117 7500375	5A	NO. OF FILM: 110	
INTERNAL INSPECTION		DATE	7500117	4U 42	RESULTS: ACCEPTABLE	
JBT		4/15/2017		1X		
		QC	DATE	AI	DATE	
MTRS for above material reviewed			5-8-17	CS	5-8-17	
Fit Up (Head to Shell, Long Seam)		JBT / JBT	3-31-17 / 4-5-17	L	L	
Weld Seam Reinforcement		JBT	4-19-17	L	L	
Fillet Weld Size		JBT	4-19-17	L	L	
Manway Davit Arm (s) Assembly		JBT	4-13-17			
* Hydrostatic Test 523PSIG		JMZ	5/8/17	CS	5-8-17	
Actual Test Pressure 540 PSIG		JMZ	5/8/17	L	L	
Nameplate(s) Checked		JMZ S.R.	5/8/17 5/8/17	CS	L	
*Manufacturer's Data Report U-1A		JMZ	5/8/17	CS	L	

"AI" HOLD POINTS*

All Comments: (List any rework required or specific inspection points for the above vessel(s).)

Use back of sheet if necessary.

Repads: N-A N-C N-B N-H N-D1 N-D2 N-J

Checked hold on nozzles after welding has been completed.

JBT- 5/1/17

[Handwritten signature]

BWFS

INSPECTION CHECKLIST

JOB # 2491 ASSIGNED AI _____
 DATE 5/5/17 ALTERNATE AI _____
 ITEM # 2491 SERIAL # 2491
 DWG # 2491 REV # 4 NB # 14730

NOTE: Do not initial a line until inspection indicated is complete.

DESIGN REQUIREMENTS

MAWP 400 @ 200 °F MDMT -20 °F 400 PSI EXT _____
 DESIGN FOR SPEC. SERVICE (L, UP, LT) YES _____ NO 3 I.T. REQ'D YES _____ NO _____
 CALCS & DWGS REVIEWED BY AI _____ DATE 5-8-17
 SIZE: OD / ID 109.346" O.D. OAL: 65'-5" NO. COURSES 6
 QUESTIONS _____

MATERIAL INSPECTION

REVIEWED BY:	QC	DATE	AI	DATE
MILL TEST REPORTS	<u>JMZ</u>	<u>5-8-17</u>		
PLATE: SPEC, GRADE & THICKNESS <u>SA-516-70N</u>	<u>JMZ</u>	<u>3-3-17</u>	<u>3</u>	<u>5-8-17</u>
SURFACE & EDGE CONDITION	<u>JMZ</u>	<u>3-3-17</u>		
PIPE: SPEC, GRADE & THICKNESS	<u>JMZ</u>	<u>3-15-17</u>		
SURFACE & EDGE CONDITION	<u>JMZ</u>	<u>3-15-17</u>		
HEADS: SPEC, GRADE & THICKNESS <u>SA-516-70N</u>	<u>JMZ</u>	<u>3-1-17</u>		
SURFACE CONDITION & SHAPE	<u>JMZ</u>	<u>3-1-17</u>		
UCS-79(d) REQUIREMENTS MET	<u>JMZ</u>	<u>3-1-17</u>		
REINFORCING PADS: SPEC <u>SA-516-70</u>	<u>JMZ</u>	<u>2-28-17</u>		
SIZE <u>SA-516-70</u>	<u>JMZ</u>	<u>2-28-17</u>		
THICKNESS	<u>JMZ</u>	<u>2-28-17</u>		
FLANGES: SPECIFICATIONS <u>SA-105</u>	<u>JMZ</u>	<u>3-16-17</u>		
RATING	<u>JMZ</u>	<u>3-16-17</u>		
BORE	<u>JMZ</u>	<u>3-16-17</u>	<u>2</u>	<u>5-8-17</u>
S/O FLANGE GAP	<u>N/A</u>	<u>N/A</u>	<u>3</u>	

FABRICATION INSPECTION

CHECKED BY:	QC	DATE	AI	DATE
SHELL SIZE (To Match Heads) <u>109.346" O.D.</u>	<u>JBT</u>	<u>3-31/4-5-17</u>	<u>3</u>	<u>5-8-17</u>
SHELL & HEAD BEVELS	<u>JBT</u>	<u>5</u>		
OUT OF ROUNDNESS	<u>JBT</u>			
EDGE OFFSET LONG & GIRTH SEAMS	<u>JBT</u>	<u>3-31/4-5-17</u>		
QUALIFIED WELD PROC- WELDERS- WELD ID	<u>JMZ</u>	<u>1-17-17</u>		
CAT. A <u>X</u> B <u>X</u> C <u> </u> D <u>X</u> WELD REINF & SIZE	<u>JMZ</u>	<u>5</u>		
PWHT REQUIRED: YES _____ NO <u>X</u>	<u>JMZ</u>		<u>2</u>	<u>5-8-17</u>
PT OR MT REQUIRED: YES _____ NO <u>X</u>	<u>JMZ</u>	<u>1-17-17</u>	<u>3</u>	
EXTENT OF RADIOGRAPHY: (NONE, RT-1, -2, -3, -4) NO. OF FILM <u>110</u>				
RT INTERPRETATION BY: <u>DIAMOND & INSPECTION</u>		<u>4-19-17</u>	<u>3</u>	<u>5-8-17</u>
ALL FILM REVIEWED & ACCEPTED BY: <u>JMZ/JBT</u>		<u>4-19-17</u>		
HYDROTEST (PSI) <u>540</u> WITNESSED BY: <u>JMZ</u>		<u>5/8/17</u>	<u>1</u>	
NAMEPLATE(S) CHECKED BY: <u>JMZ</u>		<u>5/8/17</u>	<u>3</u>	<u>5-8-17</u>
DATA REPORT CHECKED BY: <u>JMZ</u>		<u>5/6/17</u>		

NOTE: AI "HOLD" OR "INSPECTION POINTS" TO BE INDICATED BY NUMBER HERE:

IF ONLY PARTIAL INSPECTION IS PERFORMED, LIST ITEM NUMBER(S), DATE & INITIAL:



Manufacturing Data Book

Section 5

NDE X-Ray Reader Sheets

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136

P.O. Number: 4500754186

Project: J447XX

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039



11050 W. Little York Road, Bldg. G
Houston, Texas 77041
Office: 713-937-8168
Fax: 713-937-8198

105099

RADIOGRAPHIC REPORT

DATE 3-6-17 DAY Mon

CUSTOMER <u>BWFS</u>		PROJECT		CLIENT P.O. NO.					
SHOP OR JOB NO. <u>2491</u>		HEAT NO.		DESCRIPTION		S/N <u>L2, L3</u>			
TECHNIQUE <u>B</u>	CURIES / KV <u>88</u>	FOCAL SPOT SIZE <u>.184</u>	SOURCE <u>12.192</u>	MAT. TYPE <u>C/S</u>	MAT. THICKNESS <u>1.1875</u>	WELD THICKNESS <u>1.3125</u>	WELD REINFORCEMENT <u>.125</u>	SOURCE TO OBJECT <u>18</u>	S.S. OBJECT TO FILM <u>18.8125</u>
SOURCE TO FILM DISTANCE <u>20</u>		SCREEN TYPE & SIZE <u>Pb FR. .005 BK. .005</u>		FILM PER CASSETTE <u>1</u>		FILM BRAND & TYPE <u>Agfa D5</u>		SIZE FILM <u>10"</u>	
RADIOGRAPHIC PROCEDURE <u>DG 12.000 R9</u>		ACCEPTANCE STANDARD <u>SEC VIII</u>		NO. OF EXP. <u>18</u>		NO. OF WELDS <u>2</u>		EXPOSURE: DBL. WALL <u>(17)</u> OTHER <u>S. WALL</u>	
HRS. WORKED		TRAVEL TIME		MILEAGE		PERDIEM		VIEWING: DBL. WALL <u>(17)</u> S. WALL	
ARRIVE	LEAVE	TOTAL	TO	FROM	TOTAL	OFFICE USE ONLY			
DEFECT CODE AD - ACCUM. DISCONTINUITIES AB - ARC BURN BT - BURN THROUGH CH - CHILLS CS - COLD SHUTS CON - CONCAVITY CRACK - CRACK HT - HOT TEAR IF - INADEQUATE FUSION IP - INADEQUATE PENETRATION PIN - PINHOLE POR - POROSITY SI - SAND INCLUSION SLI - SLAG INCLUSION SLL - SLAG LINE UCE - UNDERCUT EXTERNAL UCI - UNDERCUT INTERNAL O - OTHER									

WELD NO.	LOCATION	SIZE & THICKNESS	ACCEPT YES NO	PENT	SFD	DEFECT TYPE/SIZE	WELDER	COMMENTS	
L2	1	2	109/1.505		1B 20		44		
	2	3							TECHNIQUE - A
	3	4							
	4	5							TECHNIQUE - B
	5	6							
	6	7							TECHNIQUE - C
	7	8							
	8	9							TECHNIQUE - D
	9	10							
L3	1	2							TECHNIQUE - E
	2	3							
	3	4							TECHNIQUE - F
	4	5							
	5	6							TECHNIQUE - G
	6	7							
	7	8							
	8	9							
	9	10							

TECHNICIAN <u>Ryan S</u>	LEVEL <u>4</u>	ASST. <u>Travis M</u>	LEVEL <u>1</u>
CLIENT REPRESENTATIVE <u>[Signature]</u>	DATE <u>3/6/17</u>	ASST.	LEVEL

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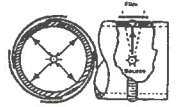
11050 W. Little York Road, Bldg. G
Houston, Texas 77041
Office: 713-937-8168
Fax: 713-937-8198

105114

RADIOGRAPHIC REPORT

DATE 3-8-17 DAY Wed

CUSTOMER <u>BWFS</u>			PROJECT			CLIENT P.O. NO.				
SHOP OR JOB NO. <u>2491</u>			HEAT NO.			DESCRIPTION			S/N <u>L1, L4</u>	
TECHNIQUE <u>B</u>	CURIES / KV <u>86</u>	FOCAL SPOT SIZE <u>.184</u>	SOURCE <u>IR-192</u>	MAT. TYPE <u>C/S</u>	MAT. THICKNESS <u>1.1875</u>	WELD THICKNESS <u>1.3125</u>	WELD REINFORCEMENT <u>.125</u>	SOURCE TO OBJECT <u>18.6875</u>	S.S. OBJECT TO FILM <u>18.8125</u>	
SOURCE TO FILM DISTANCE <u>20</u>		SCREEN TYPE & SIZE Pb FR. <u>.005</u> BK. <u>.005</u>		FILM PER CASSETTE <u>1</u>	FILM BRAND & TYPE <u>Agfa D5</u>		SIZE FILM <u>10"</u> <u>(17")</u> OTHER			
RADIOGRAPHIC PROCEDURE <u>DBIR-0001 R-9</u>		ACCEPTANCE STANDARD <u>SEC VIII</u>		NO. OF EXP. <u>18</u>		NO. OF WELDS <u>2</u>		EXPOSURE: DBL. WALL <u>S. WALL</u> VIEWING: DBL. WALL <u>S. WALL</u>		
HRS. WORKED		TRAVEL TIME		MILEAGE		PERDIEM				
ARRIVE	LEAVE	TOTAL	TO	FROM	TOTAL	☐ YES ☒ NO				
DEFECT CODE AD - ACCUM. DISCONTINUITIES CRACK - CRACK SI - SAND INCLUSION AB - ARC BURN HT - HOT TEAR SLI - SLAG INCLUSION BT - BURN THROUGH IF - INADEQUATE FUSION SLL - SLAG LINE CH - CHILLS IP - INADEQUATE PENETRATION UCE - UNDERCUT EXTERNAL CS - COLD SHUTS PIN - PINHOLE UCI - UNDERCUT INTERNAL CON - CONCAVITY POR - POROSITY O - OTHER									OFFICE USE ONLY	

WELD NO.	LOCATION	SIZE & THICKNESS	ACCEPT YES	NO	PENT	SFD	DEFECT TYPE/SIZE	WELDER	COMMENTS	
<u>L1</u>	<u>1</u>	<u>2</u>	<u>109</u>	<u>1.1875</u>	<u>18</u>	<u>20</u>		<u>42,44</u>		
	<u>2</u>	<u>3</u>								
	<u>3</u>	<u>4</u>								
	<u>4</u>	<u>5</u>								
	<u>5</u>	<u>6</u>								
	<u>6</u>	<u>7</u>								
	<u>7</u>	<u>8</u>								
	<u>8</u>	<u>9</u>								
	<u>9</u>	<u>10</u>								
<u>L4</u>	<u>1</u>	<u>2</u>								
	<u>2</u>	<u>3</u>								
	<u>3</u>	<u>4</u>								
	<u>4</u>	<u>5</u>								
	<u>5</u>	<u>6</u>								
	<u>6</u>	<u>7</u>								
	<u>7</u>	<u>8</u>								
	<u>8</u>	<u>9</u>								
	<u>9</u>	<u>10</u>								

TECHNICIAN <u>Ryan-S</u>	LEVEL <u>II</u>	ASST. <u>Travis-M</u>	LEVEL <u>I</u>
CLIENT REPRESENTATIVE <u>John TUSSELL</u>	DATE <u>3-8-17</u>	ASST.	LEVEL

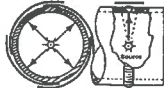
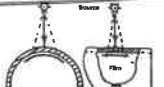
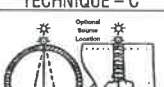
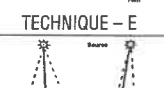
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DAILY RADIOGRAPHIC REPORT

RADIOGRAPHIC REPORT

DATE 3-28-17 DAY Thu

CUSTOMER BWFS				PROJECT				CLIENT P.O. NO.											
SHOP OR JOB NO. 2491				HEAT NO.				DESCRIPTION				S/N C2-C6							
TECHNIQUE B		CURIES / KV 116		FOCAL SPOT SIZE 1/84		SOURCE 1R-192		MAT. TYPE C/S		MAT. THICKNESS 1.1875		WELD THICKNESS 1.3125		WELD REINFORCEMENT .125		SOURCE TO OBJECT 18.6575		S.S. OBJECT TO FILM 18.8125	
SOURCE TO FILM DISTANCE 20				SCREEN TYPE & SIZE Pb FR. .005 BK. .005				FILM PER CASSETTE 1		FILM BRAND & TYPE Agfa D25				SIZE FILM 10" 17 OTHER					
RADIOGRAPHIC PROCEDURE DGIR-0001 R-9				ACCEPTANCE STANDARD SEC III				NO. OF EXP. 5		NO. OF WELDS 5				EXPOSURE: DBL. WALL VIEWING: DBL. WALL					
HRS. WORKED				TRAVEL TIME				MILEAGE				PER DIEM							
ARRIVE				LEAVE				TOTAL				TO							
FROM				TOTAL				OFFICE USE ONLY				30 min standby B-							
DEFECT CODE AD - ACCUM. DISCONTINUITIES AB - ARC BURN BT - BURN THROUGH CH - CHILLS CS - COLD SHUTS CON - CONCAVITY CRACK - CRACK HT - HOT TEAR IF - INADEQUATE FUSION IP - INADEQUATE PENETRATION PIN - PINHOLE POR - POROSITY SI - SAND INCLUSION SLI - SLAG INCLUSION SLL - SLAG LINE UCE - UNDERCUT EXTERNAL UC! - UNDERCUT INTERNAL O - OTHER																			

WELD NO.	LOCATION	SIZE & THICKNESS	ACCEPT		PENT	SFD	DEFECT TYPE/SIZE	WELDER	COMMENTS	
			YES	NO						
C2	1	2 109/1.1875	/		13	20		44,42		 TECHNIQUE - A
C3	1	2	/		1	1		1		 TECHNIQUE - B
C4	1	2	/		1	1		1		 TECHNIQUE - C
C5	1	2	/		1	1		1		 TECHNIQUE - D
C6	1	2	/		1	1		1		 TECHNIQUE - E
										 TECHNIQUE - F
										 TECHNIQUE - G

TECHNICIAN	LEVEL	ASST.	LEVEL
Ryan. J	II	Travis. M	I
CLIENT REPRESENTATIVE	DATE	ASST.	LEVEL
John Trussell	3.28.17		



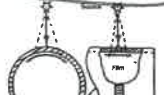
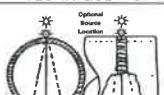
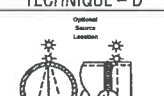
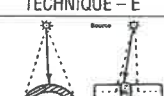
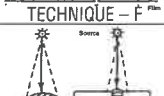
11050 W. Little York Road, Bldg. G
Houston, Texas 77041
Office: 713-937-8168
Fax: 713-937-8198

106236

RADIOGRAPHIC REPORT

DATE 3-28-17 DAY Tue

CUSTOMER BWFS			PROJECT			CLIENT P.O. NO.					
SHOP OR JOB NO. 2491			HEAT NO.			DESCRIPTION			S/N N-E C1		
TECHNIQUE B	CURIES / KV 116	FOCAL SPOT SIZE .184	SOURCE 1R-192	MAT. TYPE C/S	MAT. THICKNESS .500	WELD THICKNESS .625	WELD REINFORCEMENT .125	SOURCE TO OBJECT 8.375	S.S. OBJECT TO FILM 8.5		
SOURCE TO FILM DISTANCE 9		SCREEN TYPE & SIZE Pb FR. .005 BK. .005		FILM PER CASSETTE 1	FILM BRAND & TYPE Agfa DS		SIZE FILM 10" 17"		OTHER		
RADIOGRAPHIC PROCEDURE DGIR-0001 R-9 SEC VIII			ACCEPTANCE STANDARD			NO. OF EXP. 1		NO. OF WELDS 1		EXPOSURE: DBL. WALL ☒ S. WALL ☒	
HRS. WORKED			TRAVEL TIME			MILEAGE			PERDIEM		
ARRIVE			LEAVE			TOTAL			TO FROM TOTAL		
DEFECT CODE AD - ACCUM. DISCONTINUITIES CRACK - CRACK SI - SAND INCLUSION AB - ARC BURN HT - HOT TEAR SLI - SLAG INCLUSION BT - BURN THROUGH IF - INADEQUATE FUSION SLL - SLAG LINE CH - CHILLS IP - INADEQUATE PENETRATION UCE - UNDERCUT EXTERNAL CS - COLD SHUTS PIN - PINHOLE UCI - UNDERCUT INTERNAL CON - CONCAVITY POR - POROSITY O - OTHER									OFFICE USE ONLY		

WELD NO.	LOCATION	SIZE & THICKNESS	ACCEPT YES NO	PENT	SFD	DEFECT TYPE/SIZE	WELDER	COMMENTS	
N-1	1	2 18/.500	/	1B	9		1X		
									TECHNIQUE - A
									
									TECHNIQUE - B
									
									TECHNIQUE - C
									
									TECHNIQUE - D
									
									TECHNIQUE - E
									
									TECHNIQUE - F
									
									TECHNIQUE - G

TECHNICIAN Ryan J	LEVEL II	ASST. Travis M	LEVEL I
CLIENT REPRESENTATIVE John Russell	DATE 3-28-17	ASST.	LEVEL

SIGNATURE CERTIFIES TIME & MATERIAL CORRECT

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RADIOGRAPHY PRODUCES TWO DIMENSIONAL IMAGES ONLY AND CANNOT TELL DEPTH
DAILY RADIOGRAPHIC REPORT



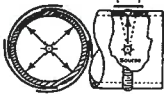
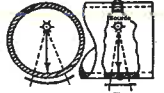
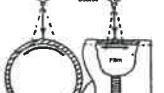
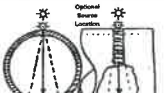
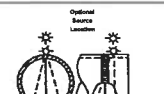
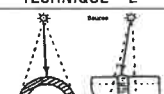
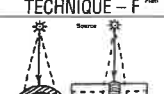
11050 W. Little York Road, Bldg. G
Houston, Texas 77041
Office: 713-937-8168
Fax: 713-937-8198

107150

RADIOGRAPHIC REPORT

DATE 4-17-17 DAY Mon

CUSTOMER <u>BWFS</u>		PROJECT		CLIENT P.O. NO.					
SHOP OR JOB NO. <u>2491</u>		HEAT NO.		DESCRIPTION		S/N <u>C1</u>			
TECHNIQUE <u>A</u>	CURIES /KV <u>128</u>	FOCAL SPOT SIZE <u>.184</u>	SOURCE <u>12.192</u>	MAT. TYPE <u>C/S</u>	MAT. THICKNESS <u>1"</u>	WELD THICKNESS <u>1.125</u>	WELD REINFORCEMENT <u>.125</u>	SOURCE TO OBJECT <u>53.125</u>	S.S. OBJECT TO FILM <u>53.5</u>
SOURCE TO FILM DISTANCE <u>54.5</u>		SCREEN TYPE & SIZE <u>Pb FR. .005</u> BK. <u>.005</u>		FILM PER CASSETTE <u>1</u>	FILM BRAND & TYPE <u>A3fc DS</u>		SIZE FILM <u>10"</u> <u>(17")</u> OTHER		
RADIOGRAPHIC PROCEDURE <u>DGIR-0001 R-9</u>		ACCEPTANCE STANDARD <u>SEC - III</u>		NO. OF EXP. <u>1</u>		NO. OF WELDS <u>1</u>		EXPOSURE: DBL. WALL <u>S. WALL</u>	
HRS. WORKED <u>1.9</u>		TRAVEL TIME TO FROM TOTAL		MILEAGE		PERDIEM		VIEWING: DBL. WALL <u>S. WALL</u>	
ARRIVE	LEAVE	TOTAL					OFFICE USE ONLY		
DEFECT CODE AD - ACCUM. DISCONTINUITIES AB - ARC BURN BT - BURN THROUGH CH - CHILLS CS - COLD SHUTS CON - CONCAVITY CRACK - CRACK HT - HOT TEAR IF - INADEQUATE FUSION IP - INADEQUATE PENETRATION PIN - PINHOLE POR - POROSITY SI - SAND INCLUSION SLI - SLAG INCLUSION SLL - SLAG LINE UCE - UNDERCUT EXTERNAL UCI - UNDERCUT INTERNAL O - OTHER									

WELD NO.	LOCATION	SIZE & THICKNESS	ACCEPT YES NO	PENT	SFD	DEFECT TYPE/SIZE	WELDER	COMMENTS	
C1	1	2 109 1"	/		13 54.5		02 42,44		
	2	3	/						TECHNIQUE - A
	3	4	/						
	4	5	/						TECHNIQUE - B
	5	6	/						
	6	7	/						TECHNIQUE - C
	7	8	/						
	8	9	/						TECHNIQUE - D
	9	10	/						
	10	11	/						TECHNIQUE - E
	11	12	/						
	12	13	/						TECHNIQUE - F
	13	14	/						
	14	15	/						TECHNIQUE - G
	15	16	/						
	16	17	/						
	17	18	/						
	18	19	/						
	19	20	/						
	20	21	/						
	21	22	/						
	22	23	/						
	23	24	/						
	24	25	/						
	25	1	/						

TECHNICIAN R/GA-5

CLIENT REPRESENTATIVE John Trussell

SIGNATURE CERTIFIES TIME & MATERIAL CORRECT

LEVEL II

DATE 4-17-17

ASST. Travis M

LEVEL I



11050 W. Little York Road, Bldg. G
Houston, Texas 77041
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Fax: 713-937-8198

107159

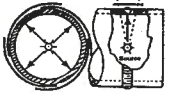
RADIOGRAPHIC REPORT

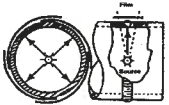
DATE 4-19-17 DAY Wed

CUSTOMER <u>BWFS</u>				PROJECT				CLIENT P.O. NO.					
SHOP OR JOB NO. <u>2491</u>				HEAT NO.				DESCRIPTION				S/N <u>C7</u>	
TECHNIQUE <u>A</u>	CURIES / KV <u>126</u>	FOCAL SPOT SIZE <u>.184</u>	SOURCE <u>1R-192</u>	MAT. TYPE <u>C/S</u>	MAT. THICKNESS <u>1"</u>	WELD THICKNESS <u>1.125</u>	WELD REINFORCEMENT <u>.125</u>	SOURCE TO OBJECT <u>53.375</u>	S.S. OBJECT TO FILM <u>53.5</u>				
SOURCE TO FILM DISTANCE <u>54.5</u>		SCREEN TYPE & SIZE <u>Pb FR. .005</u>		FILM PER CASSETTE <u>1</u>		FILM BRAND & TYPE <u>Agfa D5</u>		SIZE FILM <u>10"</u>		OTHER			
RADIOGRAPHIC PROCEDURE <u>DBIR-001 R9</u>		ACCEPTANCE STANDARD <u>SEC</u>		NO. OF EXP. <u>1</u>		NO. OF WELDS <u>1</u>		EXPOSURE: DBL. WALL <u>S. WALL</u>		VIEWING: DBL. WALL <u>S. WALL</u>			
HRS. WORKED		ARRIVE		LEAVE		TOTAL		TRAVEL TIME TO		FROM			
TOTAL		MILEAGE		PERDIEM		OFFICE USE ONLY		YES		NO			

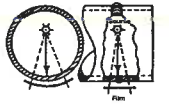
DEFECT CODE

AD - ACCUM. DISCONTINUITIES	CRACK - CRACK	SI - SAND INCLUSION
AB - ARC BURN	HT - HOT TEAR	SLI - SLAG INCLUSION
BT - BURN THROUGH	IF - INADEQUATE FUSION	SLL - SLAG LINE
CH - CHILLS	IP - INADEQUATE PENETRATION	UCE - UNDERCUT EXTERNAL
CS - COLD SHUTS	PIN - PINHOLE	UCI - UNDERCUT INTERNAL
CON - CONCAVITY	POR - POROSITY	O - OTHER

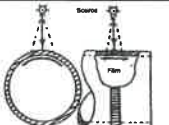
WELD NO.	LOCATION	SIZE & THICKNESS	ACCEPT		PENT	SFD	DEFECT TYPE/SIZE	WELDER	COMMENTS	
			YES	NO						
C7	1	2	109/1"	/		1B	54.5	42,44		
	2	3		/						
	3	4		/						
	4	5		/						
	5	6		/						
	6	7		/						
	7	8		/						
	8	9		/						
	9	10		/						
	10	11		/						
	11	12		/						
	12	13		/						
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	19	20		/						
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	24	25		/						
	25	1		/						



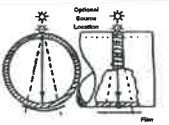
TECHNIQUE - A



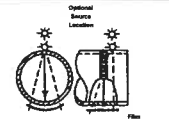
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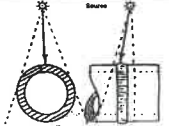
TECHNIQUE - C



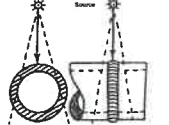
TECHNIQUE - D



TECHNIQUE - E



TECHNIQUE - F



TECHNIQUE - G

TECHNICIAN <u>Alan S</u>	LEVEL <u>II</u>	ASST. <u>Travis M</u>	LEVEL <u>F</u>
CLIENT REPRESENTATIVE <u>John Trussell</u>	DATE <u>4-19-17</u>	ASST.	LEVEL

SIGNATURE CERTIFIES TIME & MATERIAL CORRECT

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DAILY RADIOGRAPHIC REPORT



Manufacturing Data Book

Section 6

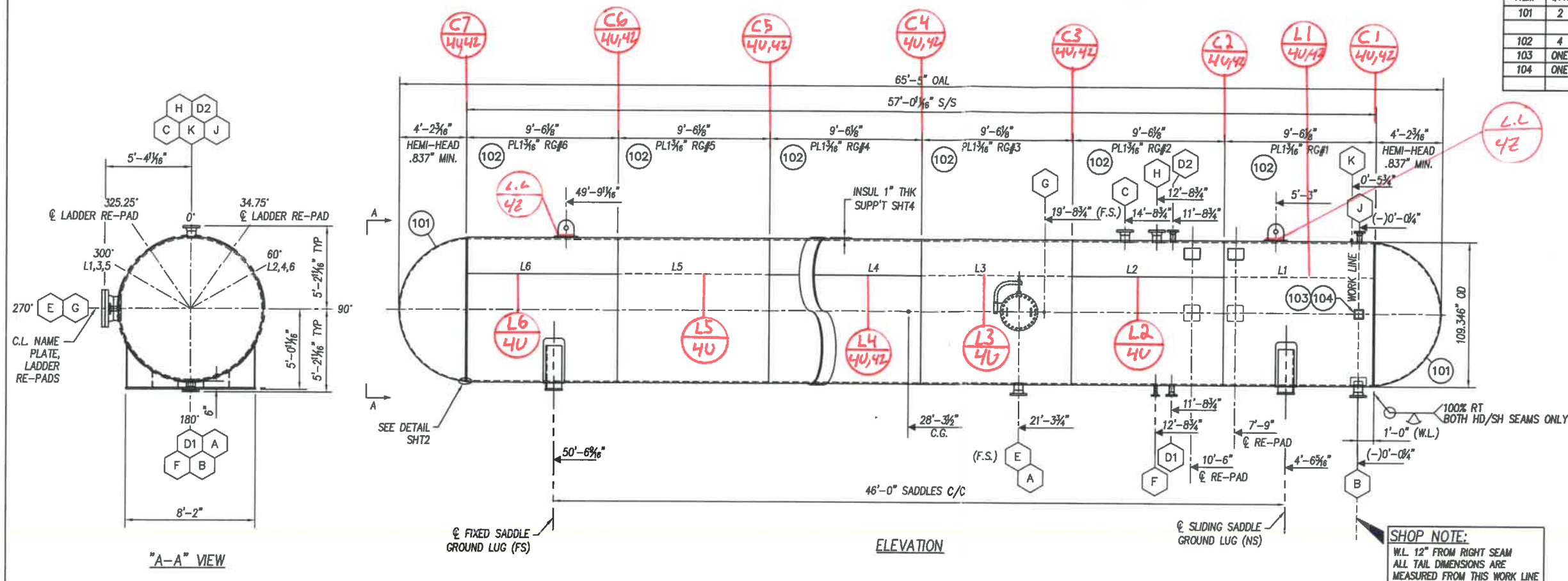
Weld Map/ Welder Log

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136

P.O. Number: 4500754186

Project: J447XX

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039



BILL OF MATERIALS				
ITEM	QTY.	DESCRIPTION	MATERIAL SPEC.	
101	2	1" NOM. (.837" MIN.) x 109" O.D. ASME CODE HEM-HEAD WITH 4" CUT BACK (HEM-HEAD I.S.R. 53.661")	SA-516-70N	
102	4	PL 1 1/4" R&W TO 109.346" O.D. x 9'-6 1/2" LG RG#1~RG#6	SA-516-70N	
103	ONE	BWFS STANDARD NAME PLATE, 6" x 6"	S.S.	
104	ONE	BWFS STANDARD N. PL. BRACKET, 7" x 7"	SA-36	

DESIGN DATA				
CONSTRUCTION IN ACCORDANCE WITH 2015 EDITION OF A.S.M.E. CODE SECTION VIII, DIVISION 1				
CODE STAMP	IS	REQ'D	NAT'L BOARD	YES
DESIGN PRESSURE (INT.)	400	P.S.I.G.	TEMP	200 °F
DESIGN PRESSURE (EXT.)	N/A	P.S.I.G.	TEMP	N/A °F
M.A.P.(N. & C.)	-	P.S.I.G.	LIMITED BY	-
M.A.W.P.(H. & C.)	-	P.S.I.G.	LIMITED BY	-
HYDROSTATIC TEST	523	P.S.I.G.	(1.3 TIMES M.A.W.P.)	
CORROSION ALLOW. SHELL	1/16"	HEADS	1/16" NOZZ.	1/16"
RADIOGRAPH	RT-2	P.W.H.T.	N/A	MFG. SER # 2491
RADIOGRAPH LONG SEAMS	FULL	CIRCUM. SEAM	UW-11(a)(5)(b) (NOTE#5)	
JOINT EFF. HEADS	100%	SHELL	100%	
MIN. DESIGN METAL TEMP.	-20	°F		
CHARPY IMPACT TEST NOT REQUIRED PER	UCS-66			
INSPECTED BY	ONECIS INSURANCE			
WEIGHT EMPTY	93,695	LBS.	FULL OF WATER	336,890 LBS.
*INCLUDES INSULATION WEIGHT				
MATERIAL				
SHELL	SA-516 70N	FLANGES	SA-105	
HEADS	SA-516 70N	SADDLES	SA-516 70	
CPLGS	SA-105	INTERNAL	SA-516 70/SA-105B	
STUDS	SA-193-B7 CAD PLD	REINF. PADS	SA-516 70/SA-516 70N	
NUTS	SA-194-2H CAD PLD	NOZZ. NECKS	SA-105/SA-105B	
GASKETS	1/8" THK GASKET, FLEXITALLIC STYLE "CG", SPIRAL WOUND 304 SS, W/ FLEXCARB FILLER			

- GENERAL NOTES:**
- FLANGE BOLT HOLES SHALL STRADDLE CENTERLINES PARALLEL TO VESSEL CENTERLINES UNLESS NOTED OTHERWISE.
 - ALL FLANGES SHALL BE PER ASME B16.5 WITH A 125 - 250 AARH GASKET CONTACT FINISH U.N.O.
 - ALL INSIDE EDGES OF NOZZLE AND CONNECTIONS, WHETHER FLUSH OR EXTENDED, SHALL BE ROUNDED OFF TO A MINIMUM RADIUS OF 1/8".
 - PRESSURE RELIEF DEVICE SHALL BE PROVIDED BY USER PER UG-125 (g).
 - (2) HEAD/SHELL SEAMS NEED 100% RT.

