MOORE CONTROL SYSTEMS, INC.
P.O. BOX 677 - KATY, TEXAS 77492 - (281) 392-7747 - FAX (281) 392-7727

Manufacturer Data Book

Marathon Oil Company

Carlsbad, New Mexico

PO# 4500261551

Vertical 2 Phase Separator

Job #18165
Serial #18165-9

MOORE CONTROL SYSTEMS, INC.
Instrument & Electrical Engineering & Design • Construction • Service
Phone: 281-392-7747 www.moore-control.com

Katy: 1435 Katy Flewellen
Katy, Tx 77494

Mailing: P.O. Box 677
Katy, Tx 77494

Baytown: 14827 I-10 East
Baytown, Tx 77523

TABLE OF CONTENTS

Serial# 18165-9

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Baytown, Tx 77523

SECTION 1

ASME CODE DATA REPORT

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 Moore Control Systems, Inc., 1435 Katy Flewellen, Katy, TX 77494
(Name and address of Manufacturer)

2. Manufactured for Marathon Oil Co., Carlsbad, New Mexico
(Name and address of Purchaser)

3. Location of installation Marathon Oil Co., 2423 Bonita St., Carlsbad, New Mexico 88220
(Name and address)

4. Type: Vertical (Horizontal or vertical, tank) | 18165-9 (Manufacturer's serial number) | (CRN) | 18165-XXXX Rev. 1 (Drawing number) | 19 (National Board number) | 2018 (Year built)

5. ASME Code, Section VIII, Div. 1: 2017 Edition [Edition and Addenda, if applicable (date)] | (Code Case number) | [Special service per UG-120(d)]

6. Shell: SA-516-70 (Material spec. number, grade) | .375" (Nominal thickness) | 0" (Corr. allow.) | 4'-0" O.D. (Inner diameter) | 20'-0" SM/SM [Length (overall)]

Body Flanges on Shells

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

7. Seams: Type 1 [Long. (welded, dbl., sngl., lap, butt)] | Full [R.T. (spot or full)] | 100% (Eff., %) | (H.T. temp.) | (Time, hr) | Type 1 [Girth (welded, dbl., sngl., lap, butt)] | Spot [R.T. (spot or full)] | 100% (Eff., %) | 2 (No. of courses)

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

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	End	.3125"	0"			2:1				Concave
(b)	End	.3125"	0"			2:1				Concave

Body Flanges on Heads

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

9. MAWP 250 PSI (Internal) | (External) at max. temp. 150 ° F (Internal) | (External).

Min. design metal temp. -20 ° F at 250 PSI. Hydro., ~~pneu., or comb.~~ test pressure Hydro @ 325 PSI.

Proof test ____.

10. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material: Nozzle	Material: Flange	Nozzle Thickness: Nom.	Nozzle Thickness: Corr.	Reinforcement Material	Attachment Details: Nozzle	Attachment Details: Flange	Location (Insp. Open.)
Manway w/Cvr *	1	18" 150#	RFSO	SA-106B	SA-105	.938"	0"	SA-516-70	Welded	Welded	Shell
Inlet	1	6" 150#	RFWN	SA-106B	SA-105	.432"	0"		Welded	Welded	Shell
Water Outlet	1	3" 3000#	CPLG	SA-105		.375"	0"		Welded		Shell
Gauge Glass	2	1/2" 6000#	CPLG	SA-105		.33"	0"		Welded		Shell
Supply Gas	1	1/2" 6000#	CPLG	SA-105		.33"	0"		Welded		Head
Drain	1	2" 3000#	CPLG	See Note 1		.33"	0"		Welded		Head

11. Supports: Skirt Yes (Yes or no) Lugs ____ (Number) Legs ____ (Number) Other ____ (Describe) Attached Welded to Head (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: Shell, Serial# 7967E & 7967L, Bise Welding & Fabricating, Inc., Cert# 30911
(Name of part, item number, Manufacturer's name and identifying stamp)

See U4 attached. No Charpy Impact Testig per UG-20(f)

(07/17)

FORM U-1A

Manufactured by Moore Control Systems, Inc., 1435 Katy Flewellen, Katy, Tx 77494

Manufacturer's Serial No. 18165-9 CRN _____ National Board No. 19

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 45443 expires May 9, 2019.

Date 6-4-18 Co. name Moore Control Systems, Inc. (Manufacturer) Signed Kenneth Wilhm (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Moore Control Systems, Inc. at 1435 Katy Flewellen, Katy, Tx 77494.

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by Authorized Inspection Associates of Houston, Tx have inspected the component described in this Manufacturer's Data Report on 22May18, 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 5JUN18 Signed J. Taylor Mooney (Authorized Inspector) Commissions NB12490BE (National Board Authorized Inspector Commission number)

(07/17)

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

1. Manufactured and certified by: Moore Control Systems, Inc., 1435 Katy Flewellen, Katy, Tx 77494
(Name and address of Manufacturer)

2. Manufactured for: Marathon Oil Co., Carlsbad, New Mexico
(Name and address of Purchaser)

3. Location of installation: Marathon Oil Co., 2423 Bonita St., Carlsbad, New Mexico 88220
(Name and address)

4. Type: Vertical (Horizontal, vertical, or sphere) | Vertical 2 Phase Separator (Tank, separator, heat exch., etc.) | 18165-9 (Manufacturer's serial number)

(CRN)	18165-XXXX Rev. 1 (Drawing number)	19 (National Board number)	2018 (Year built)

Data Report Item Number	Remarks
10.	Elbow-1-SA-234-WPB, S/80, 90° LR / Pipe-1-SA-106B, S/80
	* (QTY 16 Ea) 1 1/8" Dia. x 6 1/4" Lg. SA-193-B7 Studs w/ (2 Ea) SA-194-2H Heavy Hex Nuts
	(1) Gas Outlet Nozzle: 6" 150# RFWN, Flange-1-SA-105, S/80 / Pipe-1-SA-106B, S/80 .432" Thk., / Repad-1-SA-516-70, .375" Thk.
	0" Corr. Allow., Nozzle / Flange Attachment: Welded, Welded in Head
	(1) Safety Head Nozzle: 2" 3000# CPLG-1-SA-105, .3125" Thk., 0" Corr. Allow., Nozzle / Flange Attachment: Welded, Welded in Head
	(1) PI Nozzle: 1/2" 6000# CPLG-1-SA-105, .33 Thk., 0" Corr. Allow., Nozzle / Flange Attachment: Welded, Welded in Shell
	(1) Water LLC Nozzle: 2" 3000# CPLG-1-SA-105,, .3125" Thk., 0" Corr. Allow., Nozzle / Flange Attachment: Welded, Welded in Shell
	(1) Relief Nozzle: 2" 3000# CPLG-1-SA-105,, .3125" Thk., 0" Corr. Allow., Nozzle / Flange Attachment: Welded, Welded in Shell
	(1) Water Level Low Nozzle: 3/4" 6000# CPLG-1-SA-105,, .35" Thk., 0" Corr. Allow., Nozzle / Flange Attachment: Welded, Welded in Shell
	(1) Oil Level High Nozzle: 3/4" 6000# CPLG-1-SA-105,, .35" Thk., 0" Corr. Allow., Nozzle / Flange Attachment: Welded, Welded in Shell

Certificate of Authorization: Type U No. 45443 Expires May 9, 2019

Date 6-4-18 Name Moore Control Systems, Inc. (Manufacturer) Signed Kenneth Williams (Representative)

Date 5/30/18 Name L. Taylor Mooney (Authorized Inspector) Commissions NB1249BR (National Board Authorized Inspector Commission number)

(07/17)

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

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

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

1. Manufactured and certified by: Bise Welding & fabricating, Inc. 1900 De Soto Houston, Texas 77091
(Name and address of Manufacturer)

2. Manufactured for: MCSI More Control Systems, Inc. 14827 I-10 East. Bytown, Tx 77523
(Name and address of Purchaser)

3. Location of installation: Unknown
(Name and address)

4. Type: Cylinder [Description of vessel part (shell, two piece head, tube bundle)]; 7967 A Through L (Manufacturer's serial number); (CRN)

(National Board number); (Drawing number); (Drawing prepared by); 2018 (Year built)

5. ASME Code Section VIII Div 1; 2017 [Edition and Addenda, if applicable (date)]; (Code Case number); [Special Service per UG-120(d)]

6. Shell (a) Number of course (s): 1 (b) Overall Length: 10'-0"

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
1	48"OD	10'-0"	SA 516-70	.375"		1	Full						

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

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

Body Flanges on Heads

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

8. MAWP (Internal) (External) at max temp. (Internal) (External) Min. design metal temp. at

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

10. Hydro~~, pneu., or comb~~. test pressure. PSI Proof Test

11. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	

12. Identification of part (s)

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

13. Support: Skirt (Yes or no) Lugs (Number) Legs (Number) Other (Describe) Attached (Where and how)

14. Remarks: MCSI PO# 181656058A; Desing By Others; Formed In Accordance With UG 79, UG 80 and UCS 79; No Hydro Preformed

FORM U-2A

Manufactured by Bise Welding & fabricating, Inc. 1900 De Soto Houston, Texas 77091

Manufacturer's Serial No. 7967 A - L CRN _____ National Board No. _____

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of material, construction and workmanship of this pressure vessel part conform to the ASME Boiler and pressure Vessel Code, Section VIII, Division 1.

"U" Certificate of Authorization Number 30,911 Expires January 30, 2020

Date 3-8-18 Name Bise Welding & fabricating (Manufacturer) Signed _____ (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by OneCIS Insurance Company of Lynn, MA have inspected the pressure vessel part described in this Manufacturer's Data Report on 3-8-18 and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 3-8-18 Signed _____ (Authorized Inspector) Commissions NB 14513 AI (National Board Authorized Inspector Commission number)

(07/17)

MOORE CONTROL SYSTEMS, INC.
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Katy, Tx 77494

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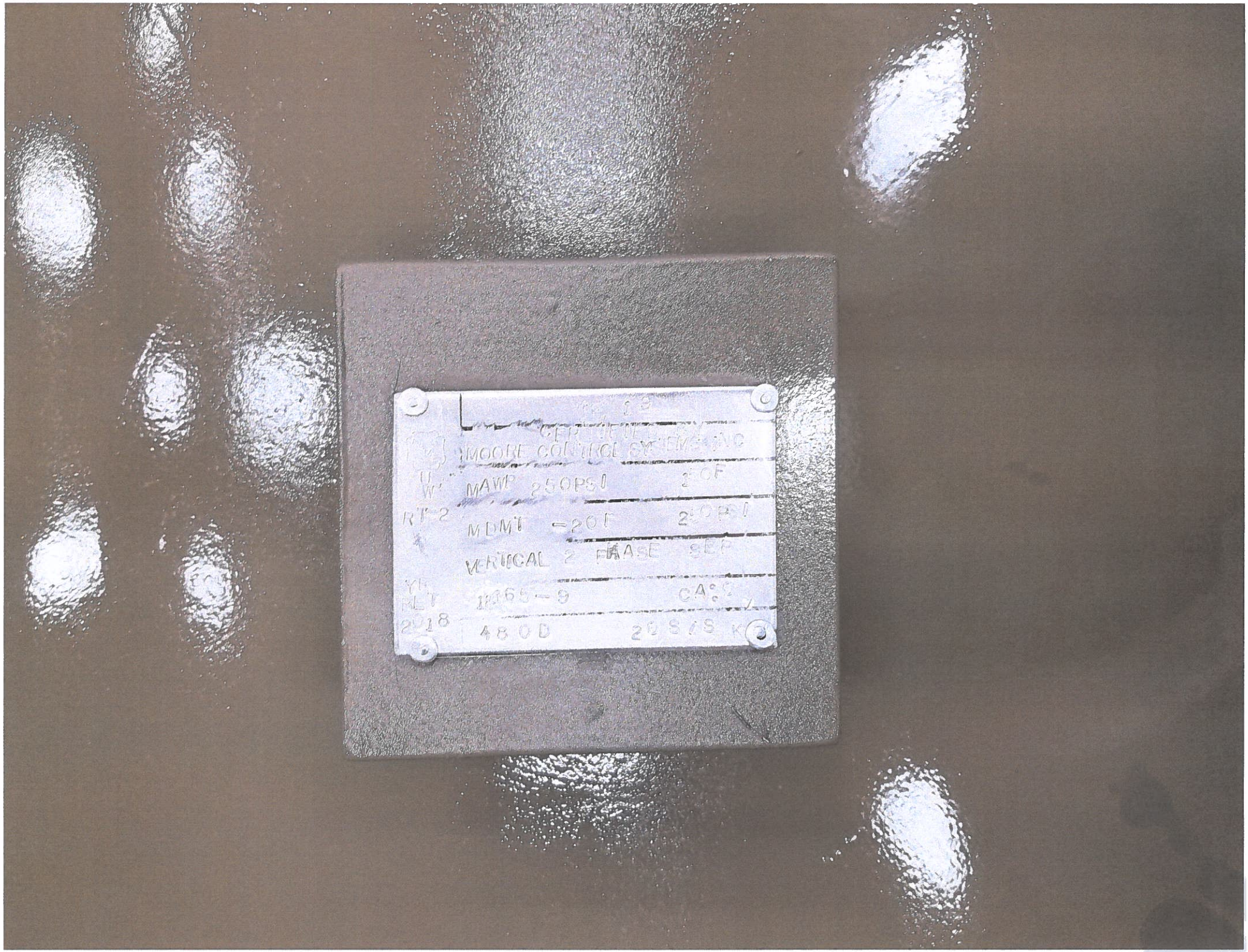
SECTION 2

NAME PLATE FACSIMILE


MOORE CONTROL SYSTEMS INC
MAWP 250PSI
MDMT -20F
VERTICAL 2 PHASE SEP
4800
250 S/S

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SECTION 3

ASME CODE TRAVELER

MOORE CONTROL SYSTEMS, INC.

Engineering & Design • Field Support • Fabrication & Buildings • Construction

Moore Personal. Moore Value. Moore Control. • Since 1981

Moore Control Systems, Inc.

JOB TRAVELER

Customer:	Marathon Oil Company	Date:	2/26/2018
Job Number:	18165 Vertical 2 Phase Separator		
Tag Number:	Later		
Drawing #	18165-XXX SHT 1		
Serial No.:	18165-9	National Board#	At time of hydro
WPS - Long Seams	Bise welded long seams WPS # BW-04L		
WPS - Girth Seams	MCS-SAW-2-P1, MCS-GM&FC-P1		
WPS - Nozzle Attach	MCS-GM&FC-P1		

Design Requirements

Design Press Int.	250 PSI			
Design Press Ext.				
Design Temperature	150°F	MDMT	-20°F	
Design for special service	(L, UB, LT)	Yes	No X	
LT Received	Yes	No X		

Calculations

Reviewed by A.I. _____ Date 28FEB18

QC Reviewed _____ Date 03-03-18

James A. Sadik

18165-9 JOB TRAVELER

18165-9

Material Inspection

	Shop	Date	Q.C.	Date	A.I. Hold	A.I. Check	A.I. Date
Examine MTR's and compare to heat number							
1) Heads			JV, VV	3-2-18	N/A		
2) Shell			JV	3-9-18			
Check thickness, surface and tolerance							
1) Heads			JV, VV	3-2-18			
2) Shell (plate) (pipe)			JV	3-9-18			
Examine cut edges (bevel) of							
1) Heads			JV, VV	3-2-18			
2) Shell (plate) (pipe)			JV	3-9-18			
Record mill stamping and transfers							
1) Heads			JV, VV	3-2-18			
2) Shell (plate) (pipe)			JV	3-9-18			
Verify flange ratings and pipe thickness							
1) Nozzles			VV	3-20-18			
2) Flanges			VV	3-20-18			
3) Pipe			VV	3-20-18			

Welding

	Shop	Date	Q.C.	Date	A.I. Hold	A.I. Check	A.I. Date
1) Welding Procedure Specifications			JV	3-2-18			
2) Welder Performance Qualifications			JV	4-17-18			

18165-9 JOB TRAVELER

18165-9

Fabrication

	Shop	Date	Q.C.	Date	A.I. Hold	A.I. Check	A.I. Date
Fabrication Inspection							
1) Examine cut edges on cylinder	CenA	5-1-18	JV	4-16-18			
2) Shell course fitup			JV	4-16-18			
3) Shell layout	CenA	5-4-18	KW	5-3-18			
4) Head layout	CenA	5-10-18	JV	4-26-18			
5) Nozzle fitup	CenA	5-4-18	KW	5-4-18			
6) Internal check	CenA	5-18-18	KW	5-18-18	✓	✓	18MAY18
Check weld groove preparation							
1) Long seam			N/A	BY OTHERS			
2) Girth seams	CenA CC2	5-11-18	JV	4-16-18			
3) Nozzle attachments	CenA	5-4-18	KW	5-4-18			
BISE CUT A							
Cutting, fitting and alignment							
1) Long seams			N/A	BY OTHERS			
2) Girth seams	CenA CC2	5-11-18	JV	4-16-18			
3) Nozzle attachments	CenA	5-4-18	KW	5-4-18			
BISE ROLLED / WELDED							
Check back chip surface							
1) Long seams			N/A	BY OTHERS			
2) Girth seams			SEE	BELOW			
3) Nozzle attachments							
BISE WELDED	ROOT	PASS	LEFT	INTACT	NO BACK GOUGE		

18165-9 JOB TRAVELER

18165-9

Non-destructive testing

	Shop	Date	Q.C.	Date	A.I. Hold	A.I. Check	A.I. Date
Radiography							
1) Long seam			KW	*	*		
2) Girth seams			KW	5-16-18	*		
3) Nozzle attachments							
* RT AT BISE							
Ultrasonics							
1) Long seam			N/A				
2) Girth seams			N/A				
3) Nozzle attachments			N/A				
Test reinforcement pads							
1) Nozzle attachments			N/A				
Final inspection							
1) Weld appearance and reinforcement	CurA	5-18-18	KW	5-18-18			
2) Check fillet weld sizes	CurA	5-18-18	KW	5-18-18			
3) Out of roundness			KW	5-18-18			
4) Final dimension	CurA	5-18-18	KW	5-18-18			
5) Check stamping on nameplate			KW	5-18-18 *			
6) Name plate attached			JV	6-15-18 *			

JOB TRAVELER

18165-9

Post fabrication

	Shop	Date	Q.C.	Date	A.I. Hold	A.I. Check	A.I. Date
Post weld heat treatment			N/A				
1) Review and approve procedure							
2) Type (furnace or local)							
3) Thermocouples attached to item							
4) Charts reviewed and signed							
5) Verify up, hold and down periods							
Hydrostatic test							
1) Pressure test verified		05-22-18	JV		K		
2) Gauge SIN		963689	JV				
3) Code Stamp		05-22-18	JV		P		
Preparation for shipment							
1) Data Report checked			JV	6-4-18	K		
2) Sandblast			JV	6-28-18			
3) Paint			JV	6-28-18			
Final Acceptance			JV	6-15-18	5		

Remarks

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Baytown: 14827 I-10 East
Baytown, Tx 77523

SECTION 4

RECEIVING INSPECTION REPORT W/MTR's AND HEAT MAP

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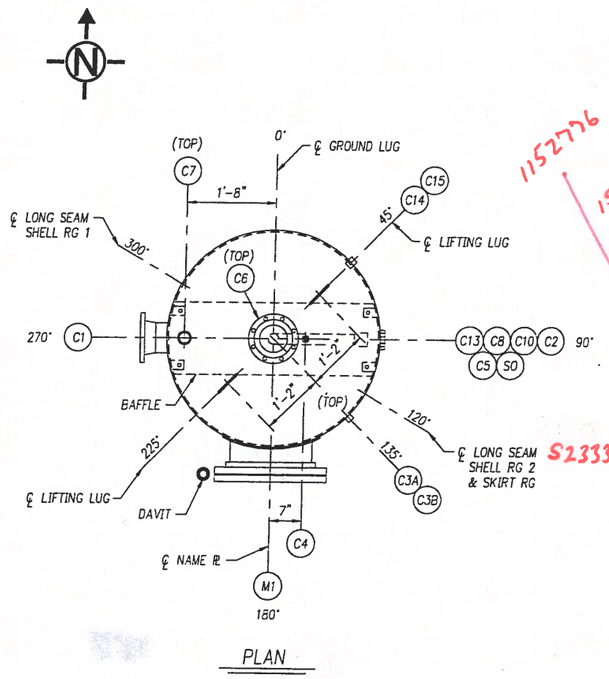
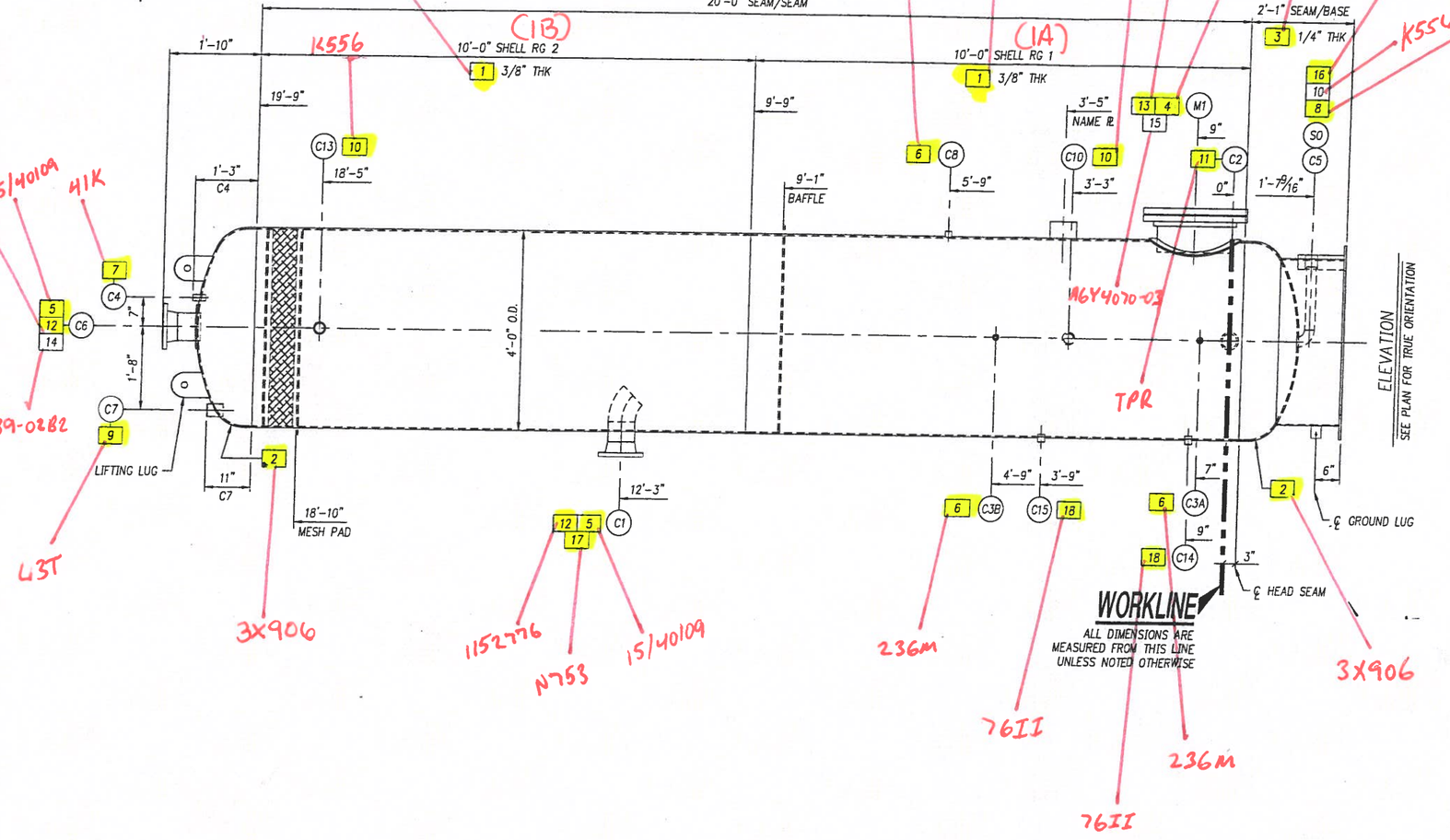


PLAN



HEAT MAP

ISSUED FOR CONSTRUCTION
MCSI #: 18165 DATE: 2/19/18

REFERENCE DRAWING	DRAWING DESCRIPTION	NO	REVISION DESCRIPTION	DATE	BY	CHK'D
		0	ISSUED FOR CONSTRUCTION	2/14/18	MLR	RR
		A	ISSUED FOR APPROVAL	1/22/18	MLR	RR

MCSI MOORE CONTROL SYSTEMS, INC.
KATY, TEXAS
(281) 392-7747
WWW.MOORE-CONTROL.COM

CARLSBAD, NEW MEXICO

CUSTOMER: MARATHON OIL CO.
AFE/CUSTOMER JOB NO:

VERTICAL 2 PHASE SEPARATOR FABRICATION DRAWING

DRAWN BY	DATE	SCALE	MCSI JOB NO
MLR	1/22/18	*	18165

DRAWING NO	SHEET	REV
18165-XXXX SHT 2	2 OF	0

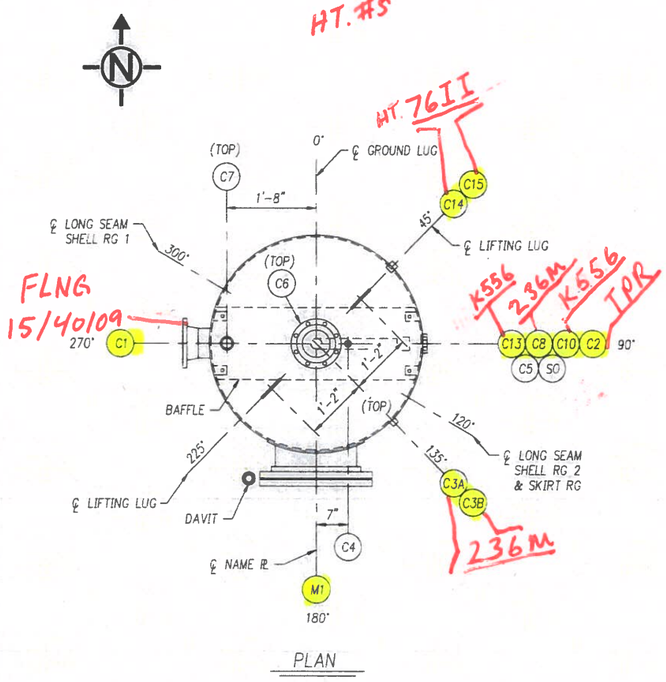
X:\MOORE CONTROLS\18165 - MARATHON SCRUBBER\18165.DWG

Lay out
ok - CD#
5-3-18

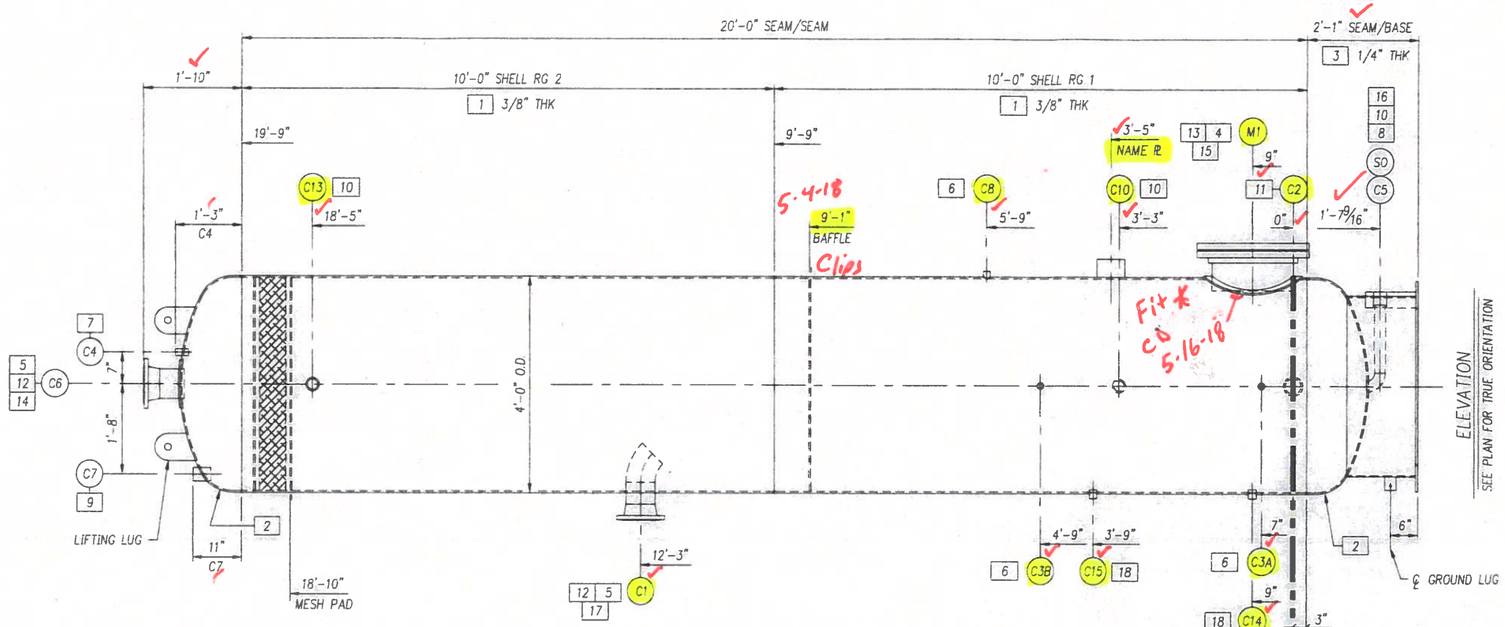
Top Head & Bottom Skirt
5-11-18 CD#

QUALITY CONTROL
MAY 0 4 2018
kw
QC 1

HT. #'S



PLAN



Finaled & Clean up
ok - 5-21-18
CD#

AS BUILT

ISSUED FOR CONSTRUCTION 1
MCSI # 18165 DATE 3/20/18

MCS-GM/FC-P1
MCS-GT-1

18165-9

NO	REVISION DESCRIPTION	DATE	BY	CHK'D
0	ISSUED FOR CONSTRUCTION	2/14/18	MLR	RR
A	ISSUED FOR APPROVAL	1/22/18	MLR	RR

MOORE CONTROL SYSTEMS, INC.
KATY, TEXAS
(281) 392-7747
WWW.MOORE-CONTROL.COM

CARLSBAD, NEW MEXICO

CUSTOMER: MARATHON OIL CO.
AFE/CUSTOMER JOB NO: *

VERTICAL 2 PHASE SEPARATOR
FABRICATION DRAWING

DRAWN BY	DATE	SCALE	MCSI JOB NO
MLR	1/22/18	*	18165

DRAWING NO: 18165-XXXX SHT 2
SHEET: 2 OF
REV: 0

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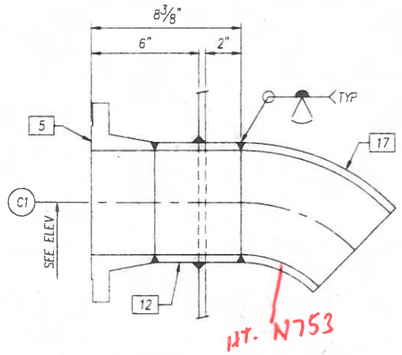
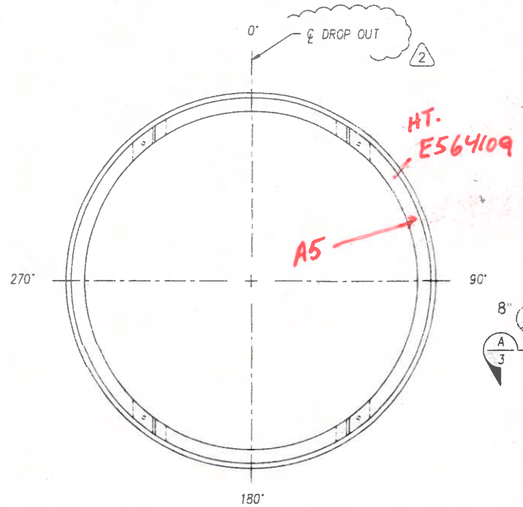
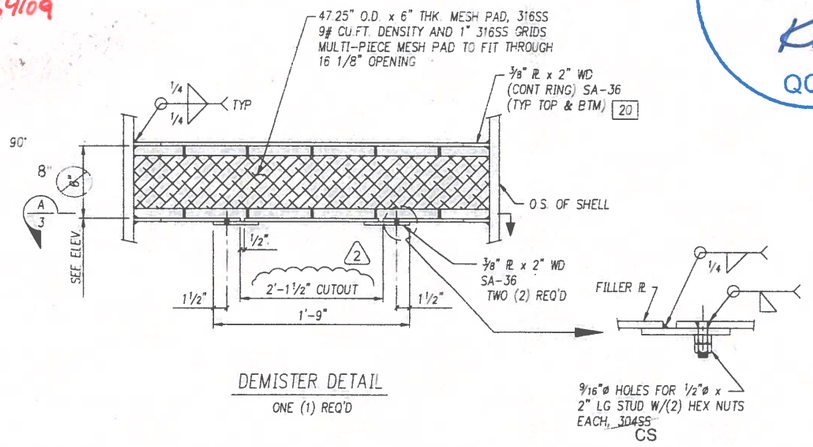
3/20/2018 3:33:21 PM