REFERENCE DRAWINGS			
DESCRIPTION	DWG NO.		
NOZZLE DETAILS	2491-2		
SADDLE DETAILS AND MISCELLANEOUS	2491-3		
INSULATION SUPPORT DETAILS	2491-4		

S/D: 2491-17 REQ'D ONE TAG No. V-404

BWFS INDUSTRIES LLC TEL: (281) 590-9391 5637 ETHELHINE HOUSTON, TEXAS

109.346" O.D. x 65'-5" OAL
PRODUCT SURGE TANK
60 MMSCFD CRYO PLANT - UOP RUSSELL PROJECT S447XX
PLAN, ELEVATIONS, NOZZLE SCHEDULE & DESIGN DATA

CUSTOMER: UOP RUSSELL LLC CUSTOMER JOB NO.: V-447

DRWN	S.R.	CHK	C.H.	DATE	01/05/17	DWG. No.	2491
PO No.	4500754186	SHT. No.	1 OF 4				

WELD MAP: JOB# 2491

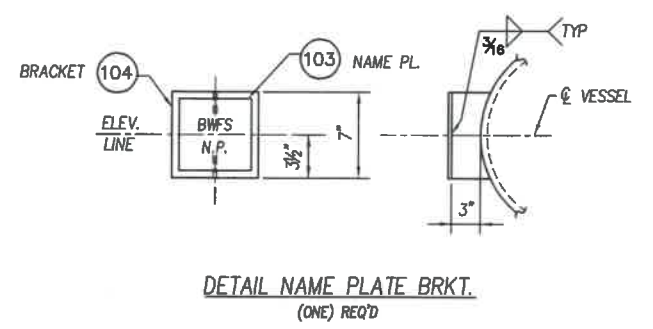
NAME PLATE STAMPING
(ONE) REQ'D

CERTIFIED BY: **BWFS INDUSTRIES LLC**
HOUSTON, TEXAS, USA
TEL (281) 590-9391

M.A.W.P. 400 PSIG AT 200 °F
M.A.E.W.P. - PSIG AT - °F
M.D.M.T. -20 °F AT 400 PSIG
SERIAL NO. 2491 YEAR BUILT 2017

109.346" O.D. x 65'-5" OAL x 1" HEADS x 1 1/4" SHELL
PRODUCT SURGE TANK
CORROSION ALLOWANCE: 1/16"
HYDROTESTED AT 523 PSI ON XX/XX/17

BWFS INDUSTRIES LLC



CERTIFIED FOR CONSTRUCTION
DATE _____
BY (ENGR) _____
BY (QC) _____

EXT. COATING NOTES: (PER TRCO PAINTING SYSTEM 3)

- SURFACE PREP: SSPC-SP6
- PRIMER: SHERWIN-WILLIAMS MACROPOXY 646 FAST CURR EPOXY B58-600, DATA SHEET 4.53. ONE COAT 4.0-6.0 MILS DFT.
- PRIMER INTERMEDIATE COAT: SHERWIN-WILLIAMS MACROPOXY 646 FAST CURE EPOXY B58-600, DATA SHEET 4.53. ONE COAT 4.0-6.0 MILS DFT
- FINISH COAT: SHERWIN-WILLIAMS HI-SOLIDS POLYURETHANE B65 SERIES/B60V30, DATA SHEET 5.21. ONE COAT 3.0-4.0 MILS DFT.

TOTAL SYSTEM: DFT 12.0-16.0 MILS.

K	ONE	0.75"	CPLG	6000#	SEAL FLUSH CONNECTION
J	ONE	3"	RFWN	300#	PUMP SPILLBACK
H	ONE	6"	RFWN	300#	PSV
G	ONE	0.75"	CPLG	6000#	TI
F	ONE	2"	RFWN	300#	DRAIN
E	ONE	18"	RFWN	300#	MANWAY W/ BLIND
D1/D2	2	3"	RFWN	300#	LI
C	ONE	6"	RFWN	300#	EQUALIZATION
B	ONE	6"	RFWN	300#	LIQUID OUTLET, W/ V.B.
A	ONE	6"	RFWN	300#	INLET

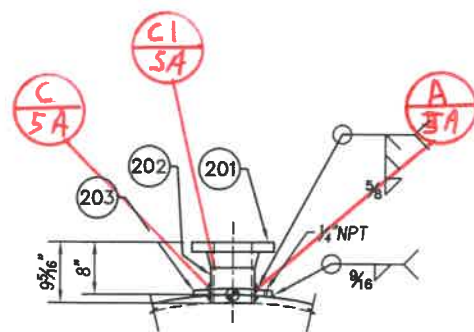
MK. NO.	QUAN.	SIZE	TYPE	RTG.	SERVICE

WELD PROCEDURES
WPS 96-045 REV.2 (GMAW/SAW)
- FOR VESSEL GIRTH & LONG SEAM

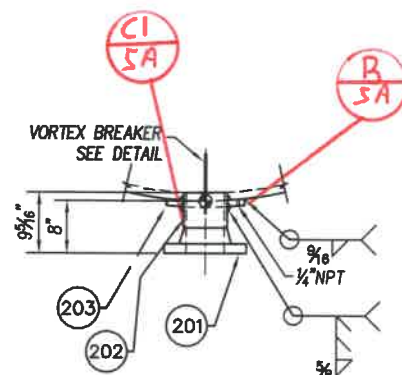
WPS 95-044 REV.2 (GMAW/FCAW/SAW)
- FOR NOZZLES AND MISC.

WELD WIRE
GMAW - 70S-6/2
FCAW - 711
SAW - 860 FLUX L61

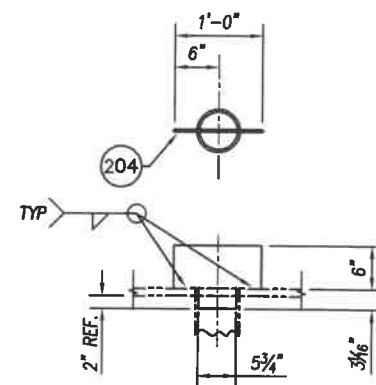
NO.	REVISIONS	BY	DATE
3	ISSUED "AS BUILT"	S.R.	4/17
2	CHG'D SADDLE HEIGHT	S.R.	03/7
1	ADDED PADS; ISSUED FOR CONSTRUCTION	S.R.	02/26
0	ISSUED FOR APPROVAL	S.R.	01/06



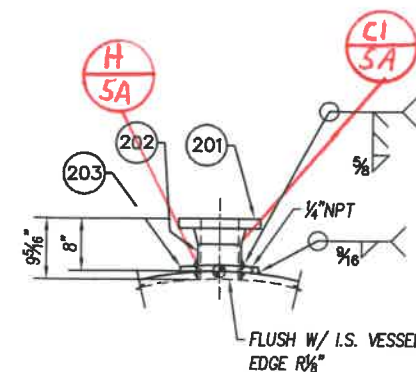
NOZZLE DETAIL - 6" 300# RFWN
(2) REQ'D, MK "A/C"



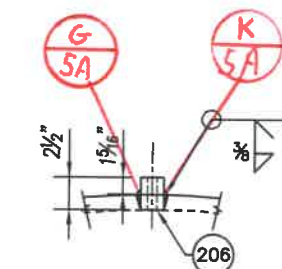
LIQ OUTLET DETAIL - 6" 300# RFWN
(ONE) REQ'D, MK "B"



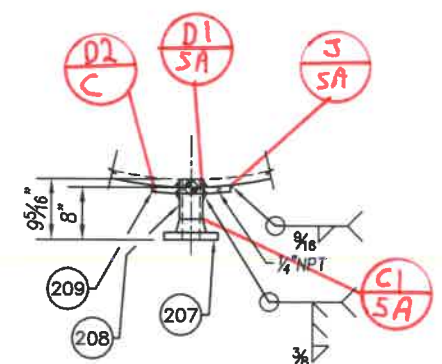
DETAIL - VORTEX BREAKER
(ONE) REQ'D



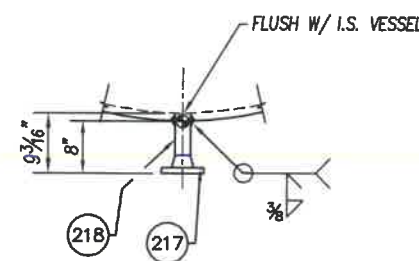
NOZZLE DETAIL - 6" 300# RFWN
(ONE) REQ'D, MK "H"



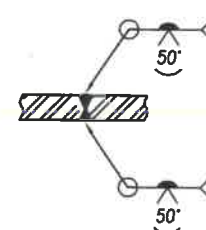
NOZZLE DETAIL
- 0.75" 6000# COUPLING
(2) REQ'D, MK "G/K"
SCALE: 2X



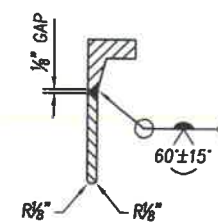
NOZZLE DETAIL - 3" 300# RFWN
(3) REQ'D, MK "D1/D2, J"



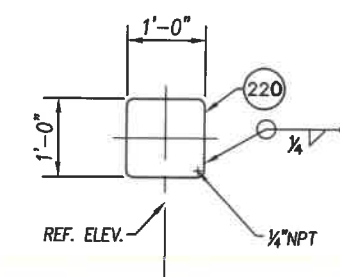
DRAIN DETAIL - 2" 300# RFWN
(ONE) REQ'D, MK "I"



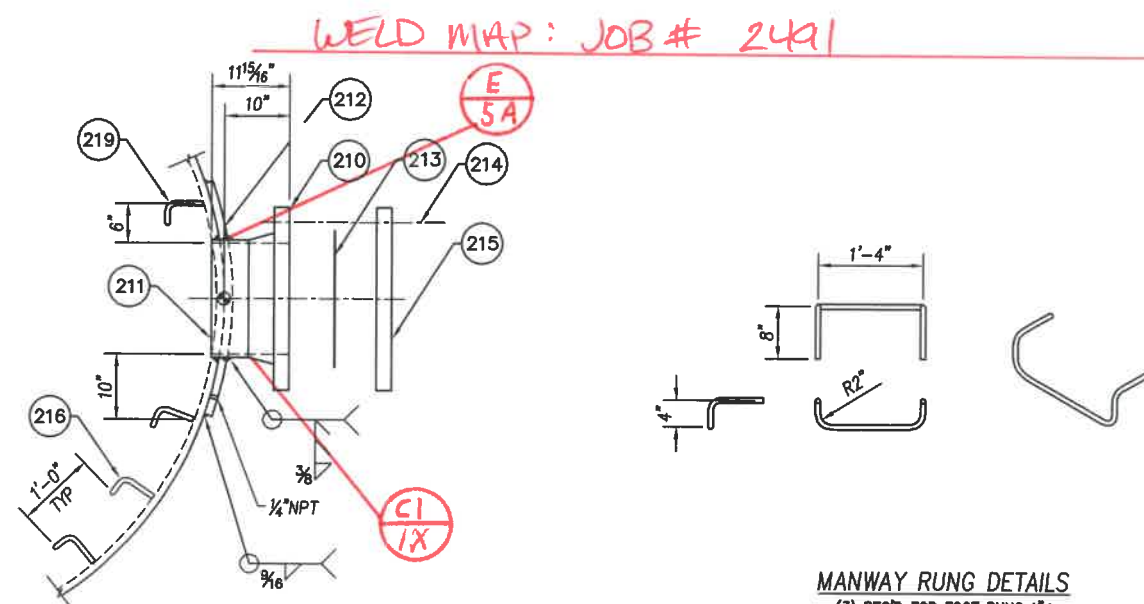
TYPICAL WELD DETAIL
BEVEL LONG OR
CIRCULAR SEAM CAT. A.B



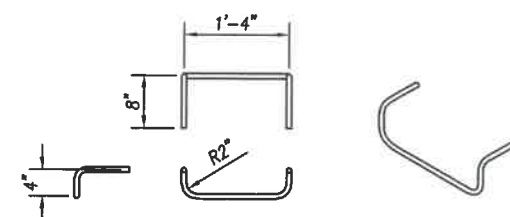
TYPICAL NOZZLE DETAIL



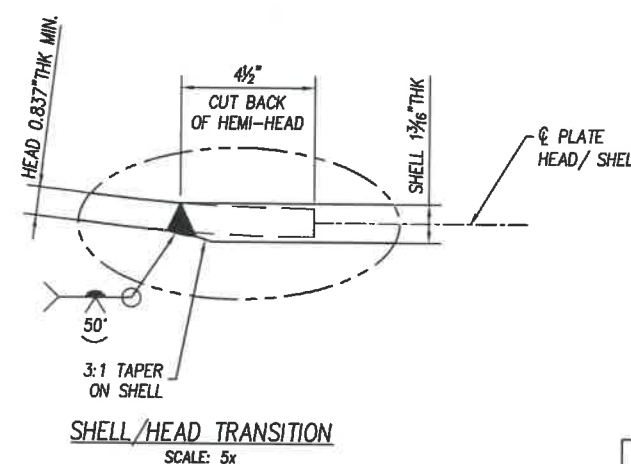
ACCESS LADDER
RE-PAD DETAIL
(6) REQ'D



MANWAY DETAIL - 18" 300# RFWN
(ONE) REQ'D, MK "E"



MANWAY RUNG DETAILS
(3) REQ'D FOR FOOT RUNG 1"
(ONE) REQ'D FOR HAND RUNG 3/4"



SHELL/HEAD TRANSITION
SCALE: 5x

BILL OF MATERIALS				
ITEM	QTY.	DESCRIPTION	MATERIAL SPEC.	
201	4	6" 300# RFWN FLANGE, S/XS BORE, FOR "A/B/C/H"	SA-105	
202	ONE	SMLS PIPE, 6" S/XS, 32" LG	SA-106B	
203	4	PL1", 6 3/4" I.D. x 12 1/2" O.D., REPAD	SA-516 70	
204	ONE	PL 1/4", 6" x 12", VORTEX BREAKER	SA-36	
205	-	-	-	
206	2	3/4" NPT 6000# FULL COUPLING	SA-105	
207	3	3" 300# RFWN FLANGE, S/160 BORE, FOR "D1/D2/J"	SA-105	
208	ONE	SMLS PIPE, 3" S/160, 27" LG	SA-106B	
209	3	PL1", 3 5/8" I.D. x 7 1/2" O.D., REPAD	SA-516 70	
210	ONE	18" 300# RFWN FLANGE, S/XS BORE, FOR "E"	SA-105	
211	ONE	SMLS PIPE, 18" S/XS, 11" LG	SA-106B	
212	ONE	PL1 1/4", 18 1/2" I.D. x 32" O.D., REPAD	SA-516 70N	
213	ONE	1/2" THK GASKET FOR 18" 300# RF FLANGE	SEE SHT1	
214	24	STUDS, 1 1/4" x 7 3/4" LG, W/ (2) H.H.N EA	SEE SHT1	
215	ONE	18" 300# RF BLIND FLANGE	SA-105	
216	3	ROUND BAR 1" x 40" LG	SA-36	
217	ONE	2" 300# RFWN FLANGE, S/160 BORE, FOR "F"	SA-105	
218	ONE	SMLS PIPE, 2" S/160, 8" LG	SA-106B	
219	ONE	ROUND BAR 3/4" x 40" LG	SA-36	
220	6	PL 3/8", 12" x 12" LG, RE-PAD	SA-516 70	

CERTIFIED FOR CONSTRUCTION
DATE _____
BY (ENGR) _____
BY (QC) _____

NOTES:

1. WN FLANGE TO NECK BUTT-WELD TO BE FULL-PEN.
2. ROUND NOZZLE INSIDE EDGES R_{1/8}" MIN.
3. NOZZLE REPAD BUTT WELDS ORIENTED > 45° FROM LONG SEAM IF THE REPAD IS ON SHELL AND IS SPLIT.
4. WHERE A SPLIT REINFORCING PAD IS UTILIZED ON HEADS, THE WELDS JOINING PORTIONS SHALL BE 100% RT.
5. NPT 1/4" THRU REQ'D AT LOWEST POINT IN EACH SEGMENT OF EACH REPAD.
6. REMOVE ALL BURRS AND SHARP EDGES

S/O:	2491-17	REQ'D	ONE	TAG No.	V-404
BWFS INDUSTRIES LLC TEL: (281) 590-8391 5637 ETHELINE HOUSTON, TEXAS 109,346" O.D. x 65'-5" OAL PRODUCT SURGE TANK 60 MMSCFD CRYO PLANT - UOP RUSSELL PROJECT S447XX NOZZLE DETAILS					
1	ADDED REPADS; ISSUED FOR CONSTRUCTION.	S.R.	2/22	CUSTOMER:	UOP RUSSELL LLC
0	ISSUED FOR APPROVAL	S.R.	1/6	CUSTOMER JOB NO.:	J-447
NO.	REVISIONS	BY	DATE	DRWN	S.R. CHK C.H. DATE 01/05/17
				PD No.	4500754186
				DWG. No.	2491
				SHT. No.	2 OF 4



Manufacturing Data Book

Section 7

Hydrostatic Test

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136

P.O. Number: 4500754186

Project: J447XX

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039

BWFS INDUSTRIES LLC

ASME CODE - VESSELS - PIPING - SKID PACKAGING - COMPRESSORS

CERTIFICATE OF HYDROSTATIC TEST

CUSTOMER: UOP

PURCHASE ORDER OR TAG NO. PO# 4500754186

BWFS JOB NO: 2491

ITEM(S) TESTED: (1) PRODUCT SURGE TANK
109.346" O.D. X 65'-5" O.A.L.

TEST PRESSURE: 523 PSIG (ACTUAL 540 PSIG)

TEST DATE: 5/8/2017 TEST DURATION: 1 HOUR

GAUGE 1: 4 1/2" Marsh Gauge GAUGE 2: N/A

SER. NO. PG-2001 0-2,000# SER. NO. N/A

CALIBRATION DATE 4/7/2017 CALIBRATION DATE N/A

CHART RECORDER 1 12" Johnny's Gauge

SER. NO. 2397 0-1,000#

CALIBRATION DATE 3/2/2017

CHART RECORDER 2 N/A

SER. NO: N/A

CALIBRATION DATE N/A

SIGNED:


QC BWFS INDUSTRIES LLC

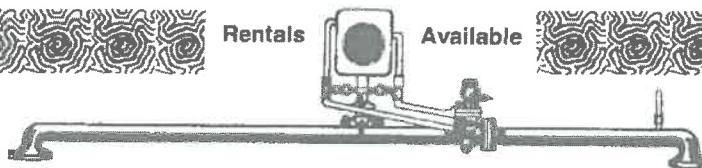
SIGNED:


Inspector

COMMENTS:

Rentals

Available



JOHNNY'S GAUGE & METER REPAIRS

(713) 695-1038 • 718 DUNWOODY
HOUSTON, TEXAS 77076-1914

CALIBRATION CERTIFICATE

CUSTOMER BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039

DATE CALIBRATED 4-07-2017
OUR INVOICE NO. 5137
CUSTOMER'S P. O. NO. _____

INDICATED RANGE 0-2,000# ACCURACY $\pm$ 0.5 % SERIAL NO. PG-2001

TYPE OF INSTRUMENT CALIBRATED 4 1/2" Marsh Pressure Gauge

TYPE OF STANDARD USED TO CALIBRATE Crosby Deadweight Tester
S/N-39037

ALL STANDARDS DIRECTLY TRACEABLE TO
NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGIES TEST NO. 2.6/172409 & 6.6/139577

ROOM TEMPERATURE AT TEST 74° F

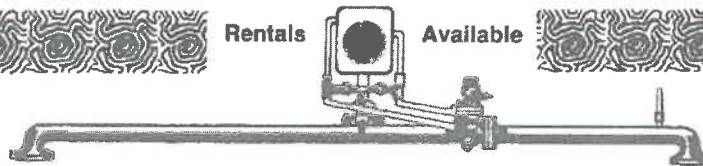
DATE OF CALIBRATION DUE 4-07-2018

INSPECTOR

Fred Snell

Rentals

Available



JOHNNY'S GAUGE & METER REPAIRS

(713) 695-1038 • 718 DUNWOODY
HOUSTON, TEXAS 77076-1914

CALIBRATION CERTIFICATE

CUSTOMER BWS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039

DATE CALIBRATED 3-02-2017
OUR INVOICE NO. 5002
CUSTOMER'S P. O. NO. _____

INDICATED RANGE 0-1,000# ACCURACY $\pm$ 1.0 % SERIAL NO. 2397

TYPE OF INSTRUMENT CALIBRATED 12" Johnnys Gauge Pressure Recorder

TYPE OF STANDARD USED TO CALIBRATE Crosby Deadweight Tester
S/N-39037

ALL STANDARDS DIRECTLY TRACEABLE TO
NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGIES TEST NO. 2.6/172409 & 6.6/139577

ROOM TEMPERATURE AT TEST 74° F

DATE OF CALIBRATION DUE 3-02-2018

INSPECTOR

Fred Lued

5 6 AM

7

8

9

10

11

NOON

1

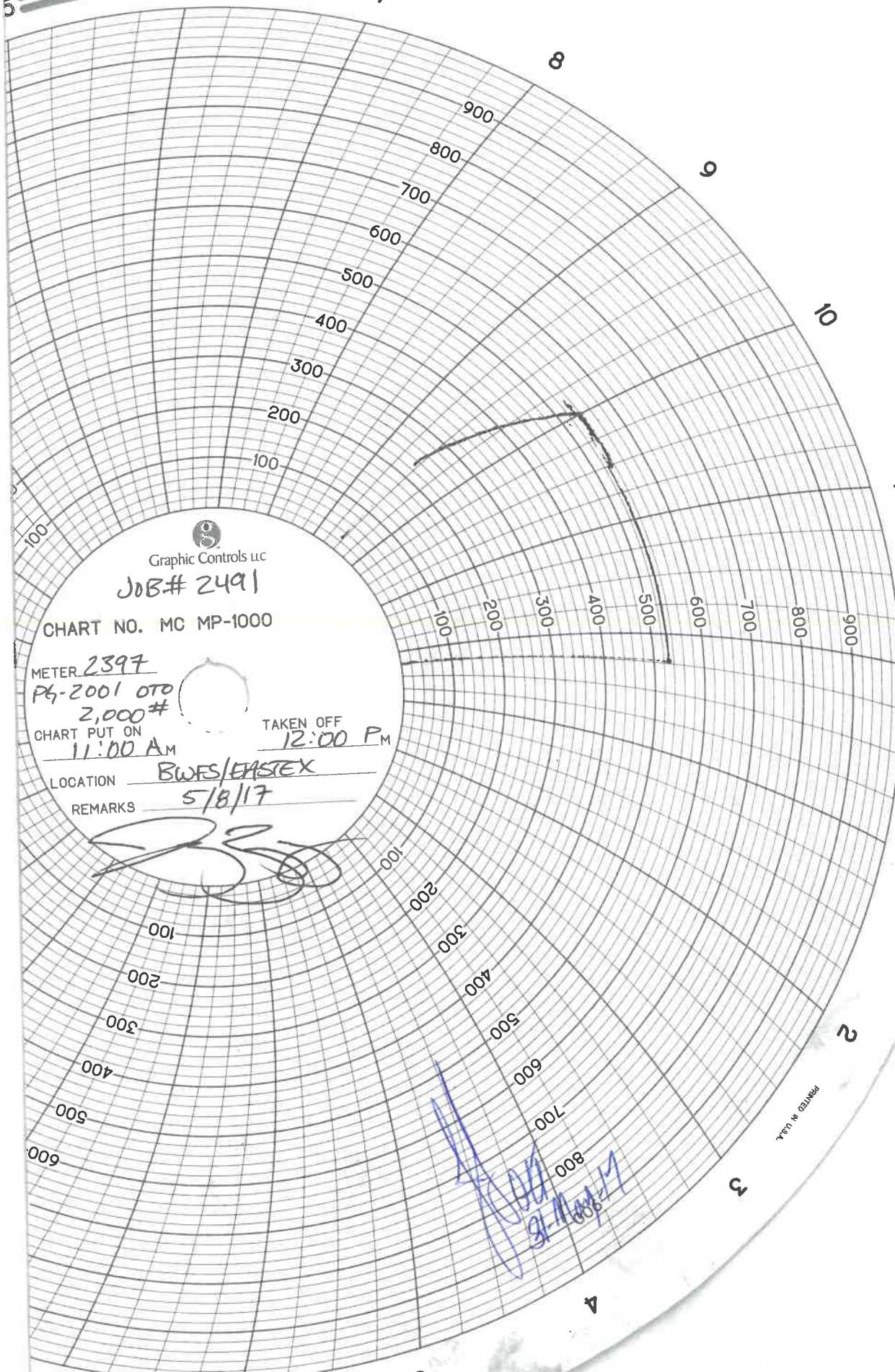
2

3

4

5

6 PM 7



Graphic Controls LLC

JOB# 2491

CHART NO. MC MP-1000

METER 2397

PG-2001 OTO

2,000 #

CHART PUT ON

11:00 AM

TAKEN OFF

12:00 PM

LOCATION

BWES/EASTEX

REMARKS

5/8/17

PRINTED IN U.S.A.



Manufacturing Data Book

Section 8

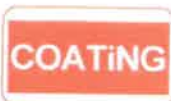
Paint Report

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136

P.O. Number: 4500754186

Project: J447XX

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039



COATING INDUSTRIES, INC.
6414 Thomas Road ~ Houston, TX 77041
Tel no : (713) 937-8581

DAILY INSPECTION REPORT

Job No.	Customer:	Description:	P.O. No.	Reference Spec.
17- 0334	BWFS	1 - 109" OD x 66' S/S Vessel	PO: 57924 / Job#: 2491	

CONDITIONS

ABRASIVE BLAST

Ambient Condition	Surface Prep.	Primer	Int I	Int. II	Finish	Type & Grade of Abrasive	Starblast XL Fine
Date Time	5/11/2017 9:30 AM	5/11/2017 1:00 PM	5/12/2017 1:00 PM		5/13/2017 1:00 PM	Specification Standard	SSPC-SP-6 Commercial
Surface Temp °F	81	96	98		84	ASTM 4285 "Blotter Test"	Passed - Dry Air
Dry Bulb °F	78	85	81		80	ASTM 4417 Anchor profile	2.5 Mils
Wet Bulb °F	68	78	70		70	Surface Check for Cleanliness	Yes
R.H. %	60	73	58		61	Pressure at Nozzle	100 PSI
Dew °F	63	76	65		65	Comments	N/A

PAINT APPLICATION

Coat	Manufacturer	Paint Description	Color	Thinner	Location of Operation
Primer	Sherwin Williams	646	Buff		@BWFS Yard
Int I	Sherwin Williams	646	Buff		@BWFS Yard
Int II					
Finish	Sherwin Williams	B65 - SW 4031	Gray		@BWFS Yard

Coat	Batch No "A"	Batch No "B"	Batch No "C"	Cumulative D.F.T.	Comments
Primer	XM0907CZ	XM1247XY		4.0	N/A
Int I	XM0907CZ	XM1247XY		8.1	N/A
Int II					
Finish	XM0597JM	MQ0774UH		12.3	N/A
Application Method	Conventional Airspray	Holiday Testing		N/A	





Manufacturing Data Book

Section 9

Bill of Material

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136

P.O. Number: 4500754186

Project: J447XX

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039

BWFS

BILL OF MATERIALS

JOB #

2491

DRAWING #

DATE

4/11/17

NAME

Sean R920

VESSEL SERIAL #

ITEM #	PART	DESCRIPTION	MATERIAL	QTY	HEAT #, HEAT CODE OR PO#
101	heads	2" Norm C.837 Min x109 ~~109~~	SA S16-70N	2	13574-1-2 (1-1)
		qsmc code ~~Head~~ - Head	Whit 4 1/2 cut Back		C1-S-R S3.661"
		9'6 1/8" LG			
102	shell 1234	PL 1 3/16 RBW 109.34.08	SA-S16-70N	6	7500117
103	Name Plate	6X6	S-S		—
104	standard ^{name} plate	7X7 - 7X3	SA-36	2	A6V2838-03
207	Noz "H"	6" #300 RFWN S/XS Bore	SA-10S	2	1541570 (E) 1337975 H
201	Noz "A-B"	6" #300 FFWN S/XS Bore	SA-10S	2	1541570 "A" 15/41570 "B"
202	Noz A-B-C-H	SMLS Pipe 6" S/XS 32" LG	SA-106-B	4	112068
203	Repads	PL 1" 63/4 I-D X 12 1/8 I-D	SA-S16-70	4	J8-3542-1392M439
204	Vortex Breacker	1/4 6X12	SA-36	1	A6V2838-03
205					
206	full coupling	3/4 NPT 6000#		2	B16 975 PM
207	Noz-D1 2" J	3" #300 RFWN Flange (5th) (160)	SA-10S	3	15/40095
208	D1-D2-J	SMLS Pipe 3" S/160 27" LG	SA-106-B	3	101311-LA1389
209	D1-D2-J	PL 3 9/8 I-D X 7 1/2 O-D	SA-S16-70	3	J8-3542-1392M439
210	Noz "E"	18" 300# RFWN flanges	SA-10S	1	60572/1
211	Noz "E"	SMLS Pipe 18" S/XS 11" LG	SA-106-B	1	X84 392
212	Repad	PL 1 1/4 18 1/8 I-D	SA-S16-70N	1	U0295-4

BWFS

BILL OF MATERIALS

JOB #

2491

DRAWING #

VESSEL SERIAL #

DATE

4/11/17

NAME

Jugan Razo

ITEM #	PART	DESCRIPTION	MATERIAL	QTY	HEAT #, HEAT CODE OR PO#
213	Cap-sket	1/8 thk 18" 300			—
214	studs				—
215	Blind	18" 300# RF Blind Flange	SA-10S	1	X246
216	Round bar	2" Manway Rungs	SA-31	3	JK16104458
217	Nor "F"	2" #300 RFWN Flange 160 Sch	SA-10S	1	R314 0615
218	Nor "F"	SMCS Pipe 2" 5/160 8" Lg	SA-106B	1	300454
219	Round bar	3/4 X 40" Lg Manway Rung	SA-36	1	JW16105825
220	Ladder Repts	PL 3/8 12" X 12"	SA-S16-70	6	5500167-07
301	sleeve	2 1/2 sch 40 X 7" Lg	SA-106-B	1	332823
302	Collar	2 1/2 sch 40 X 3 1/4" Lg	SA-106-B	1	332823
303	Gusset	1/2" PL X 6 1/2 X 3 1/16	SA-S16-70	1	6507425-02
304	Groundin	2X2 7/16 Ø	SA-240-304L	2	504754
305	Davit-arm	Pipe 2" 5/8 XHX 39" Lg	SA-106-B	1	HA 0171
306	Davit-lug	3/4 Rod X 13" Lg	SA-36	2	JW16105825
307	Handles	3/4" Rod X 13 Lg	SA-36	2	JW16105825
308	Grease Fitting		SA-193-B7	1	—
309	3/4 eye	Bot			—
					Bot

BWFS

BILL OF MATERIALS

DATE _____

NAME

#JOB#

2491

DRAWING #

VESSEL SERIAL #

[illegible]



Manufacturing Data Book

Section 10

Material Test Reports

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136

P.O. Number: 4500754186

Project: J447XX

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039



edmonton exchanger
& manufacturing ltd.

CERTIFICATE OF COMPLIANCE

5545-89 Street Edmonton, Alberta Canada T6E 5W9

www.edmontonexchanger.com

tel 780.468.6722 • QC fax 780.466.4668 • sales fax 780.466.5155

Customer BWFS INDUSTRIES LLC

PO 57548

Work Order C113574 Date 2017/02/23 CofC# 62785

Page 1 of 1

Item#	Description	Qty	Heat#	Required Min Thk	Recorded Min Thk	Form. Proc.
H113574-1-1 ✓	HEAD(S) - Hemispherical - 1.0000" NOM (0.8300" _MIN) X 107.375" ID (Material Spec: SA 516-70 Normalized) ✓	1	430453 63352-01 ✓	0.8300" ✓	0.8670" ✓	1
H113574-1-2 ✓	HEAD(S) - Hemispherical - 1.0000" NOM (0.8300" _MIN) X 107.375" ID (Material Spec: SA 516-70 Normalized) ✓	1	430453 63352-01 ✓	0.8300" ✓	0.8420" ✓	1

Forming Procedure:

1. Hot Formed @ 1650F/899C and Air Cooled

NOTE: All items which were heat treated during or after forming shall be documented as a forming procedure per UG-79(c) and UCS-79(f).

Supplementary Requirements

Normalized Material Identification Marking:

'MT' indicates normalized by the mill per ASME Code Section II, Part A, SA 20, Paragraph 13.1.1.

'GMT' indicates normalized by Edmonton Exchanger per ASME Code Section II, Part A, SA 20, Paragraph 13.1.2.

'GT' indicates normalized by Edmonton Exchanger per ASME Code Section VIII Division 1, UG-85 or ASME Code Section I, PG-77.4.

The item(s) listed above comply with the requirements of ASME Code Section I, PG-29, PG-81 and ASME Code Section VIII, Division 1, UCS-79(d), UG-79 & UG-81. All welders and procedures are qualified to ASME Code Section IX. Material being supplied conforms to the latest ASME Code Section II, Part A, 2015 Edition.

Steve Zubryckj (QAM)

Supplementary Examination - Items

p 3-12-17

This works because
the 1" thk makes
it 109.346" OD

foot



edmonton exchanger
& manufacturing ltd.

CERTIFICATE OF COMPLIANCE

MTR List

5545-89 Street Edmonton, Alberta Canada T6E 5W9 www.edmontonexchanger.com tel 780.468.6722 • QC fax 780.466.4668 • sales fax 780.466.5155

Customer **BWFS INDUSTRIES LLC** PO 57548 Work Order C113574 Date 2017/02/23 CofC# 62785 Page 1 of 1

Email to abetancourt@bwfsindustries.com

Email to kawtrey@bwfsindustries.com

Email to mbussiere@edmontonexchanger.com

MTR ID	Pages	Heat#	Thickness	Material Grades
20273 ✓	3 ✓	430453-63352-01 ✓	1" ✓	SA 516-70 N ✓

Heat#	Material Grades	MTR ID	Item#
430453 63352-01 ✓	SA 516-70 N ✓	20273 ✓	H113574-1 ✓

Heat#	Thickness	Grade	HIC Report Filename
-------	-----------	-------	---------------------

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 562531-05.04.16		A08/ Manufacturer's order/ A03 Certificate No. 412244-002		Sheet 1/...	
A05 Established inspecting body DH		A06 Purchaser SA516-70		A07.1 No. ED10683-J1010ER		A07.2 No. SA20-S5	
B02/ Steel design. B03 Any suppl. requirements		Final receiver DIL-HUE-1:R33-2014-04-04		EDMONTON STEEL, EDMON		EDMONTON STEEL, EDMON	
3-12-17							
20273							
HEAVY PLATES							
B01-B99 Description of the product							
B14 Item No.	B08 Number of pieces	B09 Thickness	B10 Width	B11 Length	B12 Theoretical mass	B04 Product delivery condition	B07.2 Heat No.
01	1	1,0000 x	164,00000 x	328,00000	6920 N	430453	430453
***	1				6920		
B04 Product delivery condition							
ITEM NO.: 01 N: HT: 1670 GR.F +36 -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							
B06 Marking of the product							
ITEM NO.: 01 STEEL DESIGNATION SA516 70 MTLTV SA516 60 MTLTV HEAT NO. / TRADEMARK / ROLLED PLATE NO.-TEST NO. / INSPECTOR'S STAMP							
B07-B99 Further information about the product							
ITEM NO.: 01 THICKNESS REDUCTION RATIO >= 3,0 IS FULFILLED (CF. A/SA20 PAR. 5.3)							
C10-C29 Tensile test							
B14 Item No.	B07.2 Heat No.	B05 Rol-plate/ Reference (heat) treatment	C01 C02/ C03 C01 Temp. GR.F	C10 C11 KSI	C12 RM	C13 C14-C15	A %
01	430453	63352	K1 Q RT	RP02 48,7	74,4		L0=8IN 30
A04							
		Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.					
AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillinger/Saar		Inspector's stamp Date 05.04.16		Test House Manager B. BALDAUF		Inspection department	
AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillinger/Saar		Inspector's stamp Date 05.04.16		Test House Manager B. BALDAUF		Inspection department	

QM-System: Certification as per ISO 9001

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

DILLINGER

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 562531-05.04.16		A08/ Manufacturer's order/ A03 Certificate No. 412244-002		Sheet 2/....																															
A05 Established inspecting body DH		A06 Purchaser EDMONTON STEEL, EDMON		A07.1 No. ED10683-J1010ER																																	
A06 Final receiver SA20-S5		EDMONTON STEEL, EDMON		A07.2 No.																																	
B02/ Steel design. SA516-70		ASME-III A:2013		SA20-S5																																	
B03 Any suppl. requirements		DIL-HUE-1:R33-2014-04-04																																			
C30-C39 Hardness test <table border="1"> <thead> <tr> <th>B14 Item No.</th> <th>B07.2 Heat No.</th> <th>B07.1 Rol, plate/ Test No.</th> <th>B05 Reference (heat) treatment</th> <th>C01</th> <th>C02/C01</th> <th>C03 Temp. GR.F</th> <th>C30 Method of test</th> <th>C35 Individual values</th> <th>C31</th> <th>C32 Mean value</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>430453</td> <td>63352</td> <td></td> <td>K1</td> <td>O</td> <td>RT</td> <td>HBW 10/3000</td> <td>HB 142</td> <td>142</td> <td>140</td> </tr> </tbody> </table>								B14 Item No.	B07.2 Heat No.	B07.1 Rol, plate/ Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GR.F	C30 Method of test	C35 Individual values	C31	C32 Mean value	01	430453	63352		K1	O	RT	HBW 10/3000	HB 142	142	140								
B14 Item No.	B07.2 Heat No.	B07.1 Rol, plate/ Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GR.F	C30 Method of test	C35 Individual values	C31	C32 Mean value																											
01	430453	63352		K1	O	RT	HBW 10/3000	HB 142	142	140																											
C40-C49 Impact test <table border="1"> <thead> <tr> <th>B14 Item No.</th> <th>B07.2 Heat No.</th> <th>B07.1 Rol, plate/ Test No.</th> <th>B05 Reference (heat) treatment</th> <th>C01</th> <th>C02/C01</th> <th>C03 Temp. GR.F</th> <th>C41 Width of test piece</th> <th>C40 Type of test piece</th> <th>C44 Testing method</th> <th>C45 Energy</th> <th>C46</th> <th>C43 Mean value</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>430453</td> <td>63352</td> <td></td> <td>K1</td> <td>LV</td> <td>-51</td> <td></td> <td>CHP-V</td> <td></td> <td>AV 8</td> <td>131</td> <td>138</td> </tr> </tbody> </table>								B14 Item No.	B07.2 Heat No.	B07.1 Rol, plate/ Test No.	B05 Reference (heat) treatment	C01	C02/C01	C03 Temp. GR.F	C41 Width of test piece	C40 Type of test piece	C44 Testing method	C45 Energy	C46	C43 Mean value	01	430453	63352		K1	LV	-51		CHP-V		AV 8	131	138				
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C70-C99 Chemical composition % - Heat analysis <table border="1"> <thead> <tr> <th>B07.2 Heat</th> <th>C</th> <th>Si</th> <th>Mn</th> <th>P</th> <th>S</th> <th>N</th> <th>CU</th> <th>MO</th> <th>NI</th> <th>CR</th> <th>V</th> <th>NB</th> <th>SN</th> <th>TI</th> </tr> </thead> <tbody> <tr> <td>430453</td> <td>Y</td> <td>0,176</td> <td>0,377</td> <td>1,18</td> <td>0,009</td> <td>0,0007</td> <td>0,0076</td> <td>0,024</td> <td>0,012</td> <td>0,037</td> <td>0,050</td> <td>0,000</td> <td>0,001</td> <td>0,002</td> </tr> </tbody> </table>								B07.2 Heat	C	Si	Mn	P	S	N	CU	MO	NI	CR	V	NB	SN	TI	430453	Y	0,176	0,377	1,18	0,009	0,0007	0,0076	0,024	0,012	0,037	0,050	0,000	0,001	0,002
B07.2 Heat	C	Si	Mn	P	S	N	CU	MO	NI	CR	V	NB	SN	TI																							
430453	Y	0,176	0,377	1,18	0,009	0,0007	0,0076	0,024	0,012	0,037	0,050	0,000	0,001	0,002																							
C94 Heat analysis Carbon equivalent / Alloying restrictions <table border="1"> <thead> <tr> <th>B07.2 Heat</th> <th>FO-02=</th> <th>FO-51=</th> <th>FO-55=</th> <th>FO-78=</th> <th>FO-91=</th> </tr> </thead> <tbody> <tr> <td>430453</td> <td>0,39</td> <td>0,000</td> <td>0,000</td> <td>0,06</td> <td>6,7</td> </tr> </tbody> </table>								B07.2 Heat	FO-02=	FO-51=	FO-55=	FO-78=	FO-91=	430453	0,39	0,000	0,000	0,06	6,7																		
B07.2 Heat	FO-02=	FO-51=	FO-55=	FO-78=	FO-91=																																
430453	0,39	0,000	0,000	0,06	6,7																																
C95 Ladle treatment ITEM NO.: 01 HEAT OF THE INDICATED ITEM: VACUUM DEGASSED / SULPHIDE SHAPE CONTROL																																					
C95 Further information about ladle treatment ITEM NO.: 01 CALCIUM TREATED																																					
A04								AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department		Date 05.04.16																											
		B. BALDAUF Test House Manager		Inspector's stamp		Date 05.04.16		PP 1		A01																											

QM-System: Certification as per ISO 9001

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

DILLINGER

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 562531-05.04.16		A08/ Manufacturer's order/ A03 Certificate No. 412244-002		Sheet 3	
A06 Established inspecting body DH		A06 Purchaser Final receiver		A07.1 No. ED10683-J1010ER A07.2 No.			
B02/ Steel design. SA516-70		EDMONTON STEEL, EDMON		B01 Product HEAVY PLATES			
B03 Any suppl. requirements ASME-IIA:2013 DIL-HUE-1:R33-2014-04-04		EDMONTON STEEL, EDMON					
SA20-S5							
C70-C99 Chemical composition % - Product analysis							
B07.2 Heat 430453 63352		C01		C		S	
K1		0,170		0,375		1,16	
B07.2 Heat 430453 63352		C01		B		CA	
K1		0,0002		0,0011		0,035	
C94 Product analysis Carbon equivalent / Alloying restrictions							
B07.2 Heat 430453 63352		C01		FO-02=		0,38	
K1		FO-02=		0,38		FO-51=	
B07.2 Heat 430453 63352		C01		FO-51=		0,000	
K1		FO-51=		0,000		FO-55=	
B07.2 Heat 430453 63352		C01		FO-55=		0,12	
C94 Carbon equivalent formula / Alloying restrictions							
FO-02 = C + (MN/6) + (CR+MO+V) / 5 + (NI+CU) / 15		FO-51 = V + NB		FO-55 = CU+MO+NI+CR		FO-78 = CR+MO	
FO-51 = V + NB		FO-55 = CU+MO+NI+CR		FO-78 = CR+MO		FO-91 = MN/C	
D01 Marking and identification, surface appearance, shape and dimensional properties							
ITEM NO.: 01							
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 1/2-ASME-SA20							
A04		Z01/Z02/Z03 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.		B. Balz		AG der Dillinger Hüttenwerke Postfach 1580, D-66748 Dillingen/Saar Inspection department	
D/H Manufacturer's mark		B. BALDAUF Test House Manager		AHB		Date 05.04.16	
		Inspector's stamp		Date 05.04.16		PP 1	



Mill Test Report

Page 3

Issuing Date : 01/20/2017 B/L No. : 462056 Load No. : 470289 Our Order No. : 14336711 Cust. Order No. : 282162
Vehicle No: ALY 91703 Sold To: NORTH SHORE STEEL PO BOX 9940 HOUSTON, TX 77213 Ship To: NORTH SHORE STEEL C/O GREENS BAYOU PIPE MILL PTRACK TRACK 2091088 SPUR 910 13935 INDUSTRIAL RD HOUSTON, TX 77015
Specification: 1.1875" x 116.000" x 345.000" ASTM A516 70/65/60/485-10(2015)/ASME SA516-70/65/60/485 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
7500117	0.18	1.03	0.009	0.002	0.20	0.16	0.08	0.07	0.01	0.033	0.004	0.001	0.002	0.0075	0.0040	0.0001	0.007	0.39	0.26
Tensile Test										Charpy Impacts									
Plate Serial No	Pieces	Tons	Dir.	Yield (psi)	TENSILE (psi)	Elong. % in 2"	Elong. % in 8"	Heat Treat		Absorbed Energy (Ft-lbs)		Dir.		Ave		Min		Ave	
								Norm °F	Time (min)	Temp °F	Time (min)	1	2	3	Ave	1	2	3	Ave
7500117-01	2	13.47	T	50,100	78,700	55.5	1650	47											

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: nmc-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, BIEN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate 14-MMPQA-723
T. A. Depretis, Metallurgist
1/23/2017 9:22:38 AM



NUCOR STEEL TUSCALOOSA, INC.

MILL TEST CERTIFICATE

1700 HOLT RD N.E.
TUSCALOOSA, AL 35404-1000
800 800-8204
CUSTOMERSERVICE@NUCORTUSK.COM

Load Number	Tally	Mill Order Number	PO NO. / Line NO	Part Number	Certificate Number	Prepared
T131707	00000000684828	N-148242-003	13665 3		D68482803-1	09/19/2016 16:03
Grade	Customer:					
Order Description:	Sold TO:					
Hot Roll Plate From Coil	RANGER STEEL HOUSTON TX					
A516 70, 0.2500 IN x 96.000 IN x 480.000 IN	Ship TO:					
Quality Plan Description:	RANGER STEEL HOUSTON TX					
A516-60: ASTM A516-60-10/ASME SA516-60-15AR	Sent TO:					

10-3-16

Shipped Item	Heat/Slab Number	Certified By	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Co	V	Al	Ti	N2	B	Ca	Sn	CEV	ACI
6H1278D	A6U2838-03 ***	A6U2838	0.21	1.06	0.009	0.004	0.19	0.11	0.05	0.06	0.017	0.001	0.003	0.027	0.001	0.012	0.0000	0.0016			0.41

Shipped Item	Certified By	Heat/Slab Number	Yield ksi	Tensile ksi	Y/T %	ELONGATION %	Bend OK?	Hard HB	Charpy Impacts (ft-lbs)	Shear %	Test Temp
6H1278D	S6H1278BTT	A6U2838-03 ***	52.0	73.9	70.4	29.0	8"		Size mm 1 2 3 Avg	1 2 3 Avg	
6H1278D	S6H1278FTT	A6U2838-03 ***	51.4	75.4	68.2	25.1					
6H1278D	S6H1278MTT	A6U2838-03 ***	53.6	74.3	72.1	27.1					

Items: 1 PCS: 8 Weight: 26137 LBS

[Signature]

Ranger Steel
QC Approved

Mercury has not come in contact with this product during the manufacturing process nor has any mercury been used by the manufacturing process. Certified in accordance with EN 10204 3.1. No weld repair has been performed on this material. Manufactured to a fully killed fine grain practice. NUTEMPER TEMPER PASSED plate from coil ISO 9001:2008 Registered, PED Certified

We hereby certify that the product described above passed all of the tests required by the specifications.

[Signature]
Dr. Gulin Yu - Metallurgist

**** Indicates Heats melted and Manufactured in the U.S.A.



METALFAR PRODOTTI INDUSTRIALI SPA
23861 CESANA BRIANZA (LC) - ITALY
VIA G. PARINI, 28
PHONE +39 031 855441 - FAX +39 031 655149
quality.mff@farnas.com

A01

COMPANY WITH
QUALITY SYSTEM
CERTIFIED BY DNV
= ISO 9001 =
= ISO 14001 =

INSPECTION CERTIFICATE EN 10204:2004 / 3.1

A02

Nr^{A03} 2014-C_MFF-02447 Data / Dated 12.05.2014 ^{A04}

US

Ordine / PO 1-1703BB/TEAM
Item 196
DDT / Delivery note 2014-3E301-0002049
Packing List 2014-3E401-0001817
Fattura / Invoice 2014-3E401-0001817
Ns. rif. / Our ref. 2012-3E201-0003026-0021

A04

US

Cod. colata ^{B07} Heat Code	Nr. colata ^{B07} Heat Nr	Quantità ^{B08} Quantity	Descrizione ^{B01 - (B09) - D:11} Description
	13/37975 ✓	78,00	WIN 300 RF 6" XS ✓ A105N

Mat. in acc. a / Mat. in acc. to ^{B02} ASTM/ASME A 105/SA 105 M - 13 ASME CODE SECT. II, PART A, ED. 2013
NACE MR-0175/2009 ISO 15156
NACE MR-0103/2012
Q.A.S. IN ACCORD WITH PRESS. EQUIPM. DIRECT. 97/23/EC (PED) ANNEX I, PARAGRAPH 4.3 CERT. MLN
0531016/01

Elementi / Elements ^(C11 - C15)	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,200	0,220	0,950	0,007	0,008	0,110	0,050	0,010	0,020	0,100	0,003	0,002	0,008
	Al								CE LF	CE SF	F1	F2	PREN
LADLE ANALYSIS	0,026								0,393	0,358	0,273	0,120	---

CE LF = C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/16 CE SF = C+Mn/6 F1 = Cu+Ni+Cr+Mo+V F2 = Cr+Mo

Provetta ^{C16} Test specimen	Forma ^{C16} Shape	Temperatura ^{C16} °C	Snervamento > 0,2% ^{C11} Yield Strength > 0,2%	Snervamento > 1,0% ^{C11} Yield Strength > 1,0%	Rottura ^{C12} Tensile	Allungamento ^{C13} Elongation	Contrazione ^{C15} Reduction of area
Sez/Seci mm2 L. mm	1=O - 2=□		MPa	MPa	MPa	%	%
126,60 60,80	1	20	338,0	---	518,0	32,0	60,0

DUREZZA / HARDNESS^{C17}

RESILIENZA / IMPACT TEST

HBW	Tipo/Type ^{C18} KV	Provetta / Test Specimen	Temperatura ^{C18} °C	1-Joule ^{C19}	2-Joule ^{C19}	3-Joule ^{C19}	Media/Average ^{C19}
154,0 - 158,0		10x10 mm	20	92	88	94	91,3

Tratt. Term. / Heat treatment ^{C19} NORMALIZED AT 920 C - COOLED IN STILL AIR

ELECTRIC FURNACE

Dim in acc. a / Dim. acc. to ^{B11} ASME/ANSI B16.5 - 2013
ASME/ANSI B36.10M - 2010

Finitura / Roughness 125/250 MICROINCH AARH

Marcatura in acc. ^{B06} Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine ^{B06} Origin of Steel	ITALY ✓
--	-------------------	-------------	--------------	---	---------

Note / Notes 100% MANUFACTURED IN ITALY
MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION

UFFICIO CONTROLLO QUALITA'
QUALITY CONTROL DEPARTMENT

S. Frigerio

ENTE UFFICIALE DI COLLAUDO
INSPECTION AUTHORITY

MARCHIO PRODUZIONE
MANUFACTURER'S SYMBOL



COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV GL = ISO 9001 = = ISO 14001 =	 METALFAR PRODOTTI INDUSTRIALI SPA 23851 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 certificate@metalfaritaly.com	COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV GL = ISO 9001 = = ISO 14001 =
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INSPECTION CERTIFICATE EN 10204:2004 / 3.1		Nr. 2016-C_MFF-04605	Data / Dated 18.11.2016
CONTINENTAL FLANGES & FITTINGS ITALIA SPA VIA VOLONTARI DELLA LIBERTA' , 1 22036 ERBA		Ordine / PO 992 Item 033 DDT / Delivery note 2016-3E301-0064061 Packing List Fattura / Invoice Ns. rif. / Our ref. 2016-3E201-0003683-0025	

Dest. CONTINENTAL FLANGES & FITTINGS ITALIA SpA VIA MAGNI, 113 (FRAZ. CARPANEA) 22044 INVERIGO	CO
--	----

Cod. colata Heat Code	Nr. colata Heat Nr	Quantità Quantity	Descrizione Description
	15/41570	156,00	WIN 300 RF 6" XS A105N

Mat. in acc. a / Mat. in acc. to
 ASTM A105M - 14, ASME SA105M-15 ASME CODE SECT. II, PART A, ED. 2015
 NACE MR-0175/2015 ISO 15156
 NACE MR-0103/2012
 Q.A.S. IN ACCORD. WITH PRESS. EQUIPM. DIRECT. 2014/68/UE (PED) ANNEX I, PARAGRAPH 4.3
 CERT. 4687-2014-CE-ITA-ACCREDIA

Elementi / Elements	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,195	0,240	1,140	0,007	0,011	0,080	0,050	0,020	0,019	0,100	0,003	0,002	0,008
	Al	B	Ca						CE LF	CE SF	F1	F2	PREN
LADLE ANALYSIS	0,029	0,000	0,002						0,416	0,385	0,253	0,100	-
CE LF=C+Mn/5+(Cr+Mo+V)/5+(Ni+Cu)/15	CE SF=C+(Mn/6)			F1=Cu+Ni+Cr+Mo+V			F2=Cr+Mo						

Provetta Test specimen	Forma Shape	Snervamento > 0,2% Yield Strength > 0,2%	Snervamento > 1,0% Yield Strength > 1,0%	Rottura Tensile	Allungamento Elongation	Contrazione Reduction of area
Sez/Secd mm2 L mm	1=O - 2=□	MPa	MPa	MPa	%	%
126,60 50,80	1 20	353,0	-	518,0	34,0	59,0

DUREZZA / HARDNESS	RESILIENZA / IMPACT TEST
HBW 150,0 - 156,0	Tipa/Type KV Provetta / Test Specimen 10x10 mm °C 1-Joule 2-Joule 3-Joule Media/Average
	-10 54 48 63 55,0

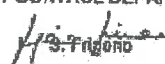
Treat. Term. / Heat treatment	NORMALIZED AT 920 °C - COOLED IN STILL AIR	ELECTRIC FURNACE
-------------------------------	--	------------------

Dim in acc. a / Dim. acc. to	ASME/ANSI B16.5 -2013 ASME/ANSI B36.10M -2015 ASME/ANSI B16.25 -2012
------------------------------	--

Finitura / Roughness	125/250 MICROINCH AARH
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Marcatura in acc. Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine Origin of Steel	ITALY
---	-------------------	-------------	--------------	----------------------------	-------

Note / Notes
 100% MANUFACTURED IN ITALY
 MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION
 COMMESSA 5454

UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL 
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Page 1 - 1

CUSTOMER	P.O.	ITEM NO.	DESCRIPTION	D.T.Y.
NORTH SCRE	27966	02	FLANGES WIN 300 RF 6" XS A105N	78

Handwritten signature



TUBOS REUNIDOS INDUSTRIAL, S.L.U

Barrio Sagarribai, 2 - 01470 AMURRIO (Spain)



EN 10204:2004 / 3.1

CERTIFICADO DE CALIDAD MILL TEST CERTIFICATE

1-12-17

PAG. 1 / 4

Nº 0000314708/1 Rev. 000

CLIENTE: CUSTOMER

PRODUCTO: TUBERÍA SIN SOLDADURA LAMINADA EN CALIENTE
ARTICLE HOT FINISHED SEAMLESS TUBES

EXTREMOS: BISELADOS
ENDS BEVELLED ENDS

NORMA / GRADO: ASTM A53/A53M-10/ASME II SA-53/SA-53M
AFL. STANDARD AND GRADE 2011A / ASTM A106/A106M-11/ASME II SA-106/SA-106M 2011A / API 5L 2007 44TH ED. PSL1 B/C/X42

ESPEC. ADICIONALES: NACE MR0175/ISO 15156.PUB.2009
ADDITIONAL SPEC. NACE MR0103.2012

PEDIDO / PARTIDA: 128819-00
P. ORDER / ITEM 3.

REF. FABRICA: 300014359
WORK ORDER 000030

PROTECCIÓN SUPERF: LACA SECA EXTERIOR
EXT. COATING OO DRY LACQUERED

PROCESO FUSION: HORNO ELECTRICO
MELTING PROCESS ACERO TOTALMENTE CALMADO
ELECTRIC FURNACE // FULLY KILLED

FAB. DE PALANQUILLA: COLADA CONTINUA
BILLETS MANUFACTURE CONTINUOUS CASTING

DIMENSIONES: 6" NB X 0.432" X
DIMENSIONS 38-42 FT.

MARCAS: ESTAMPADO: SPAIN
MARKING DIE STAMPING

PINTADO: TRI SPEC 5L-0011 (SELLO API) (MM/AA) 6 NPS X 0.432 " ASTM/ASME A/SA53/
STENCILLED 106/SLP1 B/C/X42 PSL1 SMLS 3000.0 PSI (LONG. TUBO EN PIES) FT (PESO/TU
BO EN KGS) KG HN (COLADA) NACE MR0175/ISO 15156 + MR0103

CODIGO COLOR:

TRAT. TERMICO: NORM. BRUTO LAM. ENFR. AL AIRE / AS ROLLED COOLED IN STILL AIR
HEAT TREATMENT 920 °C

Lista de Bultos / 129324
Packing List

DESCRIPCION SUMINISTRO / DESCRIPTION OF DELIVERY (1)

ITEM FAB. T.R. ITEM	ITEM CLI. CLIENT'S ITEM	LONG. INDIV (F) INDIVIDUAL LENGTH	COLADA CAST NR.	Nº TUBOS QUANTITY	LONG. TOTAL (F) LENGTH	PESO(KG) WEIGHT
000030	3.	38,000 - 42,000	112068	199	8.143,437	106638
000030	3.	38,000 - 42,000	112069	167	6.685,239	89.919
000030	3.	38,000 - 42,000	112070	134	5.505,970	72.056
000030	3.	38,000 - 42,000	112071	212	8.576,012	113910
000030	3.	38,000 - 42,000	112072	190	7.574,541	101434
000030	3.	38,000 - 42,000	112073	169	6.851,412	90.652
000030	3.	38,000 - 42,000	112100	78	3.240,321	42.176
000030	3.	38,000 - 42,000	112101	180	7.350,096	96.899
000030	3.	38,000 - 42,000	112102	18	729,757	9.693
TOTAL				1.347	54.656,785	723377

TUBOS REUNIDOS INDUSTRIAL GARANTIZA QUE TODAS LOS TUBOS CUBIERTOS POR ESTE CERTIFICADO CUMPLEN LOS REQUISITOS DEL PEDIDO Y CON LAS ESPECIFICACIONES ARRIBA MENCIONADAS.
TUBOS REUNIDOS INDUSTRIAL CERTIFY THAT ALL THE TUBES COVERED BY THIS CERTIFICATE COMPLY WITH ORDER REQUIREMENTS AND ABOVE MENTIONED SPECIFICATIONS.