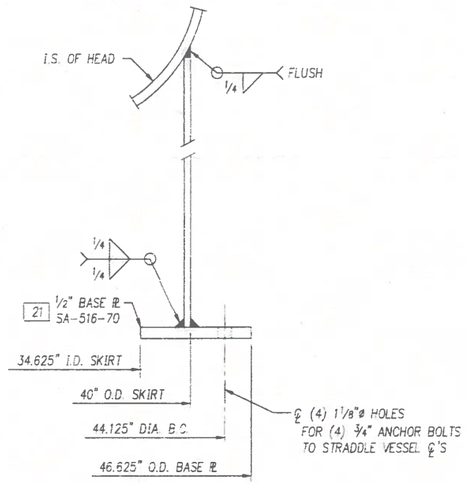
DETAIL OF 6" 150# NOZZLE MK "C1"
ONE (1) REQ'D



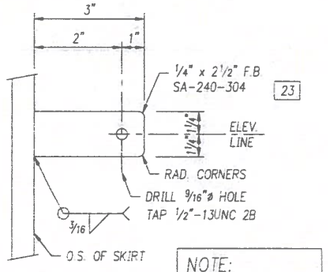
PLAN OF BOTTOM RING A/3



DEMISTER DETAIL
ONE (1) REQ'D

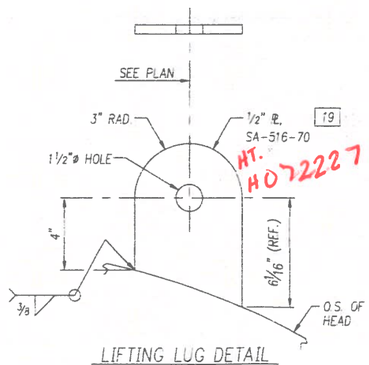


SKIRT & BASEPLATE DETAIL

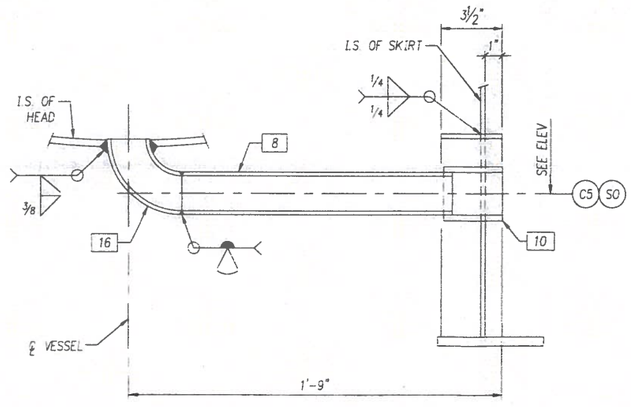


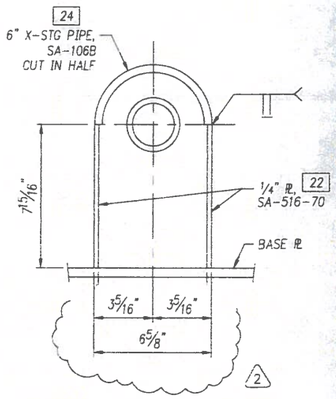
NOTE:
DO NOT PAINT
GROUNDING LUG

GROUNDING LUG DETAIL
ONE (1) REQ'D



LIFTING LUG DETAIL
TWO (2) REQ'D





DETAIL OF 2" 3000# CPLG MK "C5" & SKIRT SLEEVE MK "SO"
ONE (1) REQ'D

MCS-GM/FC-P1
MCS-GT-1

ISSUED FOR CONSTRUCTION 2
MCSI #: 18165 DATE: 4/23/18

REFERENCE DRAWING	DRAWING DESCRIPTION	NO	REVISION DESCRIPTION	DATE	BY	CHK'D
		2	REVISED AS BUILT	4/23/18	MLR	RR
		1	REVISED MESH PAD DETAIL	3/27/18	MLR	RR
		0	ISSUED FOR CONSTRUCTION	3/20/18	MAK	RR
		A	ISSUED FOR APPROVAL	2/14/18	MLR	RR

MCSI MOORE CONTROL SYSTEMS, INC.
KATY, TEXAS
(281) 392-7747
WWW.MOORE-CONTROL.COM

CARLSBAD, NEW MEXICO

CUSTOMER	AFE/CUSTOMER JOB NO
MARATHON OIL CO.	*

VERTICAL 2 PHASE SEPARATOR
FABRICATION DRAWING

DRAWN BY	DATE	SCALE	MCSI JOB NO
MLR	2/14/18	*	18165

DRAWING NO	SHEET	REV
18165-XXXX SHT 3	3 OF	2

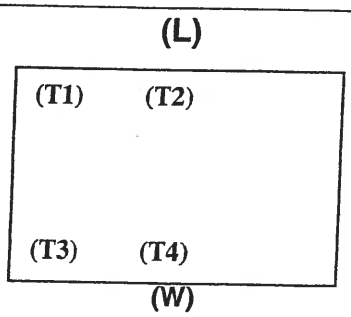
EXHIBIT F REV. 0

RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9A P.O. NO. ____

PLATE

SPEC. NO. SA____ GRADE____ T1____
MIN. THICKNESS REQD____ T2____
HEAT NO.____ T3____
MFG. BY____ T4____
M.T.R. NO.____ L ____
HARDNESS TEST IF REQD.____ W ____

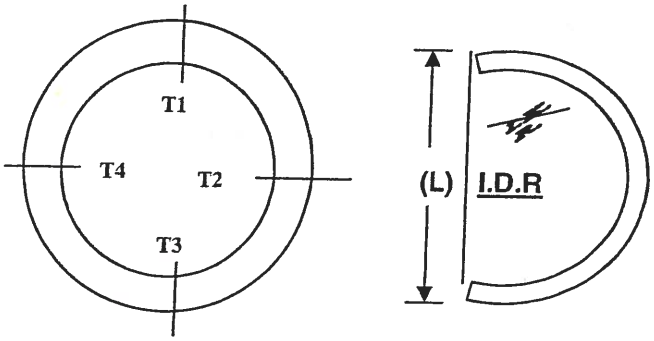


CONFORMS TO CODE YES NO

HEADS

SPEC.NO. SA____ GRADE____ T1____

MIN. THICKNESS REQD____ T2____
HEAT NO____ T3____
MFG. BY____ T4____
M.T.R.NO.____ PG/UG-79____
L____
HARDNESS TEST IF REQD ____ L.K.R.____
NO. OF IDENTICAL HEADS____ I.D.R.____

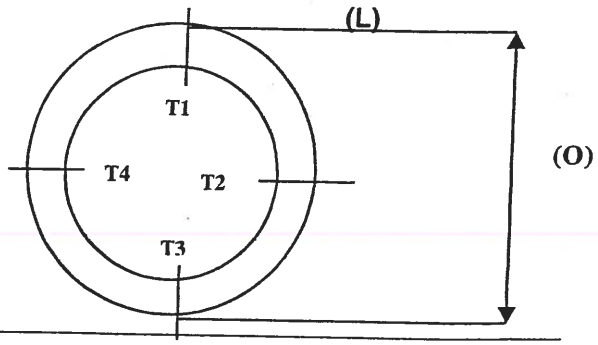


THICKNESS MEASURED AT STRAIGHT FLANGE

CONFORMS TO CODE YES NO

PIPE - SHELL SN: 7967E

SPEC.NO.SA 516 GRADE 70 T1 .382
MN. THICKNESS REQD .375 T2 .384
HEAT NO 823462000 T3 .380
MFG.BY Arcelor Mittal T4 .377
MFG.IDENTIFICATION #046096 L 120"
M.T.R.NO. N/A OD 48"
HARDNESS TEST IF REQD N/A



CONFORMS TO CODE (YES) NO

FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

CHECKED BY Jeremy Vargas DATE 4-9-18 APPROVED BY QC MANAGER.____ DATE. ____

BISE
Welding & Fabricating, Inc.
1900 De Soto St. • Houston, TX 77091
Ph: 713-681-0958 • Fax: 713-681-7555
www.BiseWelding.com

Stamp Rubbing 18165-9A

CUSTOMER MCSI

PO# 18165605BA

Paint Stick

Cylinder: 3/8 x 48 OD x 120 Lg

SN: 7967-E

U Steel Stamp
Part
Certified By Bise
SN: 7967-E

Welder Symbol: D

Material: SA 516-70

Heat: 823162000

Slab: H016096

MFG:

02/13/2018 From: AMERICAN ALLOY STEEL, INC. To: BISE WELDING & FABRICATING
P.O.#: 6768 S.O.#: 593368 AA PL#: 5191981
Item: 2 (1 PC) 3/8" X 120" X 480"

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANAYLSES

US HWY 12 Burns Harbor, Indiana

SHIPMENT NO. 803-00575 | DATE SHIPPED 08-28-17 | CAR OR VEHICLE NO. AMERICAN COMMERCIAL | PAGE 1

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

SHIP TO:
AMERICAN ALLOY STEEL INC
C/O FREIGHT MANAGEMENT & LOGISTICS
INBESA TERMINAL-PORT OF HOUSTON
16335 PENINSULA BLVD
HOUSTON TX 77015

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

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.
PLATES - ASTM A516-06 GR 70 PVQ MOD C.20 MAX
CU.15 MAX KLD FINE GRAIN PRAC, ASME
SA516 GR 70 PVQ 2015 EDITION, FIRST
TST AS ROLLED-ADD'L TENSION PER TST
PC HEAT TREATMENT --- MILL TEST PCS
NORM 1625/1675F FOR 30MIN/IN
30MINS/MIN --- TEST CERTS ARE
PREPARED IN ACCORD WITH PROCEDURES
OUTLINED IN EN 10204:2004 TYPE 3.1
NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)
CO# 112625 GH 354-5712F

H047429	823X70130	3	.375	120	480	18378	53200	78600	8	25
							51300	73500	8	25
(M55)MFST REF#:7										
→ H046096	823Y62000	3	.375	120	480	18378	51100	79500	8	24
							53600	75900	8	24
(M55)MFST REF#:7										

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

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HARD BHN	BEND	CHARPY IMPACT: THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP °F	ENERGY FT LBS 1	2	3	SHEAR(%) 1	2	3	LAT. EXP MILS 1	2	3

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL, INC.
Reviewed By:
11/16/2017

HEAT NUMBER	CHEMICAL ANALYSIS: C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	MQUAID GRAIN SIZE
823X70130	.17	1.11	.008	.003	.327	.023	.01	.12	.079	.002	.002	.038	.0002		.002	.006	.002
823Y62000	.18	1.11	.011	.003	.349	.017	.01	.12	.083	.002	.002	.032	.0002		.002	.006	.002

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

BHPLTRPT.TIF

R. SPANGLER II PER LSS
SUPV. QUALITY ASSURANCE

AMERICAN ALLOY PLATE #5191981

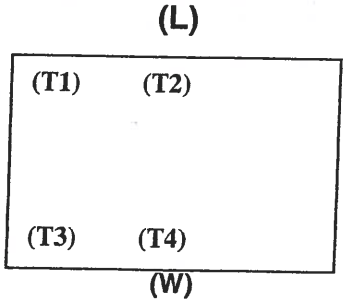
EXHIBIT F REV. 0

RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-913 P.O. NO. ____

PLATE

SPEC. NO. SA____GRADE____T1____
MIN. THICKNESS REQD____T2____
HEAT NO.____T3____
MFG. BY____T4____
M.T.R. NO.____L ____
HARDNESS TEST IF REQD.____W ____

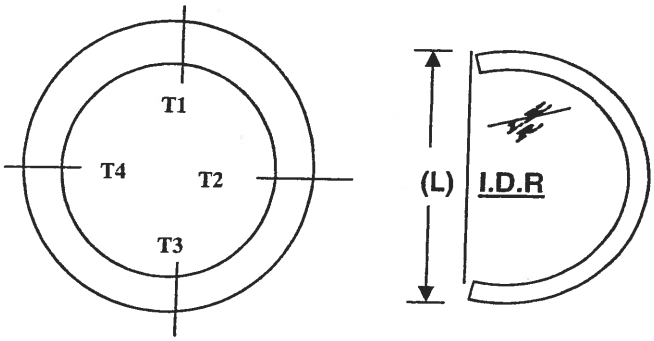


CONFORMS TO CODE YES NO

HEADS

SPEC.NO. SA____GRADE____T1____

MIN. THICKNESS REQD____T2____
HEAT NO____T3____
MFG. BY____T4____
M.T.R.NO.____PG/UG-79____
L____
HARDNESS TEST IF REQD ____ L.K.R.____
NO. OF IDENTICAL HEADS____ I.D.R.____



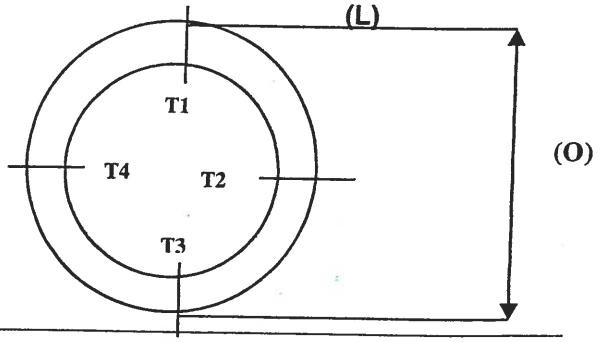
THICKNESS MEASURED AT STRAIGHT FLANGE

CONFORMS TO CODE YES NO

PIPE

~~PIPE~~ SHELL SN: 7967-L

SPEC.NO.SA 516 GRADE 70 T1 .380
MN. THICKNESS REQD .375 T2 .375
HEAT NO 811X07850 T3 .382
MFG.BY Arcelor Mittal T4 .380
MFG.IDENTIFICATION E063345 L 120"
M.T.R.NO. N/A OD 48"
HARDNESS TEST IF REQD N/A



CONFORMS TO CODE (YES) NO

FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

CHECKED BY Jeremy Vargas DATE 4-9-18 APPROVED BY QC MANAGER.____DATE. ____

BISE
Welding & Fabricating, Inc.
1900 De Soto St. • Houston, TX 77091
Ph: 713-681-0958 • Fax: 713-681-7555
www.BiseWelding.com

Stamp Rubbing 18165-9B

CUSTOMER MCSI

PO# 18165160581 ✓

Paint Stick

Cylinder: 3/8 x 1/8 ø x 120' Lg

SN: 7967-L

U Steel Stamp
Part
Certified By Bise
SN: 7967-L

Welder Symbol: D

Material: SA 516-70

Heat: B11K07850

Slab: E063345

MFG: MITTAL

02/13/2018 From: AMERICAN ALLOY STEEL, INC. To: BISE WELDING & FABRICATING
P.O.#: 6768 S.O.#: 593368 AA PL#: 5187223
Item: 2 (1 PC) 3/8" X 120" X 480"

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANAYLSES

US HWY 12 Burns Harbor, Indiana

SHIPMENT NO. 803-21142 | DATE SHIPPED 06-20-17 | CAR OR VEHICLE NO. CSS-CHGO-BNSF CSS 019017 | PAGE 3

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

SHIP TO
AMERICAN ALLOY STEEL INC
BNSF TR# 7226 MILE 66.4 LN SEG 492
6230 N HOUSTON ROSSLYN RD
HOUSTON TX 77091-3410

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

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.
PLATES - ASTM A516-06 GR 70 PVQ MOD C.20 MAX
CU.15 MAX KLD FINE GRAIN PRAC, ASME
SA516 GR 70 PVQ 2015 EDITION, FIRST
TST AS ROLLED-ADD'L TENSION PER TST
PC HEAT TREATMENT --- MILL TEST PCS
NORM 1625/1675F FOR 30MIN/IN
30MINS/MIN --- TEST CERTS ARE
PREPARED IN ACCORD WITH PROCEDURES
OUTLINED IN EN 10204:2004 TYPE 3.1
NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)
CO# 111580 GH 354-5570C

E063344	811X07850	3	.375	120	480	18378	51500	76500	8	24
							51200	73800	8	26

(M55)MFST REF#:5

E063345	811X07850	3	.375	120	480	18378	51300	76400	8	25
							51200	73700	8	26

(M55)MFST REF#:5

E063347	822X37710	1	.375	120	480	6126	52700	78400	8	26
							53300	76300	8	26

(M55)MFST REF#:5

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

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HARD BHN	BEND	CHARPY IMPACT THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP. F	ENERGY FT LBS 1	2	3	SHEAR(%) 1	2	3	LAT. EXP MILS 1	2	3

Certified a true copy of the
original, retained in our file.
AMERICAN ALLOY STEEL, INC.
Reviewed By:
7/10/2017

HEAT NUMBER	CHEMICAL ANALYSIS C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	MQUAID GRAIN SIZE
811X07850	.17	1.07	.010	.004	.319	.020	.01	.11	.078	.001	.002	.031	.0002		.002	.006	.003
822X37710	.18	1.16	.012	.004	.344	.022	.01	.13	.086	.002	.002	.033	.0002		.002	.004	.003

AMERICAN ALLOY
PLATE #5187223

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

R. SPANGLER II PER LSS
SUPV. QUALITY ASSURANCE

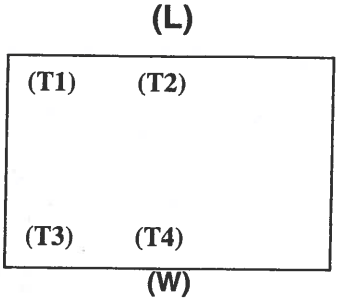
EXHIBIT F REV. 0

RECEIVING INSPECTION REPORT

CLIENT Marathon JOB NO. 18165-9B P.O. NO. ____

PLATE

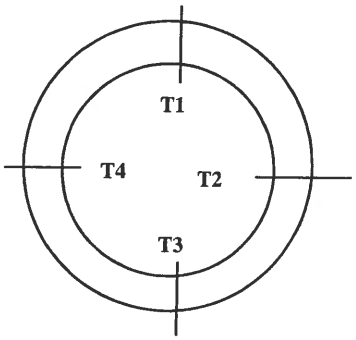
SPEC. NO. SA____ GRADE____ T1____
MIN. THICKNESS REQD____ T2____
HEAT NO.____ T3____
MFG. BY____ T4____
M.T.R. NO.____ L ____
HARDNESS TEST IF REQD.____ W ____

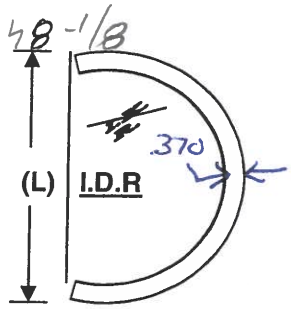


CONFORMS TO CODE YES NO

HEADS

SPEC.NO. SA 516 GRADE 70 T1 .362
MIN. THICKNESS REQD .3125 T2 .348
HEAT NO 3X906/504247 T3 .355
MFG. BY Nucor T4 .367
M.T.R.NO.____ PG/UG-79____
L 48-1/8
HARDNESS TEST IF REQD None L.K.R.____
NO. OF IDENTICAL HEADS Zero I.D.R. 47-9/16



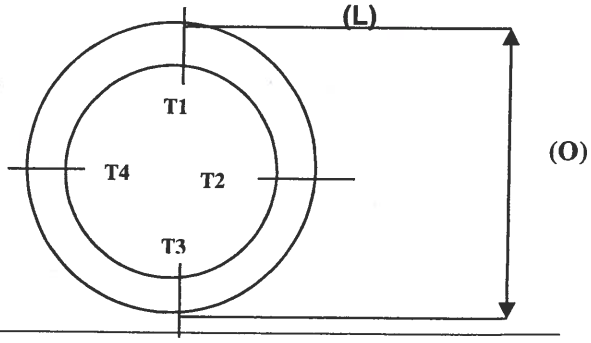


THICKNESS MEASURED AT STRAIGHT FLANGE

CONFORMS TO CODE (YES) NO

PIPE

SPEC.NO.SA____ GRADE____ T1____
MN. THICKNESS REQD____ T2____
HEAT NO____ T3____
MFG.BY____ T4____
MFG.IDENTIFICATION____ L____
M.T.R.NO.____ ____
HARDNESS TEST IF REQD____



CONFORMS TO CODE YES NO

FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

CHECKED BY____ DATE 3-2-18 APPROVED BY QC MANAGER____ DATE 3/20

Jeremy Vargas

EXHIBIT F REV. 0

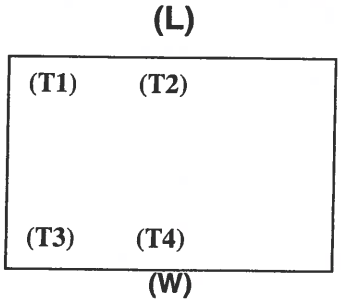
RECEIVING INSPECTION REPORT

CLIENT_____ JOB NO. 18165-9A P.O. NO. ____

PLATE

SPEC. NO. SA____GRADE_____T1_____
MIN. THICKNESS REQD_____T2_____
HEAT NO._____T3_____
MFG. BY_____T4_____
M.T.R. NO._____L _____
HARDNESS TEST IF REQD._____W _____

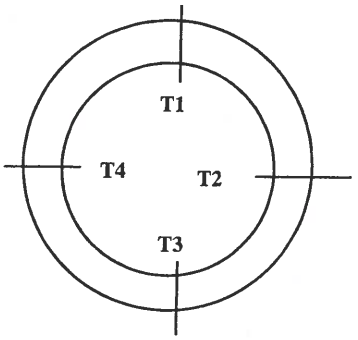
CONFORMS TO CODE YES NO

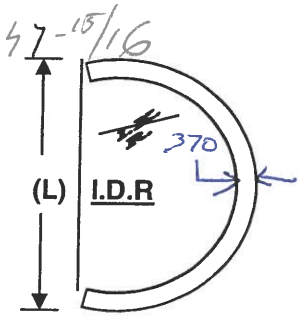


HEADS

SPEC.NO. SA 516 GRADE 70 T1 .355
MIN. THICKNESS REQD_____T2 .357
code / HEAT NO 3X906/504247 T3 .345
MFG. BY_____T4 .360
M.T.R.NO._____PG/UG-79_____
L 47-15/16
HARDNESS TEST IF REQD _____ L.K.R._____
NO. OF IDENTICAL HEADS_____ I.D.R. 47-5/16

CONFORMS TO CODE YES NO



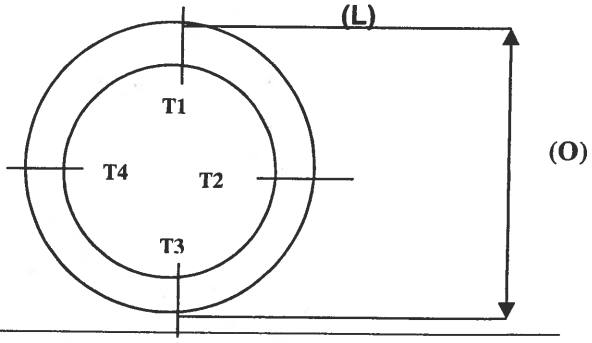


THICKNESS MEASURED AT STRAIGHT FLANGE

PIPE

SPEC.NO.SA_____GRADE_____T1_____
MN. THICKNESS REQD_____T2_____
HEAT NO_____T3_____
MFG.BY_____T4_____
MFG.IDENTIFICATION_____L_____
M.T.R.NO._____ _____
HARDNESS TEST IF REQD_____

CONFORMS TO CODE YES NO



FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

CHECKED BY_____ DATE_____APPROVED BY QC MANAGER._____DATE 3/20

Tank Head Manufacturing Complex
10703 Sheldon Road
Houston, TX 77044

UNI-FORM COMPONENTS CO.

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

Packlist No	Customer ID
PL-89830	MOCOSY

MATERIAL CERTIFICATION

Customer PO No	UCC Ref No	Date Cert. Originated
181656056A	135218	2/23/2018

Sold To:
MOORE CONTROL SYSTEMS
1435 KATY FLEWELLEN
KATY TX 77494

Ship To:
MCSI - BAYTOWN
14827 I-10 EAST
BAYTOWN TX 77523

Ln	Order Qty	Ship Qty	B/O Qty	Part Description
1	20	20	0	HEAD 2:1 ELLIP, 48 OD X 3/8 SA516-70 .3125" MIN Unit of Measure: EA

Code:	3X906	HEAT/SLAB:	504247 / 07	GRADE:	SA516-70	Size:	.375 X 120 X 480	MILL:	NUCOR
Code:	3Y160	HEAT/SLAB:	7500851-07	GRADE:	SA516-70	Size:	.375 X 120 X 480	MILL:	NUCOR
Code:	3Y525	HEAT/SLAB:	7504249 / 02	GRADE:	SA516-70	Size:	.375 X 120 X 480	MILL:	NUCOR

MILL TEST REPORTS ATTACHED

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

1 We hereby certify that these heads were hot formed at the required normalizing temperature and air cooled, in accordance with all applicable specifications
2 We hereby certify that these heads comply with tolerances of UG-81 of ASME Section VIII, Div. 1.

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

Stephen Cobb

Quality Control

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

Mill Test Report

Page 1

1505 River Rd
Cofield, NC 27922
(252) 356-3700
NUCOR
It's Our Name!

Issuing Date : 06/22/2017 B/L No. : 475576 Load No. : 485124 Our Order No. : 148421/1 Cust. Order No. : 14111

Vehicle No: NOKL 725198

Sold To: RANGER STEEL SERVICES LP
1225 NORTH LOOP W STE 650
HOUSTON,TX 77008

Ship To: WATCO TRANSLOADING CLINTON
9640 CLINTON DR
HOUSTON,TX 77245

Specification: 0.3750" x 120.000" x 480.000"
ASTM A516 70-10(2015)/ASME SA516 70 PVQ 2013/2015 Cu .15 Max, Sn .020 Max Normalized Test Coupons at 1650 F 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
504247	0.19	1.09	0.010	0.002	0.19	0.13	0.13	0.07	0.03	0.025	0.006	0.002	0.002		0.0033	0.0001	0.007	0.40	0.26
504248	0.19	1.05	0.009	0.001	0.20	0.12	0.13	0.06	0.03	0.025	0.005	0.002	0.002		0.0031	0.0001	0.006	0.39	0.26

Plate Serial No	Pieces	Tons	Tensile Test Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"
504247-07	6	18.37	T	51,200	76,500		20.0
			T	46,600	74,000		23.2
504248-01	6	18.37	T	53,800	79,500		22.6
			T	48,700	75,100		21.1
504248-03	4	12.25	T	50,700	76,400		19.1
			T	45,900	71,100		22.4
504248-04	6	18.37	T	50,000	77,100		20.0
			T	46,200	72,800		22.3
504248-05	6	18.37	T	54,000	79,300		19.3
			T	48,000	72,300		21.7

- 3X906

Ranger Steel,
QC Approved

est coupons only, normalized 60 minutes per inch of thickness at 1650 F ± 25 F. Hold 30 minutes minimum. ;

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:nhc-SalesMX@Nucor.com
Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/6)+((Cr+Mo+V)/5)+((Cu+Ni)/15)
Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B
Melted and Manufactured in the USA. ISO 9001:2008 certified (#010940) by SRI Quality System Registrar (#0985-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.
EN 50049 3.1.B/EN 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only. Quality Assurance certificate 14-MMPQA-723

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

T. A. Depretis, Metallurgist

5/22/2017 12:00:17 PM

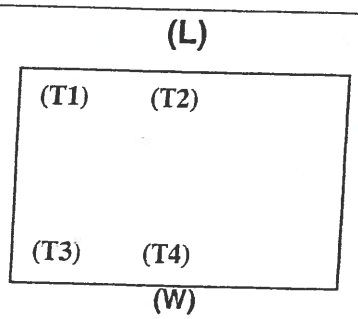
EXHIBIT F REV. 0

RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

SPEC. NO. SA____ GRADE____ T1____
MIN. THICKNESS REQD____ T2____
HEAT NO.____ T3____
MFG. BY____ T4____
M.T.R. NO.____ L ____
HARDNESS TEST IF REQD.____ W ____

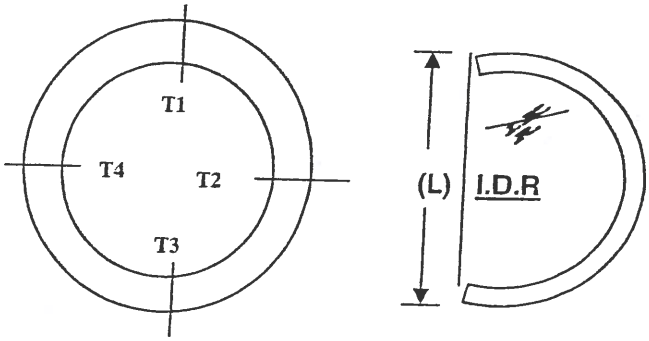


CONFORMS TO CODE YES NO

HEADS

SPEC.NO. SA____ GRADE____ T1____

MIN. THICKNESS REQD____ T2____
HEAT NO____ T3____
MFG. BY____ T4____
M.T.R.NO.____ PG/UG-79____
L____
HARDNESS TEST IF REQD ____ L.K.R.____
NO. OF IDENTICAL HEADS____ I.D.R.____

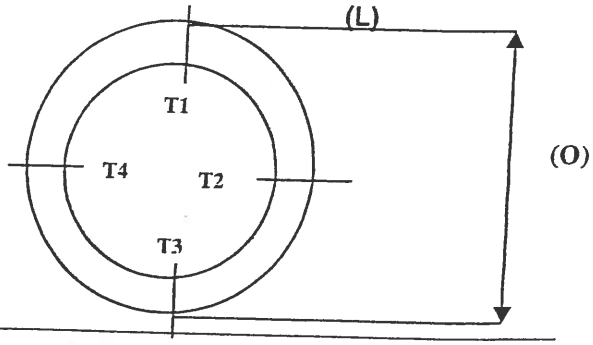


THICKNESS MEASURED AT STRAIGHT FLANGE

CONFORMS TO CODE YES NO

PIPE

SPEC.NO.SA____ GRADE____ T1____
MN. THICKNESS REQD____ T2____
HEAT NO____ T3____
MFG.BY____ T4____
MFG.IDENTIFICATION____ L____
M.T.R.NO.____ ____
HARDNESS TEST IF REQD____



CONFORMS TO CODE YES NO

FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS

CONFORMS TO CODE

MARK – C5, C1

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO
1	2"	N/A	LR 90° SCH 80	KKFF BOND	B952	SA 234 WPB	✓	
1	6"	N/A	45° SCH 80	KKFF BOND	N753	SA 234 WPB	✓	

QUALITY CONTROL
MAY 0 3 2018
QC 2

CHECKED BY____ DATE____ APPROVED BY QC MANAGER____ DATE____

CERTIFICATE OF QUALITY

CERTIFICATE TO EN10204 3.1

KKF KKFF BEND (CAMBODIA) CO.,LTD
ADD.Bldg.NO.D711,Sihanouk Ville SSEZ,
National RD NO.4 212km,Prey Nob Dist,
Sihanouk Ville,Cambodia.
TEL : 00855-097-8609813

Certificate No. :170719NC-03-02

Customer :

Brand name : KKF

Material: ASTM A/SA 234-14 WPB, NACE MR0175-15/NACE MR0103-15

Original Material, ASTM A106 GR.B seamless steel pipe.

Order No. : P1015731 Charlotte

Issued date : November 30th,2017

Specification for ASME B16.9-12

Chemical Composition		C	Si	Mn	P	S	Ni	Mo	Cr	V	Cu	Nb	N	Ultrasonic Examination	N/A
		X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100		
Heat No.	*1	MAX	MIN	0.29	MAX	MAX	MAX	MAX	MAX	MAX	MAX	-	-	RT TEST	
		0.30	0.10	1.06	0.050	0.058	0.40	0.15	0.40	0.08	0.40	-	-		
N228	Ch	0.22	0.23	0.56	0.011	0.009	0.033	0.010	0.023	0.001	0.015	-	-	Dimension Inspection	PASSED
N223	Ch	0.18	0.25	0.51	0.014	0.012	0.026	0.010	0.022	0.002	0.020	-	-		PASSED
N252	Ch	0.21	0.27	0.55	0.012	0.009	0.032	0.010	0.019	0.001	0.018	-	-		PASSED
N750	Ch	0.19	0.24	0.52	0.011	0.008	0.023	0.010	0.025	0.001	0.028	-	-		PASSED
N758	Ch	0.18	0.21	0.48	0.013	0.010	0.025	0.010	0.021	0.002	0.024	-	-		PASSED
N747	Ch	0.20	0.28	0.50	0.010	0.009	0.028	0.011	0.031	0.001	0.024	-	-		PASSED
N744	Ch	0.21	0.22	0.48	0.010	0.008	0.033	0.010	0.035	0.001	0.019	-	-		PASSED
N761	Ch	0.18	0.25	0.47	0.013	0.009	0.075	0.011	0.025	0.001	0.021	-	-		PASSED
N742	Ch	0.22	0.23	0.55	0.011	0.012	0.031	0.010	0.026	0.001	0.016	-	-		PASSED
N753	Ch	0.19	0.23	0.49	0.010	0.008	0.025	0.011	0.028	0.002	0.019	-	-		PASSED

Description & Dimension			ITEM ID	QTY (PC)	Mechanical Properties	Tension Test *2				Hardness Test (HB)	Hydrostatic Test (MPA)	Impact Test	MPI Test *4
					Specification								
					Heat No	Y.S	T.S	E.L	R.A				
						Mpa	Mpa	%	%				
						Min.240	415-655	Min.22	-	197(MAX)			
45ELL	12"	STD	S4512	10	N228	300	485	32.5	N/A	143	N/A	N/A	N/A
90ELL	12"	STD	SL912	1					N/A		N/A	N/A	N/A
45ELL	14"	STD	S4514	20	N223	285	490	30.5	N/A	135	N/A	N/A	N/A
90ELL	14"	STD	SL914	10					N/A		N/A	N/A	N/A
90ELS	3-1/2"	STD	SS903.5	200	N252	295	485	32.5	N/A	137	N/A	N/A	N/A
90ELL	3/4"	XH	XL9.75	250	N750	305	480	33.0	N/A	138	N/A	N/A	N/A
90ELL	1"	XH	XL901.0	100	N758	290	485	31.0	N/A	140	N/A	N/A	N/A
90ELS	1"	XH	XS901.0	75					N/A		N/A	N/A	N/A
45ELL	1-1/2"	XH	X4501.5	25	N747	300	495	32.0	N/A	146	N/A	N/A	N/A
45ELL	2"	XH	X4502.0	100	N744	280	485	32.0	N/A	137	N/A	N/A	N/A
90ELL	2"	XH	XL902.0	200					N/A		N/A	N/A	N/A
90ELS	2"	XH	XS902.0	50					N/A		N/A	N/A	N/A
90ELL	2-1/2"	XH	XL902.5	300	N761	280	490	32.5	N/A	144	N/A	N/A	N/A
45ELL	4"	XH	X4504	150	N742	285	495	31.5	N/A	145	N/A	N/A	N/A
90ELL	4"	XH	XL904	50					N/A		N/A	N/A	N/A
45ELL	6"	XH	X4506	25	N753	295	485	32.0	N/A	152	N/A	N/A	N/A
90ELL	6"	XH	XL906	100					N/A		N/A	N/A	N/A
			TOTAL:	1616									

Heat Treatment *3	HOT FORMED	Normalizing		℃		hrs	Water Quenching		℃	hrs
		Annealing		℃		hrs	Tempering		℃	hrs

We hereby certify that the material herein has been made and tested in accordance with as above specification and also with the requirement called for the above order.