AMURRIO 27.03.2013

CONTROL DE CALIDAD DE TUBOS REUNIDOS INDUSTRIAL
TUBOS REUNIDOS INDUSTRIAL QUALITY CONTROL

ALCA VILLALBA

P.O. :

P.O.# 57527
HCH7# 112063
J013# 2484



TUBOS REUNIDOS INDUSTRIAL, S.L.U

Barrio Sagarribai, 2 - 01470 AMURRIO (Spain)



EN 10204:2004 / 3.1

CERTIFICADO DE CALIDAD MILL TEST CERTIFICATE

PAG. 2 / 4

Nº 0000314708/1 Rev. 000

ENSAYOS NO DESTRUCTIVOS / N.D.T

ENSAYO / TEST

%CONTROL / TEST RATE(%)

REQUISITOS / REQUIREMENTS

RESULTADO / RESULT

VISUAL Y DIMENSIONAL/
VISUAL & DIMENSIONAL INSP.

100%

O.K.

P.HIDROSTATICA/
HYDROTEST

100%

3.000,0 PSI 5 SEC.

O.K.

INSP. POR PASO DE ANILLO/
RING GAUGE INSPECTION

100%

ACC. TO API 5L / ISO 3183

O.K.

ENSAYOS TECNOLÓGICOS Y METALÚRGICOS / TECHNOLOGICAL AND METALLURGICAL TEST

APLASTADO
FLATTENING

AC/ A/SA53/SA106/5L -OK

ANÁLISIS DE COLADA / CAST ANALYSIS

MIN.	C	Mn	Si	P	S	Cr	Ni	Mo	Cu	V	Al	Ti	Nb	B	C.E.
MAX.	0.27	1.06	0.10	0.015	0.0300	0.400	0.400	0.150	0.400	0.080	0.060	0.050	0.020		
112068	0.18	0.80	0.21	0.006	0.0034	0.090	0.092	0.064	0.299	0.001	0.001	0.001		0.0010	0.40
112069	0.18	0.81	0.22	0.007	0.0033	0.088	0.090	0.048	0.285	0.001	0.001	0.001		0.0001	0.37
112070	0.18	0.81	0.23	0.009	0.0054	0.083	0.097	0.049	0.303	0.001	0.001	0.001		0.0001	0.36
112071	0.17	0.82	0.24	0.008	0.0049	0.098	0.111	0.050	0.335	0.001	0.001	0.001		0.0001	0.37
112072	0.19	0.83	0.26	0.008	0.0053	0.106	0.102	0.045	0.345	0.001	0.001	0.001		0.0001	0.36
112073	0.18	0.83	0.26	0.010	0.0030	0.091	0.106	0.038	0.288	0.001	0.001	0.001		0.0001	0.39
112100	0.19	0.84	0.19	0.010	0.0024	0.101	0.098	0.042	0.293	0.002	0.003	0.002		0.0001	0.37
112101	0.18	0.90	0.23	0.013	0.0018	0.085	0.108	0.044	0.341	0.002	0.003	0.002		0.0001	0.39
112102	0.18	0.85	0.24	0.011	0.0033	0.092	0.113	0.040	0.330	0.001	0.003	0.002		0.0001	0.38

ANÁLISIS DE PRODUCTO / PRODUCT ANALYSIS

MIN.	C	Mn	Si	P	S	Cr	Ni	Mo	Cu	V	Al	Ti	Nb	B	C.E.
MAX.	0.27	1.06	0.10	0.015	0.0300	0.400	0.400	0.150	0.400	0.080	0.060	0.050	0.020		
112068	0.18	0.80	0.21	0.006	0.0034	0.090	0.092	0.064	0.299	0.001	0.001	0.001		0.0010	0.40
112069	0.18	0.80	0.21	0.005	0.0040	0.090	0.092	0.064	0.280	0.001	0.001	0.001		0.0001	0.37
112070	0.19	0.80	0.22	0.008	0.0040	0.080	0.100	0.040	0.310	0.002	0.005	0.001	0.004	0.0001	0.37
112071	0.18	0.80	0.22	0.007	0.0060	0.090	0.100	0.050	0.330	0.002	0.005	0.001	0.004	0.0002	0.38
112072	0.17	0.80	0.23	0.008	0.0070	0.080	0.110	0.050	0.330	0.002	0.005	0.001	0.004	0.0002	0.37
112073	0.19	0.81	0.23	0.008	0.0070	0.080	0.110	0.050	0.330	0.002	0.005	0.001	0.004	0.0002	0.36
112074	0.17	0.83	0.25	0.008	0.0070	0.110	0.120	0.050	0.350	0.003	0.005	0.001	0.005	0.0002	0.38
112075	0.17	0.83	0.25	0.008	0.0070	0.100	0.120	0.050	0.340	0.003	0.005	0.001	0.005	0.0002	0.38
112076	0.19	0.83	0.26	0.008	0.0053	0.106	0.102	0.045	0.345	0.001	0.001	0.001	0.005	0.0002	0.37
112077	0.19	0.83	0.26	0.008	0.0053	0.110	0.102	0.045	0.350	0.001	0.001	0.001		0.0001	0.39
112078	0.18	0.83	0.26	0.010	0.0040	0.090	0.120	0.040	0.320	0.002	0.002	0.001	0.004	0.0001	0.39
112079	0.19	0.83	0.26	0.009	0.0040	0.090	0.120	0.040	0.320	0.002	0.002	0.001	0.004	0.0001	0.37
112100	0.19	0.81	0.20	0.007	0.0030	0.100	0.110	0.040	0.310	0.003	0.003	0.001	0.004	0.0002	0.38
112101	0.18	0.81	0.20	0.008	0.0030	0.100	0.110	0.040	0.310	0.003	0.003	0.001	0.004	0.0003	0.38
112102	0.17	0.86	0.25	0.011	0.0040	0.090	0.120	0.040	0.350	0.003	0.002	0.001	0.004	0.0002	0.37
112103	0.18	0.89	0.24	0.011	0.0020	0.080	0.120	0.040	0.350	0.002	0.003	0.001	0.004	0.0003	0.38

AMURRIO 27.03.2013

CONTROL DE CALIDAD DE TUBOS REUNIDOS
INDUSTRIAL
TUBOS REUNIDOS INDUSTRIAL QUALITY CONTROL

Alex Villaverde

P.O. :



TUBOS REUNIDOS INDUSTRIAL, S.L.U

Barrio Sagarribai, 2 - 01470 AMURRIO (Spain)



EN 10204:2004 / 3.1

CERTIFICADO DE CALIDAD MILL TEST CERTIFICATE

PAG. 3 / 4

Nº 0000314708/1 Rev. 000

ANÁLISIS DE PRODUCTO / PRODUCT ANALYSIS

	C	Mn	Si	P	S	Cr	Ni	Mo	Cu	V	Al	Ti	Nb	B	C.E.
MIN.		0,29	0,10												
MAX.	0,27	1,06		0,015	0,0300	0,400	0,400	0,150	0,400	0,080	0,060	0,050	0,020	0,0010	0,40
112102	0,18	0,82	0,25	0,010	0,0030	0,090	0,120	0,040	0,350	0,002	0,002	0,001	0,004	0,0002	0,37
112102	0,17	0,81	0,25	0,010	0,0030	0,090	0,120	0,040	0,350	0,002	0,002	0,001	0,003	0,0002	0,36

FORMULAS

MIN.	(01)	(02)	(03)
MAX.	0,150	0,060	1,000
112068	0,0025	0,0016	0,5461
112068	0,0025	0,0016	0,5269
112069	0,007	0,006	0,532
112069	0,007	0,006	0,572
112070	0,007	0,006	0,572
112070	0,007	0,006	0,572
112071	0,009	0,008	0,633
112071	0,009	0,008	0,613
112072	0,002	0,0013	0,5999
112072	0,002	0,0013	0,6084
112073	0,007	0,006	0,572
112073	0,007	0,006	0,572
112100	0,008	0,007	0,563
112100	0,008	0,007	0,563
112101	0,008	0,007	0,603
112101	0,007	0,006	0,592
112102	0,007	0,006	0,602
112102	0,006	0,005	0,602

(01) Nb + Ti + V
(02) Nb + V
(03) Cr + Ni + Mo + Cu + V

ENSAYOS DE TRACCIÓN TENSILE TEST

COLADA CAST	Nº	L/T (1)	T/P (2)	DIMENSION (inches)	L.ELAST. YIELD POINT (Psi) (3)	R.TRACC. T.STRENGTH (Psi)	ALARG. ELONG. (%) (4)	DUREZA HARDNESS (HRB)
					42.000	70.000	99	
112068	0001	L	P	0,984 x 0,433	47.068	77.072	36	82
112068	0001	L	P	1,000 x 0,439	46.642	76.646	38	82
112069	0001	L	P	0,984 x 0,449	45.102	73.810	38	81
112069	0001	L	P	0,984 x 0,453	45.220	73.944	38	81
112070	0001	L	P	0,996 x 0,465	45.211	74.321	38	81
112070	0001	L	P	1,000 x 0,469	45.362	74.086	38	81
112071	0001	L	P	0,996 x 0,437	47.601	75.136	36	81
112071	0001	L	P	1,000 x 0,445	47.779	75.082	36	81
112072	0001	L	P	0,992 x 0,437	46.231	76.203	38	82
112072	0001	L	P	0,996 x 0,445	46.357	76.361	38	82

AMURRIO 27.03.2013

CONTROL DE CALIDAD DE TUBOS REUNIDOS INDUSTRIAL
TUBOS REUNIDOS INDUSTRIAL (QUALITY CONTROL)
ALCA VILLARREAL

P.O. :



TUBOS REUNIDOS INDUSTRIAL, S.L.U
Barrio Sagarribai, 2 - 01470 AMURRIO (Spain)



EN 10204:2004 / 3.1

CERTIFICADO DE CALIDAD
MILL TEST CERTIFICATE

PAG. 4 / 4

Nº 0000314708/1 Rev. 000

ENSAYOS DE TRACCIÓN
TENSILE TEST

COLADA CAST	Nº	L/T (1)	T/P (2)	DIMENSION (inches)	L.ELAST. YIELD POINT (Psi) (3)	R.TRACC. T.STRENGTH (Psi)	ALARG. ELONG. (%) (4)	DUREZA HARDNESS (HRB)
					42.000	70.000		99
112073	0001	L	P	0,972 x 0,441	46.199	76.611	38	82
112073	0001	L	P	0,976 x 0,441	46.357	76.788	38	82
112100	0001	L	P	0,984 x 0,441	46.203	74.801	38	81
112100	0001	L	P	0,984 x 0,449	46.073	74.939	38	81
112101	0001	L	P	0,976 x 0,406	49.510	76.501	36	82
112101	0001	L	P	0,980 x 0,406	49.628	76.646	36	82
112102	0001	L	P	0,988 x 0,453	46.611	76.206	36	82
112102	0001	L	P	0,988 x 0,457	46.784	76.361	36	82

- (1) : L = LONGITUDINAL // T = TRANSVERSAL
(2) : T = Full size tube // P = Strip specimen
(3) : yield point (0.2%)
(4) : Lo = 2" (50,8 mm)

ANEXOS / ANNEX

→ " BILLETS ARE PRODUCED AT OUR AMURRIO STEEL PLANT, WHICH IS ALSO
CERTIFIED TO ISO 9001, THE SAME AS OUR TUBE PLANT ".

- " NO WELD REPAIR "
" MERCURY FREE "

AMURRIO 27.03.2013

CONTROL DE CALIDAD DE TUBOS REUNIDOS
INDUSTRIAL
TUBOS REUNIDOS INDUSTRIAL (QUALITY CONTROL)

Alex Villarreal

P.O. :



TATA STEEL UK LIMITED
Park Street
Motherwell, ML1 1PU,
Tel: +44 (0)1698 268100
Fax: +44 (0)1698 266100 Ext. 227

AB1

INSPECTION CERTIFICATE

A02

In Accordance with EN10204 3.1
Product manufactured under a Management System approved to ISO 9001

Date 27/1/15		Z02	
Cert No. DALZ/15/01308150/1		A03	
Plate Ref PLATE REF 7171439		A06	
Tata Steel Ref. No. 685240		A08	
Customer Order No. R-PUR1013747-V3/251479		A07	
Contract No.: - 4/097		A09	
Specification/Product ASME SA516-2013/ASTM A516-2010 GR 70 (ASME SECTION II PART A/SA20)		B01/B02	
STEEL PLATE 40' X 8'1" X 1" Piece Weight 6.129Tonnes		B04-B12	
"N"- Normalized at +920C for 44 mins.		7-3-15	

Customer NORTH SHORE - TATA STEEL INT (AMERICAS) INC 475 N MARTINGALE ROAD SUITE 400 SCHENEBURG IL 60173 USA (INCLUDING PUERTO RICO)		A04	
CST: 3143589		A06	
Inspection OWN		A10	
Configuration NORTH SHORE - TATA STEEL INT (AMERICAS) INC CPR HOUSTON HOUSTON USA		A11	

ORDER MARKS :- 68524/251479/MADE IN UK/ HOU STON

B06A10 DL

ITEM	QTY	L-Longitudinal	T-Transverse	Z-Through Thickness	S-Side Surface	M-Mid-Thickness	Q-Quarter Thickness	TH-Third Thickness	BS-Sheet Surface	A-Supply Condition	N-Normalized	SR-Sheet Reduced	SA-Sheet Aged	C70
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ANALYSIS %														
Specification														
Cast/Heat														
Specification														

TESTED BY PCN LEVEL 1 (MIN) OPERATOR TO ASTM A578 LEVEL B - SATISFACTORY
Fully Killed Fine Grain Steel
Made and Manufactured in the UK
Plates manufactured to PED 2014/68/EU Annex 1 Chapter 4.3
Complies with NACE MR0175/ISO 15156-2:2009 Annex A Clause 2.1.2 and NACE MR0103:2012 clause 2.1.4

Robax

R.J.Preston, Test House Manager, Southbury

ATLANTIC CLOVER

All original inspection certificates issued by Tata Steel UK Limited will contain either an embossed stamp, or be incorporated with a Tata Steel UK Limited information logo, or a combination of both. Any recipient of a copy of a Tata Steel UK Limited Inspection Certificate without either the stamp or watermarking should ensure from the supplier that it is a true and accurate reproduction of the original. Company Registration Number 02280906

On behalf of Tata Steel UK Limited, the manufacturer.
This certificate is certified by Tata Steel UK Limited and comply with the requirements of the Product Description.

ORDER NUMBER 054857 CUSTOMER ORDER NUMBER 97961 DATE 05/14/12 21 00 SPECIAL METALS INC 1/4 X .467 WALL SA-105 97S OKLAHOMA CITY OK USA 73143 SPECIAL METALS INC 6406 S. EASTERN AVENUE OKLAHOMA CITY OK 73149

ROUTING COLLECT/OPEN TOP/TARPEL/FOB S LYON MI/*RTG BELOW CUST PU

ANALYSIS	SHAPE	PRODUCT	FG	ANNEAL	REQUESTED
1026	ROUND	COLD DRAWN		NORMALIZED	09/07/12
SEAMLESS	SPECIFICATION	CMST	DESCRIPTION	PROMISE	
	A105/A519		CD CARBON MECHANICAL	09/07/12	

SPECIAL INSTRUCTIONS
OIL CHEM/PHYS/ASTM A105/ASME SA105. SUL .020 MAX. MUST MEET NACE MRO 175-97, MRO 103-2010 SEC. 2.1.1-2.1.7, ISO 15156-2 A2, EN 10204 SEC 3.1, 4.1, 4.2. MK W/MST, SIZE, CR, CUST NAME, PO#, SPEC, HT#, T/R TO INCL COMPLETE CHEM (INCL UNSPECIFIED ELEMENTS) PHYS, HBW, GRAIN SIZE GUARANTEED FINISH BORE SIZE .921". *RTG-CERRI/405-677-7700/X-105.

ITEM	QUANTITY	O.D.	I.D.	WALL	LENGTH	WT/FT	WEIGHT	
		1.250		.467 AVG		6.399		09:44 09/06

ITEM	BALE	--BALE--				ITEM	PART
NUM	NUM	PCS	FTG	HEAT NO.	LENGTH	STATUS	NUMBER
1	1 2	40	553	000095287	RAND 12'-17'	COM	705787
1	2 2	44	610	000095287	RAND 12'-17'	COM	705787
1	3 2	42	580	000095287	RAND 12'-17'	COM	705787
1	4 2	42	580	000095287	RAND 12'-17'	COM	705787
1	5 2	40	551	000095287	RAND 12'-17'	COM	705787
1	6 2	42	578	000095287	RAND 12'-17'	COM	705787

HEAT NO.	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	Al	REMARKS
000095287	.250	.340	.010	.017	.250	.140	.120	.060	.160	.020	EF TIME

HEAT NO.	ULT. STR. PSI	YIELD, PSI	% ELONG 2"	HARDNESS	HYDRO TEST PSI	ULTRA SONIC %	EDDY CURRENT	
000095287	76,869	50,415	34.4	HBW 146-156			OK	
					BEND	FLATTEN	FLARE	REV. FLATTEN

NO WELD REPAIR HAS BEEN PERFORMED
NORMALIZED @ 1650F FOR 24 MINUTES
TENSILE: 1/2" STRIP LONGITUDINAL
V .003
GRAIN SIZE 7-8 TPC
371199 STK

✓ ITEM 3/4" 6000# X 3" TOE COMP
✓ HEAT CODE 97S

We hereby certify that the reported correct according to Michigan Seamle tests and those of its suppliers.

COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV GL = ISO 9001 = = ISO 14001 =	 METALFAR PRODOTTI INDUSTRIALI SPA 23861 CESANA BRIANZA (LC) - ITALY VIA G. PARINI, 28 PHONE + 39 031 655441 - FAX +39 031 655149 certificate@metalfaritaly.com	COMPANY WITH MANAGEMENT SYSTEM CERTIFIED BY DNV GL = ISO 9001 = = ISO 14001 =
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INSPECTION CERTIFICATE EN 10204:2004 / 3.1 ^{A02} Nr ^{A01} 2016-C_MFF-04605 Data / Dated 19.11.2016 ^{A03}

CONTINENTAL FLANGES & FITTINGS ITALIA SPA VIA VOLONTARI DELLA LIBERTA' 1 22036 ERBA CO IT	Ordine / PO 992 Item 020 DDT / Delivery note 2016-3E301-0004051 Packing List Fattura / Invoice Ns. rif. / Our ref. 2016-3E201-0003683-0017
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Dest. CONTINENTAL FLANGES & FITTINGS ITALIA SpA VIA MAGNI, 113 (FRAZ. CARPANEA) 22044 INVERIGO CO	
--	--

Cod. colore ^{B07} Heat Code	Nr. colore ^{B07} Heat Nr 15/40095	Quantità ^{B04} Quantity 23,00	Descrizione ^{B02 - (B03 - B11)} Description W/N 300 RF 3" 160 A105N
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Mat. in acc. a / Mat. in acc. to ^{B02} ASTM A105M - 14, ASME SA105M-15 ASME CODE SECT. II, PART A, ED. 2015
NACE MR-0175/2015 ISO 15156
NACE MR-0103/2012
Q.A.S. IN ACCORD WITH PRESS. EQUIPM. DIRECT. 2014/68/EU (PED) ANNEX I, PARAGRAPH 4.3
CERT. 4687-2014-CE-ITA-ACCREDIA

Elementi / Elements ^(C71 - C75)	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,195	0,210	1,110	0,009	0,015	0,110	0,060	0,010	0,016	0,130	0,002	0,001	0,009
	Al	B	Ca						CE LF	CE SF	F1	F2	PREN
LADLE ANALYSIS	0,025	0,000	0,002						0,417	0,360	0,312	0,120	-
CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE SF=C+(Mn/6) F1=Cu+Ni+Cr+Mo+V F2=Cr+Mo													
Provetta ^{C10} Test specimen	Forma ^{C10} Shape	Temperatura ^{C10} °C ^{C03}	Sforzo di snervamento > 0,2% ^{C11} Yield Strength > 0,2%		Sforzo di snervamento > 1,0% ^{C11} Yield Strength > 1,0%		Rottura ^{C12} Tensile	Allungamento ^{C13} Elongation		Contrazione ^{C15} Reduction of area			
Sez/Sect mm2 L. mm	1=O - 2=□		MPa		MPa		MPa	%		%			
126,60 50,80	1	20	365,0		-		529,0	30,0		59,0			

DUREZZA / HARDNESS ^{C17}		RESILIENZA / IMPACT TEST					
HBW	Tipo/Type ^{C10}	Provetta / Test Specimen	°C ^{C03}	1-Joule ^{C42}	2-Joule ^{C42}	3-Joule ^{C42}	Media/Average ^{C43}
154,0 - 158,0	KV	10x10 mm	-10	54	60	48	54,0

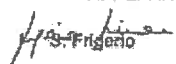
Treat. Term. / Heat treatment ^{C17} NORMALIZED AT 520 °C - COOLED IN STILL AIR ELECTRIC FURNACE

Dim in acc. a / Dim. acc. to ^{B14} ASME/ANSI B16.5 -2013
ASME/ANSI B36.10M -2015
ASME/ANSI B16.25 -2012

Finitura / Roughness 125/250 MICROINCH AARH

Marcatura in acc. ^{B24} Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine Origin of Steel	ITALY
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Note / Notes 100% MANUFACTURED IN ITALY
MANUFACTURING IN ACCORDANCE WITH ORDER AND SPECIFICATION
COMMESSA 5454

UFFICIO CONTROLLO QUALITA' ^{C25} QUALITY CONTROL DEPARTMENT 	ENTE UFFICIALE DI COLLAUDO ^{C26} INSPECTION AUTHORITY	MARCHIO PRODUZIONE ^{C21} MANUFACTURER'S SYMBOL 
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Page 1 - 1

CUSTOMER	P.D.	ITEM No	DESCRIPTION	Q.TY
NORTH SORE	279809	69	FLANGES W/N 300 RF 3" 160 A105N	23

49230



TUBOS REUNIDOS, S.A. - AMURRIO

EN 10204:2004 / 3.1

CERTIFICADO DE CALIDAD
MILL TEST CERTIFICATE

Nº 0000194702 / 1 Rev. 1

PAG. 1/ 3

CLIENTE:
CUSTOMERPEDIDO/PARTIDA: 80696
P. ORDER / ITEM 8.PRODUCTO: TUBERIA SIN SOLDADURA LAMINADA EN CALIENTE
ARTICLE HOT FINISHED SEAMLESS TUBESREF. FABRICA: 0300009716
WORK ORDER 000080EXTREMOS: LISOS A ESCUADRA
ENDS SQUARE CUT PLAIN ENDPROTECCION SUPERF: LACA SECA EXTERIOR
EXT. COATING NO DRY LACQUEREDNORMA / GRADO: ASTM/ASME A/SA 333/A 333M-05
APL. STANDARD AND GRADE GR. 1/6ESPEC. ADICIONALES: NACE MR0175/ISO 15156. ED 2003
ADDITIONAL. SPECS NACE MR0103.2003.PROCESO FUSION: HORNO ELECTRICO
MELTING PROCESS ELECTRIC FURNACE // FULLY KILLEDREQUISITOS SUP.:
SUP. REQUIREMENTSFABRICACION DE PALANQUILLA: COLADA CONTINUA
BILLETS MANUFACTURE CONTINUOUS CASTINGDIMENSIONES: 3" NB X SCH 160 X
DIMENSIONS 35-42 FT.MARCAS: ESTAMPADO
MARKING DIG STAMPING

SPAIN

PINTADO STENCILLED

TR ASTM/ASME A/SA333 GR. 1/6 H.F.S. 3" NPS SCH 160 LT -60 F HN (COLAD
A)

CODIGO COLOR COLOUR CODE

TRAT. TERMICO: NORMALIZADO. HORNO CONTINUO. / NORMALIZED. (CONT. FURNACE).
HEAT TREATMENT 900 °C 11 MIN

LISTA DE BULTOS / PACKING LIST: 093304

DESCRIPCION SUMINISTRO / DESCRIPTION OF DELIVERY

ITEM FABRICA T.R. ITEM	ITEM CLIENTE CLIENTS ITEM	LONG. INDIV (F) INDIVIDUAL LENGTH	COLADA CAST NR.	Nº TUBOS QUANTITY	LONG. TOTAL (F) LENGTH	PESO (KG) WEIGHT	PROBETAS Nº SPECIMEN NR.
000080	8.	35.0000 - 42.0000	101311 ✓	22	799.869	5120	1 - 2
TOTAL				22	799.869	5120	

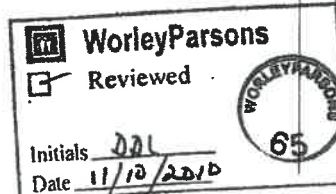
TUBOS REUNIDOS GARANTIZA QUE TODOS LOS TUBOS CUBIERTOS POR ESTE CERTIFICADO CUMPLEN LOS REQUISITOS DEL PEDIDO Y CON LAS ESPECIFICACIONES ARRIBA MENCIONADAS.
TUBOS REUNIDOS CERTIFY THAT ALL THE TUBES COVERED BY THIS CERTIFICATE COMPLY WITH ORDER REQUIREMENTS AND ABOVE MENTIONED SPECIFICATIONS

CONTROL DE CALIDAD DE TUBOS REUNIDOS
TUBOS REUNIDOS QUALITY CONTROL

AMURRIO 23.09.2009

J. URNUTIKOETXEA

K.B.: LS





TUBOS REUNIDOS, S.A. - AMURRIO

EN 10204:2004 / 3.1

CERTIFICADO DE CALIDAD
MILL TEST CERTIFICATE



Nº 0000194702 / 1 Rev. 1

PAG. 2 / 3

ENSAYOS NO DESTRUCTIVOS / N.D.T

ENSAYO / TEST	%CONTROL/TEST RATE (%)	REQUISITOS/REQUIREMENT	RESULTADO/RESULT
VISUAL Y DIMENSIONAL / VISUAL & DIMENSIONAL INSP.	100%		O.K.
P.HIDROSTATICA / HYDROTEST	100%	2500,0 PSI 5 SEC.	O.K.
CORRIENTES INDUCIDAS / INDY CURRENTS	100%	ASTM A999.04A.	O.K.

ENSAYOS TECNOLOGICOS Y METALURGICOS / TECHNOLOGICAL AND METALLURGICAL TEST

APLASTADO / FLATTENING AC/ A 333 -OK

ANALISIS DE COLADA / CAST ANALYSIS

	C	Mn	Si	P	S	Cr	Ni	Mo	Cu	V	Al	Sn	Ti	Nb	C.B.
MIN.	0,29	0,10													0,41
MAX.	0,20	1,30		0,025	0,025										
101311	0,13	1,09	0,30	0,015	0,001	0,100	0,080	0,020	0,200	0,004	0,030	0,010	0,020	0,005	0,36

ANALISIS DE PRODUCTO / PRODUCT ANALYSIS

	C	Mn	Si	P	S	Cr	Ni	Mo	Cu	V	Al	Sn	Ti	Nb	C.B.
MIN.	0,29	0,10													0,41
MAX.	0,20	1,30		0,025	0,025										
101311	0,14	1,07	0,29	0,020	0,003	0,110	0,080	0,030	0,220	0,005	0,023	0,009	0,019	0,005	0,37
101311	0,14	1,05	0,30	0,020	0,003	0,110	0,090	0,030	0,220	0,005	0,022	0,011	0,015	0,005	0,36

ENSAYO DE TRACCION
TENSILE TEST

ENSAYO DE IMPACTO - CHARPY V
IMPACT TEST

Nº L/T TP	DIMENSION	L. ELAST. YIELD POINT (Psi)	R. TRACC. T. STRENGTH (Psi)	ALARG. BLONG. ELONG. (%)(****)	DUREZA LT (HRB)	DIMENS (Inches)	Tª (°F)	RESILIENCIA IMPACT TEST (Ft.Lb)	A. DUCTIL. SHEAR AREA (%)	ESTRICCION RED. AREA (%)
		35000	60000			0.394 0.394	-60	12.0 15.0		
1 L P	0.984 x 0.461	43148	67621	42	77	0.394 0.394	-60	21.7 28.9 31.8		
2 L P	0.988 x 0.437	44793	66976	42	77					

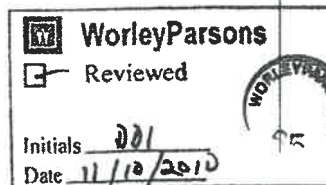
(*) : L = LONGITUDINAL // T = TRANSVERSAL
(**) : T = Full size tube // P = Strip specimen

CONTROL DE CALIDAD DE TUBOS REUNIDOS
TUBOS REUNIDOS QUALITY CONTROL

I. URRUTIKOETXEA

K : 15

AMURRIO 23.09.2009





TUBOS REUNIDOS, S.A. - AMURRIO

EN 10204:2004 / 3.1

CERTIFICADO DE CALIDAD
MILL TEST CERTIFICATE



Nº 0000194702 /1 Rev. 1

PAG. 3/ 3

ENSAYO DE TRACCION
TENSILE TEST

ENSAYO DE IMPACTO - CHARPY V
IMPACT TEST

Nº	L/T T ¹	DIMENSION	L.BLAST. YIELD POINT (Psi) (****)	R.TRACC. T-STRENGTH (Psi)	ALARG. ELONG. (%) (****)	DUREZA HARDNESS (HRB)	L/T (")	DIMENS (Inches)	T ² (°F)	RESILIHNCIA IMPACT TEST (Ft.Lb)	A.DUCTIL SHEAR AREA (%)	ESTRICCION RED. AREA (%)
			35000	60000				0.394 0.394	-60	12.0 15.0		

(****): yield point (0.2%)

(****): Lo = 2" (50,8 mm)

ANEXO / ANNEX

ACC.

EDG-333 REV.0

EDG-GEN-1 REV.0

LATERAL EXPANSION: 1.3 MM

SHEAR AREA : 90 - 95 - 90

"NO WELD REPAIR"

AMURRIO 23.09.2009

CONTROL DE CALIDAD DE TUBOS REUNIDOS
TUBOS REUNIDOS QUALITY CONTROL

I. URRUTIKORTXA

15

	WorleyParsons
☐	Reviewed
Initials	DA
Date	11/10/2009



UNITED STATES STEEL CORPORATION

TUBULAR PRODUCTS
CERTIFIED TEST REPORT

DATE: 12/29/14
TIME: 04:24:14
SERIAL NO: L0054629
EBS NO: 2000851763 1

(IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 "Type 3.1")

MILL ORDER/ITEM NO DR91419 01	SHIPPER'S NO. R03925	P.O. NUMBER 044559 2014-09-02	VEHICLE ID NS201370
SOLD TO ADDRESS TUBULAR STEEL INC ATTN ACCTS PAYABLE 1031 EXECUTIVE PARKWAY DR SAINT LOUIS MO 63141-6339		MAIL TO ADDRESS TUBULAR STEEL INC ATTN ACCTS PAYABLE 1031 EXECUTIVE PARKWAY DR SAINT LOUIS MO 63141-6339	
MEMOR UNITED STATES STEEL CORP LORAIN TUBULAR OPERATIONS 2199 EAST 28TH ST. LORAIN, OH 44055			
SPECIFICATION AND GRADE SMIS STANDARD AND LINE PIPE API 5L 45TH EDITION DATED 12/1/12 GRADE B/X42 R N OR Q PSL-1, ASTM A106-14 GRADE B/C, ASTM A53-12 GRADE B, ASME SA106-2013 GRADE B/C, ASME SA53-2013 GRADE B REG MILL COAT PE BEV 30 DEGREE APPLICABLE REQUIREMENTS OF NACE MR0103-2012 ED AND NACE MR0175/ISO 15156-2 2009 ED			
10-10-15			
MATERIAL COND: AS ROLLED	O.D.: 3.500 (88.900)		WALL: 0.438 (11.125)
PRODUCT IDENTIFICATION	TENSILE TEST TYPE/ ORIENTATION	YIELD PSI MIN: 42100 MAX: 52500	ELONG % (IN 2") MIN: 25.0 MAX: 35.0
LAL1389	STRIP/L/B	AR **	5
T - TRANSVERSE NM - NORMALIZED		CR - CR	W - WELD
C - C		NI - NI	TI - TI
MN - MN		AL - AL	CO - CO
P - P		MO - MO	CE - CE
S - S		CU - CU	
Q - Q		TR - THERMO MECHANICAL ROLLED	
R - R			
T - T			
V - V			
W - W			
X - X			
Y - Y			
Z - Z			
AA - AA			
AB - AB			
AC - AC			
AD - AD			
AE - AE			
AF - AF			
AG - AG			
AH - AH			
AI - AI			
AJ - AJ			
AK - AK			
AL - AL			
AM - AM			
AN - AN			
AO - AO			
AP - AP			
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AS - AS			
AT - AT			
AU - AU			
AV - AV			
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AX - AX			
AY - AY			
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BC - BC			
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BT - BT			
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BV - BV			
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CH - CH			
CI - CI			
CJ - CJ			
CK - CK			
CL - CL			
CM - CM			
CN - CN			
CO - CO			
CP - CP			
CQ - CQ			
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CT - CT			
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CV - CV			
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PS - PS			
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PU - PU			
PV - PV			
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PX - PX			
PY - PY			
PZ - PZ			
QA - QA			
QB - QB			
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SH - SH			
SI - SI			
SJ - SJ			</



UNITED STATES STEEL CORPORATION

TUBULAR PRODUCTS
CERTIFIED TEST REPORT

(IN ACCORDANCE WITH ISO 10474/EN10214/DIN5049 "Type 3.1")

DATE: 12/29/14
TIME: 04:24:14
SERIAL NO: L0054629
EBB NO: 2000851763 1

MATERIAL COND: DR91419 01		SHIPPER'S NO: R03925		O.D.: 044559 2014-09-02		P.O. NUMBER		0019791			
AS ROLLED		O.D.: 3.500 (88.900)		WALL: 0.438 (11.125)		In (mm)		In (mm)			
PRODUCT IDENTIFICATION	FLAT	BEND	GRAIN SIZE	MIN COLLAPSE	DIR	TEST LOC	TEMP	SIZE	CHARPY V-NOTCH IMPACT TESTING		
									TEST COND	FT/LB	FT/LB
LA1389	OK						DEG		1	2	3
									AVG	1	2
** END OF DATA THIS SHEET **											
LEGEND											
L - LONGITUDINAL				T - TRANSVERSE				B - BODY			
				W - WELD				HAZ - HEAT AFFECTED ZONE			
TEST / INSPECTION				TESTING / INSPECTION INFORMATION				RESULTS / COMMENTS			
FULL LENGTH VISUAL				YES							
FULL LENGTH EMI				X							
FULL LENGTH MPI								OD --- OOID --- L --- LT ---			
FULL LENGTH UT								ID --- OOID --- L --- LT ---			
END AREA INSPECTION (PLAIN END)								MPI --- UT ---			
SPECIAL END AREA (SEA) INSP								MPI --- UT ---			
FULL LENGTH DRIFT								DRIFT MANDREL SIZE: ---			
ADDITIONAL NOTES/COMMENTS											
MELTED AND MANUFACTURED IN THE USA. NO REPAIRS BY WELDING, NO MERCURY COMPOUNDS ARE ADDED TO THE STEEL AND ALL MERCURY BEARING EQUIPMENT IS PROTECTED BY A DOUBLE BOUNDARY OF CONTAINMENT. MANUFACTURED IN AN ISO 9001 CERTIFIED FACILITY - CERTIFICATE #32022.											

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, SAMPLED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS THE REQUIREMENTS IN SUCH RESPECTS.

PREPARED BY THE OFFICE OF: BRAD KOURY - MANAGER, Q.A.

DATE 12/29/14



UNITED STATES STEEL CORPORATION

TUBULAR PRODUCTS
ADDITIONAL COMMENTS SHEET

DATE: 12/29/14
TIME: 04:24:15
PAGE: 1 OF 1

MILL ORDER ITEM NO DR91419 01	SHIPPER'S NO. TUBULAR STEEL INC ATTN ACCTS PAYABLE 1031 EXECUTIVE PARKWAY DR SAINT LOUIS MO 63141-6339	P.O. NUMBER 044559 2014-09-02	HEAT MAIL TO ADDRESS	SERIAL NUMBER: L0054629 VENDOR UNITED STATES STEEL CORP LORAIN TUBULAR OPERATIONS 2199 EAST 30TH ST. LORAIN, OH 44055
HEAT LA1389 - MELTED AT: REPUBLIC ENGINEERED PRODUCTS, LORAIN, OH 44055-1883 END OF DATA				



BEBITZ



FLANSCHENWERK BEBITZ GmbH

Lebendorfer Str.1 - 06420 Könnern OT Bebitz / GERMANY (A01) Tel. +49 34691 40 0-Fax +49 3469140 329-Email: flanges@bebitz.de

Bebitz Flanges Works Pvt. Ltd.-Survey No. 140/2, Saravali Boisar - Taluka Palghar - Thane 401501 Maharashtra, INDIA - Email: quality@bebitz.in

Bebitz U.S.A., INC. 100 Quentin Roosevelt BLVD-Garden City, NY11530/USA Tel. +1-516-2808380-Fax +1-516-2808382-Email: bebitzusa@bebitz.de

Abnahmeprüfzeugnis 3.1 / Inspection certificate 3.1 / Certificat de reception 3.1 nach (A02) / acc. DIN EN 10204 : 2005 Nr. (A03) / No.16-13027 Datum (Z02) / Date 25.11.2016

Zeichen des Herstellers (A04)
Manufacturer's brand



Stempel des Abnehmers (Z03)
Stamp of the testing engineer



Überprüft als Hersteller nach AD-Merkblatt W0 / TRD100 und VdTÜV Werkstoffblätter 350/3, 354, 399. / Approved as manufacturer acc. AD-Merkblatt W0 / TRD100 and VdTÜV Material Sheets 350/3, 354, 399.

Zertifiziert nach DGR 97/23/EG durch TÜV CERT Zertifizierungsst. für Druckgeräte der TÜV NORD GmbH Co KG, Benannte Stelle Nr. 0045. / Certified acc. to PED 97/23/EC, certifying body for pressure equipment TÜV NORD GmbH Co KG, registration no. 0045.

Besteller Allied Fitting Corporation
(A06) 7200 Mykawa Road
Customer HOUSTON, TX 77033

Bestell-Nr (A07) / Order-No. 100616BG
Auftrag (A08) / Order 3621018
Lieferschein / Delivery No. 3632171
Position (B07.1) / Item 10

Stck (B08) Bezeichnung (B01; B09 - B11)

Quantity Product

28 18 inch Welding Neck Flange 300 lbs XS raised face

Customer ID: L3WRX18-BG

Schmelze/Prüflos (B07)
Heat no./Test no.

600572/1

Material A 105N - ASTM A105M-14 / ASME SA-105M

(B02; B05) normalized 900 °C, air cooled

Anford. ASME B 16.5-2013

(B03) NACE MR0175-2011 / MR0103-2010 - DIN EN ISO 15156-2:2015

Require- 2015 ASME Boiler & Pressure Vessel Code - Section II Part A; ASTM A961-14
ments

Schmelzenanalyse (C71 - C92) / Ladle analysis

Erschmelzung (C70) / Melting process E

C	Si	Mn	P	S	Cr	Ni	Ti	Mo	Nb	V	N	Cu	Al	CEV
0,190	0,19	0,83	0,006	0,004	0,12	0,08		0,02	0,001	0,002		0,13	0,037	0,37

Mechanische Prüfungen / Mechanical tests

$$CEV = C + \frac{Mn}{6} + \frac{V + Mo + Cr}{5} + \frac{Ni + Cu}{15} \quad PREN = Cr + 3,3 \times Mo + 16 \times N$$

Probenlage (C02): T / Position of Specimen: T Zugversuch / Tensile Test - ASTM A 370						Kerbschlagbiegeversuch / Impact test DIN EN ISO 148-1 (V-Kerb / V-notch)				Härte (C32) Hardness ISO 6506-1	
Temp (C03) °C	Streckgrenze (C11) / Yield 0,2% MPa (N/mm²)	1,0% MPa (N/mm²)	Zugfestigkeit (C12) Tensile MPa (N/mm²)	Dehnung (C13) Elongation %	Einschnürr. Red. of area %	Temp. (C03) °C	Einzelwerte (C42) Single values J	MW (C43) Average J		HBW 2,5/187,5	
20	min 250 max		485	22,0 5d ₀	30 4d ₀	20				137 187	
20	349		497	32,7	40,9	20	97 110 118	108,3		148	
20	346		495	33,5	41,9	20	100 108 115	107,7		146	
20	342		489	35,9	44,9	20	109 117 121	115,7		143	
20	340		488	36,3	40,9	20	107 115 119	113,7		143	

Country of Melting: Germany - Country of Origin: Germany

Am Material wurden keine Reparaturschweißungen vorgenommen. / No welding repair on the material.
Material ist nicht radioaktiv oder mit Quecksilber kontaminiert. / Material is free from radioactive or mercury contamination.
Sicht- und Maßprüfungen ohne Beanstandungen. (D01) / Visual and dimensional examinations without objections.
Die Anforderungen der Bestellung sind erfüllt. / The product meets the requirements of the order specifications.
Die Angaben in Klammern entsprechen den Vorgaben der DIN EN 10168 / Data in parentheses refer to DIN EN 10168.
APZ ist mit EDV erstellt und ohne Unterschrift gültig. / MTR was electronically generated and is valid without a signature.

R. Sparing

Abnahmebeauftragter des Herstellers (Z02) / Inspection Representative of the Manufacturer

DATE: 08/15/14
TIME: 04:22:36
SERIAL NO: L0051685
EBS NO: 2000765712 1

UNITED STATES STEEL CORPORATION
TUBULAR PRODUCTS
CERTIFIED TEST REPORT
(IN ACCORDANCE WITH ISO 10474/EN10204/DIN5040 "type 3.1")

SHIPPER NO: R01795
P.O. NUMBER: 1420795
VEHICLE ID: LT8184

PIPE DISTRIBUTORS INC
PO BOX 23237
HOUSTON TX 77228-3237

PIPE DISTRIBUTORS INC
MAIL TO ADDRESS
PO BOX 23237
HOUSTON TX 77228-3237

VENDOR
UNITED STATES STEEL CORP
LORAIN TUBULAR OPERATIONS
2199 EAST 28TH ST.
LORAIN, OH 44055

SPEIFICATION AND GRADE

SMLS STANDARD AND LINE PIPE API 5L 45TH EDITION DATED 12/1/12 GRADE B/X42 R N OR Q PSL-2, ASTM A106-14 GRADE B/C SPECIAL OD TOLERANCE, ASTM A53-12 GRADE B, ASME SA106-2013 GRADE B/C, ASME SA53-2013 GRADE B REG MILL COAT PE BEV 30 DEGREE APPLICABLE REQUIREMENTS OF NACE MR0103-2012 ED AND NACE MR0175/ISO 15156-2 2009 ED

MATERIAL COND: AS ROLLED

Q.D.: 18.000 (457.200) W.A.LL: 0.500 (12.700)

PRODUCT IDENTIFICATION	TENSILE TEST TYPE/ ORIENTATION	TEST COND.	GAUGE WIDTH IN	YIELD		TENSILE PSI	Y/T	ELONG % (IN 2")	HARDNESS SCALE	MIN HYDRO PSI	DWEL (SEC)
				MIN	MAX						
X84392	STRIP/L/B	AR	1.500	42100	55000	70000	0.93	29.0	1990	1990	5
		** END OF DATA THIS SHEET				77000	0.71	44.3			5

LEGEND: L - LONGITUDINAL U - UPSET

PRODUCT IDENTIFICATION	TYPE	T - TRANSVERSE NM - NORMALIZED				QT - QUENCH & TEMPERED SR - STRESS RELIEVED				AR - AS ROLLED TR - THERMO MECHANICAL ROLLED				B - BODY W - WELD				
		C	MIN	P	S	SH	CU	CR	NO	AL	N	V	B	T	CB	CO	CE*	
X84392	HEAT	20	103	008	006	26	02	01	07	01	035	03	0003	002	000			MAX .43
X84392	PROD	20	106	004	004	26	02	01	06	01	040	03	0000	001	002			.40
X84392	PROD	19	106	004	005	26	02	01	06	01	036	03	0000	001	002			.40
			** END OF DATA THIS SHEET **															.39

*CE IS BASED ON THE FOLLOWING EQUATION(S): C+Mn/6+Cr/5+Mo/5+V/5+Ni/15+Cu/15 (EUROPEAN CEV)

DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT. ELEMENTS REPORTED IN MASS FRACTION (%)

UNITED STATES STEEL CORPORATION
 TUBULAR PRODUCTS
 CERTIFIED TEST REPORT
 (IN ACCORDANCE WITH ISO 10474/EN10204/JIS54048 "type 3.1")

DATE: 08/15/14
 TIME: 04:22:36
 SERIAL NO: 10051685
 EHS NO: 2000765712 1

MILL ORDER ITEM NO: DR90564 01
 SHIPPERS NO: R01795
 P.O. NUMBER: 1420795
 O.D.: 18.000 (457.200)
 WALL: 0.500 (12.700)
 Ls (mm): 100

PRODUCT IDENTIFICATION	FLAT	BEND	GRAIN SIZE	MIN COLLAPSE	DIR	TEST LOC	TEMP	SIZE	TEST COND.	CHARPY V-NOTCH IMPACT TESTING			% SHEAR			AVG
										1	2	3	1	2	3	
X84392	OK			** END OF DATA THIS SHEET **	T	B	+ 32	3/4	AR	102	100	104	100	100	100	100

LEGEND: L - LONGITUDINAL T - TRANSVERSE B - BODY W - WELD HAZ - HEAT AFFECTED ZONE

TEST / INSPECTION	YES	RESULTS / COMMENTS
FULL LENGTH VISUAL	X	
FULL LENGTH EM	X	
FULL LENGTH MPI		OD X OMD L L/T X 10.0% NOTCH
FULL LENGTH UT	X	ID X OVID L X L/T 10.0% NOTCH
END AREA INSPECTION (PLAIN END)	X	MPI X UT
SPECIAL END AREA (SEA) INSP		MPI UT
FULL LENGTH DRIFT		DRIFT MANDEL SIZE

ADDITIONAL NOTES/COMMENTS:
 MELTED AND MANUFACTURED IN THE USA, NO REPAIRS BY WELDING, NO MERCURY COMPOUNDS ARE ADDED TO THE STEEL AND ALL MERCURY BEARING EQUIPMENT IS PROTECTED BY A DOUBLE BOUNDARY OF CONTAINMENT. MANUFACTURED IN AN ISO 9001 CERTIFIED FACILITY - CERTIFICATE #32022.

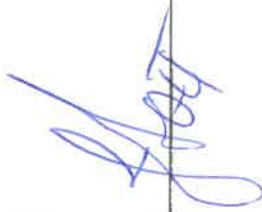
THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, SAMPLED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FILLS THE REQUIREMENTS IN SUCH RESPECTS.

PREPARED BY THE OFFICE OF: BRAD KOURY - MANAGER, Q.A.

DATE: 08/15/14

Handwritten signature

UNITED STATES STEEL CORPORATION		TUBULAR PRODUCTS		DATE: 08/15/14 TIME: 04:22:37 PAGE: 1 OF 1	
ADDITIONAL COMMENTS SHEET		P.O. NUMBER		HEAT	
MILL ORDER ITEM NO DR90564 01	SHIPPERS NO.	1420795	MAIL TO ADDRESS	SERIAL NUMBER: L0051685	VENDOR UNITED STATES STEEL CORP LORAIN TUBULAR OPERATIONS 2199 EAST 28TH ST. LORAIN, OH 44055
SOLD TO ADDRESS PIPE DISTRIBUTORS INC PO BOX 23237 HOUSTON TX 77228-3237					
HEAT X84392 - MELTED AT: FAIRFIELD WORKS, FAIRFIELD, AL 35064 END OF DATA					



TEST CERTIFICATE

SHIP TO: ARCELORMITTAL PLATE LLC
BWFS INDUSTRIES LLC
5637 ETHELINE DR
HOUSTON TX 77039

PAGE NO: 01 OF 02
FILE NO: 0838-01-01
MILL ORDER NO: 25706-001
MELT NO: U0295
SLAB NO: 4
DATE: 02/24/14

SOLD TO:
BWFS INDUSTRIES LLC
5637 ETHELINE DR
HOUSTON TX 77039

SEND TO:

01-C

STEEL PLATE DIMENSIONS / DESCRIPTION

TOTAL QTY	GAUGE	WIDTH	LENGTH	DESCRIPTION	PIECE WEIGHT
1	1.25"	96"	480"	RECTANGLE	16335#

CUSTOMER INFORMATION

CUSTOMER PO: 53458

PART NO. 2

SPECIFICATION(S)

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

ASME SA516 REV ED YR 13 GR 60
THE MANAGEMENT SYSTEMS FOR MANUFACTURE OF THIS PRODUCT ARE CERTIFIED TO ISO 9001:2008 (CERTIFICATE NO. 30130) AND ISO 14001 (CERTIFICATE NO. 009496).

CHEMICAL COMPOSITION

MELT:U0295	C	MN	P	S	CU	SI	NI	CR	MO
	.17	1.05	.004	.001	.10	.21	.04	.04	.01
MELT:U0295	V	TI	B	AL	CB	O	CEF		
	.001	.001	.0001	.014	.001	.0010	.36		

CARBON EQUIVALENT FORMULA (CEF)

$$CEF = C + (MN * .1667) + ((CR + MO + V) * .2000) + ((CU + NI) * .0667)$$

MANUFACTURE

FINELINE - VACUUM DEGASSED - MCQUAID-EHN GRAIN SIZE PER E112 - 7-8

WE HEREBY CERTIFY THE ABOVE
INFORMATION IS CORRECT:

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

Elinore Zaplitny
SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

TEST CERTIFICATE

PAGE NO: 02 OF 02
FILE NO: 0838-01-01
MILL ORDER NO: 25706-001
MELT NO: U0295
SLAB NO: 4
DATE: 02/24/14

HEAT TREAT CONDITION

MATL OR TEST	HEAT TREAT DESCRIPTION	MAX HEAT RATE PER HOUR	NOM TEMP	HOLD MINS	COOL MTHD	MAX COOL RATE PER HOUR
PL/TEST TEST ONLY	NORMALIZE STRESS RELIEVE	290F	1650F 1175F	31 210	AIR COOL FURN.COOL	360F

MECHANICAL PROPERTIES

SLAB - 4 - BRINELL PER E110 (HBW) - 183 - TEST

TENSILE PROPERTIES

SLAB NO.	LOC	DIR	YIELD STRENGTH PSI X 100	TENSILE STRENGTH PSI X 100	ELONGATION GAGE LGTH	%
4	BOT.	TRANS.	483	704	2.00"	32.0

CORROSION TESTS

HYDROGEN INDUCED CRACKING TEST SATISFACTORY

GENERAL INFORMATION

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
MATERIAL HAS BEEN VACUUM DEGASSED AND CALCIUM TREATED
FOR SULFIDE SHAPE CONTROL.
FINELINE MOD FOR SULPHUR
BRINELL TESTING WAS PERFORMED USING A CARBIDE BALL (HBW).
MERCURY OR MERCURY COMPOUNDS ARE NOT USED IN THE
MANUFACTURE OF ARCELORMITTAL PLATE LLC PRODUCTS.
ACID SOLUBLE ALUMINUM
FOR MORE INFORMATION AND PROCESSING GUIDELINES, REFER TO
WWW.ARCELORMITTAL.COM/PLATEINFORMATION

B/L #43284 BESL TRANSFER CO.

WE HEREBY CERTIFY THE ABOVE
INFORMATION IS CORRECT:

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


SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

TEST CERTIFICATE

UT NON-DESTRUCTIVE TESTING REPORT

DATE: 02/11/2014

CUSTOMER: BWFS - TX ORDER/ITEM NO: 25706 - 001

INSPECTOR: PAUL CARPENTER (LEVEL I SNT-TC-1A)

MATERIAL SPECIFICATION: ASME SA516 ED 13 60

CUST NO: 0838-01-01 PURCH ORD NO: 53458

PART NO: 2 WITNESSED BY:

NDE SPEC: SA578 L-C S-1

RECORDABLE INDICATIONS: N

GAUGE: 1.250000 WIDTH: 96.000000 LENGTH: 480.000000 UT: SB

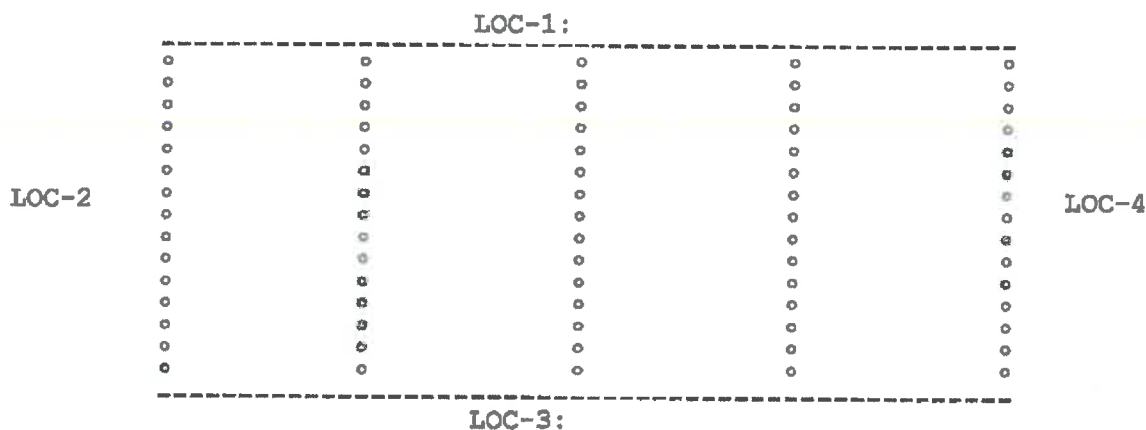
DIV-LTR: X CHARGE: 50062 POS: 04 PATT: 001 MELT: U0295 SLAB: 04 QTY: 1

COUPLANT: SOAP&WATER TYPE OF SURFACE: AS ROLLED MARK NO:

EQUIPMENT USED: OLYMPUS EP-600 SERIAL NUM: 300 CALIB DATE: 04/25/2014

METHOD: CONTACT AMPLITUDE: 75 GRID REF: 100%

TRANSDUCER: AEROTECH SIZE: 1.000 FREQ: 2.2500



HEREBY CERTIFY THAT THE ABOVE MATERIAL MEETS THE NON-DESTRUCTIVE TEST REQUIREMENTS FOR THE ABOVE SPECIFICATION. KNOWINGLY OR WILLINGLY RECORDING FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS ON ENTRIES ON THIS DOCUMENT MAY BE PUNISHED AS A FELONY UNDER FEDERAL STATUTES INCLUDING FEDERAL LAW, TITLE 18, CHAPTER 47.

MICHAEL HARTZ

INSPECTION SUPERVISOR
LEVEL II SNT-TC-1A

WE HEREBY CERTIFY THE ABOVE
INFORMATION IS CORRECT:

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

Elinore Zaplitny
SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

boltex mfg. co., l.p.

4901 Oates Road Houston TX 77013
(713)675-9433 Fax: (713)672-6527

ORDER NUMBER	0143279
PO NUMBER	281723
ORDER DATE	12/19/16

MATERIAL TEST REPORT

S
O
L
D

NORTH SHORE STEEL
P O BOX 9940
HOUSTON TX 77213

S
H
I
P

NORTH SHORE STEEL - FITTINGS
12945 MARKET ST
HOUSTON TX 77015

ITEMS

Ln#	Qty	Description	Matl Spec	Heat Code	Mill Heat Number
004	87	2" 150 RF SO	SA105-14	S278	CM3066370
019	100	2" 300 RF BLIND	SA105-14	R480	CM3064465
028	16	10" 300 RF BLIND	SA105-14	N945	CM3066135
028	9	10" 300 RF BLIND	SA105-14	N945	CM3066135
035	5	18" 300 RF BLIND	SA105-14	X246	NUMM15101701
038	7	24" 150 RF BLIND	SA105-14	X394	ABS434039
038	7	24" 150 RF BLIND	SA105-14	X394	ABS434039

CHEMICAL PROPERTIES

Heat Code	C	Si	Mn	P	S	Cr	Al	Cu	Ni	Mo	V	Nb	Sn	N	CE
S278	0.190	0.240	1.010	0.014	0.017	0.100	0.001	0.280	0.080	0.019	0.002	0.002	0.013	0.000	0.000
R480	0.200	0.250	1.020	0.013	0.023	0.090	0.002	0.240	0.080	0.020	0.003	0.000	0.010	0.000	0.000
N945	0.200	0.220	0.970	0.012	0.019	0.070	0.001	0.250	0.060	0.016	0.003	0.002	0.008	0.000	0.000
N945	0.200	0.220	0.970	0.012	0.019	0.070	0.001	0.250	0.060	0.016	0.003	0.002	0.008	0.000	0.000
X246	0.180	0.190	1.180	0.010	0.000	0.100	0.025	0.180	0.100	0.020	0.019	0.005	0.006	0.009	0.000
X394	0.190	0.250	1.260	0.013	0.002	0.090	0.025	0.080	0.060	0.020	0.048	0.001	0.005	0.000	0.000
X394	0.190	0.250	1.260	0.013	0.002	0.090	0.025	0.080	0.060	0.020	0.048	0.001	0.005	0.000	0.000

PHYSICAL PROPERTIES

HEAT CODE	TENSL	YIELD	ELONG	RAA	HBM	CHARPY	FT-LBS	LAT EXPN	SHR FRACT	TEST TEMP
S278	82600	57600	30.40	59.37	163/167					
R480	83600	51900	30.60	66.25	163/167					
N945	79600	43000	37.70	67.67	159/159					
N945	79600	43000	37.70	67.67	159/159					
X246	82600	51400	30.30	68.99	167/167					
X394	78400	50900	35.00	76.55	170/187					
X394	78400	50900	35.00	76.55	170/187					

NOTES

HEAT CODE NOTE

S278
R480
N945
N945
X246
X394
X394

All products bearing the "BOLTEX" name or logo "B" with the heat number prefix listed on the legend below have been manufactured at our Houston, TX facilities from steel melted and forged in the U.S.A. All other products have been manufactured at our Houston, TX facilities.

AR = Arkansas

CM or SI = Commercial Metals Corp.

GER = Gerdau Steel

NU = Nucor Steel

RE = Republic Steel

TI = Timken Steel

WR = Warren Steel

We certify our flanges are capable of passing a hydrostatic test compatible with their rating and all test results and process information contained herein are correct and true as contained in company records. All flanges meet NACE MR0-175 and/or MR0-103 Latest Revision.

Our quality system has been registered by DNV-GL to ISO 9001, Certificate No.: 142240-2013-AQ-RVA. Test results comply with EN 10204-3.1. Our flanges satisfy the material requirements for PED 97/23/EC Annex 1-4.3.

Notwithstanding the absence of a signature, the organization submitting either a printed certificate or an EDI transmitted certificates is responsible for content or the report. (ASTM/A 961-04a Section 19.4)

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Quality Assurance Manager

boltex mfg. co., l.p.