Quality Assurance System in accordance with Pressure Equipment Directive 2014/68EU Annex I Section 4.3 as well as EN 764-5,Para 4.2 by TUV Sud Industrie Service GmbH(Notified Body No 0036)

Quality system certification ISO9001:2008 No. 01 100 1430809 by TUV Rheinland Cert GmbH.

For and on behalf of

KKFF BEND (CAMBODIA) CO., LTD.

Wang Xinfe

Manager of Quality Control Dept

Authorized Signature(s)

MAR 0 6 2018

Note: *1—Ch=Chemical Analysis

*2—Tension Test: Y.S=Yield Strengh T.S=Tensile Strengh E.L=Elongation R.A=Reduction of Area

*3—Heat Treatment: A.C=Air Cooled

*4—MPI Test=Magnetic Powder Inspection

PO: 181655041J Line: 16 Order: 1335836 Heat: N753 Slab: Descr: 6 XH BW 45

MILL TEST CERTIFICATE

CERTIFICATE TO EN10204 3.1

Certificate No. :170620-1
Customer :
Brand name : KKF
Material Grade: ASTM A234/ASME SA234-2013 WPB

PO No. : 185398

Issued date : Sep.13th.2017
Specification for ASME B16.9-2012

KKFF BEND (CAMBODIA) CO.,LTD
ADD:Bldg.NO.D711,Sihanouk Ville,SSEZ,
National RD NO.4 212km,Prey Nob Dist,
Sihanouk Ville,Cambodia.
TEL : 00855-097-8609813

Chemical Compositions		C	Si	Mn	P	S	Ni	Mo	Cr	V	Cu	Nb	N	Ultrasonic Examination	N/A
		X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100	X1/100		
Heat No.	*1	*MAX*	*MIN*	*0.29*	*MAX*	*MAX*	*MAX*	*MAX*	*MAX*	*MAX*	*MAX*	*MAX*	*MAX*	RT TEST	
		0.25	*0.10*	*1.06*	*0.050*	*0.058*	*0.40*	*0.150*	*0.40*	-	*0.40*	*0.020*	-		
B022	Ch	0.20	0.32	0.50	0.012	0.004	0.05	0.005	0.05	-	0.05	0.001	-	Dimension Inspection	PASSED
B183	Ch	0.19	0.26	0.48	0.016	0.005	0.03	0.004	0.04	-	0.02	0.002	-		PASSED
B952	Ch	0.21	0.28	0.44	0.016	0.004	0.03	0.011	0.03	-	0.03	0.002	-		PASSED
B126	Ch	0.22	0.21	0.55	0.013	0.006	0.01	0.008	0.01	-	0.02	0.002	-		PASSED
B672	Ch	0.18	0.22	0.48	0.016	0.007	0.03	0.007	0.05	-	0.06	0.002	-		PASSED

Description & Dimension			Size (inch)	QTY (pc)	Mechanical Properties	Tension Test *2				Hardness Test	Hydrostatic Test	Impact Test	MPI Test
						Y.S	T.S	E.L	R.A.				
					Heat No.	*Mpa*	*Mpa*	%	%	*(HB)*	*(MPA)*	*(J)*	*4
90ELL	LR	XH	1/2"	150	B022	285	455	29.5	N/A	163	N/A	N/A	N/A
90ELL	LR	XH	1"	350	B183	290	460	28.0	N/A	165	N/A	N/A	N/A
90ELL	LR	XH	2"	6000	B952	305	475	30.0	N/A	170	N/A	N/A	N/A
45ELL	LR	XH	2"	300							N/A	N/A	N/A
90ELL	LR	XH	2 1/2"	150	B126	290	450	30.5	N/A	159	N/A	N/A	N/A
90ELL	LR	XH	4"	600	B672	295	485	29.5	N/A	165	N/A	N/A	N/A
45ELL	LR	XH	4"	150							N/A	N/A	N/A
			TOTAL:	7700									

Heat Treatment *3								
Normalizing	℃	hrs	Water Quenching	℃	hrs
Annealing	℃	hrs	Tempering	℃	hrs

Marking Details: KKF+Size + Schedule + A234 WPB +Heat No.

Fittings conform to NACE MR 0175

We hereby certify that the material herein has been made and tested in accordance with as above specification and also with the requirement called for the above order.

Quality Assurance System in accordance with Pressure Equipment Directive 2014/68EU Annex I Section 4.3 as well as EN 764-5,Para.4.2 by TUV Sud Industrie Service GmbH(Notified Body No.0036)
Quality system certification ISO9001:2008 No. 01 100 1430809 by TUV Rheinland Cert GmbH;

Note: *1—Ch=Chemical Analysis *2—Tension Test: Y.S=Yield Strengh T.S=Tensile Strengh E.L=Elongation R.A.=Reduction of Area
*3—Heat Treatment: A.C=Air Cooled *4—MPI Test=Magnetic Powder Inspection

Manager of Quality Control Dep't

MAR 9 2018

PO: 181655041J Line: 17 Order: 1335836 Heat: B952 Slab: Descr: 2 XH LR BW 90

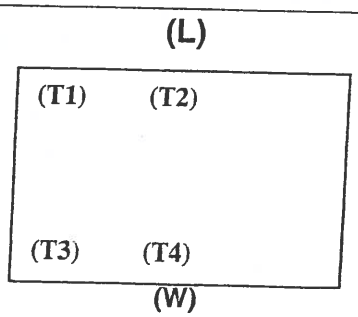
EXHIBIT F REV. 0

RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

SPEC. NO. SA____GRADE____T1____
MIN. THICKNESS REQD____T2____
HEAT NO.____T3____
MFG. BY____T4____
M.T.R. NO.____L ____
HARDNESS TEST IF REQD.____W ____

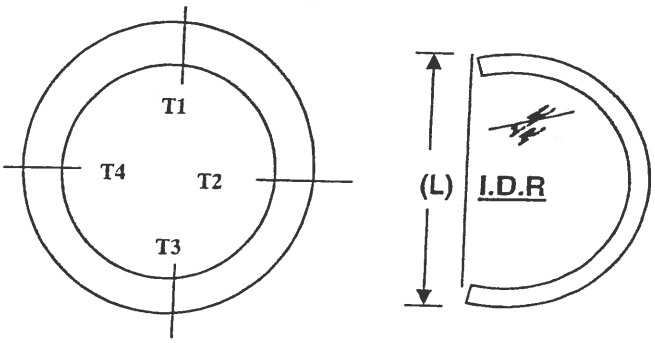


CONFORMS TO CODE YES NO

HEADS

SPEC.NO. SA____GRADE____T1____

MIN. THICKNESS REQD____T2____
HEAT NO____T3____
MFG. BY____T4____
M.T.R.NO.____PG/UG-79____
L____
HARDNESS TEST IF REQD ____ L.K.R.____
NO. OF IDENTICAL HEADS____ I.D.R.____

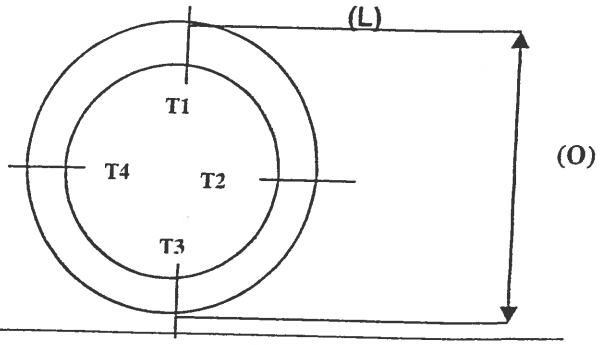


THICKNESS MEASURED AT STRAIGHT FLANGE

CONFORMS TO CODE YES NO

PIPE

SPEC.NO.SA____GRADE____T1____
MN. THICKNESS REQD____T2____
HEAT NO____T3____
MFG.BY____T4____
MFG.IDENTIFICATION____L____
M.T.R.NO.____ ____
HARDNESS TEST IF REQD____



CONFORMS TO CODE YES NO

FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS

CONFORMS TO CODE

MARK - C5 C10

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO
2	2"	3000#	FULL CPLNG	IML	K556	SA 105	✓	

QUALITY CONTROL
MAY 0 3 2018
QC 2

CHECKED BY____ DATE____APPROVED BY QC MANAGER.____DATE. ____

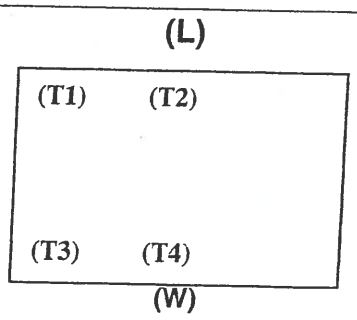
EXHIBIT F REV. 0

RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

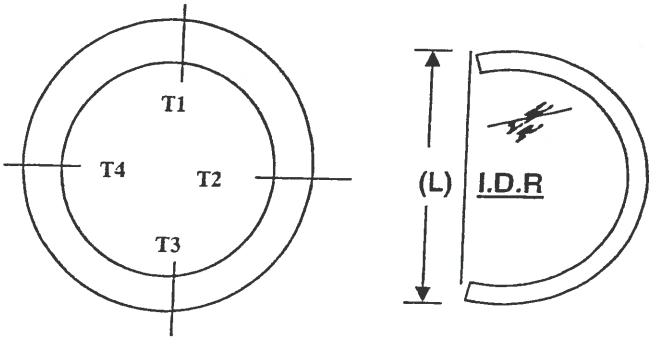
SPEC. NO. SA____GRADE____T1____
MIN. THICKNESS REQD____T2____
HEAT NO.____T3____
MFG. BY____T4____
M.T.R. NO.____L____
HARDNESS TEST IF REQD.____W____



CONFORMS TO CODE YES NO

HEADS

SPEC.NO. SA____GRADE____T1____
MIN. THICKNESS REQD____T2____
HEAT NO____T3____
MFG. BY____T4____
M.T.R.NO.____PG/UG-79____
L____
HARDNESS TEST IF REQD ____ L.K.R.____
NO. OF IDENTICAL HEADS____ I.D.R.____

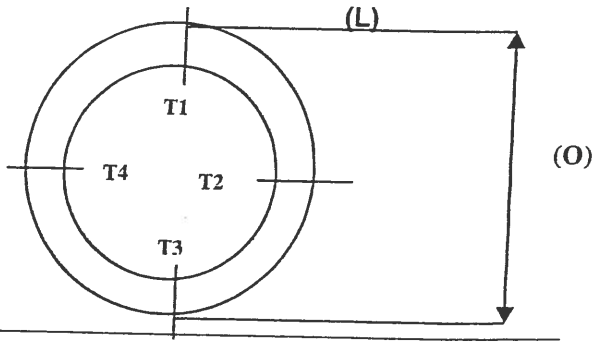


THICKNESS MEASURED AT STRAIGHT FLANGE

CONFORMS TO CODE YES NO

PIPE

SPEC.NO.SA____GRADE____T1____
MN. THICKNESS REQD____T2____
HEAT NO____T3____
MFG.BY____T4____
MFG.IDENTIFICATION____L____
M.T.R.NO.____ ____
HARDNESS TEST IF REQD____



CONFORMS TO CODE YES NO

FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS CONFORMS TO CODE

MARK-C7 C3A C3B, C8 C14, C15 C2, C4

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO
	2"x6"	3000#	6" LG (TOE)	TIMKEN	L3T	SA 105	✓	
	1/2"	6000#	FULL CPLNG	IML	236M	SA 105	✓	
	3/4"	6000#	FULL CPLNG	PHOENIX	7611	SA 105	✓	
	3"	3000#	FULL CPLNG	IML	TPR	SA 105	✓	
	1/2"x3"	6000#	3" LG (TOE)	KREHER	41K	SA 105	✓	

CHECKED BY____ DATE____ APPROVED BY QC MANAGER____ DATE____

QUALITY CONTROL
MAY 03 2018
QC 2

PO: 181645040J Line: 19 Order: 1336464 Heat: 41K Slab: Descr: 1/2 X 3 6M FS CPLG TOE

29May14 14:13 **T E S T C E R T I F I C A T E** No: 1 111614

6-4-14

KREHER STEEL COMPANY, LLC.
1550 NORTH 25TH AVENUE
MELROSE PARK, IL 60160
Tel: 708-345-8180 Fax: 708-345-8293

P/O No 3199
Rel
S/O No 1 263873-001
B/L No 1 213018-001 Shp 30May14
Inv No Inv

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

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

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

CERTIFICATE of ANALYSIS and TESTS Cert. No: 1 111614
29May14

Part No
COLD DRAWN ROUNDS SA105
1.5000 X 16'R/L

1½ 0 SA105
41K

0

ASTM A105-13
ASME SA105
HEAT NUMBER 497581
Cu .17 ; V .003 AND Cb/Nb .008
LOT NUMBER 289712 WEIGHT 25846
TENSILE 76400
YIELD 42000
ELONGATION 25 %
REDUCTION OF AREA 44.9%
HARDNESS 151 AT SURFACE
MADE IN THE USA

Heat Number *** Chemical Analysis ***
497581 C=0.2100 Mn=0.8100 P=0.0080 S=0.0300 Si=0.2200 Cu=0.1700
Ni=0.1400 Cr=0.0900 Mo=0.0200 Al=<.027> Cb=<<.008> V=<.003>
Ti=<.001>

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

G. Papp

QUALITY CONTROL
MAR 1 3 2018
002

PRODUCTION MFG, TULSA, OKLA.
CUSTOMER Northshore Steel
P.O.# 1335808-Bd1
ITEM 1/2 - 6000# X 3" TOE Complete
HEAT CODE 41K

Page: 1 .... Last

PO: 181645040J Line: 19 Order: 1336464 Heat: 41K Slab: Descr: 1/2 X 3 6M FS CPLG TOE

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

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

INSPECTION CERTIFICATE EN 10204:2004 / 3.1

Nr 2016-C_IML-28813 Data / Dated 24.11.2016

ITEX PIPING PRODUCTS LLC
13411 West Road
HOUSTON, TX 77041 US

Ordine / PO	140
Item	8
DDT / Delivery note	2016-2E301-0001338
Packing List	2016-2E301-0001338
Fattura / Invoice	2016-2E401-0001262
Ns. rif. / Our ref.	2016-2E201-0001658-0008

Dest. ITEX WAREHOUSE
(as per document heading)
US

Cod. colata / Heat Code	Nr. colata / Heat Nr	Quantità / Quantity	Descrizione / Description
K556	15/75051	1.000,00	FITTING COUPLING THRD NPT 3M 2" A105N

Mat. in acc. a / Mat. in acc. to ASTM A105/A105M-14
ASME SA105/SA105M, ASME II PART A Ed.2015
ANSI/NACE MR 0175 - ISO 15156 Ed.2015 / NACE MR 0103 Ed. 2012
P.E.D. 97/23/EC ANNEX 1 PAR. 4.3

Ann. mat. / Mat. remarks MATERIAL FULLY KILLED & FINE GRAIN PRACTICED

Elementi / Elements	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,180	0,190	0,950	0,009	0,015	0,120	0,060	0,010	0,022	0,200	0,003	0,002	0,000
	Al								CE LF	CE SF	F1	F2	PREN
LADLE ANALYSIS	0,026								0,382	0,338	0,393	0,130	0,153

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 / Test specimen		Forma / Shape	°C	Snervamento>0,2% / Yield Strength>0,2%	Snervamento>1,0% / Yield Strength>1,0%	Rottura / Tensile	Allungamento / Elongation	Contrazione / Reduction of area
Sez/Sect mm2	L mm	1=O - 2=□		MPa	MPa	MPa	%	%
122,65	50,00	1	20	326,0	--	511,0	34,3	58,0

DUREZZA / HARDNESS		RESILIENZA / IMPACT TEST				
HBW	Tipo/Type	Provetta / Test Specimen	°C	1-Joule	2-Joule	3-Joule	Media/Average
153,0 - 158,0	KV	10x10mm	-10	69	61	66	65,3

Tratt. Term. / Heat treatment Normalized at 880°-920°C / Air Cool — ELECTRIC FURNACE

Dim in acc. a / Dim. acc. to ASME B16.11 Ed.2011 - ASME B1.20.1 Ed.2013 - MSS SP25 Ed.2013

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
SUPPLIED MATERIAL MEETS SPECIFICATIONS AND P.O. REQUIREMENTS

MAR 0 9 2018

002

UFFICIO CONTROLLO QUALITA' / QUALITY CONTROL DEPARTMENT	ENTE UFFICIALE DI COLLAUDO / INSPECTION AUTHORITY	MARCHIO PRODUZIONE / MANUFACTURER'S SYMBOL
Boris Fizzotti - Q.C. Manager		IML or

PO: 181655041J Line: 9 Order: 1335836 Heat: K556 Slab: Descr: 2 3M FS THRD CPLG

Steel Certificate of Test

1835 Dueber Ave. S.W.
Canton, Ohio 44706

ID #0426162-1

TIMKENSTEEL

12/13/2016

SOLD TO
Production Manufacturing Company
5909 EAST 13TH STREET
TULSA, OK 74112 USA

SHIP TO
PRODUCTION MANUFACTURING COMPANY-ATTN ROLEY MCINTOSH
5909 EAST 13TH STREET
TULSA, OK 74112 USA

3"O.D. X .422 WALL
L3T

Customer Order: 3438 **Customer Part Number:**
Mill Order: 55767-A (2059089) **Heat Number(s):** L3153

Description of Material

OD: 3.000 in (76.200 mm) WALL: 0.422 in (10.719 mm) ID: 2.156 in (54.762 mm)
Shape: RD
Prod Type: TUBE
Sales Type: 1026
Int Quality: COMMERCIAL
Condition: HOT ROLL - SCALE FREE -

Specification

- ASTM A 105 / A 105M Rev. 14 10/01/2014 EXCEPT AS NOTED
- ASME SA-105/SA-105M Rev. 2015 EDITION EXCEPT AS NOTED
- ASTM A 961 Rev. 14 11/01/2014 EXCEPT AS NOTED

Chemistry Information

	%C	%Mn	%P	%S	%Si	%Cr	%Ni	%Mo	%Cu	%Al	%V
SPEC Ladle Min:	.22	.60			.10						
SPEC Ladle Max:	.28	.90	.030	.040	.35	.30	.40	.12	.40		.080
L3153 Ladle:	.28	.85	.012	.020	.26	.10	.09	.03	.28	.044	.001

Testing of elements performed at TimkenSteel Chemistry Labs except where noted.

Metallurgy Information

SPEC: Chemistry CR+MO 0.320 Max CR+NI+MO+CU+V 1.000 Max
Heat L3153 CR+MO: 0.130 CR+NI+MO+CU+V: 0.501

SPEC: Grain Size (Info Only)
FINE

SPEC: Hardness ASTM E10 UOM BRINELL HARDNESS 187 Max LOCATION MID

Heat	Piece#		1	UOM
L3153	2833300	HARDNESS	165	BRINELL
	2833300	LOCATION	MID	BRINELL
	2833301	HARDNESS	160	BRINELL
	2833301	LOCATION	MID	BRINELL

QUALITY CONTROL
MAR 13 2018
QC 2

When shipping document is attached it becomes part of this certification.

We certify the above materials have been inspected and tested in accordance with the methods prescribed in the governing specifications and consistent with our Standard Commercial Terms and Conditions for Sale, Manufacture, and Shipping, which are incorporated into and made part of this certification. The results of such inspections and tests conform with the applicable requirements including the purchase order, specification(s) and exception(s). This certificate or report shall not be reproduced except in full, without the written approval of TimkenSteel Corporation.

Notarized: _____ by _____
NOTARY PUBLIC

Michele Clendenen, Metallographer

TimkenSteel Corporation

PO: 181655041J Line: 10 Order: 1336469 Heat: L3T Slab: Descr: 2 X 6 3M COUPLING TOE

Steel Certificate of Test

1835 Dueber Ave. S.W.
Canton, Ohio 44706

TIMKENSTEEL

ID #0426162-1

12/13/2016

Customer Order: 3438 Customer Part Number:
Mill Order: 55767-A (2059089) Heat Number(s): L3153

Metallurgy Information

SPEC: Tensile ASTM E8 TENSILE 70,000 Min STRENGTH UOM PSI YIELD .2 36,000 Min MIN ELONGATION 22.0 Min GAUGE LENGTH 4 x Diameter MIN REDUCTION IN AREA 30.0 Min SHAPE ROUND DIRECTION LONGITUDINAL TEMPERATURE ROOM LOCATION MID

Heat	Piece#	Tensile Strength	UOM	.2% Yld Strength	Elong%	Gauge Length	%Red	Specimen	Direction	Temp	Location
L3153	A	85,511	PSI	47,891	23.5	1 IN	59.0	.252" RD	LONG.	RT	MID

All Hardness and Tensile testing performed at TimkenSteel Metallurgical Lab except where noted.

Heat L3153 Melt Source: USA
Manufacturing: USA

No welding of this material has occurred.

In reference to Section 1502 ("Conflict Minerals") of the Dodd-Frank Wall Street Reform and Consumer Protection Act, no tantalum, tin, tungsten or gold was intentionally added to this material.

PRODUCTION MFG, TULSA, OKLA.
CUSTOMER NorthShore Steel
P.O.# 1335808-Bd1
ITEM 2"-3000# X 6" TOE Coupling
HEAT CODE L3T

QUALITY CONTROL
MAR 13 2018
QC 2

PO: 181655041J Line: 10 Order: 1336469 Heat: L3T Slab: Descr: 2 X 6 3M COUPLING TOE

PO: 181655041J Line: 14 Order: 1335836 Heat: 76II Slab: Descr: 3/4 6M FS THRD CPLG

Capitol Manufacturing
1125 Capitol Avenue
Crowley, LA 70526

Phoenix * Capitol * Camco

CapProducts

Commanding a Higher Standard℠

Certified Mill Test Report

Printed: 10/5/2017
Customer

Certified: 10/03/2017
P.O. 190568-00 pt 1
Tag

Heat No 177540
Heat Code 76II
Phoenix Order # 1311382

Material ASTM A105-2014 / ASME SA105-2015 Edition

Part Number	Description
12302007	3/4 FS 6M THD COUPLING

Chemical Properties

C	Mn	P	S	Si	Cu	Ni	Cr
0.2100	0.9100	0.0060	0.0180	0.2100	0.1700	0.1010	0.1380

C Eq. Long
0.4209

Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.0320	0.0360		0.0020	0.0020					

Additional Chemical Properties

Cr + Cu + Ni
0.4090

Mechanical Properties

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in. or 4D	R of A	HBW	HBW2
87,200	64,700	26.0%	55.0%	162	162

Charpy Minimum Impact - ft/lbs

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

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

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

QUALITY CONTROL
MAR 0 9 2018
CO 2

Certified By:
Name: Sharon Thevis
Title: Certification Specialist

PO: 181655041J Line: 14 Order: 1335836 Heat: 76II Slab: Descr: 3/4 6M FS THRD CPLG

I.M.L. - INDUSTRIA MECCANICA LIGURE S.P.A. AC1
Via Giancarlo Farina, 25 - 16030 Casarza Ligure - GE - ITALY
Tel. +39 0185 467661 - Fax +39 0185 466510 - E-mail quality.iml@farinagroup.com
MATERIAL TEST DEPARTMENT

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

INSPECTION CERTIFICATE EN 10204:2004 / 3.1 A02

Nr A03 2015-C_IML-26772 Data / Dated 20.05.2015 Z02

ITEX PIPING PRODUCTS LLC A05
13411 West Road
HOUSTON. TX 77041 US

Ordine / PO	I-254547ST/A A07
Item	94
DDT / Delivery note	2015-2E301-0000795
Packing List	2015-2E301-0000795
Fattura / Invoice	A08
Ns. rif. / Our ref.	2015-2E201-0000152-0028

Dest. NORTH SHORE STEEL A06
12945 MARKET STREET
TX 77015 HOUSTON US

Cod. colata / Heat Code B07	Nr. colata / Heat Nr B07	Quantità / Quantity B08	Descrizione / Description B01 B09 B11
236M	14/78841	250,00	FITTING COUPLING THRD NPT 6M 1/2" A105N

Mat. in acc. a / Mat. in acc. to B02 ASME SA ASTM A105/A105M-14
NACE MR 0175 - ISO 15156 Ed. 2009 / NACE MR 0103 Ed. 2012
P.E.D. 97/23/EC ANNEX 1 PAR. 4.3

Ann. mat. / Mat. remarks B02 MATERIAL FULLY KILLED & FINE GRAIN PRACTICED

Elementi / Elements C70 - C021	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,185	0,220	0,890	0,010	0,015	0,160	0,070	0,010	0,015	0,200	0,002	0,002	0,000
	Al								CE LF	CE SF	F1	F2	PREN
LADLE ANALYSIS	0,025								0,386	0,333	0,442	0,170	--

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 / Test specimen		Forma / Shape C19	°C C03	Snervamento>0,2% / Yield Strength>0,2% C11	Snervamento>1,0% / Yield Strength>1,0% C11	Rottura / Tensile C12	Allungamento / Elongation C13	Contrazione / Reduction of area C14
Sez/Sect mm2	L mm	1=O - 2=□		MPa	MPa	MPa	%	%
122,65	50,00	1	20	318,0	--	501,0	34,3	58,4

DUREZZA / HARDNESS C22		RESILIENZA / IMPACT TEST					
HBW	Tipo/Type C40	Provetta / Test Specimen	°C C03	1-Joule C42	2-Joule C47	3-Joule C47	Media/Average C41
152,0 - 158,0	KV	10x10mm	-10	65	61	69	65,0

Tratt. Term. / Heat treatment C70 Normalized at 880°-920°C / Air Cool — ELECTRIC FURNACE

Dim in acc. a / Dim. acc. to B14 ASME B16.11 Ed.2011 - ASME B1.20.1 Ed.2013 - MSS SP25 Ed.2013

Marcatura in acc. to / Marking in acc. to B06	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine / Origin of Steel	ITALY

Note / Notes 100% MANUFACTURED IN ITALY
SUPPLIED MATERIAL MEETS SPECIFICATIONS AND P.O. REQUIREMENTS

cplg

QUALITY CONTROL MAR 0 9 2018 QC 2

UFFICIO CONTROLLO QUALITA' / QUALITY CONTROL DEPARTMENT A05	ENTE UFFICIALE DI COLLAUDO / INSPECTION AUTHORITY Z03	MARCHIO PRODUZIONE / MANUFACTURER'S SYMBOL A04
Boris Fizzotti - QC Manager		IML or

PO: 181655041J Line: 6 Order: 1335836 Heat: 236M Slab: Descr: 1/2 6M FS THRD CPLG

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

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

INSPECTION CERTIFICATE EN 10204:2004 / 3.1 — Nr 2017-C_IMLNL-02336 Data / Dated 14.11.2017

US

Ordine / PO
Item
DDT / Delivery note
Packing List
Fattura / Invoice
Ns. rif. / Our ref. 2017-32E21-0000762-0001

Cod. colata / Heat Code	Nr. colata / Heat Nr	Quantità / Quantity	Descrizione / Description
TPR	12/35150	250,00	FITTING COUPLING THRD NPT 3M 3" A105N

Mat. in acc. a / Mat. in acc. to: ASTM A105/A105M-14
ASME SA105/SA105M, ASME II PART A Ed.2015
ANSI/NACE MR 0175 - ISO 15156 Ed.2015
ANSI/NACE MR 0103 - ISO 17945 Ed. 2015
P.E.D. 2014/68/EU ANNEX 1 PAR. 4.3

Ann. mat. / Mat. remarks: MATERIAL FULLY KILLED & FINE GRAIN PRACTICED

Elementi / Elements	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,190	0,220	0,930	0,008	0,006	0,090	0,060	0,010	0,016	0,150	0,002	0,001	0,009

Al	CE LF	CE SF	F1	F2	PREN
0,027	0,379	0,345	0,312	0,100	-

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 / Test specimen		Forma / Shape	°C	Snervamento>0,2% / Yield Strength>0,2%	Snervamento>1,0% / Yield Strength>1,0%	Rottura / Tensile	Allungamento / Elongation	Contrazione / Reduction of area
Sez/Sect mm2	L mm	1=O - 2=□		MPa	MPa	MPa	%	%
122,65	50,00	1	20	338,0	--	506,0	32,0	58,0

DUREZZA / HARDNESS		RESILIENZA / IMPACT TEST					
HBW	Tipo/Type	Provetta / Test Specimen	°C	1-Joule	2-Joule	3-Joule	Media/Average
155,0 - 159,0	KV	10x10mm	-10	63	63	61	62,3

Tratt. Term. / Heat treatment: Normalized at 880°-920°C / Air Cool — ELECTRIC FURNACE

Dim in acc. a / Dim. acc. to: ASME B16.11 Ed.2016 - ASME B1.20.1 Ed.2013 - MSS SP25 Ed.2013

Marcatura in acc. to / Marking in acc. to	MSS SP25 Ed. 2013	Vis. & Dim.	SATISFACTORY	Origine / Origin of Steel	ITALY

Note / Notes: 100% MANUFACTURED IN ITALY
SUPPLIED MATERIAL MEETS SPECIFICATIONS AND P.O. REQUIREMENTS

MAR 05 2018

UFFICIO CONTROLLO QUALITA' / QUALITY CONTROL DEPARTMENT	ENTE UFFICIALE DI COLLAUDO / INSPECTION AUTHORITY	MARCHIO PRODUZIONE / MANUFACTURER'S SYMBOL
Boris Fizzotti - QC Manager		IML or

PO: 181655041J Line: 5 Order: 1335836 Heat: TPR Slab: Descr: 3 3M FS THRD CPLG

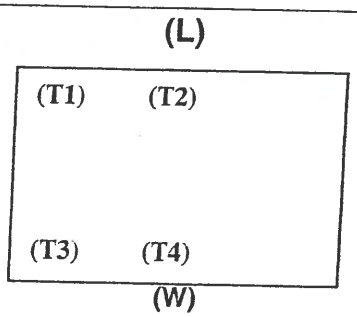
EXHIBIT F REV. 0

RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

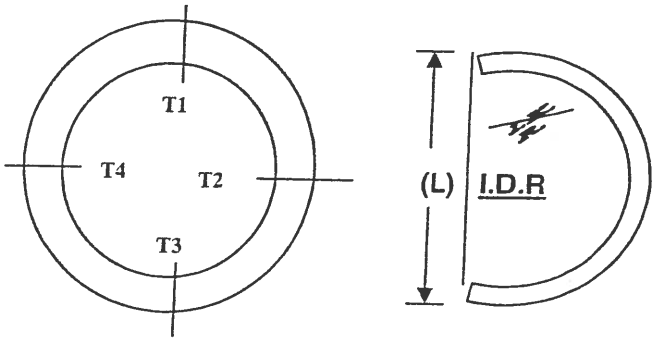
SPEC. NO. SA____GRADE____T1____
MIN. THICKNESS REQD____T2____
HEAT NO.____T3____
MFG. BY____T4____
M.T.R. NO.____L____
HARDNESS TEST IF REQD.____W____



CONFORMS TO CODE YES NO

HEADS

SPEC.NO. SA____GRADE____T1____
MIN. THICKNESS REQD____T2____
HEAT NO____T3____
MFG. BY____T4____
M.T.R.NO.____PG/UG-79____
L____
HARDNESS TEST IF REQD ____L.K.R.____
NO. OF IDENTICAL HEADS____I.D.R.____

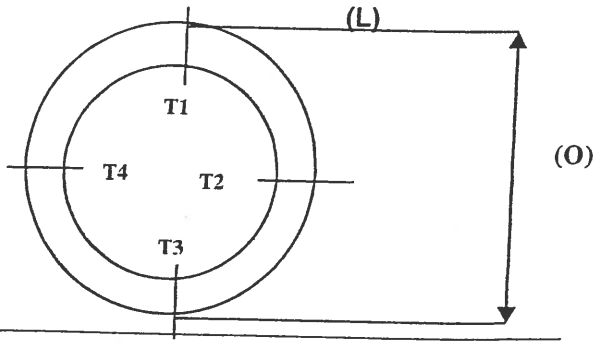


THICKNESS MEASURED AT STRAIGHT FLANGE

CONFORMS TO CODE YES NO

PIPE

SPEC.NO.SA____GRADE____T1____
MN. THICKNESS REQD____T2____
HEAT NO____T3____
MFG.BY____T4____
MFG.IDENTIFICATION____L____
M.T.R.NO.____ ____
HARDNESS TEST IF REQD____



CONFORMS TO CODE YES NO

FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS

CONFORMS TO CODE

MARK- CC, CL, MI

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO
2	6"	150#	RFWN SCH 80	METALFAR	15/40109	SA105	✓	
1	18"	150#	RFSO SCH 80	BEBITZ	605063/1	SA105	✓	

QUALITY CONTROL

CHECKED BY____ DATE____ APPROVED BY QC MANAGER. MAY 03 2018 DATE____

QC 2

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. 17-07908 **Datum (Z02) / Date** 15.08.2017

Zeichen des Herstellers (A04) / Manufacturer's brand: B

Stempel des Abnehmers (Z03) / Stamp of the testing engineer: TKO B

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 NORD Systems GmbH Co. KG, notifizierte Stelle 0045 / Certified acc. to PED 97/23/EC, certifying body TÜV NORD GmbH Co. KG, notified body no. 0045

Besteller (A06) / Customer

Bestell-Nr (A07) / Order-No. 41217OBG
Auftrag (A08) / Order 20000198
Lieferschein / Delivery No. 30001230
Position (B07.1) / Item 20

Stck (B08) Quantity	**Bezeichnung (B01; B09 - B11) Product**	**Schmelze/Prüflos (B07) Heat no./Test no.**
27	18 inch Slip-On Welding Flange 150 lbs raised face Customer ID: L1SR18-BG	605063/1