4901 Oates Road Houston TX 77013
(713)675-9433 Fax: (713)672-6527

ORDER NUMBER 0143279

PO NUMBER 281723

ORDER DATE 12/19/16

MATERIAL TEST REPORT

S
O
L
D

NORTH SHORE STEEL
P O BOX 9940
HOUSTON TX 77213

S
H
I
P

NORTH SHORE STEEL - FITTINGS
12945 MARKET ST
HOUSTON TX 77015

ITEMS

Ln#	Qty	Description	Matl Spec	Heat Code	Mill Heat Number
051	100	2" 150 RF WN STD	SA105-14	4EP	CM3064235 DEVIATION
052	100	2" 150 RF WN XH	SA105-14	4EJ	CM3050301
053	100	2" 300 RF WN XH	SA105-14	R521	CM3065951
054	75	2" 300 RF WN SCH 160 ✓	SA105-14 ✓	R314 ✓	CM3053450
055	25	2" 600 RF WN STD	SA105-H-14	R240	CM3051770
056	15	2-1/2" 150 RF WN STD	SA105-14	R503	CM3065953
059	25	3" 300 RF WN SCH 160	SA105-14	R323	CM3053450

CHEMICAL PROPERTIES

HEAT CODE	C	SI	MN	P	S	CR	AL	CU	NI	MO	V	CB	BN	N	CE
4EP	0.170	0.230	0.770	0.013	0.034	0.080	0.002	0.100	0.070	0.023	0.002	0.002	0.010	0.000	0.331
4EJ	0.190	0.220	0.890	0.010	0.028	0.110	0.002	0.240	0.070	0.020	0.002	0.002	0.010	0.000	0.385
R521 ✓	0.190	0.230	1.010	0.011	0.012	0.060	0.001	0.180	0.060	0.013	0.001	0.002	0.009	0.000	0.389
R314 ✓	0.210	0.220	1.010	0.013	0.016	0.130	0.002	0.270	0.070	0.019	0.001	0.001	0.012	0.000	0.431
R240	0.210	0.230	1.020	0.011	0.017	0.110	0.002	0.250	0.080	0.023	0.002	0.001	0.014	0.000	0.429
R503	0.210	0.200	1.000	0.012	0.009	0.050	0.001	0.170	0.060	0.014	0.002	0.002	0.006	0.000	0.405
R323	0.210	0.220	1.010	0.013	0.016	0.130	0.002	0.270	0.070	0.019	0.001	0.001	0.012	0.000	0.431

PHYSICAL PROPERTIES

HEAT CODE	TENSIL	YIELD	%ELONG	%R.A.	HBW	CHARPY	FT-LBS	LAT EXPN	SHR FRACT	TEST TEMP
4EP	72700	43400	36.40	64.70	156/156					
4EJ	78200	53600	36.60	65.20	152/156					
R521 ✓	79700	49500	24.80	42.26	163/174					
R314 ✓	82000	48500	26.20	61.61	166/166					
R240	81300	51900	32.10	60.00	163/167					
R503	80400	48400	24.60	50.67	163/167					
R323	82000	48500	26.20	61.61	166/166					

NOTES

HEAT CODE NOTE

4EP
4EJ
R521 ✓
R314 ✓
R240 NORMALIZED, TEMP/1650F, TIME @ TEMP/1 HR PER INCH, AIR COOL
R503
R323

All products bearing the "BOLTEX" name or logo "b" with the heat number prefix listed on the legend below have been manufactured at our Houston, TX facilities from steel melted and forged in the U.S.A. All other products have been manufactured at our Houston, TX facilities.

AR = Arkansas

CM or SI = Commercial Metals Corp.

GER = Gerdau Steel

HU = Nucor Steel

RE = Republic Steel

TI = Timken Steel

WR = Warren Steel

We certify our flanges are capable of passing a hydrostatic test compatible with their rating and all test results and process information contained herein are correct and true as contained in company records. All flanges meet NACE MR0-175 and/or MR0-103 Latest Revision.

Our quality system has been registered by DNV-GL to ISO 9001, Certificate No.: 142240-2013-AQ-RVA. Test results comply with EN 10204-3.1. Our flanges satisfy the material requirements for PED 97/23/EC Annex 1-4.3.

Notwithstanding the absence of a signature, the organization submitting either a printed certificate or an EDI transmitted certificate is responsible for content of the report. (ASTM/A 961-04a Section 19.4)

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Violators shall be prosecuted to the fullest extent of the law.

Quality Assurance Manager

BENTELER Steel/Tube
1 Benteler Drive | Shreveport, LA 71115 USA
Tel.: +1 318 216 4259
qms.shreveport@benteler.com

BENTELER
Steel/Tube

INSPECTION CERTIFICATE EN 10204-3.1
EN 10204:2005-01

Pipe Distributors, Inc.
PO Box 23237
HOUSTON TX 77028
USA

Document No.: 465-961815/001/P
Purchase Order No.: 16-21066
Benteler Order No.: 48000178
Dispatch Note No.:
Product: SEAMLESS STEEL TUBES

Page: 1 / 3

Manufacturer: BSTMC Shreveport USA
Manufacturer's brand:
Stamp of the inspection representative: MI
Steelmaking process: CONVERTER

Terms of delivery:

ASTM-A 53-2012, ASME SA-53, ASME BPVC.III-A-2015, ASTM-A 106-2015, ASME SA-106, ASME BPVC.III-A-2015, API Specification 5L
Forty-Fifth Edition, December 2012 Incl. Errata (2015), PSL 2, ANSI/NACE MR0175/ISO 15156-1: 2015, ANSI/NACE MR0175/ISO 15156-2:
2015, NACE Standard MR0103-2010

Dimensions-tolerances:

ASTM-A 106-2015, ASME SA-106, ASME BPVC.III-A-2015, ASTM-A 53-2012, ASME SA-53, ASME BPVC.III-A-2015, API Specification 5L
Forty-Fifth Edition, December 2012 Incl. Errata (2015)

Steel grade:

GRADE B, GRADE C, GRADE BN, GRADE X42N

Delivery condition:

N

Product marking:

FS: BENTELER BENTELER-Sign API 5L-1072 API-Sign Month/Year Conditions Dimension: O.D. * t inch Steel Grade
PSL2 SMLS Inspector's sign Heat No. Tube length feet Test Pressure PSI Customer's material no. Dimension: NPS
inch Schedule No. Production No.

AZ = Etching ink marking FK = color marking FS = paint stencilling PSD = Color jet printer UK = Laser marking PKE = tag marking PS = die stamp TS = Ink jet spray marking

Item	Number	Dimensions	Length total feet	Weight lbs	Heat No.	Test pressure PSI	sec
0002	203	2 NPS - SCH 160 38 FT - 42 FT	7816.69	58952	300454	2970	5

Heat analysis (%)

Item	Heat No.	C	SI	MIN	P	CR	MO	NI	CU	V	NB	TI	B	S
0002	300454	0.170	0.290	0.95	0.004	0.14	0.04	0.06	0.12	0.003	0.001	0.001	0.0002	0.000

- Formula: $CE \leq C + (Mn/6) + ((Cr + Mo + V)/5) + ((Cu + Ni)/15) \leq 0.43 \%$
- Formula: $C + Cu + Mo + Ni + V \leq 1.00 \%$
- Formula: $Nb + V \leq 0.06 \%$
- Formula: $Nb + Ti + V \leq 0.15 \%$

Formula results

Item	Heat No.	1. Formula	2. Formula	3. Formula	4. Formula
0002	300454	0.377	0.363	0.004	0.005

V JL

Product analysis [%]

Item	Heat No.	C	SI	MN	P	S	CR	MO	NI	CU	V	NB	TI	B
0002	300454	0.190	0.290	0.95	0.007	0.001	0.17	0.04	0.06	0.12	0.003	0.001	0.002	0.0003
0002	300454	0.190	0.300	0.93	0.006	0.001	0.16	0.04	0.06	0.11	0.003	0.001	0.002	0.0003

- Formula: CE IWI=C+(Mn/6)+((Cr+Mo+V)/5)+((Cu+Ni)/15)≤0.43 %
- Formula: Cr+Cu+Mo+Ni+V≤1.00 %
- Formula: Nb+V≤0.06 %
- Formula: Nb+Ti+V≤0.16 %

Formula results

Item	Heat No.	1. Formula	2. Formula	3. Formula	4. Formula
0002	300454	0.403	0.393	0.004	0.006
0002	300454	0.397	0.373	0.004	0.006

Test results

The tubes have been submitted to a leak tightness test by:

Hydrostatic test: acc. to API 5L. Holding time min 5 seconds, Test pressure/Time-record, the test records/charts shall be available for examination by the Inspector

PASSED

The tubes are non destructive tested:

UT-Test standard: acc. to API 5L; longitudinal testing: UT-Test method: acc. to ASTM-E 213;
UT-Outside notch depth: 12.5 %; UT-Inside notch depth: 12.5 %; UT-Notch length max: 2.000 IN.;
UT-Notch width max: 0.040 IN.

PASSED

Visual inspection:

Bending test:

PASSED

Dimensions examination:

PASSED

Results of mechanical testing

Tensile test longitudinal at RT. Strip test specimen

Item	Specimen No.	Heat No.	Specimen dimensions	Yield strength	Tensile strength	Elongation	1. Formula	RT 0.5/Rm
Requirements			In	RT 0.5 % PSI	Rm PSI	A2" %		RI 0.5/Rm
0002	00001N	300454	0.75 X 0.35	42100-71800 50763	70000-85000 77160	38.00	21.00	MAX 0.93 0.66

Elongation formula

- Formula AF=625000 * AXC*0.2 / L*0.9

Conservation

outside surface varnished

BENTELER Steel/Tube
1 Benteler Drive | Shreveport, LA 71115 USA
Tel.: +1 318 216 4259
qms.shreveport@benteler.com



Steel/Tube

INSPECTION CERTIFICATE EN 10204-3.1

Document No.: 465-961815/001/P

Page: 3 / 3

Item	Heat No.	Production No.
0002	300454	15001735

Remark

NACE Standard: Hardness acc. to ANSI/AASHTO M288-15/ISO 15156: HRC max 22, Hardness acc. to Standard MR0103 HRC max 22.; Certificate remarks: Data converted from SI units : Steel Making, Steel Mill Nucor - Jewett, Texas, USA; Melted and Manufactured in the USA; Of Domestic Origin-USA

Shreveport, 09/19/2016, TEL.: 0318 216-4258

We certify that the supplied products comply with the order specification. This document was prepared by means of electronic data processing and is valid without signature.

Inspection representative
Kirby/JD

Vallourec Tubes France TUBERIE SAINT SAULVE ZONE INDUSTRIELLE 59880 SAINT SAULVE	(A01)		MATERIAL TEST REPORT - INSPECTION CERTIFICATE 3.1 EN 10204 : 2004	(A02)
			No. : 1040Sv16 Page: 1 / 5 Date: 02.03.2016	(A03)

(A01) Vallourec Tubes France	(A08.1) Vallourec-Order-No. ZZ2700 (A08.2) Suborder 851/3526 0
(A06.1) Customer AMERICAN PIPING PRODUCTS INC. 11403 NORTH HOUSTON ROSSLYN RD HOUSTON TX 77088	(A07.1) Customer Order-No. 107950
(A08.2) Orderer /	(A07.2) Orderer Order-No. 107950 Date 23.10.2015
	(A07.3) Client's Client Order-No. 14939
(B01, B02, B04) Description of the product	Hot finished seamless steel tubes ASTM A 106 - 13 ASTM A 530 - 12 → ASME SA 106, Edition 2013 / ASME SA 530, Edition 2013 ASME Boiler and Pressure Vessel Code, Sect. II, Part. A, Edition 2013 Nace MR 0175-2009 / ISO 15156-2:2009, Annex A.2.1.2 Nace Standard MR 0103-2010, Paragraph 2.1 Spec. APP-C002, Rev. 3, dated 01-10-2014 Comments Rev. 8, dated 09-10-2014 → Grade C → Grade B Provided that YS ≥ 42100 Psi, material corresponds for chemical and mechanical properties of X42 acc. to API Spec. 5L, PSL1 As rolled Ends plain, square cut Inside without rust protection Outside dry varnish 11/2/16 ROCKWELL C HARDNESS ≤ 22 GUARANTEED NO RADIATION CONTAMINATION Material certified melted in EU 27 countries

(A13) Vallourec Item	(A08) Cust. Item	(B14) Item text	(B09) Dimensions	(B10) Single length
6			OD 2.875 in x WT 0.203 in ✓ OD-Tolerance + 0.031 in - 0.031 in WT-Tolerance + 20 % - 12.5 % Straightness acc. to API 5L, deviation from straightness max. 0.024 "/foot.	Random length from 39 to 46 Ft

Vallourec Tubes France TUBERIE SAINT SAULVE ZONE INDUSTRIELLE 59880 SAINT SAULVE	(A01) 	MATERIAL TEST REPORT - INSPECTION CERTIFICATE 3.1 EN 10204 : 2004	(A02)
		No. : 1040Sv16 Page: 2 / 5 Date: 02.03.2016	(A03)

(A13) Vallourec Item	(A09) Cust. Item	(B14) Item text	(B09) Dimensions	(B10) Single length
			total deviation of tube length max. 0.2 %	

(A13) Vallourec Item	(A09) Cust. Item	(B07.1) Heat	(B08) Quantity	(B11) Total length ft	(B13) Weight lb
6		332823	59	2.390,290	14.478
		352330	36	1.642,910	9.952
		Total	95	4.033,200	24.430

(C71)

HEAT CHEMICAL ANALYSIS

For each reduction of 0,01 % carbon below 0,30 %, an increase of 0,06 % manganese above the specified maximum will be permitted up to a maximum of 1,35 %

(B07.1) Heat	(B15) Process	C %	Si %	Mn %	P %	S %	Cr %	Mo %	Ni %	Sn %	Cu %
min	-	0,12	0,10	1,00	-	-	-	-	-	-	-
max	-	0,20	0,40	1,35	0,025	0,01	0,27	0,12	0,35	0,02	0,20
332823	Oxygen (BOF)	0,14	0,25	1,26	0,017	0,001	0,13	0,05	0,07	0,001	0,02
352330	Oxygen (BOF)	0,13	0,27	1,25	0,016	0,001	0,14	0,05	0,07	0,003	0,03

(B07.1) Heat	Al %	Ti %	Nb(Cb) %	V %	N %	B %	0002 %	0023 %	0014 %	1003 %	59 %
min	-	-	-	0,03	-	-	-	-	-	-	-
max	0,06	0,04	0,04	0,08	0,02	0,0008	0,15	0,32	1,00	0,43	0,12
332823	0,03	0,004	0,02	0,06	0,01	0,0002	0,08	0,18	0,33	0,40	0,06
352330	0,04	0,004	0,02	0,07	0,01	0,0003	0,09	0,19	0,36	0,40	0,07

0002	V+Nb+Ti
0023	Cr+Mo
0014	Cr+Cu+Mo+Ni+V
1003	CE = C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15
59	V+Ti

Heats fully killed



Vallourec Tubes France TUBERIE SAINT SAULVE ZONE INDUSTRIELLE 59880 SAINT SAULVE		MATERIAL TEST REPORT - INSPECTION CERTIFICATE 3.1 EN 10204 : 2004
		No. : 1040Sv16 Page: 3 / 5 Date: 02.03.2016

(C72)

PRODUCT CHEMICAL ANALYSIS

For each reduction of 0,01 % carbon below 0,30 %, an increase of 0,06 % manganese above the specified maximum will be permitted up to a maximum of 1,35 %

(B07.1) Heat	(C00.1) Test Piece	C %	Si %	Mn %	P %	S %	Cr %	Mo %	Ni %	Sn %	Cu %
min		0,12	0,10	1,00	-	-	-	-	-	-	-
max		0,24	0,40	1,35	0,025	0,01	0,27	0,12	0,35	0,02	0,20
332823 ✓	1AN255	0,14	0,26	1,23	0,020	0,002	0,13	0,04	0,07	0,002	0,01
332823 ✓	2AN255	0,14	0,25	1,22	0,020	0,001	0,13	0,04	0,07	0,002	0,01
352330	1AN256	0,13	0,27	1,22	0,016	0,002	0,13	0,05	0,07	0,003	0,03
352330	2AN256	0,14	0,25	1,21	0,020	0,002	0,13	0,04	0,07	0,002	0,01

(B07.1) Heat	(C00.1) Test Piece	Al %	Ti %	Nb(Cb) %	V %	N %	B %	0002 %	0023 %	0014 %	1003 %
min		-	-	-	0,03	-	-	-	-	-	-
max		0,06	0,04	0,04	0,08	0,02	0,0008	0,15	0,32	1,00	0,43
332823 ✓	1AN255	0,03	0,003	0,02	0,07	0,000	0,0003	0,09	0,17	0,32	0,40
332823 ✓	2AN255	0,03	0,003	0,02	0,06	0,000	0,0003	0,09	0,17	0,32	0,40
352330	1AN256	0,04	0,003	0,02	0,07	0,000	0,0004	0,09	0,18	0,35	0,39
352330	2AN256	0,03	0,003	0,02	0,06	0,000	0,0003	0,09	0,17	0,32	0,40

(B07.1) Heat	(C00.1) Test Piece	59 %									
min		-									
max		0,12									
332823 ✓	1AN255	0,07									
332823 ✓	2AN255	0,07									
352330	1AN256	0,07									
352330	2AN256	0,07									

0002	V+Nb+Ti
0023	Cr+Mo
0014	Cr+Cu+Mo+Ni+V
1003	CE = C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15
59	V+Ti

Handwritten signature

Vallourec Tubes France TUBERIE SAINT SAULVE ZONE INDUSTRIELLE 59880 SAINT SAULVE		MATERIAL TEST REPORT - INSPECTION CERTIFICATE (A02) 3.1 EN 10204 : 2004
No. : 1040Sv16 (A03) Page: 4 / 5 Date: 02.03.2016		

(B04)

HEAT TREATMENT

As Rolled

TENSILE TEST RESULTS

Type (C10.1)	Tube strip specimen
Test temperature (C03)	Room temperature
Direction (C02)	longitudinal

SIMPLE LENGTH

(B07.1) Heat	(C00.1) Test Piece	(C10.2) Dimension	(C11) YS	(C11) YS	(C12) TS	(C13.2) Elong.					
		In / sq in	R _{p0.2} psi	R _{p0.5} psi	R _m psi	2" %					
min			40000	40000	70000	22,0					
max											
332823 ✓	01AN255	0,75x0,22 0,17	58757	59338	81535	28,3					
352330	01AN256	0,75x0,22 0,17	56581	56581	77763	30,4					

(C10.2) Dimension	Test piece dimensions Test piece area
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(D51)

MICROGRAPHY

Test	Conditions	Test rate	Result
Grain size	ASTM E112 GRAIN 5 OR FINER		Guarantee

(D55)

OTHER TESTS ON PIPE

Test	Conditions	Test rate	Result
Hydrostatic test	2500 PSI 5 SEC	100% each lot	Satisfactory
Appearance & Dimensions	Aspect & Dimensions (specification)	100% each lot	Satisfactory

(A04, B08)

MARKING, IDENTIFICATION


Vallourec Tubes France TUBERIE SAINT SAULVE ZONE INDUSTRIELLE 59880 SAINT SAULVE		MATERIAL TEST REPORT - INSPECTION CERTIFICATE (A02) 3.1 EN 10204 : 2004
No. : 1040Sv16 (A03) Page: 5 / 5 Date: 02.03.2016		

(A04, B06)

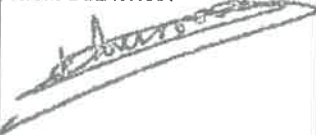
MARKING, IDENTIFICATION

6 Die stamping round nose tools		 FRANCE HTHEAT NUMBER VALLOUREC
6 Paint stenciled on one side	 VALLOUREC	VALLOUREC VTFR26 FRANCE A/SA106 B+C HTHEAT NUMBER 2.875 0.203 79.03 5.16 2500PSI 17MPA NPS2 1/2 STD/SCH40 K LENGTHLENGTH DATE O F MARKING AMERICAN PIPING PRODUCTS INC. HOUSTON 107950 14939

(Z01)

The supplied products are in compliance with the requirements of the order

(A05, Z02, Z03)

Date	02.03.2016
Validated by	Inspection Representative
	Valérie DELACROIX 
☎	+ (33) 3 27 23 14 56
📠	+ (33) 3 27 23 15 25
@	valerie.delacroix@vallourec.com
Stamp	

Indication in parentheses correspond to attributes according to EN 10169

This testimonial and certification respectively may neither be modified nor used for other products. Offences are regarded as falsification of documents and will be subject to criminal prosecution.



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

NUCOR
PLATE MILL

Mill Test Report

Page 1

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

NUCOR
It's Our Nature.

Issuing Date : 12/12/2016
Vehicle No: ALY 91731
Specification: 0.5000" x 121,000" x 480,000"
ASTM A516 70-10(2015)/ASME SA516 70 PVQ 2013/2015 ASTM A573
70-13

Load No.: 467847
Sold To: NORTH SHORE STEEL
PO BOX 9940
HOUSTON, TX 77213

Our Order No.: 142173/5

Cust. Order No.: 280571

Ship To: NORTH SHORE STEEL
C/O GREENS BAYOU PIPE MILL
PTA TRACK 2091088 SPUR 910
13935 INDUSTRIAL RD
HOUSTON, TX 77015

Marking :

3-12-17

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
6507425	0.19	1.04	0.010	0.001	0.19	0.27	0.11	0.09	0.02	0.020	0.004	0.000	0.003		0.0027	0.0000	0.011	0.41	0.27																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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Charpy Impacts

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 as-rolled, unless otherwise noted in Specification. For Mexico shipments: nbc-SalesMX@Nucor.com
Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/6)*((C+Mo+V)/5)*(Cu+N)/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 (#B10940) 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. Depreis

T. A. Depreis, Metallurgist

12/12/2016 8:09:04 AM

Mill Test Report

Page 2



Issuing Date: 12/12/2016 B/L No.: 459509 Load No.: 467847 Our Order No.: 1421737 Cust. Order No.: 280571
 Vehicle No: ALY 91731
 Specification: 0.6250" x 121.000" x 480.000"
 ASTM A516 70-10(2015)/ASME SA516 70 PVQ 2013/2015 ASTM A573
 70-13
 Marking: 3-12-17

Ship To: NORTH SHORE STEEL
 C/O GREENS BAYOU PIPE MILL
 PTRA TRACK 2091088 SPUR 910
 13935 INDUSTRIAL RD
 HOUSTON, TX 77015

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	Ceq	Pcm
6507424	0.19	1.06	0.012	0.002	0.25	0.23	0.10	0.12	0.02	0.033	0.004	0.001	0.003	0.003	0.0052	0.0001	0.010	0.42	0.28
6507425	0.19	1.04	0.010	0.001	0.19	0.27	0.11	0.09	0.02	0.020	0.004	0.000	0.003	0.003	0.0027	0.0000	0.011	0.41	0.27

Tensile Test

Plate Serial No	Pieces	Tons	Dir.	Yield (psi)	Tensile (psi)	Elongation % in 2"	Elongation % in 8"	Dir.	(%) shear	(%) shear	(%) shear	Ave.	(%) shear	Size	Temp	Min Ave.
6507424-06	4	20.58	T	51,500	80,000		20.0									
6507425-01	4	20.58	T	59,000	76,500		20.0									

Charpy Impacts

Plate Serial No	Pieces	Tons	Dir.	Yield (psi)	Tensile (psi)	Elongation % in 2"	Elongation % in 8"	Dir.	(%) shear	(%) shear	(%) shear	Ave.	(%) shear	Size	Temp	Min Ave.
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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 as-rolled, unless otherwise noted in Specification. For Mexico shipments: nbc-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

12/12/2016 8:09:04 AM

Manufacturer / Fabricante / Herstellerwerk

outokumpu



Type of document / Tipo de documento / Art der Prüfbescheinigung

INSPECTION CERTIFICATE

CERTIFICADO DE INSPECCION

ABNAHMEPRÜFZEUGNIS

according to / de acuerdo con / nach

EN 10204-3.1

Document number / 11/28/2014

Nº de certificado /

Bescheinigungen.

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Page / Página / Seite:

1 / 1

1 ThyssenKrupp Drive; P.O. Box 13000; Calvert, AL 36513-1300

SAMUEL, SON & CO. INC.

2303 CENTURY CENTER BLVD.

IRVING TX 75062

USA

Customer/Ship to / Cliente / Besteller/Empfänger

SAMUEL, SON & CO. INC., IRVING

Customer's order number / N° de Pedido Cliente / Kundenbestelln.

7132022

Manufacturer's works order no. / N° de Pedido Manufactura / Werksauftrag.

901175382 / 002

Delivery note no. / N° de Entrega / Lieferanzugs Nr.

85318906 / 010

Product / Producto / Erzeugnis

COIL/BOBINA/BAND

Steel grade and quality / Acero / Stahlqualitäts und Gütegruppe

TYPE 304L/304

Terms of delivery / Condiciones de entrega / Lieferbedingungen

ASTM A240/240M, ASME SA-240 Sec. II Part A Ed. 2013

ASTM A480/480M, ASME SA-480 Sec. II Part A Ed. 2013

Customer's material no. /
N° de material del cliente /
Kundenmaterial-Nr.Product dimensions (Thickness / Width / Length) /
Dimensiones (Espesor / Ancho / Largo) /
Maße des Erzeugnisses (Dicke / Breite / Länge)

9.53 mm x 1,524.00 mm

0.3750 inch x 60.0000 inch

Steelmaking procedure /
Proceso de manufact. /
Herstellert

AOD

Finish /
Acabado /
Ausführung

Ra / 1D / No.1

Packing-No. / N° de Empaque / Pack-Nr.	No. of pieces / Piezas / Stückzahl	Actual weight / Peso actual / Ist-Gewicht	Coil No. / Bobina No. / Band-Nr.	Heat No. / Caloria / Schmelztemp.	Sample id. / N° de muestra / Proben-ID.	Sample id. / N° de muestra / Proben-ID.
6217837	1	15,454 lb / 7,010 kg	745500	504754	1000240454	1000240455
6217840	1	15,168 lb / 6,880 kg	745500	504754	1000240454	1000240455
Sum / Suma / Summe	2	30,622 lb / 13,890 kg				

Heat / Caloria / Schmelztemp.	Country of heat / País de origen / Erzeugnisland	Chemical composition / Composición Química / Chemische Zusammensetzung									
		% C	% Si	% Mn	% P	% S	% Cr	% Mo	% Ni	% N	% Cu
504754	USA	0.029	0.36	1.61	0.032	0.0010	18.17	0.34	8.03	0.066	0.45

Sample Position / Localización de la muestra / Probenlage	TRANSVERSE
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Inspection lot / Lote de inspección / Prüflot	Y90.2% PSI / MPa	TS PSI / MPa	EL A2" %	HRB
1000240454	51,776 / 357	91,805 / 633	51.2	81
1000240455	47,135 / 325	88,470 / 610	59	80

Dimensione-surface / Dimensiones-Superficie / Maße-Oberfläche:

Test of identity (spectrum analysis) / Control de identidad (análisis espectrográfico) / Verwechslungsprüfung (Spektralanalyse):

OK

OK

No welding or weld repairs were performed on this material

No intentional additions of Mercury compounds were made or used

Free of radioactive contamination

EU RoHS Directive 2011/65/EU Compliant

Country of Heat as per ISO 3166-1

WHSE 014

TAG 9/3/17

Originator of the document / Originador del documento / Aussteller der Bescheinigung

Outokumpu Stainless USA, LLC

An ISO 9001:2008 certified company
Quality Management System EU PED 97/23/EC certifiedThe information provided is a true copy of data on file /
Los valores mostrados corresponden a los datos archivados /
Die genannten Werte entsprechen den gespeicherten Daten

Andrew Fauchet
Phone: +1 251 828 3482

Name of expert / Nombre del experto / Name des Sachverständigen

Date of issue and validation
Fecha de emisión y validación
Datum Ausstellung / Bestätigung

11/28/2014

Certificate is generated automatically / Certificado es generado automáticamente /
Das Zeugnis wurde elektronisch erstellt

ThyssenKrupp Steel Europe

7-3-15



ThyssenKrupp

Werks-Nr. Works-No. No de l'usine	A08 3849897	Zeugnis-Nr. Certificate-No. No de certificat	A03 1645401001	Sendungs-Nr. Shipment-No. No de envoi	44631113	Seite-Nr. Page-No. Page-No	1																																																																																																																																																																								
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ThyssenKrupp Steel Europe AG

Abnahme

-FOLGESEITE-

Werk-Nr. Works-No. No de fusine	A08 3849897	Zaugs-Nr. Certificate-No No de certificat	A03 1645401001	Sendungs-Nr. Shipment-No. No de envoi	44631113	Seite-Nr. Page-No. Page-No	2
ITEM	B07 BUNDLE	B07 PLATE-NO.	B07 HEAT-NO.	B08 NUMBER PIECES	B13 WEIGHT		
003	12,7 x 3048,0 x 12192 [mm] 0,5 x 120 x 480 [ZOLL]	57888101 57888202 61672101 61672202 61704101 61846101 61846202 61847101 55924101 55924202 55925101 55925202 57889101 57889202	632401 632401 632401 632401 632401 632401 632401 632401 632402 632402 632402 632402 632402 632402	1 1 1 1 1 1 1 1 1 1 1 1 1 1	3.782 3.860 3.827 3.827 3.827 3.827 3.827 3.827 3.782 3.807 3.807 3.807 3.860 3.860		
				*	14	53.527	
004	15,875 x 3048,0 x 12192 [mm] 0,625 x 120 x 480 [ZOLL]	67602202 57796101 57796202 57893101 57893202 61825101 61825202 61845202 61857202 55926101 55926202	632400 632401 632401 632401 632401 632401 632401 632401 632401 632402 632402	1 1 1 1 1 1 1 1 1 1 1	4.706 4.706 4.706 4.733 4.733 4.669 4.669 4.669 4.669 4.774 4.774		
				*	11	51.808	
005	19,05 x 3048,0 x 12192 [mm] 0,75 x 120 x 480 [ZOLL]	67601101 67601202 57832101 57832202 61854101 55928101 57890101 57890202	632400 632400 632401 632401 632401 632402 632402 632402	1 1 1 1 1 1 1 1	5.711 5.711 5.662 5.630 5.585 5.630 5.662 5.662		
				*	8	45.253	
006	25,4 x 3048,0 x 12192 [mm] 1 x 120 x 480 [ZOLL]	69215101 57942101	632400 632401	1 1	7.505 7.505		
				*	2	15.010	
007	28,575 x 3048,0 x 12192 [mm] 1,125 x 120 x 480 [ZOLL]	58001101 62134101 58004101	632401 632401 632402	1 1 1	8.602 8.508 8.602		
				*	3	25.712	
008	31,75 x 3048,0 x 12192 [mm] 1,25 x 120 x 480 [ZOLL]	69211101 58000101	632400 632401	1 1	9.529 9.571		
				*	2	19.100	
009	34,925 x 3048,0 x 12192 [mm] 1,375 x 120 x 480 [ZOLL]	68737101	632400	1	10.282		
				*	1	10.282	
				**	63	277.289	