Material (B02; B05) A 105N - ASTM A105M-14 / ASME SA-105M
normalized 900 °C, air cooled

Anford. (B03) Requirements ASME B 16.5-2013
NACE MR0175-2015 / MR0103-2010 - DIN EN ISO 15156-2:2015
2015 ASME Boiler & Pressure Vessel Code - Section II Part A; ASTM A961-14

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	0,22	0,84	0,016	0,003	0,19	0,10		0,03	0,001	0,002		0,19	0,032	0,39

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

Mechanische Prüfungen / Mechanical tests

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)

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 %		Einschnürg. Red. of area %	Temp. (C03) °C	Einzelwerte (C42) Single values J			MW (C43) Average J	Härte (C32) Hardness ISO 6506-1 HBW 2,5/187,5
20	min 250		485	22,0		30	20					137
	max			$5d_0$	$4d_0$							187
20	293		516	32,6	40,7	67	20	112	121	116	116,3	153
20	291		515	32,9	41,1	68	20	125	119	115	119,7	150
20	287		510	33,5	41,9	69	20	122	134	126	127,3	148
20	290		513	33,1	40,7	68	20	121	118	129	122,7	150

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

PO: 181655041J Line: 1 Order: 1338137 Heat: 605063/1 Slab: Descr: FLG 18 150 RF SO

METALFAR PRODOTTI INDUSTRIALI SPA A21
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 = ISO 9001 = = ISO 14001 =

INSPECTION CERTIFICATE EN 10204:2004 / 3.1 A30

Nr A31 2016-C_MFF-03196 Data / Dated 25.05.2016 A32

CONTINENTAL FLANGES & FITTINGS ITALIA SPA A35
VIA VOLONTARI DELLA LIBERTA' , 1
22036 ERBA CO IT

Ordine / PO 741 A37
Item 009
DDT / Delivery note 2016-3E301-0002889
Packing List
Fattura / Invoice A38
Ns. rif. / Our ref. 2016-3E201-0002747-0008

Dest. CONTINENTAL FLANGES & FITTINGS ITALIA SpA A36
VIA MAGNI, 113 (FRAZ. CARPANEA)
22044 INVERIGO CO

Cod. colata E57 / Heat Code	Nr. colata B67 / Heat Nr	Quantità E56 / Quantity	Descrizione / Description
	15/40109	200,00	WN 150 RF 6" XS A105N

Mat. in acc. a / Mat. in acc. to B52 ASTM A105M - 14 ,ASME SA105M-15 ASME CODE SECT. II, PART A, ED. 2015
NACE MR-0175/2015 ISO 15155
NACE MR-0103/2012
Q.A.S.IN ACCORD.WITH PRESS.EQUIPM.DIRECT.97/23/EC(PED) ANNEX I,PARAGRAPH 4.3
CERT.4667-2014-CE-ITA-ACCREDIA

Elementi / Elements C211 ÷ C221	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,200	0,240	1,060	0,009	0,010	0,100	0,050	0,010	0,017	0,130	0,002	0,001	0,010
	Al								CE LF	CE SF	F1	F2	PREN
LADLE ANALYSIS	0,025								0,411	0,377	0,292	0,110	--

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 / Test specimen		Forma C19 / Shape	°C C03	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/Sect mm2	L. mm	1=O - 2=□		MPa	MPa	MPa	%	%
126,60	50,80	1	20	358,0	--	526,0	30,0	58,0

DUREZZA / HARDNESS C22		RESILIENZA / IMPACT TEST					
HBW	Tipo/Type C40	Provetta / Test Specimen	°C C23	1-Joule C42	2-Joule C42	3-Joule C42	Media/Average C43
152,0 - 156,0	KV	10x10 mm	-10	53	46	59	53,3

Tratt. Term. / Heat treatment C70	NORMALIZED AT 920 °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. B50 / 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 2650

MAR 9 2018

UFFICIO CONTROLLO QUALITA' A25 / QUALITY CONTROL DEPARTMENT	ENTE UFFICIALE DI COLLAUDO A33 / INSPECTION AUTHORITY	MARCHIO PRODUZIONE A34 / MANUFACTURER'S SYMBOL
S. Frigerio		MFF

CUSTOMER	P.O.	ITEM No.	DESCRIPTION	Q.TY
NORTH SCRE	279559	80	FLANGES W/N 150 RF 6" XS A105N	200

PO: 181655041J Line: 2 Order: 1335836 Heat: 15/40109 Slab: Descr: FLG 6 150 RF WN XH

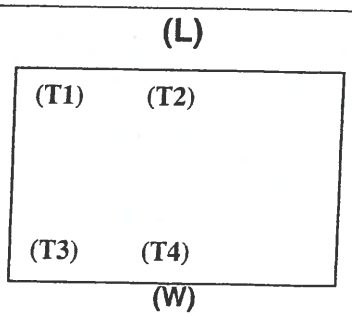
EXHIBIT F REV. 0

RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

SPEC. NO. SA____GRADE____T1____
MIN. THICKNESS REQD____T2____
HEAT NO.____T3____
MFG. BY____T4____
M.T.R. NO.____L ____
HARDNESS TEST IF REQD.____W ____

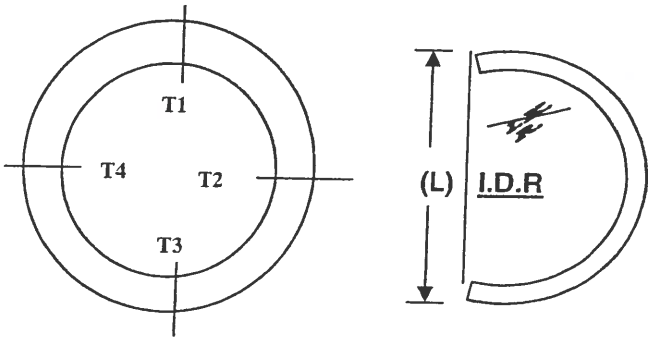


CONFORMS TO CODE YES NO

HEADS

SPEC.NO. SA____GRADE____T1____

MIN. THICKNESS REQD____T2____
HEAT NO____T3____
MFG. BY____T4____
M.T.R.NO.____PG/UG-79____
L____
HARDNESS TEST IF REQD ____ L.K.R.____
NO. OF IDENTICAL HEADS____ I.D.R.____

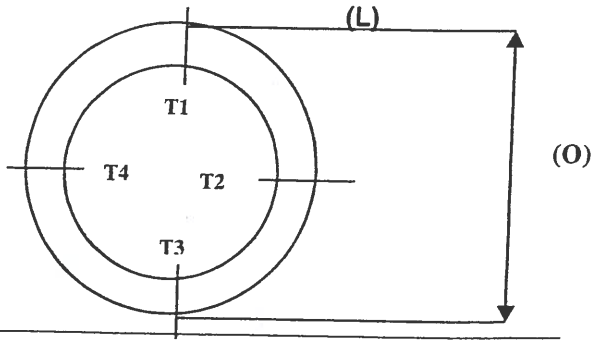


THICKNESS MEASURED AT STRAIGHT FLANGE

CONFORMS TO CODE YES NO

PIPE

SPEC.NO.SA____GRADE____T1____
MN. THICKNESS REQD____T2____
HEAT NO____T3____
MFG.BY____T4____
MFG.IDENTIFICATION____L____
M.T.R.NO.____ ____
HARDNESS TEST IF REQD____



CONFORMS TO CODE YES NO

FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO
1	22"OD	N/A	3/8" THK Reqd	Nucor	A6Y4070	SA 516-70		
1	10 5/8"OD	N/A	3/8" THK Reqd	Nucor	A6Y4070	SA 516-70		

QUALITY CONTROL
MAY 03 2018
QC 2

CHECKED BY____ DATE____ APPROVED BY QC MANAGER____ DATE____

NUCOR STEEL TUSCALOOSA, INC.

MILL TEST CERTIFICATE

P.O. Box 2909
Tuscaloosa, AL 35403-2909
800-550-8364
CustomerService@nucor.com

Page 1 of 2

(Paid)

Load Number	Tally	Mill Order Number	PO NO | Line NO	Part Number	Certificate Number	Prepared
6140038	0000000070809S	N 151777-003	14982 | 3		570080803-1	12/23/2016 11:02

Grade

Order Description:
Hot Roll Plate From Coil
A516 70, 0.3750 IN x 96.000 IN x 480.000 IN

Quality Plan Description:
A51670 43CE 15CU: A516-70/ASME SA516-70AR-15 LOW CU NORM TESTS

Customer:

Shipped Item	Heat/Slab Number	Certified By	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Cb	V	Al	Ti	N2	B	Ca	Sn	CEV	ACI
6L1895B	A6Y4070-03 ***	A6Y4070	0.21	1.04	0.015	0.003	0.29	0.14	0.05	0.06	0.017	0.001	0.004	0.028	0.001	0.009	0.0000	0.0015	0.007	0.42	
6L1895C	A6Y4070-03 ***	A6Y4070	0.21	1.04	0.015	0.003	0.29	0.14	0.05	0.06	0.017	0.001	0.004	0.028	0.001	0.009	0.0000	0.0015	0.007	0.42	

Shipped Item	Certified By	Heat/Slab Number	Yield ksi	Tensile ksi	Y/T %	ELONGATION % 2"	ELONGATION % 8"	Bend OK?	Hard HB	Charpy Impacts (ft-lbs) Size mm	1	2	3	Avg	Shear % 1	2	3	Avg	Test Temp
6L1895B	S6L1895BTT	A6Y4070-03 ***	53.4	75.1	71.1	32.9													
6L1895B	S6L1895FTT	A6Y4070-03 ***	55.2	79.1	69.8	30.9													
6L1895B	S6L1895MTT	A6Y4070-03 ***	48.8	71.9	67.9	31.9													
6L1895B	S6L1895NBT	A6Y4070-03 ***	54.1	76.3	70.9	34.9													
6L1895B	S6L1895NFT	A6Y4070-03 ***	54.5	76.2	71.5	34.6													
6L1895B	S6L1895NMT	A6Y4070-03 ***	52.7	75.5	69.8	35.7													
6L1895C	S6L1895BTT	A6Y4070-03 ***	53.4	75.1	71.1	32.9													
6L1895C	S6L1895FTT	A6Y4070-03 ***	55.2	79.1	69.8	30.9													
6L1895C	S6L1895MTT	A6Y4070-03 ***	48.8	71.9	67.9	31.9													
6L1895C	S6L1895NBT	A6Y4070-03 ***	54.1	76.3	70.9	34.9													
6L1895C	S6L1895NFT	A6Y4070-03 ***	54.5	76.2	71.5	34.6													
6L1895C	S6L1895NMT	A6Y4070-03 ***	52.7	75.5	69.8	35.7													

Items: 2 PCS: 14 Weight: 68600 LBS

MTR'S Approved
Date: 2/27/17
Initials: A.C.

Mercury was 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. Normalized test coupons at 1650F for at least 30 minutes per inch of thickness. Material is compliant with NACE MR0175, Annex A.1.2, and MR0103. Manufactured in a fully killed fine grain practice. NUTEMPER FLAME PASS(H) plate from coil.
ISO 9001:2008 Registered. PED Certified.

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

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

Quality Assurance Manager

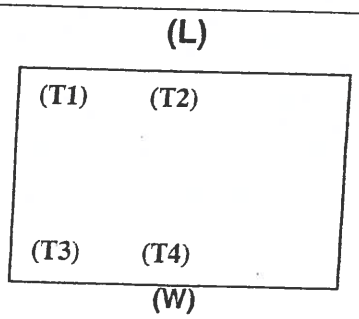
EXHIBIT F REV. 0

RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

SPEC. NO. SA____ GRADE____ T1____
MIN. THICKNESS REQD____ T2____
HEAT NO.____ T3____
MFG. BY____ T4____
M.T.R. NO.____ L ____
HARDNESS TEST IF REQD.____ W ____

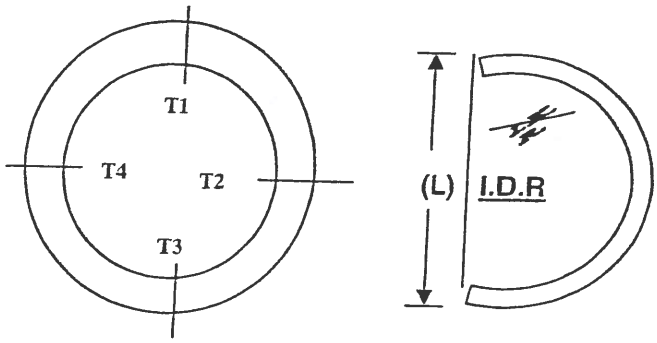


CONFORMS TO CODE YES NO

HEADS

SPEC.NO. SA____ GRADE____ T1____

MIN. THICKNESS REQD____ T2____
HEAT NO____ T3____
MFG. BY____ T4____
M.T.R.NO.____ PG/UG-79____
L____
HARDNESS TEST IF REQD ____ L.K.R.____
NO. OF IDENTICAL HEADS____ I.D.R.____

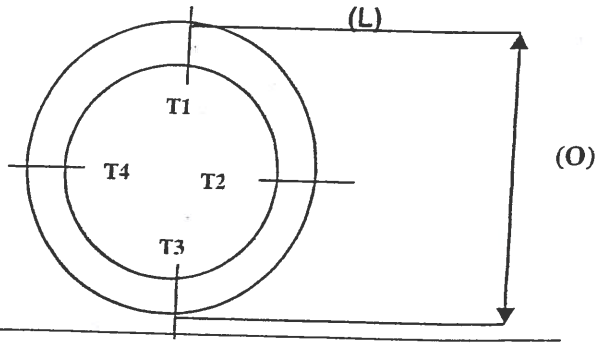


THICKNESS MEASURED AT STRAIGHT FLANGE

CONFORMS TO CODE YES NO

PIPE MARK- C1, C6

SPEC.NO.SA 106 GRADE B T1 .438
MN. THICKNESS REQD____ T2 .462
HEAT NO 1152776 T3 .457
MFG.BY INTER PIPE T4 .452
MFG.IDENTIFICATION____ L____
M.T.R.NO.____ 6 5/8" OD
HARDNESS TEST IF REQD YES



CONFORMS TO CODE (YES) NO

FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

CHECKED BY____ DATE____ APPROVED BY QC MANAGER QUALITY CONTROL MAY 03 2018 DATE ____

QC 2

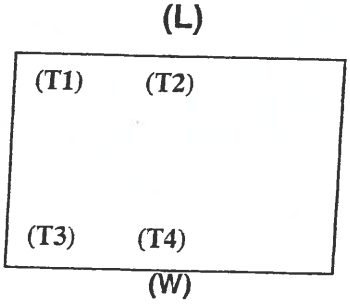
EXHIBIT F REV. 0

RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

SPEC. NO. SA____ GRADE____ T1____
MIN. THICKNESS REQD____ T2____
HEAT NO.____ T3____
MFG. BY____ T4____
M.T.R. NO.____ L ____
HARDNESS TEST IF REQD.____ W ____

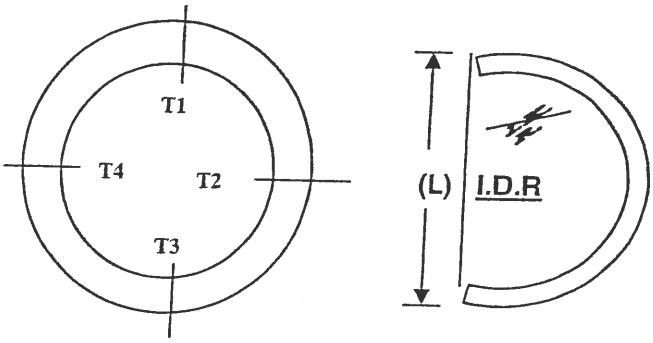


CONFORMS TO CODE YES NO

HEADS

SPEC.NO. SA____ GRADE____ T1____

MIN. THICKNESS REQD____ T2____
HEAT NO____ T3____
MFG. BY____ T4____
M.T.R.NO.____ PG/UG-79____
L____
HARDNESS TEST IF REQD ____ L.K.R.____
NO. OF IDENTICAL HEADS____ I.D.R.____

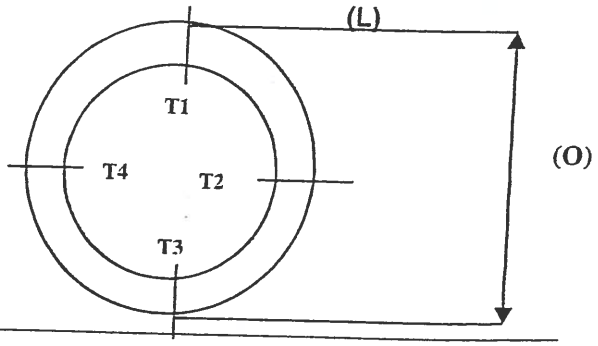


THICKNESS MEASURED AT STRAIGHT FLANGE

CONFORMS TO CODE YES NO

PIPE MARK - C5

SPEC.NO.SA 106 GRADE B T1 .232
MN. THICKNESS REQD____ T2 .223
HEAT NO 169720 T3 .232
MFG.BY Byelorussian STEEL T4 .227
MFG.IDENTIFICATION____ L____
M.T.R.NO. TIC 15 116 15 624 23/8" OD
HARDNESS TEST IF REQD YES



CONFORMS TO CODE (YES) NO

FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

QUALITY CONTROL
MAY 0 3 2018
QC 2

CHECKED BY____ DATE____ APPROVED BY QC MANAGER____ DATE____

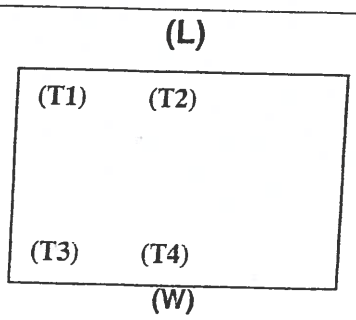
EXHIBIT F REV. 0

RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

SPEC. NO. SA____ GRADE____ T1____
MIN. THICKNESS REQD____ T2____
HEAT NO.____ T3____
MFG. BY____ T4____
M.T.R. NO.____ L ____
HARDNESS TEST IF REQD.____ W ____

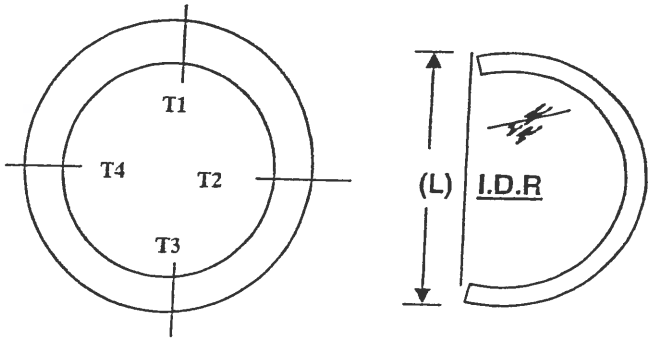


CONFORMS TO CODE YES NO

HEADS

SPEC.NO. SA____ GRADE____ T1____

MIN. THICKNESS REQD____ T2____
HEAT NO____ T3____
MFG. BY____ T4____
M.T.R.NO.____ PG/UG-79____
L____
HARDNESS TEST IF REQD ____ L.K.R.____
NO. OF IDENTICAL HEADS____ I.D.R.____

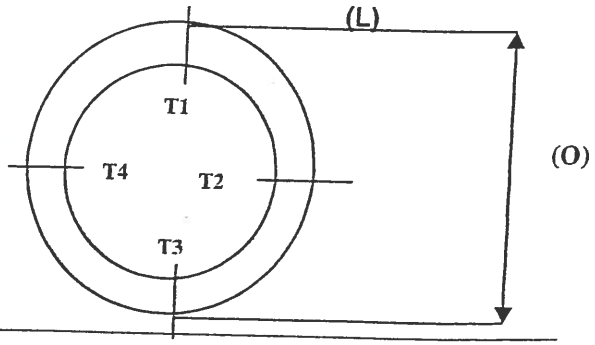


THICKNESS MEASURED AT STRAIGHT FLANGE

CONFORMS TO CODE YES NO

PIPE MARK-M1

SPEC.NO.SA 106 GRADE B T1 .953
MN. THICKNESS REQD____ T2 .963
HEAT NO 70882 T3 .958
MFG.BY VALCOUR TRUB CHROMTOV T4 .953
MFG.IDENTIFICATION N/A L____
M.T.R.NO. 3434/17 18" OD
HARDNESS TEST IF REQD Yes



CONFORMS TO CODE (YES) NO

FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

QUALITY CONTROL MAY 03 2018 QC 2

CHECKED BY____ DATE____ APPROVED BY QC MANAGER____ DATE____

18" Pipe

Válcovny trub Chomutov, a.s.
Tovární 629, Chomutov 430 01, Czech Republic www.vtchomutov.cz

Příloha - Anlage - Annex - Annexe
3

Výsledky zkoušek - Ergebnis der Prüfungen - Test results - Résultats des tests

Atest č. - Attest Nr. - Certificate No - Certificat No : **3434/17** **13.11.2017**

Mechanické zkoušky-Mechanische Prüfungen-Mechanical tests-Tests méchaniques — ASTM A 370 — ASTM A 370

		Rozměry vzorku Probeabmessung Dim. of Specimen Dim. de l'echantillon		Odběr vzorku Probenentnahme Specimen Prélevement		Mez kluzu Streck/Dehngrenze Yield strength Proof stress Limite d'elasticité	Pevnost v tahu Zugfestigkeit Tensile strength Résistance á la traction	Tažnost Bruchdehnung Elongation Allongement	Kontrakce Brucheinschnürung Reduction of area Contraction	Nárazová práce Schlagarbeit Energy of Impact Energie de rupture	Vrub.Houževnatost Kerbschlagzähigkeit Impact strength Résilience
Č. zkoušky Probe Nr. Test No No du test	Číslo tavby Schmelze Nr. Heat No No coulée	Tloušťka Dicke Thickness Epaisseur "	Šíře Breite Width Largeur "	Směr Richtung Direction Direction	Zkuš. teplota Prüftemperatur Test temperature Temperature du test C°	40000 Rt 0.5 psi	70000 Rm psi	A %e	Z %	Kv J	J/cm2
15085	**70844**		**Ø 1/2**	**L**	**20**	**52055**	**75690**	**33,60**			
15097	**70882**		**Ø 1/2**	**L**	**20**	**49735**	**74240**	**35,60**			

L = Podél - Längs - Along - En longueur T = Příčně = Quer = Transverse = En travers, A = Average

Technologické zkoušky - Technologische Prüfungen - Technolcgical test - Test technologiques:
Hardness test < 22 HRC. Flattening test satisfied acc to ASTM A530.

Chemické složení - Chemische Zusammensetzung - Chemical composition - Composition chimique (%)

Heat analysis (S) / product analysis (K)

Tavba číslo Schmelze Nr Heat No No Coulée	C	Mn	Si	P	S	Cr	Ni	Cu	Mo	V	Nb	Ti	Al	N	B	Cev	Co
70844S	0,15	1,20	0,28	0,015	0,004	0,10	0,08	0,17	0,02	0,00	0,002	0,002					
70844K	0,14	1,21	0,29	0,015	0,002	0,10	0,07	0,14	0,02	0,00	0,003	0,002					
70844K	0,14	1,22	0,21	0,015	0,003	0,10	0,07	0,14	0,02	0,00	0,003	0,002					
70882S	0,15	1,19	0,30	0,015	0,004	0,09	0,08	0,17	0,02	0,00	0,002	0,002					
70882K	0,14	1,20	0,30	0,012	0,003	0,09	0,07	0,14	0,02	0,00	0,003	0,002					
70882K	0,14	1,20	0,30	0,012	0,003	0,09	0,07	0,14	0,02	0,00	0,003	0,002					

Chomutov **S. 13.11.2017**
Dne - Datum - Date - Date

Jana SOCHROVÁ
Zocpovědná osoba - Der Werkssachverständige - inspecteur responsable

Válcovny trub Chomutov, a.s.
Tovární 629, 430 01 Chomutov
IČ: 227 74 645

PO: 1816450400 Line: 29 Order: 1335808 Heat: 70882 Slab: Descr: PIPE 18 TRUE S.80 SA106B X SRL

18" pipe

Válcovny trub Chomutov, a.s.

Tovární 629, Chomutov 430 01, Czech Republic www.vtchomutov.cz

Inspekční certifikát
Abnahmeprüfzeugnis
Inspection Certificate

Atest č. - Attest Nr
Certificate No - Certificat No :

Certificat de Reception: **EN 10204:2004/3.1** **3434/17**

Objednávka č. - Bestell Nr.
Order No - No de la commande :
16209
Code : 1741383
Zakázka č. - Bestell Nr. - Order No - Commande No:
831342

Zákazník - Besteller - Customer - Client:

Znak výrobce - Herstellerszeichen
Brand of the manufacture-Marque du fabricant:

Razítko znalce - Stempel des Sachverständigen
Inspector's stamp - Poincon de l'expert: **TK7**

Ocelové bezešvé trubky - Nahtlose Stahlrohre - Seamless steel tubes - Tubes en aciers sans soudure
black, lacquered

Úkosy - Beweled ends
beveled for welding 30° (-0/+5°) with flat 1,6 mm with tol. -0/+0,8 mm

Technické požadavky - Prüfgrundlagen/Anforderungen - Technical requirements/Demand - Exigences techniques:
API Spec. 5L - 45 ed., july 1, 2013 PSL1 ASTM A106/A106M-15 ASME SA-106/SA-106M - 17 ASTM A53/A53M - 12 ASME SA-53/SA-53M - 17 ANSI/NACE MR0175/ISO 15156:ed2015 ANSI/NACE MR 0103/ISO 17495:ed2016

Materiál - Werkstoff - Material - Matiére:	Dle - Entsprechend - According to - Selon	Vydání - Ausgabe - Edition - Edition:
X42	API 5L	2013
GR.B	API 5L	2013
GR.B	ASTM A 106	2015
GR.C	ASTM A 106	2012
GR.B	ASTM A 53	2017
GR.B	ASME SA 106	2017
Gr.C	ASME SA 106	2017
GR.B	ASME SA 53	2017

Stav dodávky - Lieferzustand - State of delivery - Etat de livraison:
Hot rolled - normalized 925 +/- 15 °C - cooled in air

Způsob zpracování tavby - Erschmelzungsart - Melting process - Procédé d'élaboration:
Steelmakers: Válcovny trub Chomutov, a.s., Workplace-Rokycanská 204, 338 42 Hrádek, Czech republic; Fully killed - vacuum E+LF+VD

Značení - Kennzeichnung - Marking - Marquage:
Stencilled : logo VT API SPEC 5L 0286 API (10-2017) ASTM/ASME A/SA 106/53 18" x 0,938 X42/Gr.B PSL1/Gr.B/C SMLS HEAT No. (heat no.) TESTED 2970 PSI LENGTH (length) ... ft WEIGHT (weight) ... lb

Tolerance:

Prům. těl. trub/diameter pipe:	+	2.40 mm	Stěny / wall thickness:	+	15.00 %
	-	0.80 mm		-	12.50 %
Prům. konce. trub/diameter pipe end:	+	1.60 mm	Hm/mass:	+	10.00 %
	-	0.80 mm		-	3.50 %

Specifikace - Specification:

Rozsah dodávky - Umfang der Lieferung - Extent of material delivery - Liste descriptive

Kusy Stücke Pieces Piéces	Celková délka Gesamtlänge Total length Longueur totale [ft]	Celková hmotnost Gesamtmasse Total mass Masse totale [t]	Rozměry Dimensionen Dimensions Dimensions [mm]	Tavba číslo Schmelze Nr. Heat No. No Coulée	Vodní tlak Druckprobe Hydr. Test Essai hydralique [psi]	Avízo: Aviso: Advice: Avis	Datum: Datum: Date: Date:
6	220,472	17,287	18" x 0,938	70844	2970.0	15544917	23.10.2017
7	245,079	19,217	(457,2 x 23,83)	70882	10 sec.	15545017	23.10.2017

Country of melt - Czech republic
The Manufacturer declares that it is certified by the notified body TÜV NORD reg. No 0045 according to Article 4.3 Annex I of Directive 2014/68/EU and AD-2000 Merkblatt W0 and EN 10210-1:2006 appendix to ZA CPR (EU) No. 305/2011.
Uvedené výrobky jsou ve shodě s předpisy, které jsou specifikovány kupní smlouvou. -Angegebene produkte sind in einklang mit den vorschriften, die im Kaufvertrag scezifiziert werden.We thereby declare that the above mentioned products were manufactured in accordance with specifications and contract recuirements. - Des produits indiqués sont dans un accord avec les disposition contrait de vente on spécifie.
Raw material by used for pipe production is without radicactive contamination.

Válcovny trub Chomutov, a.s.
Tovární 629, 430 01 Chomutov
IČ: 227 74 645

Chomutov S. 13.11.2017
Dne - Datum - Date - Date

Příloha-Anlage-Annex-Annexe 1

Jana SOCHROVÁ
Zodpovědná osoba - Der Werkssachverständige - Inspector-le responsable

PO: 1616450400 Line: 29 Order: 1335808 Heat: 70882 Slab: Descr: PIPE 18 TRUE S/80 SA106B X SRL

18" pipe

Válcovny trub Chomutov, a.s.

Tovární 629, Chomutov 430 01, Czech Republic www.vtchomutov.cz

Inspekční certifikát
Abnahmeprüfzeugnis
Inspection Certificate
Certificat de Reception

Atest č. - Attest Nr.
Certificate No - Certificat No :

EN 10204:2004/3.1 **3434/17**

Objednávka č - Bestell Nr.
Order No - No de la commande
16209
Code : 1741383
Zakázka č. - Bestell Nr. - Order No - Commande No:
831342

Zákazník - Besteller - Customer - Client:

Znak výrobce - Herstellerszeichen
Brand of the manufacture-Marque du fabricant:

Razítko znalce - Stempel des Sachverständigen
Inspector's stamp - Poincon de l'expert

TK7

34 - 42 ft

Doplňující údaje - Zusätzliche - Additional remarks - Autres remarques.
Visual inspection and dimensional check without objection.

Country of melt - Czech republic.
The Manufacturer declares that it is certified by the notified body TÜV NORD reg. No 0045 according to Article 4.3 Annex I of Directive 2014/68/EU and AD-2000 Merkblatt W0 and EN 10210-1:2006 appendix to ZA CPR (EU) No. 305/2011.
Uvedené výrobky jsou ve shodě s předpisy, která jsou specifikovány kupní smlouvou. -Angegebene produkte sind in einklang mit den vorschriften, die im Kaufvertrag spezifiziert werden.We thereby declare that the above mentioned products were manufactured in accordance with specifications and contract requirements - Des produits indiqués sont dans un accord avec les disposition contrait de vente or spécifie.
Raw material by used for pipe production is without radioactive contamination

Válcovny trub Chomutov, a.s.
Tovární 629, 430 01 Chomutov
IČ: 227 74 645

Chomutov S.....13.11.2017.....
Dne - Datum - Date

Příloha-Anlage-Annex-Annexe 2

.....Jana SOCHROVÁ.....
Zodpovědná osoba - Der Werkssachverständige - Inspector-le responsable

PO: 18164504OJ Line 29 Order: 1335808 Heat: 70882 Slab: Descr: PIPE 18 TRUE S/80 SA106B X SRL

PO: 181655041J Line: 20 Order: 1335836 Heat: 169720 Slab: Descr: A106 SML GR B 2 S/80 X S/R

INSPECTION CERTIFICATE DIN EN 10204: 2005-01 3.1 / 1-2880 /

Quality management system has been certified according to ISO 9001:2008 by TUV Thuringen e.V. (Certificate Number TIC 15 100 159230)
Environmental management system has been certified according to ISO 14001:2004 by TUV Thuringen e.V. (Certificate Number TIC 15 104 151299)
Occupational health and safety management system has been certified according to OHSAS 18001:2007 by TUV Thuringen e.V. (Certificate Number TIC 15 116 15624)

Open Joint-Stock Company
"Byelorussian Steel Works – management company of "Byelorussian Metallurgical Company" holding"
37, Promyshlennaya street 247210 Zhlobin – Belarus
Tel. +375 (2334) 5-41-29, Fax +375 (2334) 5-60-42
www.belsteel.com qualdir@bmz.gomel.by

Description of the goods: Seamless hot deformed pipes for oil and gas pipelines.
Описание товара: Трубы бесшовные горячедеформированные для нефте- и газопроводов.
Final application: For pipeline transportation systems for petroleum and natural gas industries.
Конечное назначение: Для трубопроводных транспортных систем для нефтяной и газовой промышленности.
Deoxidation degree: Fully deoxidized steel.
Степень раскисления: Полностью раскисленная сталь.
Type of pipe: SMLS Plain End.
Тип трубы: Бесшовная, с гладкими концами.
Delivery Conditional: As-rolled.
Условие поставки: Стандартная прокатка.
Technical specification level: PSL1
Уровень спецификации PSL1

Contract № 17021621 **appendix** 6
Контракт № приложение
PO number
Номер заказа
Wagon № 60470663
Вагон
Country of destination: USA
Страна назначения:
Consignee:
Получатель:

№ position № позиции	Number of heat Номер плавки	Number of lot Номер партии	Grade steel/Standard Марка стали/Стандарт		Chemical composition, % – Химический состав, %																		Steel making-process:
					C	Si	Mn	P	S	Cr	Ni	Cu	Ti	Mo	V	Al	Nb	B	Nb+V	Nb+Ti+V	Cr+Ni+Mo+Cu+V	CE IIW	
				Norm Норма	max .28	min .10	.29 - 1.06	max .030	max .030	max .40	max .40	max .40		max .15	max .08			max .0010	max .06	max .15	max 1.00		
1	169720	173543	B/X42 acc. to API 5L/ISO 3183(45E) B acc. to ASTM A53/A53M-12 B acc. to ASME SA53/SA-53M-2013 B/C acc. to ASTM A106/A106M-15 B/C acc. to ASME SA106-SA106M-2013 NDE NACE MR 0175/ISO 15156-2:2009 and PED 97/23/EC, NACE MR 0103-2012	Ladle (fact) Ковшовая (факт)	.28	.26	.53	.008	.012	.11	.13	.25	.002	.02	.012	-	.001	.0002	.013	.015	.52	.40	Electric furnace
				Product (fact) Гпс (факт)	.26	.27	.51	.009	.012	.11	.13	.25	.002	.02	.014	-	.002	.0010	.016	.018	.52	.14	
				Product (fact) Гпс (факт)	.26	.27	.51	.010	.013	.11	.14	.26	.002	.02	.014	-	.002	.0002	.016	.018	.54	.14	

№ position № позиции	Dimensions – Размеры						Quantity – Количество							Hardness acc. to NACE MR 0175-2:2009 Твердость согласно NACE MR 0175-02:2009		Mechanical properties – Механические свойства								
	OD Диаметр		WT Толщина стенки		Length Длина		Number of packages Количество мест	Quantity of pipe bundles, pcs Количество труб в пакетах, шт	Weight Вес				Total length Фактический метраж			Tensile Test – Испытание на растяжение Longitudinal Strip Test Specimens Образец в виде полосы в продольном направлении Gauge width 0.75 inch Ширина образца 0,75 дюйма ASTM A370				CVN Impact test, KV Работа удара ASTM A370 Dimension of specimen Размер образца 0,197 x 0,394 inch				T
									Net Нетто		Gross Брутто					Tensile strength Предел прочности R_m	Yield strength Предел текучести $R_{0,5}$	Elongation longitudinal Удлинение A_{50}	Ratio Коэффициент $Rt_{0,5}$/Rm	Impact energy (longitudinal) Работа удара (продольная)				
	mm мм	inch дюйм	mm мм	inch дюйм	m м (-0/+0.10)	ft фут (-0/+0.33)			t т	lb фунт	t т	lb фунт	m м	ft фут		ISO 6506-1		psi	psi	%		ft*lbf min 10				°F
																HBW						1	2	3	Average Среднее	
1	60.3	2.375	5.54	0.218	6.10	20.0	3	173	8.047	17740.57	8.059	17767.03	1069.05	3507.3	154	156	min 70000	min 42100	min 22		41	37	35	38	68
TOTAL							3	173	8.047	17740.57	8.059	17767.03	1069.05	3507.3			78000	53000	36	-					

Personal for NDT – methods ET and UT is qualified acc. to ISO 9712, level II
Персонал по неразрушающему контролю – методами ВТК и УЗК – имеет квалификацию в соотв. с ISO 9712, уровень II

Nondestructive Electric Tested/Eddy current test
Неразрушающий электрический контроль /Вихретоковый
ASTM E 309
Reference standard pipe with hole (Ø 3.2 mm/ 0.125 inch)
Эталонная труба с отверстиями (Ø 3,2 мм / 0.125 дюйма)
Results:ok
Результат:

NDT/UT
Метод испытаний/Ультразвуковой
ASTM E 213
Results:-
Результат:

Technological test
Технологическое испытание
Flattening Tests ASTM A106/A106M
Results: ok
Результат:

Hydrostatic testing according API 5L 45th ed
Гидростатическое испытание согласно API 5L 45th ed
P: 2970 psi
Duration: min 5 sec
Results: ok
Результат:

- It is hereby certified that products covered by this certificate has been tested and is complied with the requirements of the contract and the material specifications above mentioned.
- Подтверждаем, что продукция, указанная в настоящем сертификате, испытана и соответствует условиям контракта и требованиям к материалу описанным выше.
- Visually measuring test was performed with satisfactory result.
- Визуально-измерительный контроль проведен с удовлетворительным результатом.
- No weld repair. Free of mercury and mercury containing compounds.
- Без следов зачистки сваркой. Без ртути и ртутьсодержащих элементов.
- Country of origin: Belarus (including steel melting process).
- Страна происхождения: Беларусь. (включая выплавку стали).

Technical Control Inspector: Shchemeliova
Отдел технического контроля:

On Behalf of BMZ JSC "Byelorussian Steel Works", Joint-Stock Company "Byelorussian Steel Works – management company of "Byelorussian Metallurgical Company" holding"
Date: 19.07.2017
Дата:

QUALITY CONTROL FOR CERTIFICATE

MAR 0 4 2018

PO: 181655041J Line: 20 Order: 1335836 Heat: 169720 Slab: Descr: A106 SML GR B 2 S/80 X S/R

PO: 181655041J Line: 19 Order: 1335836 Heat: 1152776 Slab: Descr: A106 SML GR B 6 S/80 X S/R

1512184

ІНТЕРПАЙП НТЗ

ПАТ"ІНТЕРПАЙП НИЖНЬОДНІПРОВСЬКИЙ ТРУБОПРОКАТНИЙ ЗАВОД"
Україна, м. Дніпропетровськ, вул. Столєтова, 21
Тел./факс +38(0562) 34-90-99

Заказчик
Customer

6" pipe

Сертификат № 1701/5 Page 1 of 2
Certificate №
INSPECTION CERTIFICATE ACC. TO EN 10204-2004/3.1

Контракт №
Contract №

Заказ № 751102/101
Customer order № 15-1102
PO # 90309

№ транспортного средства AE 2803 HI / AE 5358 XO Лист 1 Листов 1
№ vehicle Sheet Sheets

Наименование и код товара Description and code of goods	НД Standard	Термообработка Heat treatment
STEEL SEAMLESS HOT-ROLLED PIPES FOR OIL AND GAS PIPELINES	API 5L (PSL 2) -2012/ ASTM A106/A106M-2014/ASME SA106-2013/ ASTM A53/A53M-2012/ASME SA53-2013/ NACE MR0175-2009/ NACE MR0103-2012	Normalized

№ п.п p. No	Номер плавки Number of heat	Номер партии Number of lot	Марка стали Grade steel	Размеры, дюйм Dimensions, In. Диаметр O.D.	Тол. ст. W.T.	Длина фут Length ft.	Метраж, фут Metreage ft.	К-во труб, шт Q-ty of pipes, pcs.	Вес, фунт Weight, lb. Брутто Gross	Нетто Net
			B/X42N						Actual weight	
1.	1152755	2583	"	6.625	0.280	37.99-38.71	768.34	20	15189.9	15123.7
2.	1152776	2557	"	6.625	0.432	37.99-38.71	1386.61	36	40984.0	40785.6
						Total:	2154.95	56	56173.9	55909.3

Показатели качества товара Quality characteristics of goods

№ п.п. p. No	Номер плавки Number of heat	Химический состав, массовая доля % Chemical composition, mass fraction % C x 100	Si x 100	Mn x 100	S x 1000	P x 1000	Cr x 100	Ni x 100	Cu x 100	Mo x 1000	Ti x 1000	V x 1000	Nb x 1000	B x 1000	CE_{IIW} max. 0.43%
1.	1152755 H	18	24	51	5	10	11	12	18	12	5	5	10	1	0.31
	1152755 P	18	29	57	6	11	15	12	16	14	5	5	1	0.1	0.32
		18	29	56	6	10	15	12	16	13	5	5	1	0.1	0.32
2.	1152776 H	19	26	46	7	9	11	11	16	22	5	5	10	1	0.31
	1152776 P	18	26	49	5	8	14	11	15	31	5	5	1	0.2	0.31
		18	26	48	5	8	14	11	16	31	5	5	1	0.2	0.31

Cr+Cu+Ni+Mo+V ≤ 1 % Nb+V ≤ 0.06 % Nb+V+Ti ≤0.15%

Продолжение на обороте The continuation on the back

QUALITY CONTROL MAR 0 20[illegible]

INTERPIPE NTRP

PJSC "INTERPIPE NIZHNEDNEPROVSKY TUBE ROLLING PLANT"
UKRAINE, Dnepropetrovsk, 21, Stoletova str.
Tel./fax +38(0562) 34-90-99

053447

PO: 181655041J Line: 19 Order: 1335836 Heat: 1152776 Slab: Descr: A106 SML GR B 6 S/80 X S/R

EXHIBIT F REV. 0

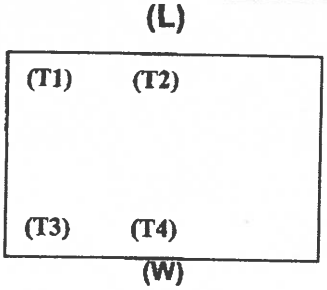
ASME RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

SPEC. NO. SA 516 GRADE 70 T1 1/4
MIN. THICKNESS REQD N/A T2 1/4
HEAT NO. A752459-02 T3 1/4
MFG. BY NUCOR T4 1/4
M.T.R. NO. N/A L 96"
HARDNESS TEST IF REQD. N/A W 48"

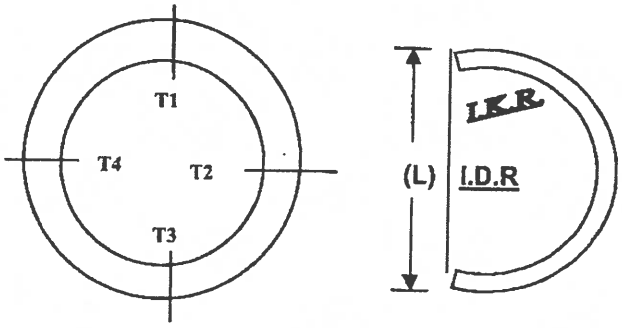
CONFORMS TO CODE ☐ ☐ (YES) NO



HEADS

SPEC.NO. SA____ GRADE____ T1____
MIN. THICKNESS REQD____ T2____
HEAT NO____ T3____
MFG. BY____ T4____
M.T.R.NO.____ PG/UG-79____
L____
HARDNESS TEST IF REQD ____ L.K.R.____
NO. OF IDENTICAL HEADS____ I.D.R.____

CONFORMS TO CODE ☐ YES ☐☐☐☐ NO

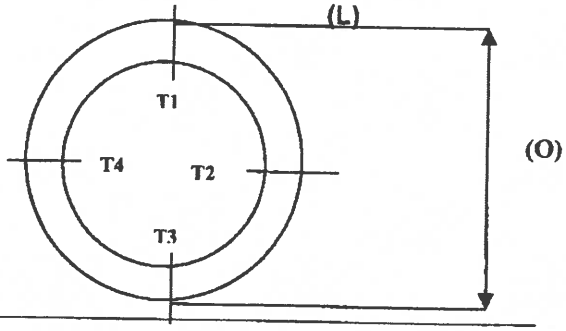


THICKNESS MEASURED AT STRAIGHT FLANGE

PIPE

SPEC.NO.SA____ GRADE____ T1____
MN. THICKNESS REQD____ T2____
HEAT NO____ T3____
MFG.BY____ T4____
MFG.IDENTIFICATION____ L____
M.T.R.NO.____ ____
HARDNESS TEST IF REQD____

CONFORMS TO CODE YES ☐☐☐☐ NO



FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS

CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

CHECKED BY VV DATE 3-28-2018 APPROVED BY QC MANAGER.____ DATE ____

Skirt

02/13/2018 From:AMERICAN ALLOY STEEL, INC. To: BISE WELDING & FABRICATING
P.O.#: 6768 S.O.#: 593368 AA PL#: 5190414
Item: 4 (1 PC) 1/4" X 96" X 127"

NUCOR
NUCOR STEEL TUSCALOOSA, INC.

MILL TEST CERTIFICATE

1700 HOLT RD N.E.
Tuscaloosa, AL 35404-1000
800 800-8204
customerservice@nucortusk.com

QC OK 3-28-18 VH

Load Number / Tally	Mill Order Number	PO NO | Line NO	Part Number	Certificate Number	Prepared
T155922 00000000731912	N-156793-001	112217 1		S73191201-1	06/22/2017 12:40

Grade

Order Description:
Hot Roll Plate From Coil
A516 70, 0.2500 IN x 96.000 IN x 480.000 IN
Quality Plan Description:
A51670 .43 CEV: A516-70/ASME SA516-70AR-15 LO CE NORM TESTS

Customer:
Sold TO:
AMERICAN ALLOY STEEL HOUSTON TX
Ship TO:
AMERICAN ALLOY STEEL Houston TX
Sent TO:

AMERICAN ALLOY
PLATE #5190414

Shipped Item	Heat/Slab Number	Certified By	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Cb	V	Al	Ti	N2	B	Ca	Sn	CEV	ACI
7F0519F	A7S2329-01 ***	A7S2329	0.20	1.03	0.011	0.003	0.19	0.14	0.04	0.04	0.019	0.002	0.004	0.024	0.001	0.008	0.0001	0.0009	0.005	0.40	
7F1525B	A7S2459-02 ***	A7S2459	0.21	1.05	0.015	0.005	0.22	0.16	0.05	0.05	0.016	0.000	0.000	0.033	0.001	0.009	0.0000	0.0024	0.006	0.41	
7F1525C	A7S2459-02 ***	A7S2459	0.21	1.05	0.015	0.005	0.22	0.16	0.05	0.05	0.016	0.000	0.000	0.033	0.001	0.009	0.0000	0.0024	0.006	0.41	

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL, INC.
Reviewed By:
J.F 6/30/2017

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. Normalized test coupons at 1650f for at least 30 minutes per inch of thickness Material is compliant with NACE MR0175 Annex 2.1.2 and ISO 15156, and NACE MR 0103. Manufactured to a fully killed fine grain practice. NUTEMPER TEMPER PASSED plate from coil
ISO 9001:2015 Registered, PED Certified

"***" indicates Heats melted and Manufactured in the U.S.A.

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

Quilin Yu
Dr. Quilin Yu - Metallurgist

02/13/2018 From: AMERICAN ALLOY STEEL, INC. To: BISE WELDING & FABRICATING
P.O.#: 6768 S.O.#: 593368 AA PL#: 5190414
Item: 4 (1 PC) 1/4" X 96" X 127"

QC OK
VV
3-28-18
Job#18165

NUCOR
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
T155922	00000000731912	N-156793-001	112217 1		S73191201-1	06/22/2017 12:40

Grade

Order Description:
Hot Roll Plate From Coil
A516 70, 0.2500 IN x 96.000 IN x 480.000 IN
Quality Plan Description:
A51670 .43 CEV: A516-70/ASME SA516-70AR-15 LO CE NORM TESTS

Customer:
Sold TO:
AMERICAN ALLOY STEEL HOUSTON TX
Ship TO:
AMERICAN ALLOY STEEL Houston TX
Sent TO:

Shipped Item	Certified By	Heat/Slab Number	Yield ksi	Tensile ksi	Y/T %	ELONGATION % 2"	ELONGATION % 8"	Bend OK?	Hard HB	Charpy Impacts (ft-lbs) Size mm	1	2	3	Avg	Shear % 1	2	3	Avg	Test Temp
7F0519F	S7F0519BTT	A7S2329-01 ***	51.7	71.5	72.3	34.5													
7F0519F	S7F0519FTT	A7S2329-01 ***	57.0	78.3	72.8	25.2													
7F0519F	S7F0519MTT	A7S2329-01 ***	55.4	72.5	76.4	32.6													
7F0519F	S7F0519NBT	A7S2329-01 ***	54.6	75.5	72.3	31.7													
7F0519F	S7F0519NFT	A7S2329-01 ***	57.6	77.9	73.9	31.8													
7F0519F	S7F0519NMT	A7S2329-01 ***	51.5	71.7	71.8	35.8													
7F1525B	S7F1525BTT	A7S2459-02 ***	50.5	73.3	68.9	31.7													
7F1525B	S7F1525FTT	A7S2459-02 ***	57.8	78.9	73.3	26.7													
7F1525B	S7F1525MTT	A7S2459-02 ***	55.5	74.6	74.4	27.1													
7F1525B	S7F1525NBT	A7S2459-02 ***	60.9	82.3	74.0	31.0													
7F1525B	S7F1525NFT	A7S2459-02 ***	59.2	81.5	72.6	30.8													
7F1525B	S7F1525NMT	A7S2459-02 ***	58.4	80.6	72.5	31.8													
7F1525C	S7F1525BTT	A7S2459-02 ***	50.5	73.3	68.9	31.7													
7F1525C	S7F1525FTT	A7S2459-02 ***	57.8	78.9	73.3	26.7													
7F1525C	S7F1525MTT	A7S2459-02 ***	55.5	74.6	74.4	27.1													
7F1525C	S7F1525NBT	A7S2459-02 ***	60.9	82.3	74.0	31.0													
7F1525C	S7F1525NFT	A7S2459-02 ***	59.2	81.5	72.6	30.8													
7F1525C	S7F1525NMT	A7S2459-02 ***	58.4	80.6	72.5	31.8													

Items: 3 PCS: 12 Weight: 39205 LBS

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. Normalized test coupons at 1650f for at least 30 minutes per inch of thickness Material is compliant with NACE MR0175 Annex 2.1.2 and ISO 15156, and NACE MR 0103. Manufactured to a fully killed fine grain practice. NUTEMPER TEMPER PASSED plate from coil
ISO 9001:2015 Registered, PED Certified

"***" indicates Heats melted and Manufactured in the U.S.A.

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

Quilin Yu
Dr. Quilin Yu - Metallurgist

EXHIBIT F REV. 0

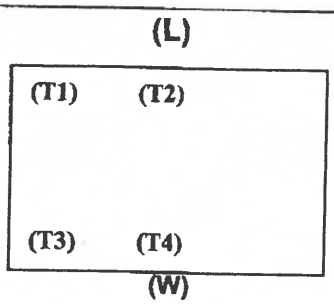
ASME RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

SPEC. NO. SA 516 GRADE 70 T1 3/8
MIN. THICKNESS REQD N/A T2 3/8
HEAT NO. 813X68400 T3 3/8
MFG. BY ARCELOR MITTAL T4 3/8
M.T.R. NO. N/A L ____
HARDNESS TEST IF REQD. N/A W 2"

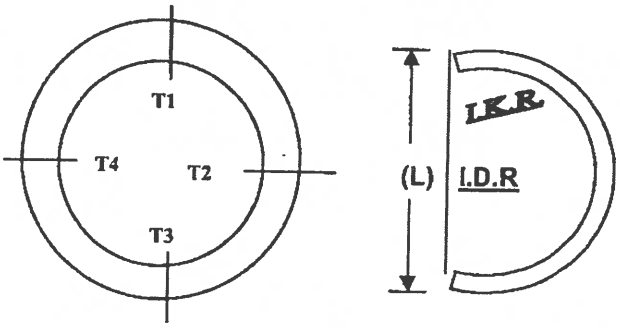
CONFORMS TO CODE ☐ ☐ (YES) NO



HEADS

SPEC.NO. SA ____ GRADE ____ T1 ____
MIN. THICKNESS REQD ____ T2 ____
HEAT NO ____ T3 ____
MFG. BY ____ T4 ____
M.T.R.NO. ____ PG/UG-79 ____
L ____
HARDNESS TEST IF REQD ____ L.K.R. ____
NO. OF IDENTICAL HEADS ____ I.D.R. ____

CONFORMS TO CODE ☐ YES ☐☐☐☐ NO

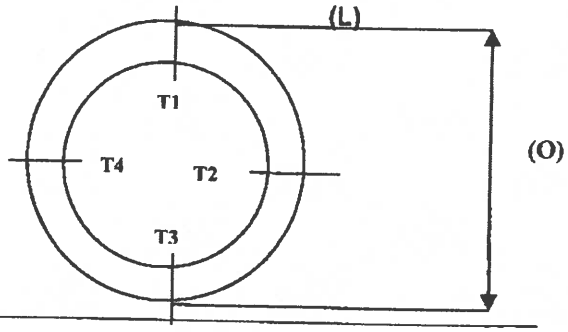


THICKNESS MEASURED AT STRAIGHT FLANGE

PIPE

SPEC.NO.SA ____ GRADE ____ T1 ____
MN. THICKNESS REQD ____ T2 ____
HEAT NO ____ T3 ____
MFG.BY ____ T4 ____
MFG.IDENTIFICATION ____ L ____
M.T.R.NO. ____ ____
HARDNESS TEST IF REQD ____

CONFORMS TO CODE YES ☐☐☐☐ NO



FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS

CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

CHECKED BY NY DATE 3-27-18 APPROVED BY QC MANAGER. ____ DATE ____

Carl King

Book
VV
3-27-18

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANAYLSES

US HWY 12 Burns Harbor, Indiana

SHIPMENT NO.	DATE SHIPPED	CAR OR VEHICLE NO.	
804-09262	06-29-17	CSS-CHGO-UP	BNSF 545743

SOLD TO

SHIP TO

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

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.
PLATES - ASTM A516-06 GR 70 PVQ 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# & PATTERN# MFST PPI 0071739-0001 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
CO# P15811 GH 403-1244

TEST SPECIMENS LABORATORY HEAT TREATED AND YIELD STRENGTH @ .5% E.U.L.

E564109	813X68400	3	3/8	96	480	14703	55400	77900	B	24
							54200	76000	B	25

(M55)MFST REF#:51A0375MD

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

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HARD BHN	BEND	CHARPY IMPACT: THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP. F	ENERGY FT LBS 1	2	3	SHEAR(%) 1	2	3	LAT. EXP MILS 1	2	3

HEAT NUMBER	CHEMICAL ANALYSIS: C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	MOLAID GRAIN SIZE
813X68400	.16	1.08	.016	.004	.314	.231	.18	.03	.006	.002	.002	.029	.0002	.002	.006	.003	
	CE .37																

MTR'S Approved
Date: 2/23/18
Initials: KJ

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

R. SPANGLER II PER LSS
SUPV. QUALITY ASSURANCE

EXHIBIT F REV. 0

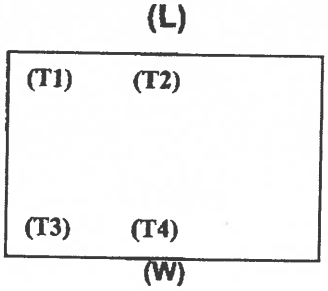
ASME RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

SPEC. NO. SA 516 GRADE 70 T1 1/2
MIN. THICKNESS REQD NA T2 1/2
HEAT NO. B227.39730 T3 1/2
MFG. BY ARCELOR MITTAL T4 1/2
M.T.R. NO. NA L 6
HARDNESS TEST IF REQD. NA W 9-1/16

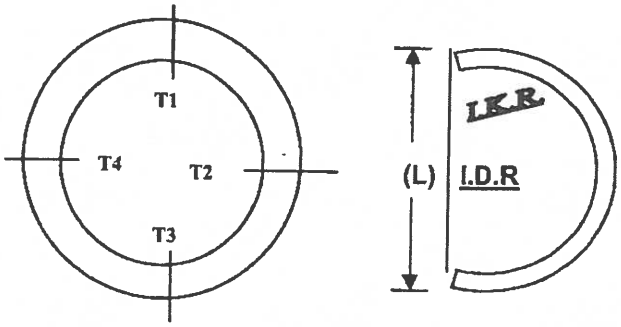
CONFORMS TO CODE ☐ ☐ (YES) NO



HEADS

SPEC.NO. SA____ GRADE____ T1____
MIN. THICKNESS REQD____ T2____
HEAT NO____ T3____
MFG. BY____ T4____
M.T.R.NO.____ PG/UG-79____
L____
HARDNESS TEST IF REQD ____ L.K.R.____
NO. OF IDENTICAL HEADS____ I.D.R.____

CONFORMS TO CODE ☐ YES ☐☐☐☐ NO

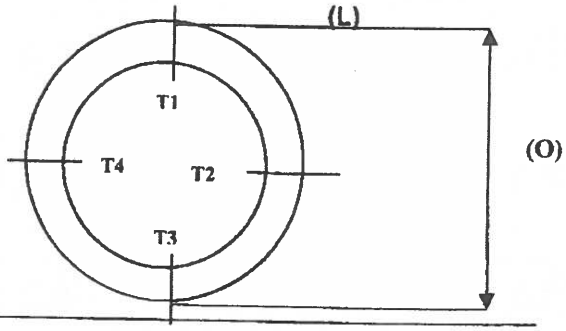


THICKNESS MEASURED AT STRAIGHT FLANGE

PIPE

SPEC.NO.SA____ GRADE____ T1____
MN. THICKNESS REQD____ T2____
HEAT NO____ T3____
MFG.BY____ T4____
MFG.IDENTIFICATION____ L____
M.T.R.NO.____ ____
HARDNESS TEST IF REQD____

CONFORMS TO CODE YES ☐☐☐☐ NO



FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS

CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

CHECKED BY YY DATE 3-27-18 APPROVED BY QC MANAGER.____ DATE ____

Lug

CYCLONE STEEL SERVICES, LLC
4950 W. GREENS ROAD / HOUSTON, TX 77066
PHONE: 713-635-5555 / FAX: 281-537-7144

STRAIGHT BILL OF LADING 195956

Date:03/19/18
Page:1
Delivery Carrier:DELIVERED

CONSIGNOR
CYCLONE STEEL SERVICES, LLC
4950 WEST GREENS ROAD
HOUSTON, TX 77066
.

CONSIGNED TO: MOOR01
MOORE CONTROL SYSTEMS, INC
~~1435 KARY FLEWELLEN ROAD~~
~~KATY, TX 77494~~
14827 I-10 E
BAYTOWN TX 77523

Vitali VY
Good
3-26-18

CUSTOMER P.O. NUMBER / S.O. NUMBER	DUE DATE	PmLn	DESCRIPTION / CUSTOMER MATERIAL CODE	HEAT NUMBER	SLAB	PCS	WEIGHT
MATERIAL: NO CHINA OR INDIA							
MARKING: MARK ALL PARTS WITH PO # AND BOM #							
181655039J		1	516-70 AS ROLLED PRINT 1/2 X 6 X 9 1/16 PRINT # BOM # 19 Notes: DRILL				
187976	03/14/18			822Z39730	H072227	20	154
181655039J		5	A 36 PRINT 3/8 X 2 X 3 1/16 PRINT # BOM # 25 Notes: DRILL				
187976	03/14/18			280309		1	1
				280312		39	25
					Sub total:		26

CYCLONE STEEL SERVICES, LLC
4950 W. GREENS ROAD / HOUSTON, TX 77066
PHONE: 713-635-5555 / FAX: 281-537-7144

The following documents were requested for sales order 187976

Ran on 03/19/18 07:47

DOCUMENT	REFERENCE NUMBER	DATE	TIME
00045629	516A-0.50 822Z39730- H072227 ARC02 18	03/19/18	07:47
00045721	0036-0.37 280309 AHM01 18	03/19/18	07:47
00045715	0036-0.37 280312 AHM01 18	03/19/18	07:47
00045723	0036-0.37 180300 AHM01 18	03/19/18	07:47
00045724	0036-0.37 380041 AHM01 18	03/19/18	07:47

Mill Test Reports furnished by

Cyclone Steel Services, LLC

Order Date...: 03/05/18

Customer.....: MOORE CONTROL SYSTEMS,INC

Customer P.O.: 181655039J

Sales Order #: 187976

Item.....:

L Lug

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANAYLSES

US HWY 12 Burns Harbor, Indiana

SHIPMENT NO.	DATE SHIPPED	CAR OR VEHICLE NO.	
803-29334	12-31-17	CSS-CHGO-UP	LMIC 266002

SOLD TO

SHIP TO

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

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.
PLATES - ASTM A516-06 GR 70 PVQ 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# & PATTERN# MFST PPI 0073558-0001 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
CO# P15999 GH 405-1101A

TEST SPECIMENS LABORATORY HEAT TREATED AND YIELD STRENGTH @ .5% E.U.L.

H072227	822Z39730	2	1/2	120	480	16336	44400	73400	8	27
							50400	73300	8	26

(M55)MFST REF#:51A0500MD

Q:QUENCH TEMPERATURE T:TEMPER TEMPERATURE N:NORMALIZE TEMPERATURE

SERIAL NUMBER	PAT NO	HEAT NUMBER	HARD BHN	BEND	THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP F	CHARPY IMPACT ENERGY FT LBS 1	2	3	SHEAR % 1	2	3	LAT EXP MILS 1	2	3

HEAT NUMBER	CHEMICAL ANALYSIS C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	MOLD GRAIN SIZE
822Z39730	.17	1.04	.010	.005	.325	.225	.17	.03	.003	.002	.002	.032	.0002	.002	.004	.002	
	CE .38																

MTR'S Approved
Date: 2/27/18
Initials: KJ

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.

SHPLTRPT TIF

R. SPANGLER II LSS
SUPV. QUALITY ASSURANCE PER

EXHIBIT F REV. 0

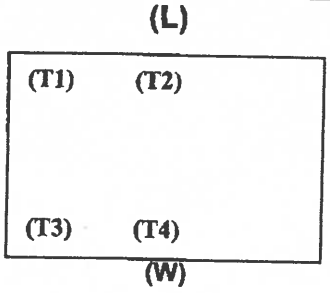
ASME RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

SPEC. NO. SA 516 GRADE 70 T1 3/8
MIN. THICKNESS REQD NA T2 3/8
HEAT NO. 280312 T3 3/8
MFG. BY AHMSA T4 3/8
M.T.R. NO. B1183808 L 2"
HARDNESS TEST IF REQD. NA W 3-1/16"

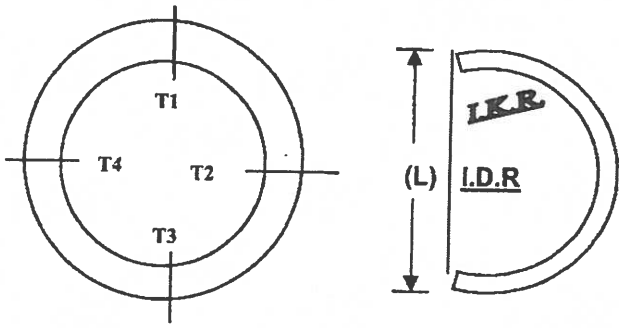
CONFORMS TO CODE ☐☐ (YES) NO



HEADS

SPEC.NO. SA ____ GRADE ____ T1 ____
MIN. THICKNESS REQD ____ T2 ____
HEAT NO ____ T3 ____
MFG. BY ____ T4 ____
M.T.R.NO. ____ PG/UG-79 ____
L ____
HARDNESS TEST IF REQD ____ L.K.R. ____
NO. OF IDENTICAL HEADS ____ I.D.R. ____

CONFORMS TO CODE ☐ YES ☐☐☐☐ NO

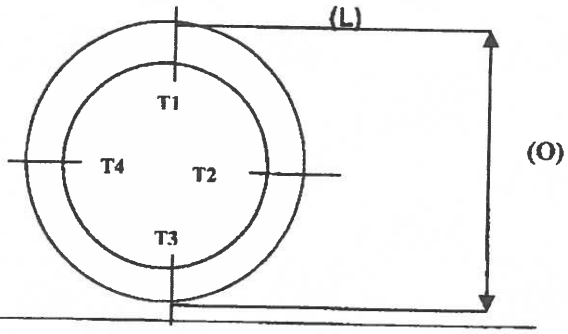


THICKNESS MEASURED AT STRAIGHT FLANGE

PIPE

SPEC.NO.SA ____ GRADE ____ T1 ____
MN. THICKNESS REQD ____ T2 ____
HEAT NO ____ T3 ____
MFG.BY ____ T4 ____
MFG.IDENTIFICATION ____ L ____
M.T.R.NO. ____ ____
HARDNESS TEST IF REQD ____

CONFORMS TO CODE YES ☐☐☐☐ NO



FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS

CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

CHECKED BY VV DATE 3-20-18 APPROVED BY QC MANAGER. ____ DATE ____

EXHIBIT F REV. 0

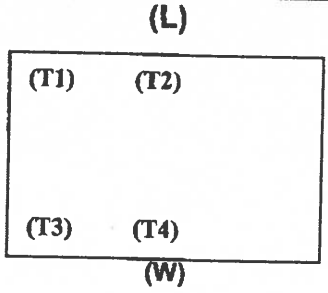
ASME RECEIVING INSPECTION REPORT

CLIENT MARATHON JOB NO. 18165-9 P.O. NO. ____

PLATE

SPEC. NO. SA 516 GRADE 70 T1 3/8
MIN. THICKNESS REQD NA T2 3/8
HEAT NO. 280309 T3 3/8
MFG. BY AHMSA T4 3/8
M.T.R. NO. B1183BOB L 2"
HARDNESS TEST IF REQD. NA W 3 1/16"

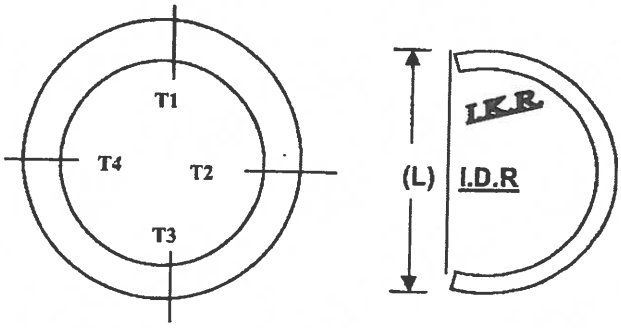
CONFORMS TO CODE ☐☐(YES) NO



HEADS

SPEC.NO. SA____GRADE____T1____
MIN. THICKNESS REQD____T2____
HEAT NO____T3____
MFG. BY____T4____
M.T.R.NO.____PG/UG-79____
L____
HARDNESS TEST IF REQD ____L.K.R.____
NO. OF IDENTICAL HEADS____I.D.R.____

CONFORMS TO CODE ☐ YES ☐☐☐☐ NO

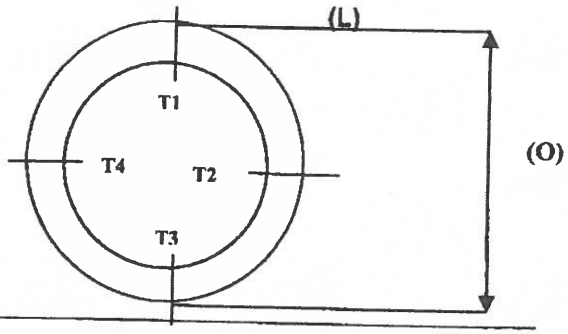


THICKNESS MEASURED AT STRAIGHT FLANGE

PIPE

SPEC.NO.SA____GRADE____T1____
MN. THICKNESS REQD____T2____
HEAT NO____T3____
MFG.BY____T4____
MFG.IDENTIFICATION____L____
M.T.R.NO.____ ____
HARDNESS TEST IF REQD____

CONFORMS TO CODE YES ☐☐☐☐ NO



FITTINGS

FLANGES – COUPLINGS – NOZZLES – COMPONENTS

CONFORMS TO CODE

NO.	SIZE	P.S.I.	DESCRIPTION	MFG.BY	MARKING	OTHER INFORMA	YES	NO

CHECKED BY VV DATE 3-20-18 APPROVED BY QC MANAGER.____DATE ____

ALTOS HORNOS DE MEXICO

MILL TEST CERTIFICATE AHMSA:QUALITY WITH THE STRENGTH OF STEEL

PROLONGACION JUAREZ SIN NUMERO COLONIA LA LOMA MONCLOVA COAHUILA 25770

B118380B

Baffle Clip

CUSTOMER AHMSA INT/

ADDRESS

DATE OF ISSUED	PAGE
16.01.2018	1

WE HEREBY CERTIFY THAT CHEMICAL AND / OR TEST SHOW IN THIS REPORT ARE CORRECT AS CONTAINED THE RECORDS OF THE COMPANY

ING. RAMIRO CISNEROS MENCHACA

MECHANICAL TESTS AND CERTIFICATION

PRODUCT STECKEL PLATE

CHEMICAL COMPOSITION

HEAT	SPECIFICATION	C	Mn	P	S	Si	Cu	Cr	Ni	Mo	Alt	V	Cb	Ti
280309	ASTM A36/ASME SA36 ED15	0.180	0.840	0.011	0.007	0.120	0.036	0.025	0.017	0.004	0.045	0.002	0.002	0.002
280312	ASTM A36/ASME SA36 ED15	0.160	0.860	0.018	0.006	0.120	0.036	0.031	0.018	0.005	0.043	0.002	0.002	0.002

HEAT	B
280309	0.0002
280312	0.0002

TEST OF THE PRODUCT

HEAT	SLAB	PLATE NO.	THICKNESS(Inch)	Y.STRENGTH	T.STRENGTH	%ELON.	T.ELONG.
280309	7050	7184026001	0.2500	53.754(KSI)	72.103(KSI)	24(%)	8
280309	7130	7184058001	0.3750	47.817(KSI)	70.495(KSI)	25(%)	8
280309	7140	7184052001	0.3125	49.905(KSI)	70.454(KSI)	26(%)	8
280309	7150	7184055001	0.3750	50.341(KSI)	71.070(KSI)	27(%)	8
280309	7160	7184028001	0.2500	52.352(KSI)	71.342(KSI)	27(%)	8
280312	7130	7182052001	0.7500	44.652(KSI)	67.815(KSI)	25(%)	8
280312	7140	7186052004	0.2500	51.334(KSI)	72.228(KSI)	26(%)	8
280312	7150	7186049001	0.2500	52.050(KSI)	72.507(KSI)	24(%)	8

SHIPPED PRODUCT

HEAT	PLANCHON	PLATE NO.	THICKNESS(Inch)	WIDTH(Inch)	LARGE(Inch)	ORDER	ITEM	DELIVERY
280309	7070	7188059001	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059002	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059003	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059004	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059005	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059006	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059007	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280309	7070	7188059008	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060001	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060002	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060003	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060004	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060005	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060006	0.3750	96.0000	240.0000	0000209478	000030	1002585246
280312	7090	7188060007	0.3750	96.0000	240.0000	0000209478	000030	1002585246

ISSUED : S119333

Pallet Up

CYCLONE STEEL SERVICES, LLC
4950 W. GREENS ROAD HOUSTON, TX 77066
PHONE: 713-635-5555 FAX: 281-537-7144

STRAIGHT BILL OF LADING 195956

Date:03/19/18
Page:1
Delivery Carrier:DELIVERED

OK
VV
3-20-18
Job # 18165

CONSIGNOR
CYCLONE STEEL SERVICES, LLC
4950 WEST GREENS ROAD
HOUSTON, TX 77066
.