ThyssenKrupp Steel Europe AG

Abnahme

-FOLGESEITE-

Werk-Nr. Works-No. No de usine	A08 3849897	Zeugnis-Nr. Certificate-No No de certificat	A03 1645401001	Sendungs-Nr. Shipment-No. No de envoi	44631113	Seite-Nr. Page-No. Page-No	3						
TRANSPORT-NO. TTM DRAGON													
CHEMICAL COMPOSITION OF THE LADLE SAMPLES % C71-C99													
B07 HEAT NO.	C	SI	MN	P	S	AL-G	B-G	CR	CU	MO	N		
632400	,180	,340	1,140	,012	,0012	,037	,0002	,050	,250	,030	,0036		
632401	,170	,350	1,140	,009	,0011	,043	,0003	,050	,250	,030	,0028		
632402	,180	,330	1,130	,008	,0007	,030	,0003	,040	,250	,030	,0036		
	NE	NI	TI	V	66	85							
632400	,021	,210	,005	,002	,540	,080							
632401	,019	,210	,005	,001	,540	,080							
632402	,018	,200	,004	,001	,520	,070							
66 = NI+CU+MO+CR 85 = CR+MO													
C70 HEAT PROCESS								OXYGEN STEEL					
MECHANICAL CHARACTERISTICS TENSILE TEST													
B07 HEAT- NO.	C00 SAMPLE NO.	C01/ 02 POS.	B05 STAT.	C10 TYPE	AGED	C03 TEST- TEMP. °C	C11 R MPa	R Art	C12 Rm MPa	R/ Rm %	L0 mm	C13 A %	Rm*A
632400	67601	0401	0004	0003	0006	+20	396 RP0,2%		553	72	203	24	13272
632400	67602	0401	0004	0003	0006	+20	407 RP0,2%		554	73	203	26	14404
632400	68737	0401	0004	0003	0006	+20	362 RP0,2%		519	70	203	37	19203
632400	69211	0401	0004	0003	0006	+20	376 RP0,2%		534	70	203	33	17622
632400	69215	0401	0004	0003	0006	+20	382 RP0,2%		536	71	203	33	17688
632401	57796	0401	0004	0003	0006	+20	400 RP0,2%		543	74	203	25	13575
632401	57832	0401	0004	0003	0006	+20	381 RP0,2%		536	71	203	23	12328
632401	57888	0401	0004	0003	0006	+20	378 RP0,2%		536	71	203	25	13186
632401	57893	0401	0004	0003	0006	+20	385 RP0,2%		533	72	203	25	13325
632401	57942	0401	0004	0003	0006	+20	384 RP0,2%		528	73	203	27	14256
632401	58000	0401	0004	0003	0006	+20	373 RP0,2%		522	71	203	34	17748
632401	58001	0401	0004	0003	0006	+20	374 RP0,2%		520	72	203	33	17160
632401	61672	0401	0004	0003	0006	+20	392 RP0,2%		535	73	203	22	11770
632401	61704	0401	0004	0003	0006	+20	397 RP0,2%		542	73	203	23	12466
632401	61825	0401	0004	0003	0006	+20	388 RP0,2%		541	72	203	26	14066
632401	61845	0401	0004	0003	0006	+20	391 RP0,2%		536	73	203	24	12864
632401	61846	0401	0004	0003	0006	+20	396 RP0,2%		534	74	203	25	13350
632401	61847	0401	0004	0003	0006	+20	387 RP0,2%		533	73	203	25	13325
632401	61854	0401	0004	0003	0006	+20	379 RP0,2%		538	70	203	25	13450
632401	61857	0401	0004	0003	0006	+20	397 RP0,2%		545	73	203	24	13080
632401	62134	0401	0004	0003	0006	+20	374 RP0,2%		519	72	203	31	16089
632402	55255	0401	0004	0003	0006	+20	412 RP0,2%		556	74	203	23	12788
632402	55270	0401	0004	0003	0006	+20	414 RP0,2%		556	74	203	24	13344
632402	55274	0401	0004	0003	0006	+20	420 RP0,2%		556	76	203	23	12788
632402	55275	0401	0004	0003	0006	+20	411 RP0,2%		556	74	203	23	12788
632402	55918	0401	0004	0003	0006	+20	409 RP0,2%		554	74	203	25	13850
632402	55919	0401	0004	0003	0006	+20	418 RP0,2%		558	75	203	23	12834
632402	55920	0401	0004	0003	0006	+20	414 RP0,2%		555	75	203	25	13875
632402	55921	0401	0004	0003	0006	+20	411 RP0,2%		554	74	203	23	12742
632402	55922	0401	0004	0003	0006	+20	414 RP0,2%		554	75	203	26	14404
632402	55924	0401	0004	0003	0006	+20	404 RP0,2%		552	73	203	22	12144
632402	55925	0401	0004	0003	0006	+20	403 RP0,2%		550	73	203	24	13200
632402	55926	0401	0004	0003	0006	+20	400 RP0,2%		551	73	203	24	13224
632402	55928	0401	0004	0003	0006	+20	396 RP0,2%		546	73	203	26	14196
632402	57889	0401	0004	0003	0006	+20	394 RP0,2%		546	72	203	24	13104
632402	57890	0401	0004	0003	0006	+20	390 RP0,2%		540	72	203	25	13500
632402	57898	0401	0004	0003	0006	+20	408 RP0,2%		555	74	203	21	11655
632402	58004	0401	0004	0003	0006	+20	380 RP0,2%		530	72	203	32	16960
MECHANICAL CHARACTERISTICS IMPACT TEST													
B07 HEAT- NO.	C00 SAMPLE NO.	C01/ 02 POSIT	B05 STAT	C40 TYPE	B mm	AGED	C03 TEST- TEMP. °C	C42	C42 ENERGY [Joule]	C43			
								1	2	3	M		
632400	67601	0101	0004	0010	10,00	0006	-46	112	138	149	133		
632400	67602	0101	0004	0010	10,00	0006	-46	72	135	135	114		
632400	68737	0104	0004	0010	10,00	0006	-40	121	117	117	118		

ThyssenKrupp Steel Europe AG

Abnahme

-FOLGESEITE-

Werk-Nr. Works-No. No de usine		A08 3849897	Zeugnis-Nr. Certificate-No No de certificat		A03 1845401001	Sendungs-Nr. Shipment-No No de envoi		44631113			Seite-Nr. Page-No. Page-No		4
B07 HEAT- NO.	C00 SAMPLE NO.	C01/ 02 POSIT	B05 STAT.	C40 TYPE	C41 B mm	AGED	C03 TEST- TEMP. °C	C42 1	C42 2	C42 3	C43 ENERGY [Joule] M		
632400	69211	0104	0004	0010	10,00	0006	-40	141	147	139	142		
632400	69215	0104	0004	0010	10,00	0006	-40	140	142	139	140		
632401	57796	0101	0004	0010	10,00	0006	-46	157	104	96	119		
632401	57832	0101	0004	0010	10,00	0006	-46	160	156	149	155		
632401	57888	0101	0004	0010	10,00	0006	-46	166	121	138	142		
632401	57893	0101	0004	0010	10,00	0006	-46	145	140	149	145		
632401	57942	0104	0004	0010	10,00	0006	-40	164	170	159	164		
632401	58000	0104	0004	0010	10,00	0006	-40	150	168	172	163		
632401	58001	0104	0004	0010	10,00	0006	-40	148	154	140	147		
632401	61672	0101	0004	0010	10,00	0006	-46	115	167	153	148		
632401	61704	0101	0004	0010	10,00	0006	-46	85	153	149	129		
632401	61825	0101	0004	0010	10,00	0006	-46	128	152	149	143		
632401	61845	0101	0004	0010	10,00	0006	-46	126	166	152	148		
632401	61846	0101	0004	0010	10,00	0006	-46	94	129	94	106		
632401	61847	0101	0004	0010	10,00	0006	-46	132	104	132	123		
632401	61854	0101	0004	0010	10,00	0006	-46	135	152	159	149		
632401	61857	0101	0004	0010	10,00	0006	-46	138	147	125	137		
632401	62134	0104	0004	0010	10,00	0006	-40	148	151	166	155		
632402	55255	0101	0004	0010	7,50	0006	-46	103	96	93	97		
632402	55270	0101	0004	0010	7,50	0006	-46	149	140	115	135		
632402	55274	0101	0004	0010	7,50	0006	-46	150	115	113	126		
632402	55275	0101	0004	0010	7,50	0006	-46	134	116	101	117		
632402	55918	0101	0004	0010	7,50	0006	-46	114	142	112	123		
632402	55919	0101	0004	0010	7,50	0006	-46	91	116	102	103		
632402	55920	0101	0004	0010	7,50	0006	-46	112	101	105	106		
632402	55921	0101	0004	0010	7,50	0006	-46	109	156	122	129		
632402	55922	0101	0004	0010	7,50	0006	-46	112	110	116	113		
632402	55924	0101	0004	0010	10,00	0006	-46	93	63	71	76		
632402	55925	0101	0004	0010	10,00	0006	-46	75	123	89	96		
632402	55926	0101	0004	0010	10,00	0006	-46	150	133	142	142		
632402	55928	0101	0004	0010	10,00	0006	-46	135	141	143	140		
632402	57889	0101	0004	0010	10,00	0006	-46	110	91	156	119		
632402	57890	0101	0004	0010	10,00	0006	-46	144	155	134	144		
632402	57898	0101	0004	0010	7,50	0006	-46	38	30	42	37		
632402	58004	0104	0004	0010	10,00	0006	-40	149	140	172	154		
HEAT TREATMENT PRODUCT													
Item	TEMP °C	HOLDTIME MIN.		COOL DOWN									
001, 002	920	2,00		AIR									
003, 004	920	3,00		AIR									
005	920	4,00		AIR									
006- 009	920	7,00		AIR									
LEGENDS													
STAT.						POSIT (IST)							
0004 = NORMALIZED						0101 = LONG. TOP S							
						0104 = LONG. TOP 1/4 T.							
						0401 = TRANS. TOP S.							
AGED						TYPE TENSILE TEST							
0006 = NOT AGED						0003 = FLAT TENSILE TEST							
TYPE IMPACT TEST													
0010 = CHARPY- V ASME													
STATUS PRODUCT													
001- 009	NORMALIZED												
NORMALIZED, FULLY KILLED, FINE AUSTENITIC GRAINE TREATED													

ThyssenKrupp Steel Europe AG

Abnahme

-FOLGESEITE-

Werks-Nr. Works-No. No de l'usine	A08 3849897	Zeugnis-Nr. Certificate-No. No de certificat	A03 1645401001	Sendungs-Nr. Shipment-No. No de envoi	44631113	Seite-Nr. Page No. Page-No	5
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Z02
ABNAHMEBEAUFTRAGTER DES HERSTELLERS
THE MANUFACTURER'S AUTHORIZED INSPECTION REPRESENTATIVE
LE REPRÉSENTANT AUTORISÉ DU CONTRÔLEUR DU PRODUCTEUR

Kern

Z03 Prof. Dr.-Ing. Kern

ThyssenKrupp Steel Europe AG

Abnahme

Es wird bestätigt, dass die Lieferung
den Vereinbarungen mit der Bestellung entspricht.
We hereby certify, that the above mentioned materials
have been delivered in accordance with the terms of order.
Nous attestons que les produits livrés sont conformes
aux stipulations de la commande.

Z01





P.O. Box 802404 ♦ Houston, TX 77280-2404 ♦ Telephone (713) 460-3655 ♦ FAX (713) 460-3695

Report Date: 03/17/15
Report No: 713541.06
Rev.: A
Cust Acct: NOR213

To: North Shore Supply Company
Vendor #04350
P.O. Box 9940
Houston, TX 77213-0940

Ordered By: Junior Johnston PO#: 256559
Material: SA516-70 N .075" x 120" x 480"
ID/Heat: 632401 Slab #578321-01 Tag #: 022715-47 Qty 1
Job Info:

Ultrasonic Examination Report

Specification: A578 100% Scan All Accessible Volume
Acceptance Criteria: Level B
Equipment: Epoch 600 SN: 110175908 Cal. Date: 03/05/15 to 09/05/15
Part Condition: Clean
Couplant: Cellulose

Longitudinal Wave Examination

Transducer: Technisonic Size: 1" Freq.: 5 MHZ
Standardization: 75% FSH DB: 38 + 6

Shear Wave Examination

Transducer: Size: Freq.: Angle:
Standardization:

Comments/ Test Notes

No significant loss of back reflection.

No. Pcs. Tested: 1 No. Pcs. Accepted: 1 No. Recordable Ind.: 0 No. Rejected: 0
Operator: Amine Brittain SNT Level: III

Signed:

Amine Brittain
ASNT Level III - UT - Certificate Number: 215947

Our reports are for the exclusive use of our customer and our name may be used only with prior written approval. Our reports apply only to the sample tested or inspected and do not necessarily represent the quality of other apparently similar or identical materials. This test report shall not be reproduced, except in full, without the written approval of Accu-Test Labs LLP.



TATA STEEL UK LIMITED
Park Street
Motherwell, ML1 1PU.
Tel: +44 (0)1236 286100
Fax: +44 (0)1896 286100 E:

INSPECTION CERTIFICATE

In accordance with EW10204 3.1
Product manufactured under a

AMERICAN ALLOY STEEL - TATA ST
ELL INT (AMERICA) INC
20370 RICHMOND AVE. SUITE 1325
HOUSTON, TX 77042
USA (INCLUDING PUERTO RICO)

CAI:0058262

Toll Free 800-967-8888	AMT	Work Order#
100% Satisfaction Guarantee		

Customer Order No.

[illegible]

APR 08 2013 - **2013/ASPH BILA-2010 GRADE 60/65/70 (NOME II PT A 2013/SACD)**

STEEL PLATE 30' X 10' X 1.500" Piece Weight 8.478Tonnas
cpr.- Normalized at +930C for 1 hr

AMERICAN ALLOY
PLATE: 51040

CHECKER MARKED :- PUN1009070, VL-MOD/98022/ DOB 8706/2432 STAGE/PT068336/ 30

[illegible]

The industry of Tuna Street UK Limited, the manufacturers. These pens are certified by the United Kingdom and comply with the requirements of the Product Description.

Robert
R.L. Prewitt, Text House Manager, Southbury
April 22
Copy of a True and UK Limited Importation Certificate.

[illegible]

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANALYSES

US HWY 12 Burns Harbor, Indiana

SHIPMENT NO. 804-04594		DATE SHIPPED 08-30-16		CAR OR VEHICLE NO. CSS-CHGO-BNSF		LMIC 007070		PAGE 4	
GRIFFIN TRADE GROUP LLC 12777 JONES RD STE 315 HOUSTON TX 77070-4692					GRIFFIN TRADE GROUP LLC C/O ALLTRANS PORT SERVICES INC PTRA ZONE 23 TRACK 411 HOUSTON TX 77029-4324				

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

QUALITY STEEL MELTED AND MANUFACTURED IN THE U.S.A

PLATES - ASTM A516-06 GR 70 PVQ KLD FINE GRAIN PRAC CE FOR INFO PER IIW

✓ FORMULA, ASTM A516-06 GR 65 PVQ, ASTM A516-06 GR 60 PVQ, ASME SA516

GR 70 PVQ 2015 EDITION, ASME SA516 GR 65 PVQ 2015 EDITION, ASME

SA516 GR 60 PVQ 2015 EDITION, FIRST TST AS ROLLED-ADD'L TENSION PER

TST PC HEAT TREATMENT --- MILL TEST PCS NORM 1650F FOR 1HR/IN AIRCL

--- TEST CERTS IN ACCORD PROCEDURES IN EN 10204:2004 TYPE 3.1,&

PLTS CONTAIN < 1% NI, NOT RESULPHURIZED, BHN <=200 PER NACE MR0175

NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)

MFST - MFST MILL SERIAL# MFST PPI 0067869- 001 MFST

TEST CERTS IN ACCORD PROCEDURES IN EN

10204:2004 TYPE 3.1,& PLTS MFST CONTAIN < 1%

NI, NOT RESULPHURIZED, BHN <=200 PER NACE

MR0175 - LIFT MAX 5 TON UNLDG FORK

LIFT-SIDE TOMMY@GRIFFINTRADEGROUP.COM AND

TMARANG@GRIFFINTRADE GROUP.COM

CO# P15424 GH 403-1001

TEST SPECIMENS LABORATORY HEAT TREATED AND YIELD STRENGTH @ .5% E.U.L.

C547131✓	811U02680✓	3	3/8✓	96	480	14703	51000✓	76100✓	8	21
							51400	72900	8	26

(M55)MFST REF#:51A0375MD

Q-QUENCH TEMPERATURE	T-TEMPERATURE	N-NORMALIZE TEMPERATURE
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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																MQUAD GRAIN SIZE
	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	
811U02680	.17	1.04	.012	.005	.326	.227	.18	.03	.006	.002	.002	.038	.0002	.003	.004	.004	
CE																	
.38																	

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

R. SPANGLER II PER LSS

MILL TEST CERTIFICATE

Date, 08.04.2015
Ref:2015-109H

Customer

Description of Goods

✓ PRIME HOT ROLLED MERCHANT BARS
QUALITY : ASTM A36/A6

PURCHASE ORDER NUMBER: PUR1001244.v4
Lot 3 : JS012715T

Manufacturer CAG ÇELİK DEMİR VE ÇELİK END. A.Ş.

MECHANICAL PROPERTIES							CHEMICAL ANALYSIS (%)						
		Heat No	Yield Point N/MM2	Tensile Strength N/MM2	Elong. (%)	Bend Test	C	Mn	Si	S	P	N (ppm)	Cu
HOT ROLLED EQUAL ANGLES													
SIZE (Inch)	SIZE CODE												
3/4 X 3/4 X 1/8	58	53958	270	454	32	OK	0.12	0.66	0.19	0.019	0.018	59	0.054
3/4 X 3/4 X 1/8	58	53959	273	459	32	OK	0.12	0.70	0.16	0.020	0.017	60	0.052
HOT ROLLED FLAT BARS													
SIZE (Inch)	SIZE CODE												
1/8" x 1/2	17	531467	285	476	32	OK	0.13	0.74	0.20	0.022	0.020	61	0.053
1/8" x 3/4	20	53969	267	448	36	OK	0.12	0.65	0.16	0.022	0.018	61	0.054
1/8" x 1 1/2	34	53802	271	453	35	OK	0.15	0.81	0.18	0.019	0.019	80	0.053
1/8" x 2	39	53972	285	466	32	OK	0.15	0.65	0.20	0.022	0.018	61	0.051
3/16 x 5/8	239	54131	278	464	32	OK	0.14	0.66	0.20	0.021	0.017	60	0.054
3/16 x 3/4	21	53970	270	469	36	OK	0.14	0.70	0.17	0.020	0.017	61	0.053
3/16 x 1	26	53968	277	466	37	OK	0.16	0.65	0.16	0.020	0.018	60	0.053
1/4" x 1/2	19	54386	279	476	32	OK	0.14	0.74	0.16	0.020	0.017	59	0.051
1/4 x 5/8	104	54383	265	449	35	OK	0.13	0.63	0.17	0.021	0.018	64	0.052
1/4" x 3/4	22	53971	272	456	35	OK	0.15	0.62	0.17	0.020	0.020	62	0.052
3/8 x 3/4	24	54446	273	468	36	OK	0.14	0.69	0.18	0.019	0.020	63	0.054

HOT ROLLED ROUND BARS

SIZE (Inch)	SIZE CODE												
1/4"	1	531539	286	469	36	OK	0.15	0.67	0.19	0.022	0.019	62	0.052
5/16"	2	531540	278	458	35	OK	0.15	0.63	0.17	0.020	0.018	60	0.054
3/8"	3	54230	260	453	36	OK	0.12	0.67	0.16	0.021	0.020	64	0.054

CAG ÇELİK
DEMİR VE ÇELİK END. A.Ş.

[Handwritten signature]

SOLD TRIPLE S STEEL
PO BOX 21119
TO: HOUSTON, TX 77226-

NUCOR
NUCOR STEEL JACKSON, INC.

CERTIFIED MILL TEST REPORT

Page: 1

SHIP TRIPLE S STEEL
6000 JENSEN DR
TO: HOUSTON, TX 77026-

Ship from:

MTR #: 0000061380
Nucor Steel Jackson, Inc.
3630 Fourth Street
Flowood, MS 39232
800-723-1623

Date: 7-Nov-2016
B.L. Number: 432577
Load Number: 153483

Material Safety Data Sheets are available at www.nucorbar.com or by contacting your inside sales representative.

LOT # HEAT #	DESCRIPTION	PHYSICAL TESTS				CHEMICAL TESTS														
		YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8"	BEND	WT%	DEF	C	Ni	Mn	Cr	P	Mo	S	V	Si	Cb	Cu	Sn	C _{eq}
PO# => JK1610333701 JK16103337	HOU-173206 Nucor Steel - Jackson Inc 1-1/4x1-1/4x1/8 Angle 20' A36/A529-50/44W/50W A36/A529GR50/CSA44W/50W MEETS THE REQUIREMENTS OF: ASTM A36/36M, ASTM A529/A529 GR50 ASTM A709/709M GR36/GR50 CSA G40.21 GR44W(300W)/GR50W(350W) AASHTO M270/M270M GR36 ASME SA36/SA36M MEETS THE EN10204 SEC 3.1 REPORTING REQUIREMENTS HOU-173206	54,914 379MPa 55,287 381MPa	75,220 519MPa 74,810 516MPa	26.3% 25.0%		***		.14 .10 REDRAT PB = * **		.75 .09		.015 .017	.033 .011		.18 .001			.30		
PO# => JK1610445801 JK16104458	HOU-173206 Nucor Steel - Jackson Inc 1" (1.0000) Round 20' NUCOR MULTIGRADE NUCOR MULTIGRADE NUCOR MULTIGRADE MEETS THE REQUIREMENTS OF: ASTM A36/36M, ASTM A529/529M GR50 ASTM A572/572M GR50 ASTM A709/709M GR36/GR50 CSA G40.21 GR44W(300W)/GR50W(350W) AASHTO M270/M270M GR36/GR50 ASME SA36/SA36M MEETS THE EN10204 SEC 3.1 REPORTING REQUIREMENTS	59,159 408MPa 59,778 412MPa	78,200 539MPa 78,100 538MPa	25.0% 27.5%				.15 .11 CE4020 0.36		.78 .19 CEA529 0.40		.030 .031	.043 .031		.21 .002			.35 .012		

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MEETS THE EN10204 SEC 3.1 REPORTING REQUIREMENTS

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I hereby certify that the material described herein has been manufactured in accordance with the specifications and standards listed above and that it satisfies those requirements.
1.) Weld repair was not performed on this material.
2.) Melled and Manufactured in the United States.
3.) Mercury, Radium, or Alpha source materials in any form have not been used in the production of this material.

QUALITY ASSURANCE: Christopher Smith

Christopher Smith



GOOLSBY TESTING, INC.

2620 WILSON ROAD - P.O. BOX 1416
HUMBLE, TEXAS 77347-1416
(281) 540-1255 FAX (281) 540-8125

TO: BWFS	DATE: 9/25/2012
5637 ETHELINE	REPORT DATE: 09/27/2012
HOUSTON, TX 77039	LABORATORY TEST NO: 12-09-72323
JOB: 1908	GT# 1790
5-1/2" SQUARE NUTS	A&M REPORT#: 12-4119

CHEMICAL ANALYSIS

THE TESTING FOR THIS LAB # WAS COMPLETED BY A THIRD PARTY: A & M TECHINAL.

Sample: 5 nuts.

<u>Sample:</u>	<u>nut</u>	<u>nut</u>	<u>nut</u>	<u>nut</u>	<u>nut</u>
Carbon	.12	.11	.12	.12	.12
Manganese	.39	.36	.44	.39	.39
Phosphorus	.024	.023	.030	.025	.025
Sulfur	.015	.020	.017	.016	.014
Silicon	.18	.20	.20	.18	.19
Nickel	.05	.05	.05	.05	.05
Molybdenum	.01	.01	.01	.01	.01
Chromium	.11	.11	.13	.11	.11
Copper	.04	.04	.04	.04	.04
Aluminum	.005	.012	.006	.006	.006
Vanadium	<.002	<.002	<.002	<.002	<.002
Titanium	<.002	<.002	<.002	<.002	<.002
Niobium	<.002	<.002	<.002	<.002	<.002
Cobalt	.013	.014	.013	.013	.013
Boron	<.0005	<.0005	<.0005	<.0005	<.0005
Tungsten	<.01	<.01	<.01	<.01	<.01
Zirconium	<.01	<.01	<.01	<.01	<.01
Tin	<.005	<.005	<.005	<.005	<.005

GOOLSBY TESTING, INC.

PER:

APPROVED SIGNEE

Our letters and reports are for the use of our clients to whom they are addressed. Our name may be used only with our prior written approval. Our letters and reports apply only to the sample tested and / or inspected, and do not necessarily represent the quality of other apparently similar or identical materials.



Manufacturing Data Book

Section 11

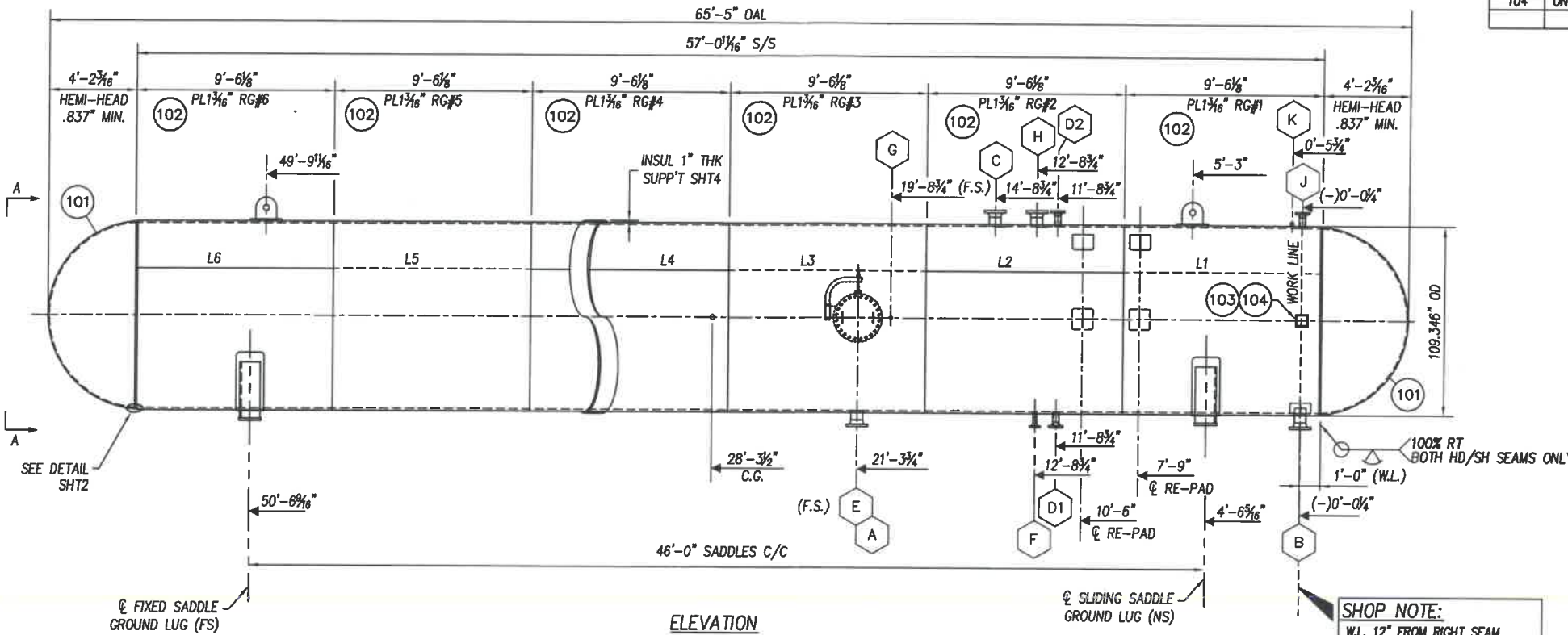
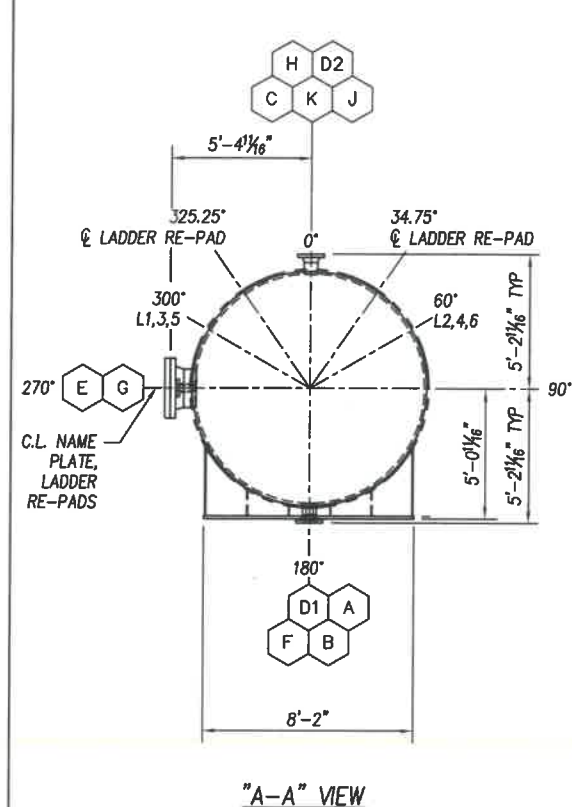
As Built Drawings

UOP Russell, LLC
7050 S. Yale Ave., Suite 210
Tulsa, OK 74136

P.O. Number: 4500754186

Project: J447XX

BWFS Industries, LLC.
5637 Etheline Dr.
Houston, Texas 77039



BILL OF MATERIALS			
ITEM	QTY.	DESCRIPTION	MATL. SPEC.
101	2	1" NOM. (.837" MIN.) x 109" O.D. ASME CODE HEMI-HEAD WITH 4 1/2" CUT BACK (HEMI-HEAD I.S.R. 53.661")	SA-516-70N
102	4	PL 1 1/8", R&W TO 109.346" O.D. x 9'-6 1/2" LG RG#1~RG#6	SA-516-70N
103	ONE	BWFS STANDARD NAME PLATE, 6" x 6"	S.S.
104	ONE	BWFS STANDARD N. PL BRACKET, 7" x 7"	SA-36

DESIGN DATA			
CONSTRUCTION IN ACCORDANCE WITH 2015 EDITION OF A.S.M.E. CODE SECTION VIII, DIVISION 1			
CODE STAMP	IS	REQ'D	NAT'L BOARD YES
DESIGN PRESSURE (INT.)	400	P.S.I.G.	TEMP 200 °F
DESIGN PRESSURE (EXT.)	N/A	P.S.I.G.	TEMP N/A °F
M.A.W.P. (N. & C.)	-	P.S.I.G. LIMITED BY	-
M.A.W.P. (H. & C.)	-	P.S.I.G. LIMITED BY	-
HYDROSTATIC TEST	523	P.S.I.G. (1.3 TIMES M.A.W.P.)	
CORROSION ALLOW. SHELL	1/16"	HEADS	1/16" NOZZ. 1/16"
RADIOGRAPH RT-2	P.W.H.T.	N/A	MFG. SER # 2491
RADIOGRAPH LONG SEAMS	FULL	CIRCUM. SEAM	UW-11(a)(5)(b) (NOTE#5)
JOINT EFF. HEADS	100%	SHELL	100%
MIN. DESIGN METAL TEMP.	-20	°F	
CHARPY IMPACT TEST NOT REQUIRED PER	UCS-66		
INSPECTED BY	ONECIS INSURANCE		
WEIGHT EMPTY	93,695*	LBS.	FULL OF WATER 336,890* LBS.
*INCLUDES INSULATION WEIGHT			
MATERIAL			
SHELL	SA-516 70N	FLANGES	SA-105
HEADS	SA-516 70N	SADDLES	SA-516 70
CPLGS	SA-105	INTERNALS	SA-516 70/SA-106B
STUDS	SA-193-B7 CAD PLD	REINF. PADS	SA-516 70/SA-516 70N
NUTS	SA-194-2H CAD PLD	NOZZ. NECKS	SA-105/SA-106B
GASKETS	1/8" THK GASKET, FLEXMETALIC STYLE "CG", SPIRAL WOUND 304 SS, W/ FLEXCARB FILLER		

- GENERAL NOTES:**
- FLANGE BOLT HOLES SHALL STRADDLE CENTERLINES PARALLEL TO VESSEL CENTERLINES UNLESS NOTED OTHERWISE.
 - ALL FLANGES SHALL BE PER ASME B16.5 WITH A 125 - 250 AARR GASKET CONTACT FINISH U.N.O.
 - ALL INSIDE EDGES OF NOZZLE AND CONNECTIONS, WHETHER FLUSH OR EXTENDED, SHALL BE ROUNDED OFF TO A MINIMUM RADIUS OF 1/8".
 - PRESSURE RELIEF DEVICE SHALL BE PROVIDED BY USER PER UG-125 (g).
 - (2) HEAD/SHELL SEAMS NEED 100% RT.