CONSIGNED TO: MOOR01
MOORE CONTROL SYSTEMS, INC
~~1435 KARY FLEWELLEN ROAD~~
~~KATY, TX 77494~~
14827 I-10 C
BAYTOWN TX 77523

CUSTOMER P.O. NUMBER / S.O. NUMBER	DUE DATE	PmLn	DESCRIPTION / CUSTOMER MATERIAL CODE	HEAT NUMBER	SLAB	PCS	WEIGHT
			MATERIAL: NO CHINA OR INDIA MARKING: MARK ALL PARTS WITH PO # AND BOM #				
181655039J 187976	03/14/18	1	516-70 AS ROLLED PRINT 1/2 X 6 X 9 1/16 PRINT # BOM # 19 Notes: DRILL ✓	822Z39730-	H072227	20	154
181655039J 187976	03/14/18	5	A 36 PRINT 3/8 X 2 X 3 1/16 PRINT # BOM # 25 Notes: DRILL	280309		1	1 ✓
				280312		39	25 ✓
						Sub total:	26

CYCLONE STEEL SERVICES, LLC
4950 W. GREENS ROAD / HOUSTON, TX 77066
PHONE: 713-635-5555 / FAX: 281-537-7144

The following documents were requested for sales order 187976

Ran on 03/19/18 07:47

DOCUMENT	REFERENCE NUMBER	DATE	TIME
00045629	516A-0.50 822Z39730- H072227 ARC02 18	03/19/18	07:47
00045721	0036-0.37 280309 AHM01 18	03/19/18	07:47
00045715	0036-0.37 280312 AHM01 18	03/19/18	07:47
00045723	0036-0.37 180300 AHM01 18	03/19/18	07:47
00045724	0036-0.37 380041 AHM01 18	03/19/18	07:47

Mill Test Reports furnished by

Cyclone Steel Services, LLC

Order Date...: 03/05/18

Customer.....: MOORE CONTROL SYSTEMS, INC

Customer P.O.: 181655039J

Sales Order #: 187976

Item.....:

Semper Fi Fabrication - Packing Slip

Customer Name	MCSI - Moore Controls Systems Inc.	Delivery Date	4/2/2018
Customer PO#	181655037J	Freight	N/A
Packing Slip No.	PS-001	Items	Davit Arm Assembly Kit

Line Item	Quantity	Item Description	Ordered	Back Order	Delivered
1	1	MTR's Package	0	0	0
2	10	2" Pipe S/80 Davit Arms	10	0	10
3	10	2.5" Pipe S/40 Davit Arm Socket	10	0	10
4	20	1/4" NPT Straight Grease Fittings	20	0	20
5	10	3/4" -10 Eye Bolt Assembly w/ 2H Nuts and 1 Flat Washer	10	0	10
6	20	1/2" Plate 4.375" OD x 2.375" ID	20	0	20
7	10	1/4" Plate 1.9375" OD (Davit Arm End Cap)	10	0	10
8	10	1/4" Plate 2.375" OD (Davit Arm Bottom Cap)	10	0	10
9	10	1/4" Brass Wear Plate	10	0	10
10	10	3/4" Flange Hook	10	0	10
11	10	7/8" Flange and Socket Gusset	10	0	10
12	N/A				0
13	N/A				0
14	N/A				0
15	N/A				0
16	N/A				0
17	N/A				0
18	N/A				0
19	N/A				0
20	N/A				0

Notes

7/8" thk gussets approved in lieu of 3/4" on 3/30/18 by Engineering and communicated by Jay Nelson

Proof of Delivery

Customer Signature		Date:	4-2-18
Freight Representative		Date:	
SFF Representative		Date:	4/2/18

Brass Wear Plate

Non-Ferrous Metal Works (SA) (Pty) Ltd

EXTRUSION DIVISION

1 The Avenue East, Prospection, Kwa-Zulu Natal, South Africa Reg. No.: 1951/000559/07

Telephone: +27 (31) 902 7470 Fax: +25 (31) 902 8865

TEST CERTIFICATE

Test Certificate Number	TOR0026590
Works Order Number	TOR0026590
Sales Order Number	SO0438563
Delivery Note No	SO-DN00007164
Invoice Number	SO-IN00252582
Purchase Order No.	HOU- 12111-XG
Alloy	360
Quantity Ordered	10000 Lbs
Weight Despatched	10251.391 Lbs

Description	Specifications
4-1/2" DIA X 6 - 7 FT MACHINED BRASS BILLET Free Cutting Brass HALF HARD	ASTM B16 C36000 [15] ASTM B249 [14]

Mechanical/Physical Test Results

Size 1	Size 2	Area	Yield Strength		Tensile Strength		Elongation	Hardness		
mm	mm	mm²	Kg/mm²	PSI	Kg/mm²	PSI	%	Vickers	Brinell	Rockwell
19.91	0.00	311.34	23.90	33,988.95	30.83	43,846.75	29.00	0.00	0.00	43.90
19.92	0.00	311.65	24.19	34,398.34	30.96	44,029.87	28.00	0.00	0.00	43.90

Chemical Composition

Charge Number	Cu	Zn	Fe	Mn	Al	Ni	Sn	Pb	Si	As	P	Te
DS377	61.30	35.43	0.17	0.00	0.00	0.02	0.07	2.87	0.00	0	0	0

Charge Number	Sb	Mg	Ti	Co	Cd	Sr	Cr	Ca	Other
DS377	0.01	0	0	0	0	0	0	0	0.00

APPROVED
12:09 pm, Jul 20, 2017
ANITA MCGRAY, MTR Administrator

Remarks

QUALITY CONTROLLED COPY

We certify that the material is free from mercury contamination
Signed for on behalf
Non-Ferrous Metal Works(SA) (PTY) Ltd

Quality Manager

Metallurgist

2017/06/23
Date

1/2" PL (20") 4.375 OD x 2.375 ID

MAKSTIL Duferco group
16 Makedonska Brigada 18,
1000 Skopje, Republic of Macedonia
www.makstil.com A01

Customer A100: DUFERCO S.A.
Customer's order no. A07: SO4201006753
Order No. / Lot No A08 : /4014
Manufacturer's symbol A09 ŽSK
Delivered conditions B04 NR - normalizing rolling

INSPECTION CERTIFICATE No. 703436 4014 001 A05 A03

FM.ML.03.54

Pages : 1/ 1

According to EN 10204 / 2004 : 3.1
Issued in electronic form

Technical delivery conditions B02: ASTM A516M:15/ASTM A20M:15/ASTM A370:15 G=200mm
ASME SA516M:15/ASME SA370:15/ASME SA20M:15 G=200mm
50% of"–"tol.for thickness and flatness

Issued Z01: 10.04.2017

HOT ROLLED STEEL PLATES B01

Heat No.	Steel grade	Item no.	Pieces	Dimensions (inch) Thickness	Width	Length	Weight (kg)
B07	B02	A07	B08	B09	B13	B11	B12
476333	SA/A516M Gr.70	8	1	1/2	120	480	3705
476394	"	8	4	1/2	120	480	14820

CHEMICAL COMPOSITION

C 10^{-2} %	Si 10^{-2} %	Mn 10^{-2} %	P 10^{-3} %	S 10^{-3} %	Al 10^{-3} %	N 10^{-3} %	Cr 10^{-2} %	Cu 10^{-2} %	Ni 10^{-2} %	Ti 10^{-3} %	V 10^{-3} %	Nb 10^{-3} %	Mo 10^{-3} %	B 10^{-4} %	Ca 10^{-4} %	Pb 10^{-3} %	As 10^{-3} %	CEV 10^{-3} %
C71	C72	C75	C74	C75	C76	C77	C78	C79	C80	C81	C82	C83	C84	C85	C86	C87	C87	C93
17	28	131	14	7	38	8	5	28	8	1	1	1	1	6				
18	28	107	13	5	31	8	7	27	9	1	1	1	1	5				

Total : 5 18525 MANUFACTURING PROCESS: EAF C70

PRODUCT IDENTIFICATION / TENSILE TEST / IMPACT TEST / SUPPLEMENTARY REQUIREMENTS

Heat No.	Plate No.	Plate No.	Test No.	Tensile Direction 1)	Tensile Location 2)	Yield MPa	Tensile MPa	Elongation % G 8 in		Impact Direction 1)	Impact Type	Impact Individual values ft.lbr 1	2	3	Impact Mean value ft.lbr	Impact At F°	Impact Width of tests piece	Supplementary Requirements Direction 1)		
B07	B07	B07	C00	C01	C07	C1	C12	C12	C13	C02	C40	C42	C42	C42	C43	C03		C02		B03
476333	14951-01		14951	1	T	410	569	25.5												
476394	14927-01		14927	1	T	377	538	27.5												
"	14928-01		14928	1	T	388	551	26.5												
"	14929-01		14929	1	T	406	553	26.5												
"	14931-01	←	14931	1	T	400	557	25.0												

"Fully killed with fine grain structure"

PRECISE STEEL INTERNATIONAL
PO# 6507
HT# 476394-14931-01
PL# 11346

1/2" SA516-70 A/R

Bend test C50 :

Ultra-sonic test B02 :
Visual and dimensional ispection : without objection
We hereby certify, that the delivered material complies with the terms of the order.

1) Direction of the test piece : L - longitudinal; T - transverse; Z - in the thickness direction
2) Location of the test sample : 1 - top; 2 - bottom

Die-stamp marking :
Makstil's symbol / Grade / Heat No. / Plate No./CS mark

B05

Q.D. 'MAKSTIL' A.D
Q.M.dip.eng I.BOGESKI A09

RZ TECHNICAL CONTROL A.D. - SKOPJE
tech.manager.dipl.Eng.S.Marinova Z92

MAKSTIL QA Skopje

1 1/4" PL 10 - 2.375 OD
10 - 1.9375 OD

ALTOS HORNOS DE MEXICO

MILL TEST CERTIFICATE STEEL

AHMSA:QUALITY WITH THE STRENGTH OF STEEL

B042575B

CUSTOMER	AHMSA INT/Beshert Steel Partners, LLC d.b.a.Triple-S Steel Supply,LLC	DATE OF ISSUE: 13.07.2017	PAGE 1
ADDRESS	5150 N LOOP1604 W San Antonio, Tx.		
PRODUCT	STECKEL HOT ROLLED COIL		

WE HEREBY THAT CHEMICAL AND / OR TEST SHOW IN THIS REPORT ARE CORRECT AS CONTAINED THE RECORDS OF THE COMPANY.

ING. RAMIRO CISNEROS MENCHACA
MECHANICAL TESTS AND CERTIFICATION

CHEMICAL COMPOSITION

HEAT	SPECIFICATION	C	Mn	P	S	Si	Cu	Cr	Ni	Mo	Alt	V	Nb(Cb)	Ti
275352	ASTM A 1018 SS 36 TYPE 2.	0.170	0.820	0.014	0.006	0.1400	0.028	0.024	0.018	0.004	0.039	0.002	0.001	0.002
372401	ASTM A 1018 SS 36 TYPE 2.	0.170	0.840	0.010	0.006	0.1300	0.140	0.087	0.057	0.016	0.035	0.002	0.001	0.002

HEAT	NZ
275352	0.0053
372401	0.0055

TEST OF THE PRODUCT

HEAT	COIL NO.	SLAB	THICKNESS(Inch)	Y.STRENGTH	T.STRENGTH	%ELON.	T.ELONG.
275352	S6208014	7010	0.2550	50.160(KSI)	70.172(KSI)	42(%)	2
275352	S6202012	7050	0.2500	53.666(KSI)	72.242(KSI)	43(%)	2
372401	S6210032	7010	0.3750	54.418(KSI)	72.215(KSI)	47(%)	2
372401	S6210033	7020	0.3750	56.250(KSI)	73.828(KSI)	43(%)	2
372401	S6212001	7030	0.4980	50.760(KSI)	70.294(KSI)	48(%)	2
372401	S6214001	7070	0.5000	48.552(KSI)	68.683(KSI)	45(%)	2

SHIPPED PRODUCT

HEAT	COIL NO.	THICKNESS(Inch)	WIDTH(Inch)	ORDER	ITEM	DELIVERY	CUSTOMER ORD
275352	S6208014	0.2450	96.0000	0000203343	000010	1002497700	AHI4957(JVT-755-JC) /
275352	S6208011	0.2450	96.0000	0000203343	000010	1002497700	AHI4957(JVT-755-JC) /
372401	S6212001	0.4980	72.0000	0000203315	000070	1002497700	AHI4954(JVT-753-JC) /

FOR CONVERSION TO ASTM A36
FOR CONVERSION TO ASTM A36
COUNTRY OF ORIGIN: MÉXICO

END OF DATA

Precise Steel International
PO# 6496
HT# 275352
PL# 11331

1/4" A-36

AHMSA'S COMPROMISE IS ONLY WITH THE CUSTOMER MENTIONED IN THISCERTIFICATE, AHMSA WILL ONLY ACCEPT THE ORIGINAL DOCUMENT.

ISSUED : S0550133

CC-03-F-01-A

PO: vbl Aaron Line: 2 Order: 1338874 Heat: JW18101953 Slab: Descr: HR ROUND 3/4 X 20

NUCOR
NUCOR CORPORATION
NUCOR STEEL TEXAS

Mill Certification
3/7/2018

MTR #: J1-403228
8812 Hwy 79 W
Jewett, TX 75846
(903) 626-4461
Fax: (903) 626-6290

Sold To: NORTH SHORE SUPPLY CO
BOX 9940
HOUSTON, TX 77213-0940
(713) 453-3533
Fax: (713) 671-5578

Ship To: NORTH SHORE SUPPLY CO
WAREHOUSE 5
12929 MARKET ST
HOUSTON, TX 77015
(713) 453-3533

Customer P.O.	299745		
Product Group	Merchant Bar Quality	Sales Order	268438.96
Grade	A36/A529GR50/CSA44W/50W	Part Number	3000075024004W0
Size	3/4" (.7500) Round	Lot #	JW1810195301
Product	3/4" (.7500) Round 20'A36/A529-50/44W/50W	Heat #	JW18101953
Description	A36/A529-50/44W/50W	B.L. Number	J1-810921
Customer Spec		Load Number	J1-403228
		Customer Part #	

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.

Roll Date: 3/4/2018 **Melt Date: 2/28/2018** **Qty Shipped LBS: 5,047** **Qty Shipped Pcs: 168**

ASTM A36/A36M-12, A709/709M-13 GR36, ASME SA36-10 Ed '11 Ad.
ASME SA36-2010 EDITION-2011 ADDENDA
ASTM A709/A709M-13 GR 36 [250]

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Cb
0.14%	0.85%	0.012%	0.033%	0.21%	0.34%	0.15%	0.14%	0.050%	0.0347%	0.002%

Yield 1: 56,900psi
Yield 2: 57,000psi
Tensile 1: 73,500psi
Tensile 2: 73,700psi
Elongation: 21% in 8"(% in 203.3mm)
Elongation 20% in 8"(% in 203.3mm)

Specification Comments: MEETS THE REQUIREMENTS OF: ASTM A36/A36M-14, A529/A529-05 GR50(345), A709/A709M-10 GR36(250); CSA G40.21-04 GR44W(300W)&GR50W(350W); AASHTO M270/270M-10 GR36(270); ASME SA36/SA36M-10 MEETS REPORTING REQUIREMENTS OF EN10204 S 3.1

Comments: E-mail: websales@nstexas.com

1. All manufacturing processes of the steel, including melting, casting & hot rolling, have been performed in U.S.A
2. Mercury in any form has not been used in the production or testing of this product.
3. Welding or weld repair was not perfomed on this material.
4. This material conforms to the specifications described on this document and may not be reproduced, except in full, without written approval of Nucor Corporation.
5. Results reported for ASTM E45 (Inclusion content) and ASTM E381 (Macro-etch) are provided as interpretation of ASTM procedures.

3/4 RB - 20 - Hook Details

Bhargava R Vantari
Division Metallurgist

NBMG-10 October 1, 2017

PO: vbl Aaron Line: 2 Order: 1338874 Heat: JW18101953 Slab: Descr: HR ROUND 3/4 X 20

SSAB

Preliminary Test Certificate

1770 Bill Sharp Boulevard, Muscatine, IA 52761-9412 **Official copy to follow**

Form TC1: Revision 1 Date 31 Oct 2000

Customer:
STEELCO
C/O E. TREVINO
P.O. BOX 21119
HOUSTON
TX 77226-1119

Customer P.O. No.: SLC-3352 | **Mill Order No.:** 41-246235-18 | **Shipping Manifest :** MR086775

Product Description: ASTM A516-70(06)/ASME SA516-70(07ED.)

Ship Date: 13 Jul 09
Cert Date: 13 Jul 09

Cert No: 061162312
(Page 1 of 1)

Size: 0.875 X 120.0 X 240.0 (IN)

Tested Pieces				Tensiles						Charpy Impact Tests									
Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (PSI)	UTS (PSI)	%RA	Elong % 2in 8in	Tst Dir	Average Hardness	Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
A9C127	C08	0.875 X 120.0 (DISCRT)	L	49000	75000		22	T							

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	CEV	
A9C127	.18	1.12	.011	<.001	.20	.031	.031	.29	.14	.13	.04	.001	.006	.003	.43	ORGN USA

MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED
DURING THE MANUFACTURE OF THIS PRODUCT
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15
100% MELTED AND MANUFACTURED IN THE USA. MTR DIN EN10204 TYPE 3.1 COMPLIANT.
A9C127 C08 PCES: 1, WGT: 7169

7/8" PL 10- gussets

Precise Steel International LLC
PO # 4340
HT # A9C127
PL # 8751

(0) Cust Part # : FLOOR STOCK

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION

SENIOR METALLURGIST - PRODUCT

pipe 2" S/80 to. Davit Arms

INSPECTION CERTIFICATE DIN EN 10204: 2005-01 3.1 / 1-2880 /

Quality management system has been certified according to ISO 9001:2008 by TUV Thuringen e.V. (Certificate Number TIC 15 100 159230)
Environmental management system has been certified according to ISO 14001:2004 by TUV Thuringen e.V. (Certificate Number TIC 15 104 151299)
Occupational health and safety management system has been certified according to OHSAS 18001:2007 by TUV Thuringen e.V. (Certificate Number TIC 15 116 15624)

Open Joint-Stock Company
"Byelorussian Steel Works – management company of "Byelorussian Metallurgical Company" holding"
37, Promyshlennaya street 247210 Zhlobin – Belarus
Tel. +375 (2334) 5-41-29, Fax +375 (2334) 5-60-42
www.belsteel.com qualdir@bmz.gomel.by

Description of the goods: Seamless hot deformed pipes for oil and gas pipelines.
Описание товара: Трубы бесшовные горячедеформированные для нефте- и газопроводов.
Final application: For pipeline transportation systems for petroleum and natural gas industries.
Конечное назначение: Для трубопроводных транспортных систем для нефтяной и газовой промышленности.
Deoxidation degree: Fully deoxidized steel.
Степень раскисления: Полностью раскисленная сталь.
Type of pipe: SMLS Plain End.
Тип трубы: Бесшовная, с гладкими концами.
Delivery Conditional: As-rolled.
Условия поставки: Стандартная прокатка.
Technical specification level: PSL1
Уровень спецификации: PSL1

Contract № 17021621 appendix 6
Контракт № приложение
PO number
Номер заказа
Wagon № 60470663
Вагон
Country of destination: USA
Страна назначения:
Consignee:
Получатель:

№ position № позиции	Number of heat Номер плавки	Number of lot Номер партии	Grade steel/Standard Марка стали/Стандарт		Chemical composition, % – Химический состав, %																		Steel making-process:
					C	Si	Mn	P	S	Cr	Ni	Cu	Ti	Mo	V	Al	Nb	B	Nb+V	Nb+Ti+V	Cr+Ni+Mo+Cu+V	CE IIW	
				Norm Норма	max .28	min .10	.29 - 1.06	max .030	max .030	max .40	max .40	max .40		max .15	max .08			max .0010	max .06	max .15	max 1.00		
1	169720	173543	S/X43 acc. to API SPEC 5L:2012(45E) B acc. to ASTM A53/A53M-12 B acc. to ASME SA53/SA-53M-2013 B/C acc. to ASTM A106/A106M-15 B/C acc. to ASME SA106-SA106M-2013 NDE NACE MR 0175/ISO 15156-2:2009 and PED 97/23/EC, NACE MR 0103-2012	Ladle (fact) Ковшовая (факт)	.28	.26	.53	.008	.012	.11	.13	.25	.002	.02	.012	-	.001	.0002	.013	.015	.52	.40	Electric furnace
				Product (fact) Гпс (факт)	.28	.27	.51	.009	.012	.11	.13	.25	.002	.02	.014	-	.002	.0010	.016	.018	.52	.14	
				Product (fact) Гпс (факт)	.28	.27	.51	.010	.013	.11	.14	.26	.002	.02	.014	-	.002	.0002	.016	.018	.54	.14	

№ position № позиции	Dimensions – Размеры						Quantity – Количество							Hardness acc. to NACE MR 0175-2:2009 Твердость согласно NACE MR 0175-02:2009		Mechanical properties – Механические свойства								
	OD Диаметр		WT Толщина стенки		Length Длина		Number of packages Количество мест	Quantity of pipes bundles, pcs Количество труб в пакетах, шт	Weight Вес				Total length Фактическая метраж			Tensile Test – Испытание на растяжение Longitudinal Strip Test Specimens Образец в виде полосы в продольном направлении Gauge width 0.75 inch Ширина образца 0.75 дюйм ASTM A370				CVN impact test, KV Работа удара ASTM A370 Dimension of specimen Размер образца 0,197 x 0,394 inch				T
									Net Нетто		Gross Брутто					Tensile strength Предел прочности R_m	Yield strength Предел текучести $R_{t0.5}$	Elongation longitudinal Удлинение A_{50}	Ratio Коэффициент $Rt_{0.5}$/Rm	Impact energy (longitudinal) Работа удара (продольная)				°F
	mm мм	inch дюйм	mm мм	inch дюйм	m м (-0/+0.10)	ft фут (-0/+0.33)			t т	lb фунт	t т	lb фунт	m м	ft фут		ISO 6506-1		psi	psi	%		ft*lbf min 10				
																HBW						1	2	3	Average Среднее	
1	60.3	2.375	5.54	0.218	6.10	20.0	3	173	8.047	17740.57	8.059	17767.03	1069.05	3507.3		154	156	78000	53000	36	-	41	37	35	38	68
TOTAL							3	173	8.047	17740.57	8.059	17767.03	1069.05	3507.3												

Personal for NDT – methods ET and UT is qualified acc. to ISO 9712, level II
Персонал по неразрушающему контролю – методами ВТК и УЗК – имеет квалификацию в соотв. с ISO 9712, уровень II

Nondestructive Electric Tested/Eddy current test
Неразрушающий электрический контроль /Вихретоковый
ASTM E 309
Reference standard pipe with hole (Ø 3.2 mm/ 0.126 inch)
Эталонная труба с отверстиями (Ø 3,2 мм / 0.125 дюйма)
Results:ok
Результат:

NDT/UT
Метод испытаний/Ультразвуковой
ASTM E 213
Results:-
Результат:

Technological test
Технологическое испытание
Flattening Tests ASTM A106/A106M
Results: ok
Результат:

Hydrostatic testing according API 5L 45th ed
Гидростатическое испытание согласно API 5L 45th ed
P: 2970 psi
Duration: min 5 sec
Results: ok
Результат:

- It is hereby certified that products covered by this certificate has been tested and is complied with the requirements of the contract and the material specifications above mentioned.
- Подтверждаем, что продукция, указанная в настоящем сертификате, испытана и соответствует условиям контракта и требованиям к материалу описанным выше.
- Visually measuring test was performed with satisfactory result.
- Визуально-измерительный контроль проведен с удовлетворительным результатом.
- No weld repair. Free of mercury and mercury containing compounds.
- Без следов ремонта сварной. Без ртути и ртутьсодержащих элементов.
- Country of origin: Belarus (including steel melting process).
- Страна происхождения: Беларусь (включая выплавку стали).

Technical Control Inspector: Shchamelkova
Отдел технического контроля:

On Behalf of SMI Subsidiary "Byelorussian Steel SMI, Works-Metallurgical Complex of "Byelorussian Metallurgical Company"
Date: 10.07.2014
Дата:
QUALITY CONTROL FOR CERTIFICATE

PO: vbl Aaron Line: 3 Order: 1338874 Heat: 169720 Slab: Descr: A106 SML GR B 2 S/80 X S/R

Pipe 2.5" S/40 10" Sockets

CERTIFICATE NO.	: IJQ20171109102
DATE OF ISSUE	: 09.NOV.2017
CUSTOMER	:
CONTRACT(P/O) NO.	: 710623
COMMODITY	: SEAMLESS CARBON STEEL HOT FINISHED PIPE
STANDARD	: ASTM AS3 2012 Edition/A106 2015 Edition // ASME SA53/SA106 2015 Edition // API 5L FORTY-FIFTH EDITION, 2012

INSPECTION CERTIFICATE

EN10204-3.1 ■ / EN10204-3.2 □

ILJIN Steel Corporation

Jeonju Plant Address

1746 Hoguk-ro, Imsil-eup, Imsil-gun, Jeollabuk-do, Korea 556-805 TEL : 82-63-730-4574 / FAX : 82-63-730-4798

SUPPLIER | ILJIN STEEL Corporation

NO.	W/O (HEAT NO.)	ORDER SIZE ID	OD	WT	LENGTH	QUANTITY PCS	MASS lbs / ft	MASS TOTAL (lbs/ft)	TOTAL LENGTH	Manufacturing Process *1	Pipe End (Type) *2	HEAT TREATMENT *3
1	ST17100114 (D04522)	2.469 "	2.875"	0.203 "	42.0 '	207	5.80	50,425.20	8694.00 '	HF	BEP	N/A
		TOTAL				207	5.80	50425.20	8,694.00			

Grade: ASTM AS3 B; ASTM A106 B & C; ASME SA53 B; ASME SA106 B & C; API 5L B (PSL1); API X42 (PSL1)

REMARK

1. THE HARDNESS DESCRIBED HEREIN COMPLIANCE WITH NACE MR-0175/MR-0103(MAX.22HRC), EACH 2015 EDITION.
2. *R - CHEMICAL COMPOSITION REQUIREMENT FOLLOWS NEXT
   - ASTM A538 : TABLE 1 (REMARK C)
   - ASTM A106B&C : TABLE 1 (REMARK B)
   - API 5L : TABLE 4 (REMARK b)
3. NO WELD REPAIR WAS PERFORMED.
4. NO MERCURY AND LEAD, MERCURY COMPOUNDS OR MERCURY BEARING INSTRUMENTS AND/OR EQUIPMENT HAVE BEEN USED IN ANY MANNER WHICH MIGHT CAUSE CONTAMINATION IN MANUFACTURE, ASSEMBLY, OR TEST OF MATERIAL.
5. Pb CONTENT (SPEC. MAX. 0.010%) : 0.0018%
6. MADE IN KOREA

NO.	W/O (HEAT NO.)	STATUS	CHEMICAL COMPOSITION(%) C	Si	Mn	P	S	Cr	Ni	Mo	Cu	Al	Ti	V	Nb	B	U4	VN	V1	V2	CEQ	NDT
		*4	X100		*R	X1000		X100				X1000					*5	*6	*7	*8	*9	*10
Spec		MAX	25		135	30	30	40	40	15	40			80			1.0		0.15		0.44	EC / UT
		MIN		10	29																	
1	ST17100114 (D04522)	LA	19	22	117	10	6	11	4	2	10	20	23	2	3	0.4	0.3		0.03		0.39	
		BA	17	24	115	8	5	11	4	1	10	24	24	2	1	0.4	0.3		0.03		0.36	
		PA	17	25	116	8	5	11	4	1	10	24	24	2	2	0.4	0.3		0.03		0.36	*G

NO.	W/O (HEAT NO.)	HYDRO-STATIC TEST Sec.	PRESSURE psi	TENSILE TEST (GAGE LENGTH : 50.8±0.13mm) Width *L	Y.S 0.5% EUL *P psi	T.S psi	E.L %	IMPACT TEST (ASTM E23) Energy (1) Temp °C (2) Unit Jule *T	*L	HARDNESS (ASTM E18) ■ HRB ☐ HRC ☐ HB ☐ HV	BENDING TEST	FLATTENING TEST H=(1+e)t/(e+t/O.D.)	FLARING TEST	DWT Skg X 2m Temp : ℃	HYDRO-BURST MPa Temp : ℃	VISUAL	DIMENSION	DRIFT TEST	STRAIGHTNESS
Spec		S	2970	19.05	42100	70300	18.6					39.24							
1	ST17100114 (D04522)	*G	*G		68383	84293	33.6			86.9		*G				*G	*G		*P
					70239	82350	33.4			87.2									
										87.2									

NOTE

*1 - NF : Normalizing Forming / HF : Hot Finished / CF : Cold Finished
*2 - BEP : Bevelled End / PEP : Plain End
*3 - A : As Rolled / SRA : Stress Relieved Annealing / Q+T : Quenched & Tempered / N+T : Normalized & Tempered / N : Normalized / Iso : Isothermal Annealing
*4 - LA : Ladle Analysis / BA : Billet Analysis / PA : Product Analysis
*5 - Cu+Ni+Cr+Mo+V
*6 - Nb+V
*7 - Nb+V+Ti
*8 - Cr+Ni
*9 - C+Mn/6
*10 - UT : Ultrasonic Test / EC : Eddy Current Test / MT : Magnetic Particle Test/ EM : Electro Magnetic Inspection
*P - Tubular or Plate Type of ASTM E8 Fig.12
*F - Full Section Type of ASTM E8 Fig.11
*G - Good / *L - Longitudinal / *T - Transverse

Third party Section

- WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE AND TESTED IN ACCORDANCE WITH ABOVE SPECIFICATION AND THE RESULTS OF ALL TEST ARE ACCEPTABLE
- THE QUALITY SYSTEM OF OUR WORKS HAS BEEN ASSESSED AND REGISTERED AS MEETING THE REQUIREMENS OF ISO 9001, ANY WELDING HAS NOT BEEN PERFORMED ON THE MATERIAL
- THIS CERTIFICATION IS INTENDED ONLY FOR PRODUCTS LISTED. MODIFICATION TO OR UNAUTHORIZED USE OF THIS CERTIFICATION IS STRICTLY PROHIBITED. OFFENSES MAY BE REGARDED AS FORGERY OF DOCUMENTS AND BE SUBJECT TO CRIMINAL PROSECUTION.

YOUNG KYU SEO

Manager of Q.M Dept.:

PO: vbl Aaron Line: 4 Order: 1338874 Heat: D04522 Slab: Descr: A106 SML GR B 2 1/2 S/40 X S/R

MOORE CONTROL SYSTEMS, INC.
Instrument & Electrical Engineering & Design • Construction • Service
Phone: 281-392-7747 www.moore-control.com

Katy: 1435 Katy Flewellen
Katy, Tx 77494

Mailing: P.O. Box 677
Katy, Tx 77494

Baytown: 14827 I-10 East
Baytown, Tx 77523

SECTION 5

NDE REPORTS / NDE TECH CERTIFICATIONS

Moore Control Systems, Inc.

14827 I-10 East
Baytown, TX 77523
P 281-385-0009
F 281-392-7727

CERTIFICATION STATEMENT

This document certifies that VASILE VITAN has the training and experience, has met all qualification requirements in accordance with Moore Control Systems, Inc. procedure for the qualification, certification, and training of nondestructive test personnel and is hereby certified in the applications listed below.

EXAMINATION RESULTS

METHOD	MT	PT	VT
LEVEL	II	II	II
GENERAL EXAMINATION	80	94	80
SPECIFIC EXAMINATION	100	100	90
PRACTICAL EXAMINATION	96	95	95
COMPOSITE SCORE	92	96	88

Original Test Date:	02/20/2018
Performance Evaluation in accordance with ASNT SNT-TC-1A and CP-189.	
Date of method evaluation:	02/20/2018
Next method evaluation / certification due on or before:	02/20/2023

EXAMINED AND / OR APPROVED BY:	TITLE:	LEVEL III	ASNT CERTIFICATE #	170794
William R.K. Goolsby	DATE:	02/20/2018	WILLIAM R.K. GOOLSBY	

GOOLSBY TESTING, INC.

2620 WILSON ROAD P.O. BOX 1416
HUMBLE, TEXAS 77347-1416
(281) 540-1255 FAX (281) 540-8125

CERTIFICATION STATEMENT & VISUAL ACUITY RECORD

This document certifies that JUSTIN REPP has the training and experience, has met all qualification requirements in accordance with GOOLSBY TESTING, INC. procedure for the qualification, certification, and training of nondestructive test personnel and is hereby certified in the applications listed below.

EXAMINATION RESULTS

METHOD	RT	MT	PT	VT	UT
LEVEL	II	II	II	II	N/A
GENERAL EXAMINATION	82	80	90	86	N/A
SPECIFIC EXAMINATION	94	95	90	90	N/A
PRACTICAL EXAMINATION	95	95	95	94	N/A
COMPOSITE SCORE	90	90	92	90	N/A

Original Test Date:	10/07/2017	IDENTIFICATION NO.:	4388
Performance Evaluation in accordance with ASNT SNT-TC-1A and CP-189			
Date of method evaluation:			01/10/2018
Next method evaluation / certification due on or before:			01/10/2023
Next Visual Acuity evaluation due on or before:			01/10/2019

VISUAL ACUITY RECORD

NEAR-VISION ACUITY:

AS PER ASNT SNT-TC-1A, THE EXAMINATION SHOULD ENSURE NATURAL OR CORRECTED NEAR-DISTANCE ACUITY IN AT LEAST ONE EYE SUCH THAT THE APPLICANT IS CAPABLE OF READING A MINIMUM OF JAEGER NUMBER 2 OR EQUIVALENT TYPE AND SIZE LETTER AT THE DISTANCE DESIGNATED ON THE CHART BUT NOT LESS THAN 12 INCHES ON A STANDARD JAEGER TEST CHART.

I CONFIRM THAT THE CANDIDATE: (PLEASE MARK ONLY ONE BOX)

- ☒ MEETS THE JAEGER NUMBER 2 OR EQUIVALENT TYPE REQUIREMENTS WITHOUT CORRECTION
- ☐ MEETS THE JAEGER NUMBER 2 OR EQUIVALENT TYPE REQUIREMENTS WITH CORRECTION
- ☐ DOES NOT MEET THE JAEGER NUMBER 2 OR EQUIVALENT TYPE REQUIREMENTS

DISTANCE-VISION ACUITY:

THE EXAMINATION SHALL EQUAL SNELLEN FRACTION 20/30 OR BETTER IN AT LEAST ONE EYE, EITHER CORRECTED OR UNCORRECTED.

I CONFIRM THAT THE CANDIDATE: (PLEASE MARK ONLY ONE BOX)

- ☒ MEETS THE SNELLEN FRACTION 20/30 REQUIREMENTS WITHOUT CORRECTION
- ☐ MEETS THE SNELLEN FRACTION 20/30 REQUIREMENTS WITH CORRECTION
- ☐ DOES NOT MEET THE SNELLEN FRACTION 20/30 REQUIREMENTS

COLOR VISION:

A TECHNICIAN WHO PASSES ISHIHARA TEST (SHORT OR LONG) IS ACCEPTABLE.

I CONFIRM THAT THE CANDIDATE CAN DISTINGUISH CONTRAST BETWEEN THE COLORS USED IN THE NDT METHOD(S) CONCERNED, AND/OR HAS PASSED AN ISHIHARA TEST EITHER CORRECTED OR UNCORRECTED.

EYE EXAMINATION: SHADES OF GRAY

THE INDIVIDUAL SHALL BE CAPABLE OF DISTINGUISHING SHADES OF GRAY ON "EYE EXAMINATION: SHADES OF GRAY". THEY MUST USE A HARD COPY OR ON THE COMPUTER SCREEN AT A DISTANCE OF 30-50 cm (11 13/16" - 19 11/16") UNDER NORMAL DESKTOP WORKING LIGHT CONDITIONS. THE PASSING GRADE IS A MINIMUM 20 OF 25 CORRECT READINGS.

I CONFIRM THAT THE CANDIDATE CAN DISTINGUISH CONTRAST BETWEEN THE SHADES OF GRAY USED IN THE NDT METHOD(S) CONCERNED, AND/OR HAS PASSED THE "EYE EXAMINATION: SHADES OF GRAY" EITHER CORRECTED OR UNCORRECTED.

WILLIAM R.K. GOOLSBY EXAMINER'S NAME (PRINT/TYPE)	William R.K. Goolsby
ASNT LEVEL III APPOINTMENT / TITLE	01/10/2018 DATE OF EYE EXAMINATION

EXAMINED AND / OR APPROVED BY:	TITLE:	LEVEL III	ASNT CERTIFICATE #	170794
William R.K. Goolsby	DATE:	01/10/2018	WILLIAM R.K. GOOLSBY	

MCSI MOORE CONTROL SYSTEMS, INC.
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Moore Pressure, Moore Valve, Moore Control • Since 1981

REPORT NO.: 140

NON-DESTRUCTIVE EXAMINATION REPORT

JOB NO.: 18165 DATE: 05-22-2018 FACILITY: ☑ BAYTOWN ☐ KATY ☐ ☐

PART NO.: - SERIAL NO.: 18165-9 PART DESCRIPTION:

EXAMINATION PERFORMED: ☑ MT ☐ PT ☐ UT ☐ VT PROCEDURE NO.: 5000 REV. 18-1

CODE/ACCEPT CRITERIA: ASME SECT. VIII ☑ DIV. 1, ☐ DIV. 2, ASME B31.3, SERVICE -, B31.4 ☐ B31.8 ☐ API-1104 ☐

AWS D1.1 ☐ CONNECTION TYPE ☐ STAT. LOADED NT ☐ CYCL. LOADED NT ☐ TUBULAR CONN. OTHER ☐: -

MATERIAL: CS ☑ SS ☐ OTHER: ☐ - SURFACE COND.: AS WELDED ☑ GROUND ☐ CLEANED

EQUIPMENT

EQUIP. DESC.	MANUFACTURER	MODEL NO.:	SERIAL NO.:	CAL.DUE DATE
YOKE	Contour Probe	B100	11342	3/14/2019
LIGHT METER	N/A	N/A	N/A	N/A
BLACKLIGHT	N/A	N/A	N/A	N/A
UT SCOPE	N/A	N/A	N/A	N/A
TRANSDUCERS	N/A	N/A	N/A	N/A
CABLES	N/A	N/A	N/A	N/A
CAL. BLOCKS	Parker	TB-10	11328	4/16/18

CONSUMABLES

	CLEANER	PENETRANT	DEVELOPER	MAG. PARTICLE	CONTRAST PAINT	COUPLANT
MANUFACTURER	N/A	N/A	N/A	Sherwin	Sherwin	N/A
BRAND/TYPE	N/A	N/A	N/A	B.O. No. 1	CP-2	N/A
BATCH NO.	N/A	N/A	N/A	727-D42	78-H-23	N/A

TECHNIQUE

MT: ☑ AC YOKE ☒ WET ☐ DRY ☐ FLUORESCENT ☑ COLOR CONTRAST, LIGHT INTENSITY +100 FC ✓, SURFACE TEMP AMB ✓
RADIOMETER MODEL -, SERIAL NO -, CAL. DUE DATE -

PT N/A: ☐ TYPE I FUORESCENT ☐ TYPE II VISIBLE ☐ A WATER WASH, ☐ B LIPOPHILIC, ☐ C SOLVENT ☐ D HYDROPHILIC
- DWELL TIME, - DEVELOP TIME, LIGHT INTENSITY -, SURFACE TEMP -
RADIOMETER MODEL: -, SERIAL NO -, CAL. DUE DATE -

UT N/A: ☐ ST. BEAM ☐ ANGLE BEAM ☐ 45° ☐ 60° ☐ 70° TRANSDUCER SIZE & FREQUENCY -

VT N/A: ☐ DIRECT, ☐ REMOTE BORE SCOPE, ☐ REMOTE VIDEO, LIGHT INTENSITY -
RADIOMETER MODEL: -, SERIAL NO.: -, CAL. DUE DATE: -

EXAMINATION RESULTS

INDICATION CODES: NR = NO RECORDABLE INDICATION, L = LINEAR INDICATIONS, C = CRACK, NI = NO INDICATIONS

IDENTIFICATION	SIZE/THICKNESS	ACC. /REJ.	IND.CODE	WELDER STENCIL	REMARKS
DAVID BRACKOT HRM	NA	ACC	NI	Q	
BOOK ON BLINDS	NA	ACC	NI	H	
					ALL WELDS WAS ACCEPTED AT THE TIME OF INSPECTION
CERTIFICATION					

Vasile Jitaru
TECHNICIAN SIGNATURE

II
LEVEL

05-22-2018
DATE

CLIENT SIGNATURE

DATE

JOB HOURS

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Moore Personnel. Moore Value. Moore Control. • Since 1981

REPORT NO.: 127

NON-DESTRUCTIVE EXAMINATION REPORT

JOB NO.: 18165 DATE: 05-17-18 FACILITY: ☐ BAYTOWN ☑ KATY ☐ ☐

PART NO.: — SERIAL NO.: 18165-9 PART DESCRIPTION: PHASE SEPARATOR

EXAMINATION PERFORMED: ☑ MT ☐ PT ☐ UT ☐ VT PROCEDURE NO.: 5000 REV. 18-1

CODE/ACCEPT CRITERIA: ASME SECT. VIII ☑ DIV. 1. ☐ DIV. 2. ASME B31.3. SERVICE —, B31.4 ☐ B31.8 ☐ API-1104 ☐

AWS D1.1 ☐ CONNECTION TYPE ☐ STAT. LOADED NT ☐ CYCL. LOADED NT ☐ TUBULAR CONN. OTHER ☐: —

MATERIAL: CS ☑ SS ☐ OTHER: ☐ — SURFACE COND.: AS WELDED ☑ GROUND ☐ CLEANED

EQUIPMENT

EQUIP. DESC.	MANUFACTURER	MODEL NO.:	SERIAL NO.:	CAL.DUE DATE
YOKE	Contour Probe	B100	11342	3/14/2019
LIGHT METER	N/A	N/A	N/A	N/A
BLACKLIGHT	N/A	N/A	N/A	N/A
UT SCOPE	N/A	N/A	N/A	N/A
TRANSDUCERS	N/A	N/A	N/A	N/A
CABLES	N/A	N/A	N/A	N/A
CAL. BLOCKS	Parker	TB-10	11328	4/16/18

CONSUMABLES

	CLEANER	PENETRANT	DEVELOPER	MAG. PARTICLE	CONTRAST PAINT	COUPLANT
MANUFACTURER	N/A	N/A	N/A	Sherwin	Sherwin	N/A
BRAND/TYPE	N/A	N/A	N/A	B.O. No. 1	CP-2	N/A
BATCH NO.	N/A	N/A	N/A	727-D42	78-H-23	N/A

TECHNIQUE

MT ☐ AC YOKE ☒ WET ☐ DRY ☐ FLUORESCENT ☐ COLOR CONTRAST, LIGHT INTENSITY +100 FC ✓, SURFACE TEMP AMB ✓
RADIOMETER MODEL: —, SERIAL NO.: —, CAL. DUE DATE: —

PT N/A ☐ TYPE I FUORESCENT ☐ TYPE II VISIBLE ☐ A WATER WASH, ☐ B LIPOPHILIC, ☐ C SOLVENT ☐ D HYDROPHILIC
— DWELL TIME, — DEVELOP TIME, LIGHT INTENSITY —, SURFACE TEMP —
RADIOMETER MODEL: —, SERIAL NO.: —, CAL. DUE DATE: —

UT N/A ☐ ST. BEAM ☐ ANGLE BEAM ☐ 45° ☐ 60° ☐ 70° TRANSDUCER SIZE & FREQUENCY —

VT N/A ☐ DIRECT, ☐ REMOTE BORE SCOPE, ☐ REMOTE VIDEO, LIGHT INTENSITY —
RADIOMETER MODEL: —, SERIAL NO.: —, CAL. DUE DATE: —

EXAMINATION RESULTS

INDICATION CODES: NR = NO RECORDABLE INDICATION, L = LINEAR INDICATIONS, C = CRACK, NI = NO INDICATIONS

IDENTIFICATION	SIZE/THICKNESS	ACC. /REJ.	IND.CODE	Welder Stencil	REMARKS
LL-1	NA	ACC	NI	A5	
LL-2	NA	ACC	NI	A5	
					AT THE TIME OF INSPECTION INDICATION WAS FIXED AND REMOVED BY GRINDING. AND REINSPECTED
CERTIFICATION					

Basile Vitale II 05-17-18
TECHNICIAN SIGNATURE LEVEL DATE

CLIENT SIGNATURE

DATE JOB HOURS:

Goolsby Testing, Inc.
2620 WILSON ROAD - P.O. BOX 1416
HUMBLE, TX. 77347-1416
PH:281.540.1255 FX:281.540.8125

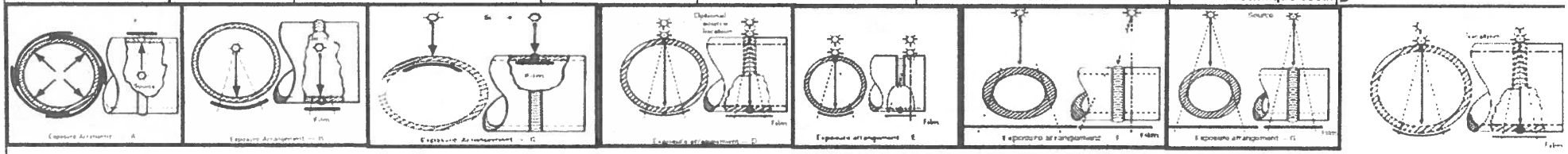
RADIOGRAPHY REPORT

GT TICKET/ORDER ID#: RT46 - 18 - 05 - 43236 - 4 -*-

This Box for GTL Office Use Only:	

J/N#: 18165-9 P.O.#: 181656629A
S/N#: 0 GT#: 0

Technician:	JUSTIN REPP	46	Date:	05/16/18	Report:	04	REV#:		J/N#:	18165-9	S/N#:		
									P.O.#:	181656629A	GT#:		
Manufacturer:	MOORE CONTROL												
Diameter:	48.000 in.	Thickness:	00.375 in.	Material Type:	CS	Weld Thickness:	00.475 in.	Weld Reinforcment:	00.100 in.				
Source to Object (Min.):	24.000 in.	Source to Film (MAX.):	24.000 in.	Source side of object to film:	00.475 in.			#Film in cassette:	1	ASME Req.:	UW-52 (Spot)		
Wall Exposure:	Single	Viewing:	Single	Spec.:	ASME Section VIII Div.1	PED(97/23/EC):	N/A	Procedure #:	2000	Rev.:	18-1		
Radiation:	IR-192	Curies:	26	Focal Size	00.160 in.	Film Mfg.:	Agfa			Film Type:	D7		
Voltage		Amperage:		Penetrameter Size:	B Pack		Placement:	Film Side	Shim Thickness:	N/A			
Markers:	Film Side	Front Lead Screens:	0.005		Back Lead Screens:		0.005		Technique Used:	D			



A B C D E F G

Radiographic Terms and Abbreviations

•BT-Burn Thru •BTA-Burn Thru Area •C-Crack •P-Porosity •NW-Narrow Weld •LC-Low Crown •FA-Film Artifacts
•SI-Slag Inclusion •SL-Slag Line •NF-Non Fusion •GP-Gas Pocket •IU-Internal Undercut •OU-Outside Undercut •IP-Inadequate Penetration

Weld Number	Film Number	Interpretation	Remarks
C1	1-2	Accepted	Q
C2	1-2	Accepted	B1

Weld Number	Film Number	Interpretation	Remarks

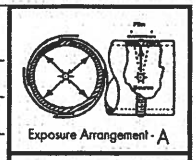
Accepted by:	Kenneth Withers Kenneth Withers 5-16-18	Date:	05/16/18	Level II Radiographer:	JUSTIN REPP
Representative of:	MOORE CONTROL SYSTEMS, INC.			Level II Interpreter:	JUSTIN REPP

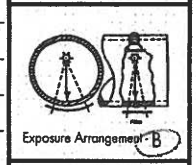
DIAMOND G INSPECTION

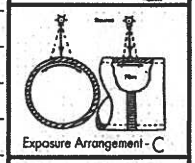
RADIOGRAPHIC REPORT – Continued

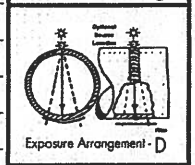
Client:	Fire Welding	Date:	3.3.18	Report No.:	117983

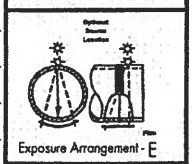
WELD NO.	LOCATION	SIZE & THICKNESS	ACCEPT YES	ACCEPT NO	PENT	SFD	DEFECT TYPE/SIZE	WELDER	REMARKS
D	1 – 2	3/8 x 48	✓		B	70"		5	
	2 – 3		✓						
	3 – 4		✓						
	4 – 5		✓						
	5 – 6		✓						
	6 – 7		✓						
	7 – 8		✓						
	8 – 9		✓						
	9 – 10		✓						
	10 – 11		✓						
F	1 – 2		✓					5	
	2 – 3		✓						
	3 – 4		✓						
	4 – 5		✓						
	5 – 6		✓						
	6 – 7		✓						
	7 – 8		✓						
	8 – 9		✓						
	9 – 10		✓						
	10 – 11		✓		2	2			

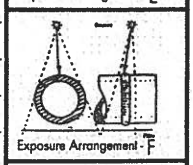

Exposure Arrangement - A

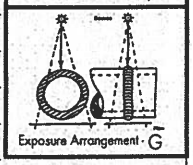

Exposure Arrangement - B


Exposure Arrangement - C


Exposure Arrangement - D


Exposure Arrangement - E


Exposure Arrangement - F


Exposure Arrangement - G

TECHNICIAN:	Calvin S	LEVEL	II	ASST:	Freddy A	LEVEL	
CLIENT REPRESENTATIVE:	Roberto Perez	DATE:	3-5-18	ASST:	Taylor B	LEVEL	1

Signature certifies time & material correct

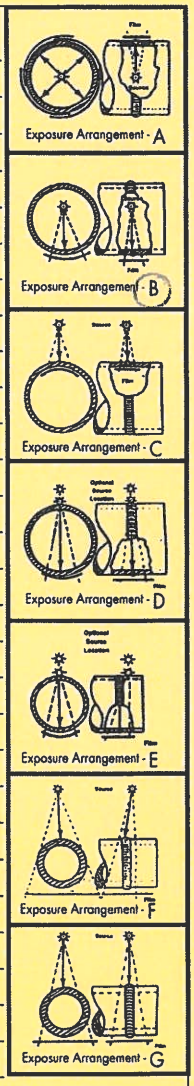
11050 W. Little York Rd, Bldg. G • Houston, Texas 77041
Office: (713) 937-8168 • Fax: (713) 937-8198

DIAMOND G INSPECTION

RADIOGRAPHIC REPORT – Continued

Client:	Base Welding	Date:	3-5-18	Report No.:	117993

WELD NO.	LOCATION	SIZE & THICKNESS	ACCEPT YES	ACCEPT NO	PENT	SFD	DEFECT TYPE/SIZE	WELDER	REMARKS
L	1-2	3/8 x 48	/		B	20"		D	
	2-3	"	/		"	"		"	
	3-4	"	/		"	"		"	
	4-5	"	/		"	"		"	
	5-6	"	/		"	"		"	
	6-7	"	/		"	"		"	
	7-8	"	/		"	"		"	
	8-9	"	/		"	"		"	
	9-10	"	/		"	"		"	
	10-11	"	/		"	"		L	



TECHNICIAN:	Cesar	LEVEL	II	ASST:	Freddy A.	LEVEL	
CLIENT REPRESENTATIVE:		DATE:	3-6-18	ASST:	Taylor	LEVEL	1

Signature certifies time & material correct

11050 W. Little York Rd, Bldg. G • Houston, Texas 77041
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MOORE CONTROL SYSTEMS, INC.
Instrument & Electrical Engineering & Design • Construction • Service
Phone: 281-392-7747 www.moore-control.com

Katy: 1435 Katy Flewellen
Katy, Tx 77494

Mailing: P.O. Box 677
Katy, Tx 77494

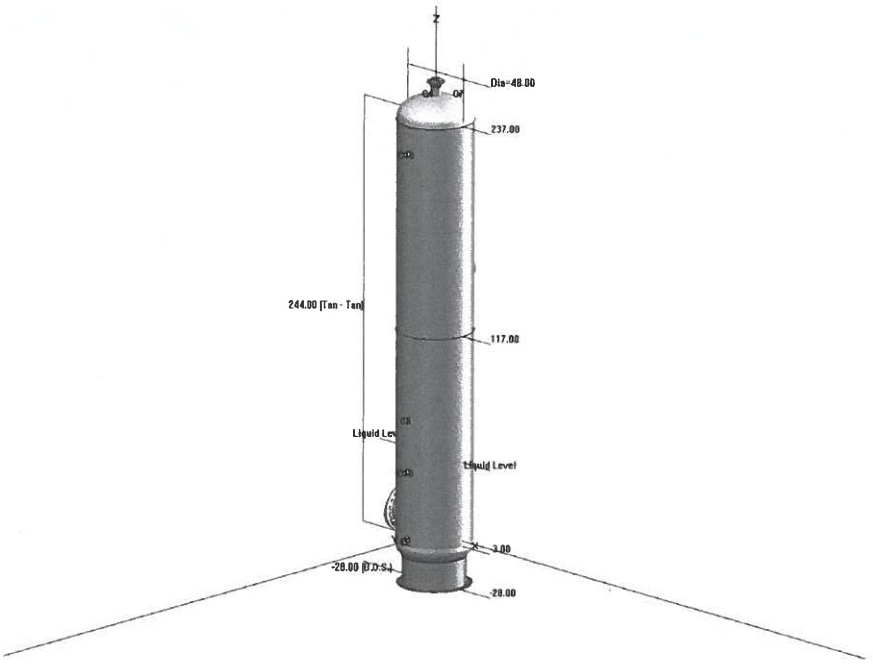
Baytown: 14827 I-10 East
Baytown, Tx 77523

SECTION 6

ASME CODE CALCULATIONS

Moore Control Systems, Inc.

1435 Katy Flewellen



COMPRESS Pressure Vessel Design Calculations

Vessel No.: VERTICAL 2-PHASE SEPARATOR
Job: 18165
Customer: Marathon Oil
P.O.: 181656011A
Designer: L. Rodriguez
Date: January 20, 2018

King Design Group, Inc.
14011 Park Drive #113
Tomball, TX 77377
markkdg@sbcglobal.net

ISSUED FOR APPROVAL

MCSI #: 18165 DATE: 1/29/18

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Revision History

Revisions			
No.	Date	Operator	Notes
0	1/20/2018	KDG4	ISSUED FOR APPROVAL

Settings Summary

COMPRESS 2018 Build 7800	
ASME Section VIII Division 1, 2017 Edition	
Units	U.S. Customary
Datum Line Location	3.00" from bottom seam
Vessel Design Mode	Design Mode
Minimum thickness	0.0625" per UG-16(b)
Design for cold shut down only	No
Design for lethal service (full radiography required)	No
Design nozzles for	Design P only
Corrosion weight loss	100% of theoretical loss
UG-23 Stress Increase	1.20
Skirt/legs stress increase	1.0
Minimum nozzle projection	1"
Juncture calculations for $\alpha > 30$ only	Yes
Preheat P-No 1 Materials > 1.25" and <= 1.50" thick	No
UG-37(a) shell tr calculation considers longitudinal stress	No
Cylindrical shells made from pipe are entered as minimum thickness	No
Nozzles made from pipe are entered as minimum thickness	No
ASME B16.9 fittings are entered as minimum thickness	No
Butt welds	Tapered per Figure UCS-66.3(a)
Disallow Appendix 1-5, 1-8 calculations under 15 psi	No
Hydro/Pneumatic Test	
Shop Hydrotest Pressure	1.3 times vessel MAWP [UG-99(b)]
Test liquid specific gravity	1.00
Maximum stress during test	90% of yield
Required Marking - UG-116	
UG-116(e) Radiography	RT4
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	Yes
Apply interpretation VIII-1-07-50	Yes
Apply interpretation VIII-1-16-85	No
No UCS-66.1 MDMT reduction	No
No UCS-68(c) MDMT reduction	No
Disallow UG-20(f) exemptions	No
UG-22 Loadings	
UG-22(a) Internal or External Design Pressure	Yes
UG-22(b) Weight of the vessel and normal contents under operating or test conditions	Yes
UG-22(c) Superimposed static reactions from weight of attached equipment (external loads)	No
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	King Design Group
License	Commercial
License Key ID	24086
Support Expires	April 21, 2018

Pressure Summary

Component Summary						
Identifier	P Design (psi)	T Design (°F)	MDMT (°F)	MDMT Exemption		Impact Tested
TOP HEAD	250	150	-40.4	Note 1		No
Straight Flange on TOP HEAD	250	150	-40.4	Note 2		No
SHELL RG 2	250	150	-40.5	Note 3		No
SHELL RG 1	250	150	-39.9	Note 4		No
Straight Flange on BOTTOM HEAD	250	150	-39.8	Note 6		No
BOTTOM HEAD	250	150	-39.8	Note 5		No
INLET (C1)	250	150	-32.3	Note 7		No
WATER LLC (C10)	250	150	-155	Note 8		No
RELIEF (C13)	250	150	-155	Note 8		No
WATER LEVEL LOW (C14)	250	150	-155	Note 9		No
OIL LEVEL HIGH (C15)	250	150	-155	Note 8		No
WATER OUTLET (C2)	250	150	-155	Note 10		No
GAUGE GLASS (C3A)	250	150	-155	Note 11		No
GAUGE GLASS (C3B)	250	150	-155	Note 12		No
SUPPLY GAS (C4)	250	150	-34	Note 13		No
DRAIN (C5)	250	150	-155	Note 14		No
GAS OUTLET (C6)	250	150	-32.3	Nozzle	Note 7	No
				Pad	Note 15	No
SAFETY HEAD (C7)	250	150	-155	Note 8		No
PI (C8)	250	150	-155	Note 12		No
MANWAY (M1)	250	150	-31.8	Nozzle	Note 16	No
				Pad	Note 17	No

Chamber Summary	
Design MDMT	-20 °F
Rated MDMT	-31.8 °F @ 250 psi
MAWP hot & corroded	250 psi
(1) This pressure chamber is not designed for external pressure.	

Notes for Maximum Pressure Rating	
Note #	Details
1.	Option to calculate MAP was not selected. See the Calculation->General tab of the Set Mode dialog.
2.	Option to calculate MAWP was not selected. See the Calculation->General tab of the Set Mode dialog.

Notes for MDMT Rating		
Note #	**Exemption**	**Details**
1.	Straight Flange governs MDMT	
2.	Material impact test exemption temperature from Fig UCS-66 Curve B = -20°F Fig UCS-66.1 MDMT reduction = 20.4°F, (coincident ratio = 0.796)	UCS-66 governing thickness = 0.375 in
3.	Material impact test exemption temperature from Fig UCS-66 Curve B = -20°F Fig UCS-66.1 MDMT reduction = 20.5°F, (coincident ratio = 0.7953)	UCS-66 governing thickness = 0.375 in
4.	Material impact test exemption temperature from Fig UCS-66 Curve B = -20°F Fig UCS-66.1 MDMT reduction = 19.9°F, (coincident ratio = 0.8008)	UCS-66 governing thickness = 0.375 in
5.	Straight Flange governs MDMT	
6.	Material impact test exemption temperature from Fig UCS-66 Curve B = -20°F Fig UCS-66.1 MDMT reduction = 19.8°F, (coincident ratio = 0.8017)	UCS-66 governing thickness = 0.375 in
7.	Flange rating governs: Flange rated MDMT per UCS-66(b)(1)(b) = -32.3°F (Coincident ratio = 0.8772) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	
8.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.0479).	
9.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.0481).	
10.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.0592).	
11.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.0161).	
12.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.016).	
13.	Nozzle impact test exemption temperature from Fig UCS-66 Curve B = -20°F Fig UCS-66.1 MDMT reduction = 14°F, (coincident ratio = 0.8597)	UCS-66 governing thickness = 0.3125 in.
14.	Nozzle is impact test exempt per UCS-66(d) (NPS 4 or smaller pipe).	
15.	Pad impact test exemption temperature from Fig UCS-66 Curve B = -20°F Fig UCS-66.1 MDMT reduction = 14°F, (coincident ratio = 0.8597)	UCS-66 governing thickness = 0.375 in.
16.	Flange rating governs: Flange rated MDMT per UCS-66(b)(1)(b) = -31.8°F (Coincident ratio = 0.8818) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	
17.	Pad impact test exemption temperature from Fig UCS-66 Curve B = -20°F Fig UCS-66.1 MDMT reduction = 19.9°F, (coincident ratio = 0.8011)	UCS-66 governing thickness = 0.375 in.

Nozzle Schedule

Specifications									
Nozzle mark	**Identifier**	**Size**	**Materials**		**Impact Tested**	**Normalized**	**Fine Grain**	**Flange**	**Blind**
C1	INLET	NPS 6 Sch 80 (XS)	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 6 Class 150 WN A105	No
C10	WATER LLC	NPS 2 Class 3000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C13	RELIEF	NPS 2 Class 3000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C14	WATER LEVEL LOW	NPS 2 Class 3000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C15	OIL LEVEL HIGH	NPS 2 Class 3000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C2	WATER OUTLET	NPS 3 Class 3000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C3A	GAUGE GLASS	NPS 0.5 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C3B	GAUGE GLASS	NPS 0.5 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C4	SUPPLY GAS	NPS 0.5 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C5	DRAIN	NPS 2 Sch 80 (XS)	Nozzle	SA-106 B Smls pipe	No	No	No	N/A	No
C6	GAS OUTLET	NPS 6 Sch 80 (XS)	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 6 Class 150 WN A105	No
			Pad	SA-516 70	No	No	No		
C7	SAFETY HEAD	NPS 2 Class 3000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
C8	PI	NPS 0.5 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
M1	MANWAY	NPS 18 Sch 80	Nozzle	SA-106 B Smls pipe	No	No	No	NPS 18 Class 150 SO A105	NPS 18 Class 150 A105
			Pad	SA-516 70	No	No	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)		
C1	6.625	0.432	0.28	Yes	Yes	0.375	0.2985		N/A	N/A	0	106.3
C10	3	0.3125	0.0625	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
C13	3	0.3125	0.0625	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
C14	3	0.3125	0.0625	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
C15	3	0.3125	0.0625	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
C2	4.25	0.375	0.0625	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
C3A	1.5	0.33	0.0625	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
C3B	1.5	0.33	0.0625	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
C4	1.5	0.33	0.0625	Yes	Yes	0.3125*	N/A		N/A	N/A	0	Exempt
C5	2.375	0.218	0.154	Yes	Yes	0.3125*	N/A		N/A	N/A	0	Exempt
C6	6.625	0.432	0.28	Yes	Yes	0.3125*	0.2687		2	0.375	0	180.5
C7	3	0.3125	0.0625	Yes	Yes	0.3125*	N/A		N/A	N/A	0	Exempt
C8	1.5	0.33	0.0625	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
M1	18	0.938	0.1368	Yes	Yes	0.375	0.3004		2	0.375	0	109.9
*Head minimum thickness after forming												

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

Thickness Summary

Component Data								
Component Identifier	Material	Diameter (in)	Length (in)	Nominal t (in)	Design t (in)	Total Corrosion (in)	Joint E	Load
TOP HEAD	SA-516 70	48 OD	12.1563	0.3125*	0.2967	0	1.00	Internal
Straight Flange on TOP HEAD	SA-516 70	48 OD	2	0.375	0.2986	0	1.00	Internal
SHELL RG 2	SA-516 70	48 OD	120	0.375	0.3509	0	0.85	Internal
SHELL RG 1	SA-516 70	48 OD	120	0.375	0.3533	0	0.85	Internal
Straight Flange on BOTTOM HEAD	SA-516 70	48 OD	2	0.375	0.3007	0	1.00	Internal
BOTTOM HEAD	SA-516 70	48 OD	12.1563	0.3125*	0.2993	0	1.00	Internal
Support Skirt #1	SA-516 70	40 OD	16.17	0.25	0.0156	0	0.55	Seismic
*Head minimum thickness after forming								

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

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 ft²
							New	Corroded	New	Corroded	
TOP HEAD	260.4	260.4	0	0	0	0	0	0	633.5	633.5	21
SHELL RG 2	1,901	1,901	0	0	0	0	0	0	7,597.8	7,597.8	125
SHELL RG 1	1,874.1	1,874.1	0	0	0	0	3,076.2	3,076.2	7,633.5	7,633.5	124
BOTTOM HEAD	263.8	263.8	0	0	0	0	629.3	629.3	629.3	629.3	21
Support Skirt #1	138.4	138.4	0	0	0	0	0	0	0	0	28
Skirt Base Ring #1	108	108	0	0	0	0	0	0	0	0	11
TOTAL:	**4,545.6**	**4,545.6**	**0**	**0**	**0**	**0**	**3,705.5**	**3,705.5**	**16,494.1**	**16,494.1**	**331**
*Shells with attached nozzles have weight reduced by material cut out for opening.											