REFERENCE DRAWINGS			
DESCRIPTION	DWG NO.		
NOZZLE DETAILS	2491-2		
SADDLE DETAILS AND MISCELLANEOUS	2491-3		
INSULATION SUPPORT DETAILS	2491-4		
S/O: 2491-17	REQ'D ONE	TAG No.	V-404

BWFS INDUSTRIES LLC

109.346" O.D. x 65'-5" OAL
PRODUCT SURGE TANK
60 MMSCFD CRYO PLANT - UOP RUSSELL PROJECT 54470X
PLAN, ELEVATIONS, NOZZLE SCHEDULE & DESIGN DATA

CUSTOMER: UOP RUSSELL LLC CUSTOMER JOB NO.: J-447

DRWN S.R. CHK C.H. DATE 01/05/17 DWG. No. 2491
PO No. 4500754186 SHT. No. 1 OF 4

CERTIFIED BY

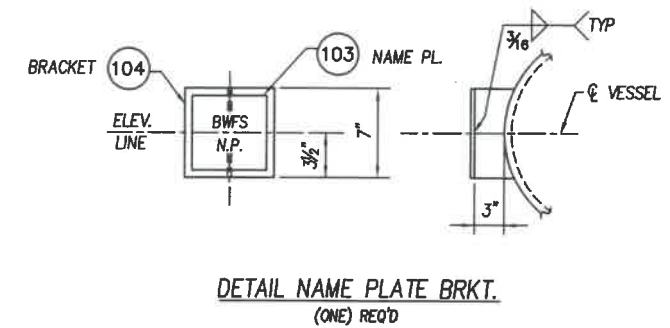
BWFS INDUSTRIES LLC
HOUSTON, TEXAS, USA
TEL (281) 590-9391

M.A.W.P. 400 PSIG AT 200 °F
M.A.E.W.P. - PSIG AT - °F
M.D.M.T. -20 °F AT 400 PSIG
SERIAL NO. 2491 YEAR BUILT 2017

109.346" O.D. x 65'-5" OAL x 1" HEADS x 1 1/8" SHELL
PRODUCT SURGE TANK
CORROSION ALLOWANCE: 1/8"
HYDROTESTED AT 523 PSI ON 01/05/17

BWFS INDUSTRIES LLC

NAME PLATE STAMPING
(ONE) REQ'D



CERTIFIED FOR CONSTRUCTION
DATE _____
BY (ENGR) _____
BY (QC) _____

EXT. COATING NOTES: (PER TRCO PAINTING SYSTEM 3)

- SURFACE PREP: SSPC-SP6
- PRIMER: SHERWIN-WILLIAMS MACROPOXY 646 FAST CURR EPOXY B58-600, DATA SHEET 4.53. ONE COAT 4.0-6.0 MILS DFT.
- PRIMER INTERMEDIATE COAT: SHERWIN-WILLIAMS MACROPOXY 646 FAST CURE EPOXY B58-600, DATA SHEET 4.53. ONE COAT 4.0-6.0 MILS DFT
- FINISH COAT: SHERWIN-WILLIAMS HI-SOLIDS POLYURETHANE B65 SERIES/B60V30, DATA SHEET 5.21. ONE COAT 3.0-4.0 MILS DFT.

TOTAL SYSTEM: DFT 12.0-16.0 MILS.

MK. NO.	QUAN.	SIZE	TYPE	RTG.	SERVICE
K	ONE	0.75"	CPLG	6000#	SEAL FLUSH CONNECTION
J	ONE	3"	RFWN	300#	PUMP SPILLBACK
H	ONE	6"	RFWN	300#	PSV
G	ONE	0.75"	CPLG	6000#	TI
F	ONE	2"	RFWN	300#	DRAIN
E	ONE	18"	RFWN	300#	MANWAY W/ BLIND
D1/D2	2	3"	RFWN	300#	LI
C	ONE	6"	RFWN	300#	EQUALIZATION
B	ONE	6"	RFWN	300#	LIQUID OUTLET, W/ V.B.
A	ONE	6"	RFWN	300#	INLET

NOZZLE SCHEDULE

WELD PROCEDURES

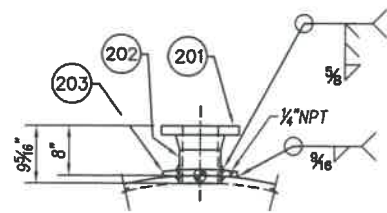
WPS 96-045 REV.2 (GMAW/SAW)
- FOR VESSEL GIRTH & LONG SEAM

WPS 95-044 REV.2 (GMAW/FAW/SAW)
- FOR NOZZLES AND MISC.

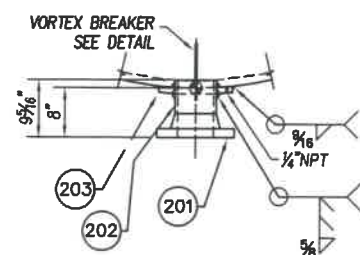
WELD WIRE

GMAW - 70S-6/2
FAW - 711
SAW - 860 FLUX L61

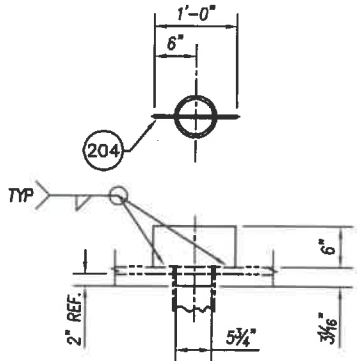
NO.	REVISIONS	BY	DATE
3	ISSUED "AS BUILT"	S.R.	5/17
2	CHGD SADDLE HEIGHT	S.R.	03/7
1	ADDED PADS: ISSUED FOR ISSUED FOR CONSTRUCTION.	S.R.	02/26
0	ISSUED FOR APPROVAL	S.R.	01/06



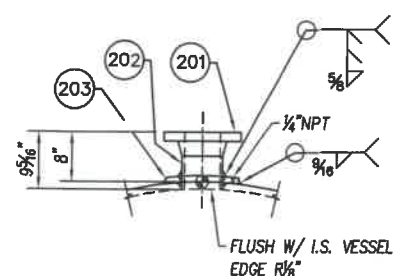
NOZZLE DETAIL - 6" 300# RFWN
(2) REQ'D, MK "A/C"



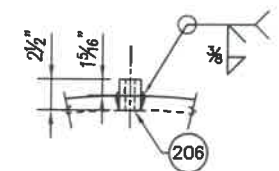
LIQ OUTLET DETAIL - 6" 300# RFWN
(ONE) REQ'D, MK "B"



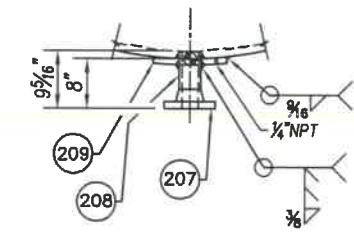
DETAIL - VORTEX BREAKER
(ONE) REQ'D



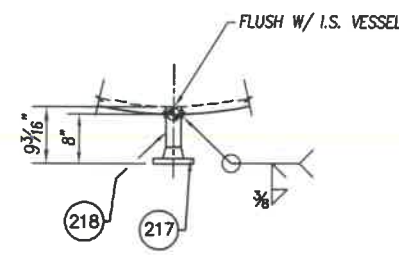
NOZZLE DETAIL - 6" 300# RFWN
(ONE) REQ'D, MK "H"



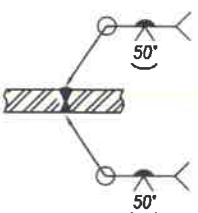
NOZZLE DETAIL
- 0.75" 6000# COUPLING
(2) REQ'D, MK "G/K"
SCALE: 2X



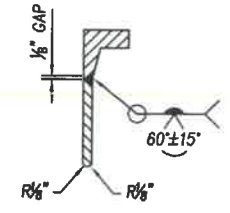
NOZZLE DETAIL - 3" 300# RFWN
(3) REQ'D, MK "D1/D2, J"



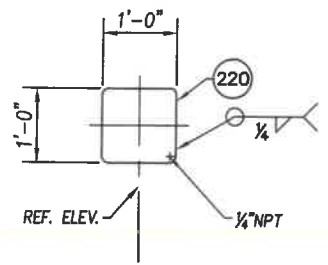
DRAIN DETAIL - 2" 300# RFWN
(ONE) REQ'D, MK "I"



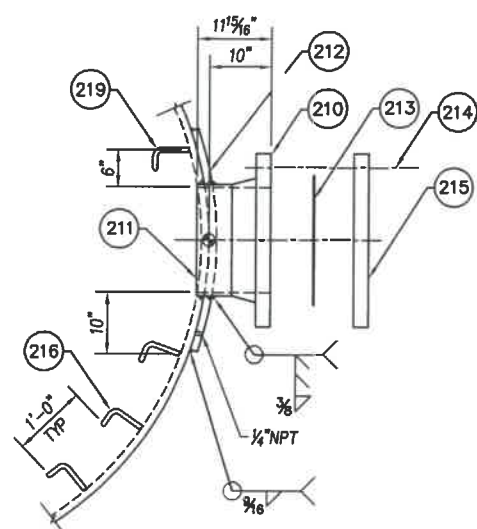
TYPICAL WELD DETAIL
BEVEL LONG OR
CIRCULAR SEAM CAT. A.B



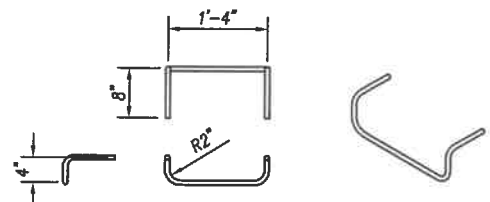
TYPICAL NOZZLE DETAIL



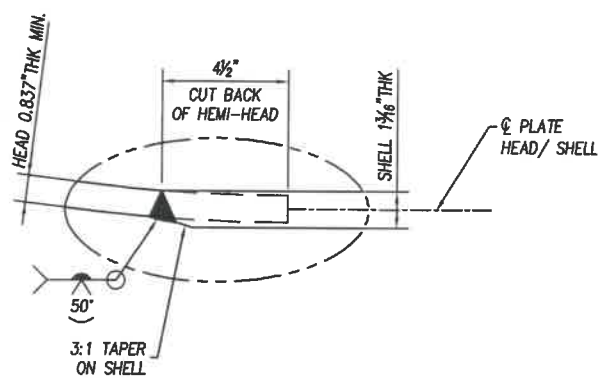
ACCESS LADDER
RE-PAD DETAIL
(6) REQ'D



MANWAY DETAIL - 18" 300# RFWN
(ONE) REQ'D, MK "E"



MANWAY RUNG DETAILS
(3) REQ'D FOR FOOT RUNG 1"Ø
(ONE) REQ'D FOR HAND RUNG 3/4"Ø



SHELL/HEAD TRANSITION
SCALE: 5x

BILL OF MATERIALS				
ITEM	QTY.	DESCRIPTION	MATL. SPEC.	
201	4	6" 300# RFWN FLANGE, S/XS BORE, FOR "A/B/C/H"	SA-105	
202	ONE	SMLS PIPE, 6" S/XS, 32" LG	SA-106B	
203	4	PL 1", 6 3/4" I.D. x 1 3/8" O.D., REPAD	SA-516 70	
204	ONE	PL 3/4", 6" x 12", VORTEX BREAKER	SA-36	
205	-	-	-	
206	2	3/4"NPT 6000# FULL COUPLING	SA-105	
207	3	3" 300# RFWN FLANGE, S/160 BORE, FOR "D1/D2/J"	SA-105	
208	ONE	SMLS PIPE, 3" S/160, 27" LG	SA-106B	
209	3	PL 1", 3 3/8" I.D. x 7 1/2" O.D., REPAD	SA-516 70	
210	ONE	18" 300# RFWN FLANGE, S/XS BORE, FOR "E"	SA-105	
211	ONE	SMLS PIPE, 18" S/XS, 11" LG	SA-106B	
212	ONE	PL 1 1/4", 18 3/8" I.D. x 32" O.D., REPAD	SA-516 70N	
213	ONE	1/2" THK GASKET FOR 18" 300# RF FLANGE	SEE SHIT	
214	24	STUDS, 1 1/4"Ø x 7 3/4" LG, W/ (2) H.H.N EA	SEE SHIT	
215	ONE	18" 300# RF BLIND FLANGE	SA-105	
216	3	ROUND BAR 1"Ø x 40" LG	SA-36	
217	ONE	2" 300# RFWN FLANGE, S/160 BORE, FOR "I"	SA-105	
218	ONE	SMLS PIPE, 2" S/160, 8" LG	SA-106B	
219	ONE	ROUND BAR 3/4"Ø x 40" LG	SA-36	
220	6	PL 3/8", 12" x 12" LG., RE-PAD	SA-516 70	

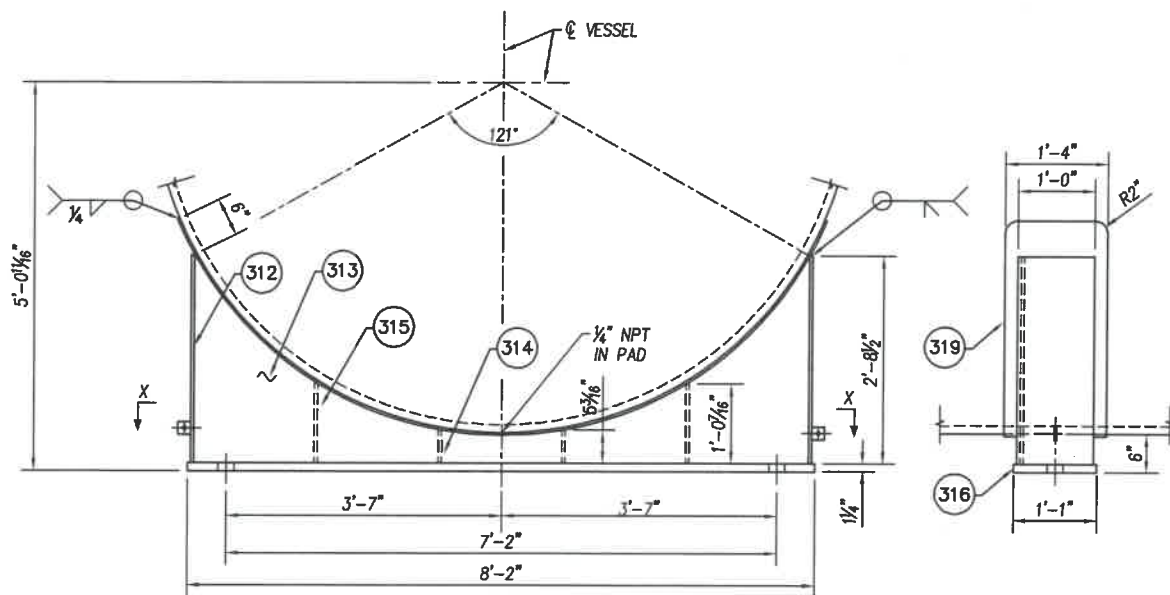
CERTIFIED FOR CONSTRUCTION
DATE _____
BY (ENGR) _____
BY (QC) _____

NOTES:

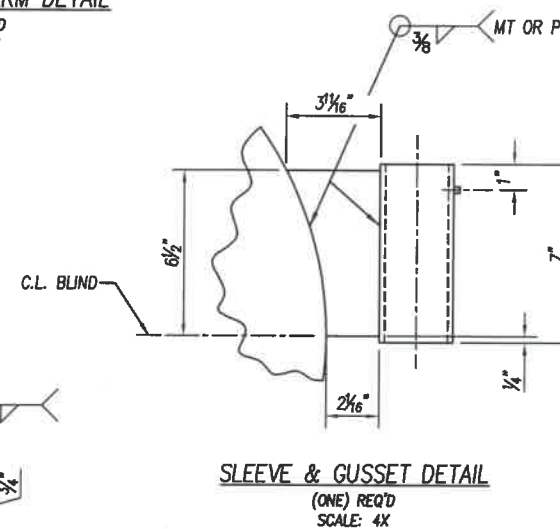
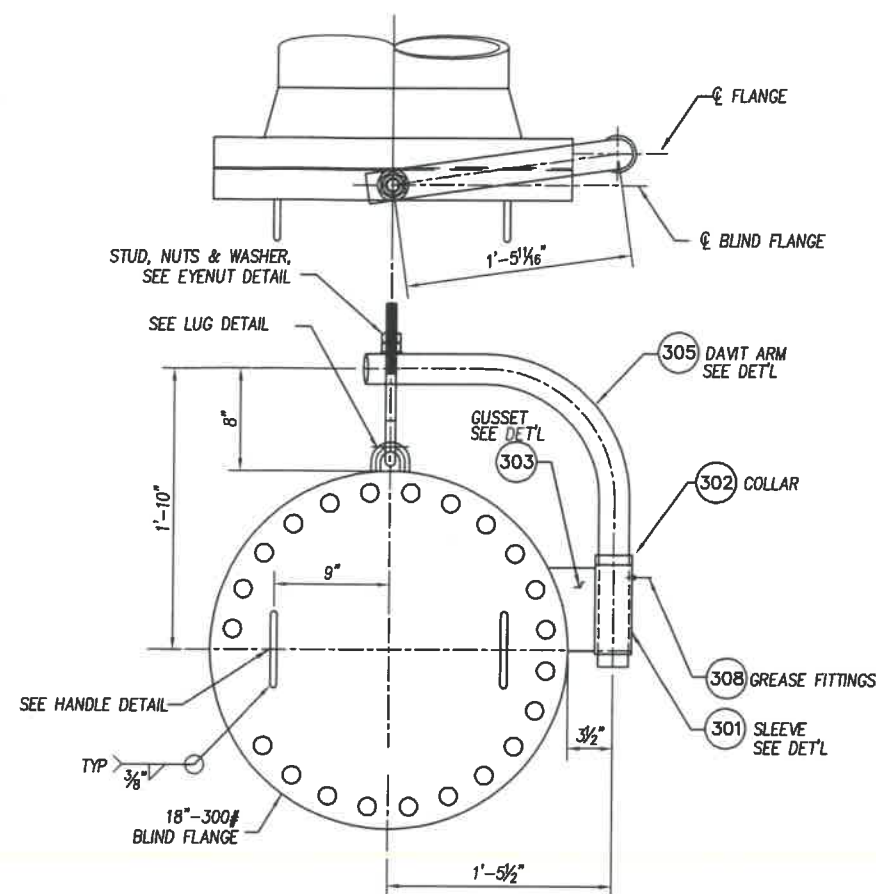
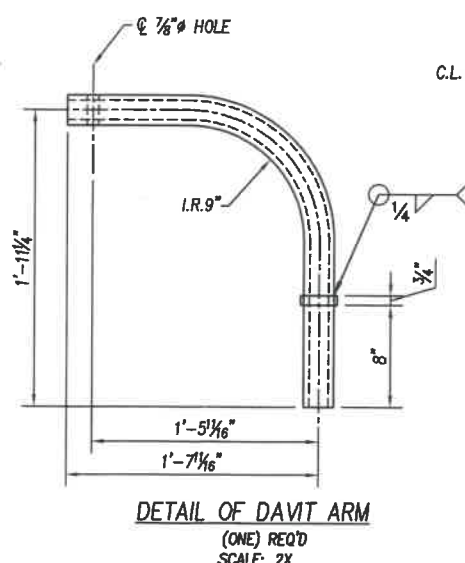
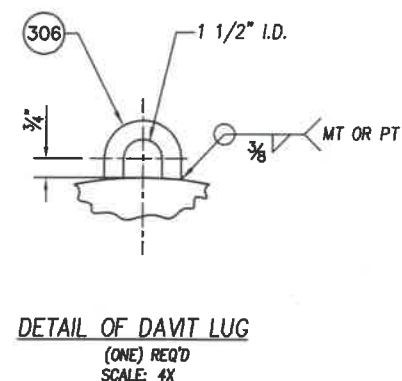
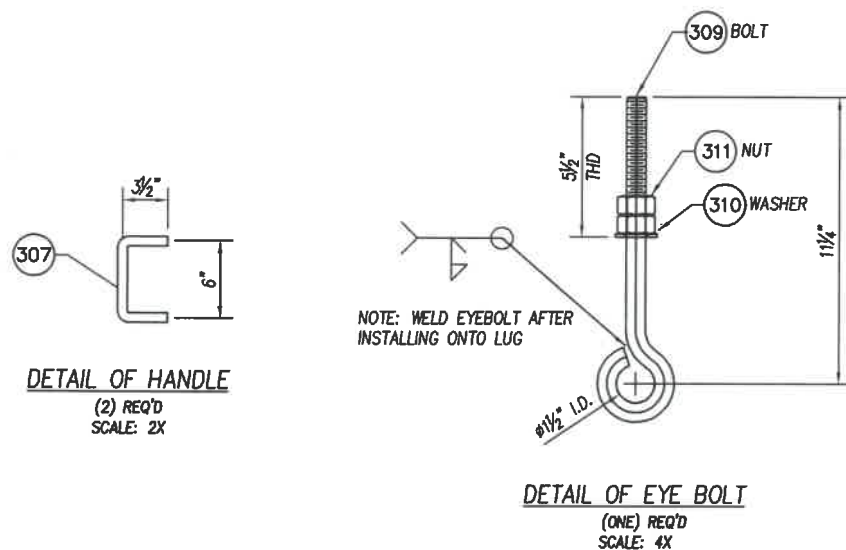
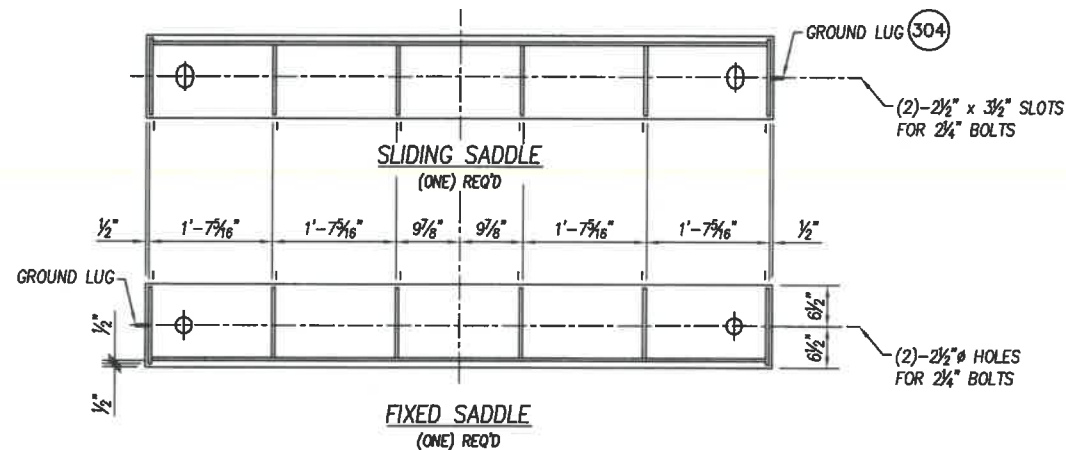
1. WN FLANGE TO NECK BUTT-WELD TO BE FULL-PEN.
2. ROUND NOZZLE INSIDE EDGES R6" MIN.
3. NOZZLE REPAD BUTT WELDS ORIENTED > 45° FROM LONG SEAM IF THE REPAD IS ON SHELL AND IS SPLIT.
4. WHERE A SPLIT REINFORCING PAD IS UTILIZED ON HEADS, THE WELDS JOINING PORTIONS SHALL BE 100% RT.
5. NPT 1/4" THRU REQ'D AT LOWEST POINT IN EACH SEGMENT OF EACH REPAD.
6. REMOVE ALL BURRS AND SHARP EDGES

S/O: 2491-17	REQ'D ONE	TAG No. V-404
BWFS INDUSTRIES LLC TEL: (281) 590-9391 5637 ETHELINE HOUSTON, TEXAS		
109.346" O.D. x 65'-5" OAL PRODUCT SURGE TANK 60 MMSCFD CRYO PLANT - UOP RUSSELL PROJECT S447X		
NOZZLE DETAILS		
CUSTOMER: UOP RUSSELL LLC		CUSTOMER JOB NO.: J-447
DRWN S.R.	CHK C.H.	DATE 01/05/17
PO No. 4500754186	DWG. No. 2491	
		SHT. No. 2 OF 4

NO.	REVISIONS	BY	DATE
2	ISSUED "AS BUILT"	S.R.	4/20
1	ADDED REPADS, ISSUED FOR CONSTRUCTION	S.R.	2/22
0	ISSUED FOR APPROVAL	S.R.	1/6

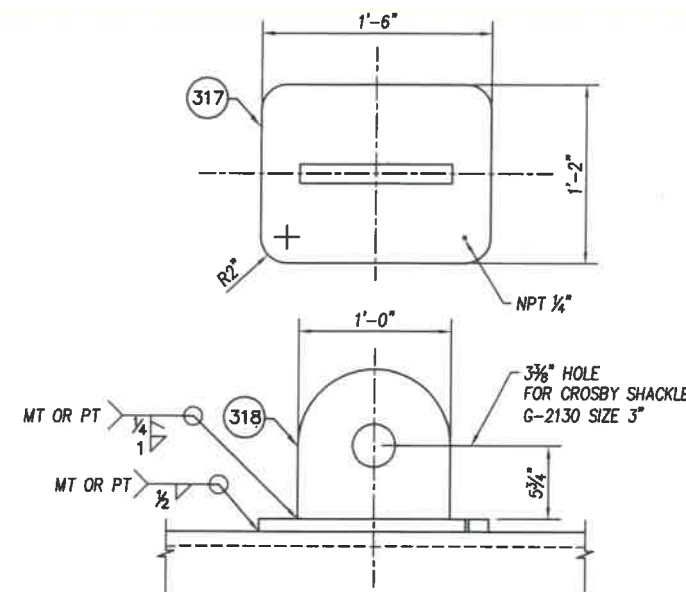


SADDLE DETAILS - ELEV. VIEW
(2) REQ'D



BILL OF MATERIALS			
ITEM	QTY.	DESCRIPTION	MATL. SPEC.
301	ONE	SMLS PIPE, 2 1/2" SCH.40 x 7' LG SLEEVE	SA-106B
302	ONE	SMLS PIPE, 2 1/2" SCH.40 x 3/4" LG., COLLAR	SA-106B
303	ONE	1/2" PL x 6 1/2" x 3 11/16" LG., GUSSET	SA-516-70
304	2	PL 3/4", 2" x 2" W/ 3/8" AT CENTER, GROUND LUG	S.S.
305	ONE	PIPE 2" S/XXH x 39" LG., DAVIT ARMS (BEND)	SA-36
306	ONE	3/4" ROD x 5 1/2" LG., LUG (BEND)	SA-36
307	2	3/4" ROD x 13" LG., HANDLE (BEND)	SA-36
308	ONE	1/4" STD. GREASE FITTINGS	C.S.
309	ONE	3/4" ROD x 16 9/16" LG, W/ NC THREAD SHOWN DETAIL	SA-193-B7
310	ONE	3/4" STD. FLAT WASHER	C.S.
311	2	3/4" HEX NUTS	SA-194-2H
312	4	PL 1/2", 12" x 3 1/2", OUTER RIB	SA-516-70
313	2	PL 1/2", 8'-0" x 3 1 1/16", WEB	SA-516-70
314	4	PL 1/2", 11" x 5 1/4", INNER RIB#1	SA-516-70
315	4	PL 1/2", 11" x 12 1/8", INNER RIB#2	SA-516-70
316	2	PL 1/4", 13" x 8'-2", BASE PL	SA-516-70
317	2	PL 3/4", 14" x 18" REPAD	SA-516-70
318	2	PL 1/2", 12" x 11 3/4", LIFT LUG	SA-516-70N
319	2	PL 3/8", 16" x 10'-9", WEAR PL	SA-516-70

NOTES:
1. REMOVE ALL BURRS AND SHARP EDGES



S/O: 2886-13 REQ'D ONE TAG No. V-404

BWFS INDUSTRIES LLC

TEL: (281) 590-9391
5637 ETHELINE
HOUSTON, TEXAS

109.346" O.D. x 65'-5" OAL
PRODUCT SURGE TANK
60 MMSCFD CRYO PLANT - UOP RUSSELL PROJECT S447XX

DETAILS OF
SADDLES AND MISC.

2	ISSUED "AS BUILT"	S.R.	4/17	CUSTOMER: UOP RUSSELL LLC DRWN S.R. CHK C.H. DATE 01/5/17 PO No. 4500754186	CUSTOMER JOB NO.: 447 DWC. No. 2491 SHT. No. 3 OF 4
1	REVISED SADDLE HEIGHT	S.R.	3/9		
0	ISSUED FOR APPROVAL	S.R.	01/06		
NO.	REVISIONS	BY	DATE		