Weight (lb) Contributed by Attachments											
Component	Body Flanges		Nozzles & Flanges		Packed Beds	Ladders & Platforms	Trays	Tray Supports	Rings & Clips	Vertical Loads	Surface Area ft²
	New	Corroded	New	Corroded							
TOP HEAD	0	0	46.4	46.4	0	0	0	0	0	0	2
SHELL RG 2	0	0	38.6	38.6	0	0	0	0	0	0	2
SHELL RG 1	0	0	518.2	518.2	0	0	0	0	0	0	8
BOTTOM HEAD	0	0	1.1	1.1	0	0	0	0	0	0	0
Support Skirt #1	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	**0**	**0**	**604.4**	**604.4**	**0**	**0**	**0**	**0**	**0**	**0**	**13**

Vessel Totals		
	New	Corroded
Operating Weight (lb)	8,856	8,856
Empty Weight (lb)	5,150	5,150
Test Weight (lb)	21,644	21,644
Surface Area (ft2)	344	-
Capacity** (US gal)	1,973	1,973
**The vessel capacity does not include volume of nozzle, piping or other attachments.		

Vessel Lift Condition	
Vessel Lift Weight, New (lb)	5,150
Center of Gravity from Datum (in)	101.5514

Hydrostatic Test

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

Gauge pressure at 70°F =
1.3*MAWP*LSR
= 1.3*250*1
= 325 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**
TOP HEAD (1)	326.71	1.71	1	1.30
Straight Flange on TOP HEAD	326.708	1.708	1	1.30
SHELL RG 2	326.708	1.708	1	1.30
SHELL RG 1	326.708	1.708	1	1.30
Straight Flange on BOTTOM HEAD	326.708	1.708	1	1.30
BOTTOM HEAD	326.71	1.71	1	1.30
DRAIN (C5)	325.89	0.89	1	1.30
GAS OUTLET (C6)	325.959	0.959	1	1.30
GAUGE GLASS (C3A)	326.504	1.504	1	1.30
GAUGE GLASS (C3B)	326.504	1.504	1	1.30
INLET (C1)	325.959	0.959	1	1.30
MANWAY (M1)	326.938	1.938	1	1.30
OIL LEVEL HIGH (C15)	326.343	1.343	1	1.30
PI (C8)	325.87	0.87	1	1.30
RELIEF (C13)	325.898	0.898	1	1.30
SAFETY HEAD (C7)	325.898	0.898	1	1.30
SUPPLY GAS (C4)	325.87	0.87	1	1.30
WATER LEVEL LOW (C14)	326.343	1.343	1	1.30
WATER LLC (C10)	325.898	0.898	1	1.30
WATER OUTLET (C2)	325.918	0.918	1	1.30

(1) TOP HEAD 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 -1.8 °F so the brittle fracture provision of UG-99(h) has been met.

Wind Code

Building Code: ASCE 7-10		
Elevation of base above grade		1.00 ft
Increase effective outer diameter by		1.00 ft
Wind Force Coefficient, Cf		0.7000
Risk Category (Table 1.5-1)		III
Basic Wind Speed, V		115.00 mph
Exposure Category		B
Wind Directionality Factor, Kd		0.9500
Top Deflection Limit		6.00 in. per 100 ft.
Topographic Factor, Kzt		1.0000
Enforce min. loading of 16 psf		Yes
Hazardous, toxic, or explosive contents		No
Vessel Characteristics		
Height, h		23.2628 ft
Minimum Diameter, b	Operating, Corroded	4.0000 ft
	Empty, Corroded	4.0000 ft
Fundamental Frequency, n_1	Operating, Corroded	19.9582 Hz
	Empty, Corroded	20.1052 Hz
Damping coefficient, β	Operating, Corroded	0.0250
	Empty, Corroded	0.0200

Table Lookup Values

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

Wind Deflection Reports:

Operating, Corroded
Empty, Corroded
Wind Pressure Calculations

Wind Deflection Report: Operating, Corroded								
Component	Elevation of Bottom above Base (in)	Effective OD (ft)	Elastic Modulus E (10^6 psi)	Inertia I (ft^4)	Platform Wind Shear at Bottom (lb_f)	Total Wind Shear at Bottom (lb_f)	Bending Moment at Bottom (lb_f-ft)	Deflection at Top (in)
TOP HEAD	264.9979	5.00	29.0	*	0	48	30	0.0093
SHELL RG 2	144.9979	5.00	29.0	0.7672	0	528	2,998	0.0087
SHELL RG 1	24.9979	5.00	29.0	0.7672	0	1,008	11,862	0.0039
BOTTOM HEAD (top)	16.17	5.00	29.0	*	0	1,042	12,617	0.0003
Support Skirt #1	0	4.33	29.0	0.2974	0	1,098	14,059	0.0001
*Moment of Inertia I varies over the length of the component								

Wind Deflection Report: Empty, Corroded								
Component	Elevation of Bottom above Base (in)	Effective OD (ft)	Elastic Modulus E (10^6 psi)	Inertia I (ft^4)	Platform Wind Shear at Bottom (lb_f)	Total Wind Shear at Bottom (lb_f)	Bending Moment at Bottom (lb_f-ft)	Deflection at Top (in)
TOP HEAD	264.9979	5.00	29.4	*	0	48	30	0.0092
SHELL RG 2	144.9979	5.00	29.4	0.7672	0	528	2,998	0.0086
SHELL RG 1	24.9979	5.00	29.4	0.7672	0	1,008	11,862	0.0038
BOTTOM HEAD (top)	16.17	5.00	29.4	*	0	1,042	12,617	0.0003
Support Skirt #1	0	4.33	29.4	0.2974	0	1,098	14,059	0.0001
*Moment of Inertia I varies over the length of the component								

Wind Pressure (WP) Calculations

Gust Factor (G^-) Calculations

$Kz = 2.01 * (Z/Zg)^{2/\alpha}$
$= 2.01 * (Z/1{,}200.00)^{0.2857}$
$qz = 0.00256 * Kz * Kzt * Kd * V^2$
$= 0.00256 * Kz * 1.0000 * 0.9500 * 115.0000^2$
$= 32.1632 * Kz$
$WP = 0.6 * \max[\, qz * G * Cf,\ 16\ lb/ft^2\,]$
$= 0.6 * \max[\, qz * G * 0.7000,\ 16\ lb/ft^2\,]$

Design Wind Pressures							
Height Z (')	Kz	qz (psf)	WP (psf)				
			Operating	Empty	Hydrotest New	Hydrotest Corroded	Vacuum
15.0	0.5747	18.48	9.60	9.60	N.A.	N.A.	N.A.
20.0	0.6240	20.07	9.60	9.60	N.A.	N.A.	N.A.
25.0	0.6650	21.39	9.60	9.60	N.A.	N.A.	N.A.
Design Wind Force determined from: F = Pressure * Af , where Af is the projected area.							

Gust Factor Calculations

Operating, Corroded
Empty, Corroded

Gust Factor Calculations: Operating, Corroded

Vessel is considered a rigid structure as n_1 = 19.9582 Hz ≥ 1 Hz.

z^- = max[0.60 * $\underline{h}$, z_{min}]
= max[0.60 * 23.2628 , 30.0000]
= 30.0000
I_{z^-} = $\underline{c}$ * (33 / z^-)$^{1/6}$
= 0.3000 * (33 / 30.0000)$^{1/6}$
= 0.3048
L_{z^-} = $\underline{l}$ * (z^- / 33)$^{\underline{ep}}$
= 320.0000 * (30.0000 / 33)$^{0.3333}$
= 309.9934
Q = Sqr(1 / (1 + 0.63 * (($\underline{b}$ + $\underline{h}$) / L_{z^-})$^{0.63}$))
= Sqr(1 / (1 + 0.63 * ((4.0000 + 23.2628) / 309.9934)$^{0.63}$))
= 0.9381
G = 0.925 * (1 + 1.7 * g_Q * I_{z^-} * Q) / (1 + 1.7 * g_v * I_{z^-})
= 0.925 * (1 + 1.7 * 3.40* 0.3048 * 0.9381) / (1 + 1.7 * 3.40 * 0.3048)
= 0.8885

Gust Factor Calculations: Empty, Corroded

Vessel is considered a rigid structure as n_1 = 20.1052 Hz ≥ 1 Hz.

z^- = max[0.60 * $\underline{h}$, z_{min}]
= max[0.60 * 23.2628 , 30.0000]
= 30.0000
I_{z^-} = $\underline{c}$ * (33 / z^-)$^{1/6}$
= 0.3000 * (33 / 30.0000)$^{1/6}$
= 0.3048
L_{z^-} = $\underline{l}$ * (z^- / 33)$^{\underline{ep}}$
= 320.0000 * (30.0000 / 33)$^{0.3333}$
= 309.9934
Q = Sqr(1 / (1 + 0.63 * (($\underline{b}$ + $\underline{h}$) / L_{z^-})$^{0.63}$))

$= \text{Sqr}(1 / (1 + 0.63 * ((4.0000 + 23.2628) / 309.9934)^{0.63}))$

$= 0.9381$

G $= 0.925 * (1 + 1.7 * g_Q * I_{z^-} * Q) / (1 + 1.7 * g_v * I_{z^-})$

$= 0.925 * (1 + 1.7 * 3.40 * 0.3048 * 0.9381) / (1 + 1.7 * 3.40 * 0.3048)$

$= 0.8885$

Table Lookup Values	
$\alpha = 7.0000$, $z_g = 1{,}200.00$ ft	[Table 26.9-1, page 256]
c = 0.3000, l = 320.0000, ep = 0.3333	[Table 26.9-1, page 256]
$a^- = 0.2500$, $b^- = 0.4500$	[Table 26.9-1, page 256]
$z_{min} = 30.0000$ ft	[Table 26.9-1, page 256]
$g_Q = 3.40$	[26.9.4 page 254]
$g_v = 3.40$	[26.9.4 page 254]

Seismic Code

Building Code: ASCE 7-10 ground supported		
Site Class		C
Importance Factor, I_e		1.0000
Spectral Response Acceleration at short period (% g), S_s		75.00%
Spectral Response Acceleration at period of 1 sec (% g), S_1		75.00%
Response Modification Coeficient from Table 15.4-2, R		3.0000
Acceleration-based Site Coefficient, F_a		1.1000
Velocity-based Site Coefficient, F_v		1.3000
Long-period Transition Period, T_L		12.0000
Redundancy factor, ρ		1.0000
Risk Category (Table 1.5-1)		III
User Defined Vertical Accelerations Considered		No
Hazardous, toxic, or explosive contents		No
Vessel Characteristics		
Height		23.2628 ft
Weight	Operating, Corroded	8,856 lb
	Empty, Corroded	5,150 lb
Period of Vibration Calculation		
Fundamental Period, T	Operating, Corroded	0.050 sec (f = 20.0 Hz)
	Empty, Corroded	0.050 sec (f = 20.1 Hz)

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

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

W_i is the weight of the i^{th} lumped mass, and
y_i is its deflection when the system is treated as a cantilever beam.

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

Seismic Shear Reports:

Operating, Corroded
Empty, Corroded
Base Shear Calculations

Seismic Shear Report: Operating, Corroded					
Component	**Elevation of Bottom above Base (in)**	**Elastic Modulus E (10^6 psi)**	**Inertia I (ft^4)**	**Seismic Shear at Bottom (lb_f)**	**Bending Moment at Bottom (lb_f-ft)**
TOP HEAD	264.9979	29.0	*	103	74
SHELL RG 2	144.9979	29.0	0.7672	592	3,856
SHELL RG 1	24.9979	29.0	0.7672	999	12,645
BOTTOM HEAD (top)	16.17	29.0	*	1,017	13,388
Support Skirt #1	0	29.0	0.2974	1,023	14,764
*Moment of Inertia I varies over the length of the component					

Seismic Shear Report: Empty, Corroded					
Component	**Elevation of Bottom above Base (in)**	**Elastic Modulus E (10^6 psi)**	**Inertia I (ft^4)**	**Seismic Shear at Bottom (lb_f)**	**Bending Moment at Bottom (lb_f-ft)**
TOP HEAD	264.9979	29.4	*	75	55
SHELL RG 2	144.9979	29.4	0.7672	429	2,816
SHELL RG 1	24.9979	29.4	0.7672	589	9,194
BOTTOM HEAD (top)	16.17	29.4	*	592	9,628
Support Skirt #1	0	29.4	0.2974	595	10,429
*Moment of Inertia I varies over the length of the component					

11.4.3: Maximum considered earthquake spectral response acceleration

The maximum considered earthquake spectral response acceleration at short period, S_{MS}
$S_{MS} = F_a * S_s = 1.1000 * 75.00 / 100 = 0.8250$
The maximum considered earthquake spectral response acceleration at 1 s period, S_{M1}
$S_{M1} = F_v * S_1 = 1.3000 * 75.00 / 100 = 0.9750$

11.4.4: Design spectral response acceleration parameters

Design earthquake spectral response acceleration at short period, S_{DS}
$S_{DS} = 2 / 3 * S_{MS} = 2 / 3 * 0.8250 = 0.5500$

Design earthquake spectral response acceleration at 1 s period, S_{D1}
$S_{D1} = 2 / 3 * S_{M1} = 2 / 3 * 0.9750 = 0.6500$

11.6 Seismic Design Category

The Risk Category is III.
The mapped spectral response acceleration parameter at 1-s period, S_1 is 75.00.
This vessel is assigned to Seismic Design Category E.

12.4.2.3: Seismic Load Combinations: Vertical Term

Factor is applied to dead load.

Compressive Side: $= 1.0 + 0.14 * S_{DS}$
$= 1.0 + 0.14 * 0.5500$
$= 1.0770$
Tensile Side: $= 0.6 - 0.14 * S_{DS}$
$= 0.6 - 0.14 * 0.5500$
$= 0.5230$

Base Shear Calculations

Operating, Corroded
Empty, Corroded

Base Shear Calculations: Operating, Corroded

Paragraph 15.4.2: $\underline{I} < 0.06$, so:
$V = 0.30 * \underline{S_{DS}} * \underline{W} * \underline{I_e}$
$= 0.30 * 0.5500 * 8,855.5361 * 1.0000$
$= 1,461.16$ lb

12.4.2.1 Seismic Load Combinations: Horizontal Seismic Load Effect, E_h

$Q_E = V$
$E_h = 0.7 * \rho * Q_E$ (Only 70% of seismic load considered as per Section 2.4.1)
$= 0.7 * 1.0000 * 1,461.16$
$= 1,022.81$ lb

Base Shear Calculations: Empty, Corroded

Paragraph 15.4.2: $\underline{I} < 0.06$, so:
$V = 0.30 * \underline{S_{DS}} * \underline{W} * \underline{I_e}$
$= 0.30 * 0.5500 * 5,150.0630 * 1.0000$
$= 849.76$ lb

12.4.2.1 Seismic Load Combinations: Horizontal Seismic Load Effect, E_h

$Q_E = V$
$E_h = 0.7 * \rho * Q_E$ (Only 70% of seismic load considered as per Section 2.4.1)
$= 0.7 * 1.0000 * 849.76$
$= 594.83$ lb

TOP HEAD

ASME Section VIII Division 1, 2017 Edition				
Component		Ellipsoidal Head		
Material		SA-516 70 (II-D p. 18, ln. 33)		
Attached To		SHELL RG 2		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		250	150	-20
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Test horizontal		1.71	47.375	1
Dimensions				
Outer Diameter		48"		
Head Ratio		2		
Minimum Thickness		0.3125"		
Corrosion	**Inner**	0"		
	Outer	0"		
Length L_{sf}		2"		
Nominal Thickness t_{sf}		0.375"		
Weight and Capacity				
		Weight (lb)[1]		**Capacity (US gal)[1]**
New		260.36		75.43
Corroded		260.36		75.43
Radiography				
Category A joints		Seamless No RT		
Head to shell seam		Spot UW-11(a)(5)(b) Type 1		

[1] includes straight flange

Results Summary	
Governing condition	internal pressure
Minimum thickness per UG-16	0.0625" + 0" = 0.0625"
Design thickness due to internal pressure (t)	0.2967"
Straight Flange governs MDMT	-40.4°F

Factor K		
$K = (1/6)*[2 + (D / (2*h))^2]$		
Corroded	$K = (1/6)*[2 + (47.375 / (2*11.8438))^2]$	1
New	$K = (1/6)*[2 + (47.375 / (2*11.8438))^2]$	1

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

$t = P*D_o*K / (2*S*E + 2*P*(K - 0.1)) + Corrosion$
$= 250*48*1 / (2*20,000*1 + 2*250*(1 - 0.1)) + 0$
$= \underline{0.2967}$"

% Extreme fiber elongation - UCS-79(d)

$EFE = (75*t / R_f)*(1 - R_f / R_o)$
$= (75*0.375 / 8.2413)*(1 - 8.2413 / \infty)$
$= 3.4127\%$

The extreme fiber elongation does not exceed 5%.

Straight Flange on TOP HEAD

ASME Section VIII Division 1, 2017 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, ln. 33)		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		250	150	-20
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Test horizontal		1.71	47.3125	1
Dimensions				
Outer Diameter		48"		
Length		2"		
Nominal Thickness		0.375"		
Corrosion	**Inner**	0"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)	**Capacity (US gal)**	
New		31.76	15.18	
Corroded		31.76	15.18	
Radiography				
Longitudinal seam		Seamless No RT		
Bottom Circumferential seam		Spot UW-11(a)(5)(b) Type 1		

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	0.0625" + 0" = 0.0625"
Design thickness due to internal pressure (t)	0.2986"
Design thickness due to combined loadings + corrosion	0.1444"
Rated MDMT	-40.4 °F

UCS-66 Material Toughness Requirements	
Governing thickness, t_g =	0.375"
Exemption temperature from Fig UCS-66 Curve B =	-20°F
t_r = 250*24 / (20,000*1 + 0.4*250) =	0.2985"
Stress ratio = t_r*E* / (t_n - c) = 0.2985*1 / (0.375 - 0) =	0.796
Reduction in MDMT, T_R from Fig UCS-66.1 =	20.4°F
MDMT = max[MDMT - T_R, -55] = max[-20 - 20.4 , -55] =	-40.4°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

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

t = $P*R_o / (S*E + 0.40*P)$ + Corrosion
= 250*24 / (20,000*1.00 + 0.40*250) + 0
= 0.2986"

% Extreme fiber elongation - UCS-79(d)

EFE = $(50*t / R_f)*(1 - R_f / R_o)$
= $(50*0.375 / 23.8125)*(1 - 23.8125 / \infty)$
= 0.7874%

The extreme fiber elongation does not exceed 5%.

Thickness Required Due to Pressure + External Loads								
Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S_t	S_c					
Operating, Hot & Corroded	250	20,000	14,898	150	0	Wind	0.1444	0.1443
						Seismic	0.1444	0.1443
Operating, Hot & New	250	20,000	14,898	150	0	Wind	0.1444	0.1443
						Seismic	0.1444	0.1443
Hot Shut Down, Corroded	0	20,000	14,898	150	0	Wind	0.0001	0.0001
						Seismic	0	0.0002
Hot Shut Down, New	0	20,000	14,898	150	0	Wind	0.0001	0.0001
						Seismic	0	0.0002
Empty, Corroded	0	20,000	14,898	70	0	Wind	0.0001	0.0001
						Seismic	0	0.0001
Empty, New	0	20,000	14,898	70	0	Wind	0.0001	0.0001
						Seismic	0	0.0001
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	20,000	14,898	150	0	Weight	0.0001	0.0001

Allowable Compressive Stress, Hot and Corroded- S_{cHC}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$
= 0.001953

B = 14,898 psi

S = 20,000 / 1.00 = 20,000 psi

S_{cHC} = min(B, S) = 14,898 psi

Allowable Compressive Stress, Hot and New- S_{cHN}

S_{cHN} = S_{cHC}
= 14,898 psi

Allowable Compressive Stress, Cold and New- S_{cCN}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$
= 0.001953

B = 14,898 psi

S = 20,000 / 1.00 = 20,000 psi

S_{cCN} = min(B, S) = 14,898 psi

Allowable Compressive Stress, Cold and Corroded- S_{cCC}

S_{cCC} = S_{cCN}
= 14,898 psi

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$

$= 0.001953$

B $= 14,898$ psi

S $= 20,000 / 1.00 = 20,000$ psi

$S_{cVC} = \min(B, S) = \underline{14,898 \text{ psi}}$

Operating, Hot & Corroded, Wind, Bottom Seam

$t_p = P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)

$= 250*23.625 / (2*20,000*1.20*0.85 + 0.40*|250|)$

$= 0.1444"$

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 360 / (\pi*23.8125^2*20,000*1.20*0.85)$

$= 0"$

$t_w = 0.6*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.60*306.8 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0001"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0.1444 + 0 - (0.0001)$

$= \underline{0.1444"}$

$t_{wc} = W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 306.8 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0001"$

$t_c = |t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

$= |0 + (0.0001) - (0.1444)|$

$= \underline{0.1443"}$

Operating, Hot & New, Wind, Bottom Seam

$t_p = P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)

$= 250*23.625 / (2*20,000*1.20*0.85 + 0.40*|250|)$

$= 0.1444"$

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 360 / (\pi*23.8125^2*20,000*1.20*0.85)$

$= 0"$

$t_w = 0.6*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.60*306.8 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0001"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0.1444 + 0 - (0.0001)$

$= \underline{0.1444"}$

$t_{wc} = W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 306.8 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0001"$

$t_c = |t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

= |0 + (0.0001) - (0.1444)|
= 0.1443"

Hot Shut Down, Corroded, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = M / (π*R_m^2*S_c*K_s) (bending)
= 360 / (π*23.8125^2*14,898.49*1.20)
= 0"

t_w = 0.6*W / (2*π*R_m*S_c*K_s) (Weight)
= 0.60*306.8 / (2*π*23.8125*14,898.49*1.20)
= 0.0001"

t_t = |t_p + t_m - t_w| (total, net compressive)
= |0 + 0 - (0.0001)|
= 0.0001"

t_{wc} = W / (2*π*R_m*S_c*K_s) (Weight)
= 306.8 / (2*π*23.8125*14,898.49*1.20)
= 0.0001"

t_c = t_{mc} + t_{wc} - t_{pc} (total required, compressive)
= 0 + (0.0001) - (0)
= 0.0001"

Hot Shut Down, New, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = M / (π*R_m^2*S_c*K_s) (bending)
= 360 / (π*23.8125^2*14,898.49*1.20)
= 0"

t_w = 0.6*W / (2*π*R_m*S_c*K_s) (Weight)
= 0.60*306.8 / (2*π*23.8125*14,898.49*1.20)
= 0.0001"

t_t = |t_p + t_m - t_w| (total, net compressive)
= |0 + 0 - (0.0001)|
= 0.0001"

t_{wc} = W / (2*π*R_m*S_c*K_s) (Weight)
= 306.8 / (2*π*23.8125*14,898.49*1.20)
= 0.0001"

t_c = t_{mc} + t_{wc} - t_{pc} (total required, compressive)
= 0 + (0.0001) - (0)
= 0.0001"

Empty, Corroded, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = M / (π*R_m^2*S_c*K_s) (bending)
= 360 / (π*23.8125^2*14,898.49*1.20)
= 0"

t_w = 0.6*W / (2*π*R_m*S_c*K_s) (Weight)
= 0.60*306.8 / (2*π*23.8125*14,898.49*1.20)

$= 0.0001"$

$t_t = |t_p + t_m - t_w|$ (total, net compressive)
$= |0 + 0 - (0.0001)|$
$= \underline{0.0001"}$

$t_{wc} = W / (2*\pi*R_m*S_c*K_s)$ (Weight)
$= 306.8 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0001"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0 + (0.0001) - (0)$
$= \underline{0.0001"}$

Empty, New, Wind, Bottom Seam

$t_p = 0"$ (Pressure)
$t_m = M / (\pi*R_m^2*S_c*K_s)$ (bending)
$= 360 / (\pi*23.8125^2*14,898.49*1.20)$
$= 0"$

$t_w = 0.6*W / (2*\pi*R_m*S_c*K_s)$ (Weight)
$= 0.60*306.8 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0001"$

$t_t = |t_p + t_m - t_w|$ (total, net compressive)
$= |0 + 0 - (0.0001)|$
$= \underline{0.0001"}$

$t_{wc} = W / (2*\pi*R_m*S_c*K_s)$ (Weight)
$= 306.8 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0001"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0 + (0.0001) - (0)$
$= \underline{0.0001"}$

Hot Shut Down, Corroded, Weight & Eccentric Moments Only, Bottom Seam

$t_p = 0"$ (Pressure)
$t_m = M / (\pi*R_m^2*S_c*K_s)$ (bending)
$= 55 / (\pi*23.8125^2*14,898.49*1.00)$
$= 0"$

$t_w = W / (2*\pi*R_m*S_c*K_s)$ (Weight)
$= 306.8 / (2*\pi*23.8125*14,898.49*1.00)$
$= 0.0001"$

$t_t = |t_p + t_m - t_w|$ (total, net compressive)
$= |0 + 0 - (0.0001)|$
$= \underline{0.0001"}$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0 + (0.0001) - (0)$
$= \underline{0.0001"}$

Operating, Hot & Corroded, Seismic, Bottom Seam

t_p = $P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)
= $250*23.625 / (2*20{,}000*1.20*0.85 + 0.40*|250|)$
= 0.1444"

t_m = $M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)
= $890 / (\pi*23.8125^2*20{,}000*1.20*0.85)$
= 0"

t_w = $(0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
= $0.52*306.8 / (2*\pi*23.8125*20{,}000*1.20*0.85)$
= 0.0001"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= $0.1444 + 0 - (0.0001)$
= 0.1444"

t_{wc} = $(1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
= $1.08*306.8 / (2*\pi*23.8125*20{,}000*1.20*0.85)$
= 0.0001"

t_c = $|t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)
= $|0 + (0.0001) - (0.1444)|$
= 0.1443"

Operating, Hot & New, Seismic, Bottom Seam

t_p = $P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)
= $250*23.625 / (2*20{,}000*1.20*0.85 + 0.40*|250|)$
= 0.1444"

t_m = $M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)
= $890 / (\pi*23.8125^2*20{,}000*1.20*0.85)$
= 0"

t_w = $(0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
= $0.52*306.8 / (2*\pi*23.8125*20{,}000*1.20*0.85)$
= 0.0001"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= $0.1444 + 0 - (0.0001)$
= 0.1444"

t_{wc} = $(1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
= $1.08*306.8 / (2*\pi*23.8125*20{,}000*1.20*0.85)$
= 0.0001"

t_c = $|t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)
= $|0 + (0.0001) - (0.1444)|$
= 0.1443"

Hot Shut Down, Corroded, Seismic, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)
= $890 / (\pi * 23.8125^2 * 14{,}898.49 * 1.20)$
= 0"

t_w = $(0.6 - 0.14 * S_{DS}) * W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $0.52 * 306.8 / (2 * \pi * 23.8125 * 14{,}898.49 * 1.20)$
= 0.0001"

t_t = $|t_p + t_m - t_w|$ (total, net compressive)
= $|0 + 0 - (0.0001)|$
= <u>0"</u>

t_{wc} = $(1 + 0.14 * S_{DS}) * W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $1.08 * 306.8 / (2 * \pi * 23.8125 * 14{,}898.49 * 1.20)$
= 0.0001"

t_c = $t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
= $0 + (0.0001) - (0)$
= <u>0.0002"</u>

Hot Shut Down, New, Seismic, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)
= $890 / (\pi * 23.8125^2 * 14{,}898.49 * 1.20)$
= 0"

t_w = $(0.6 - 0.14 * S_{DS}) * W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $0.52 * 306.8 / (2 * \pi * 23.8125 * 14{,}898.49 * 1.20)$
= 0.0001"

t_t = $|t_p + t_m - t_w|$ (total, net compressive)
= $|0 + 0 - (0.0001)|$
= <u>0"</u>

t_{wc} = $(1 + 0.14 * S_{DS}) * W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $1.08 * 306.8 / (2 * \pi * 23.8125 * 14{,}898.49 * 1.20)$
= 0.0001"

t_c = $t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
= $0 + (0.0001) - (0)$
= <u>0.0002"</u>

Empty, Corroded, Seismic, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)
= $659 / (\pi * 23.8125^2 * 14{,}898.49 * 1.20)$
= 0"

t_w = $(0.6 - 0.14 * S_{DS}) * W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $0.52 * 306.8 / (2 * \pi * 23.8125 * 14{,}898.49 * 1.20)$
= 0.0001"

t_t = $|t_p + t_m - t_w|$ (total, net compressive)

$= |0 + 0 - (0.0001)|$

$= \underline{0"}$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)

$= 1.08*306.8 / (2*\pi*23.8125*14,898.49*1.20)$

$= 0.0001"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)

$= 0 + (0.0001) - (0)$

$= \underline{0.0001"}$

Empty, New, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)

$t_m = M / (\pi*R_m^2*S_c*K_s)$ (bending)

$= 659 / (\pi*23.8125^2*14,898.49*1.20)$

$= 0"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)

$= 0.52*306.8 / (2*\pi*23.8125*14,898.49*1.20)$

$= 0.0001"$

$t_t = |t_p + t_m - t_w|$ (total, net compressive)

$= |0 + 0 - (0.0001)|$

$= \underline{0"}$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)

$= 1.08*306.8 / (2*\pi*23.8125*14,898.49*1.20)$

$= 0.0001"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)

$= 0 + (0.0001) - (0)$

$= \underline{0.0001"}$

SHELL RG 2

ASME Section VIII Division 1, 2017 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, ln. 33)		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		250	150	-20
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Test horizontal		1.71	47.3125	1
Dimensions				
Outer Diameter		48"		
Length		120"		
Nominal Thickness		0.375"		
Corrosion	**Inner**	0"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)	**Capacity (US gal)**	
New		1,900.98	910.88	
Corroded		1,900.98	910.88	
Radiography				
Longitudinal seam		Spot UW-11(b) Type 1		
Top Circumferential seam		Spot UW-11(a)(5)(b) Type 1		
Bottom Circumferential seam		Spot UW-11(a)(5)(b) Type 1		

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	0.0625" + 0" = 0.0625"
Design thickness due to internal pressure (t)	0.3509"
Design thickness due to combined loadings + corrosion	0.1453"
Rated MDMT	-40.5 °F

UCS-66 Material Toughness Requirements	
Governing thickness, t_g =	0.375"
Exemption temperature from Fig UCS-66 Curve B =	-20°F
t_r = 250*24 / (20,000*0.85 + 0.4*250) =	0.3509"
Stress ratio = t_r*E* / (t_n - c) = 0.3509*0.85 / (0.375 - 0) =	0.7953
Reduction in MDMT, T_R from Fig UCS-66.1 =	20.5°F
MDMT = max[MDMT - T_R, -55] = max[-20 - 20.5 , -55] =	-40.5°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

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

t = P*R_o / (S*E + 0.40*P) + Corrosion
= 250*24 / (20,000*0.85 + 0.40*250) + 0
= 0.3509"

% Extreme fiber elongation - UCS-79(d)

EFE = (50*t / R_f)*(1 - R_f / R_o)
= (50*0.375 / 23.8125)*(1 - 23.8125 / ∞)
= 0.7874%

The extreme fiber elongation does not exceed 5%.

Thickness Required Due to Pressure + External Loads								
Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S_t	S_c					
Operating, Hot & Corroded	250	20,000	14,898	150	0	Wind	0.145	0.1427
						Seismic	0.1453	0.1423
Operating, Hot & New	250	20,000	14,898	150	0	Wind	0.145	0.1427
						Seismic	0.1453	0.1423
Hot Shut Down, Corroded	0	20,000	14,898	150	0	Wind	0.0005	0.002
						Seismic	0.0009	0.0024
Hot Shut Down, New	0	20,000	14,898	150	0	Wind	0.0005	0.002
						Seismic	0.0009	0.0024
Empty, Corroded	0	20,000	14,898	70	0	Wind	0.0005	0.002
						Seismic	0.0005	0.002
Empty, New	0	20,000	14,898	70	0	Wind	0.0005	0.002
						Seismic	0.0005	0.002
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	20,000	14,898	150	0	Weight	0.001	0.001

Allowable Compressive Stress, Hot and Corroded- S_{cHC}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$
= 0.001953

B = 14,898 psi

S = 20,000 / 1.00 = 20,000 psi

S_{cHC} = min(B, S) = 14,898 psi

Allowable Compressive Stress, Hot and New- S_{cHN}

S_{cHN} = S_{cHC}
= 14,898 psi

Allowable Compressive Stress, Cold and New- S_{cCN}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$
= 0.001953

B = 14,898 psi

S = 20,000 / 1.00 = 20,000 psi

S_{cCN} = min(B, S) = 14,898 psi

Allowable Compressive Stress, Cold and Corroded- S_{cCC}

S_{cCC} = S_{cCN}
= 14,898 psi

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$

$= 0.001953$

B $= 14,898$ psi

S $= 20,000 / 1.00 = 20,000$ psi

$S_{cVC} = \min(B, S) = \underline{14,898 \text{ psi}}$

Operating, Hot & Corroded, Wind, Bottom Seam

$t_p = P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)

$= 250*23.625 / (2*20,000*1.20*0.85 + 0.40*|250|)$

$= 0.1444"$

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 35,975 / (\pi*23.8125^2*20,000*1.20*0.85)$

$= 0.001"$

$t_w = 0.6*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.60*2,246.4 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0004"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0.1444 + 0.001 - (0.0004)$

$= \underline{0.145"}$

$t_{wc} = W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 2,246.4 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0007"$

$t_c = |t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

$= |0.001 + (0.0007) - (0.1444)|$

$= \underline{0.1427"}$

Operating, Hot & New, Wind, Bottom Seam

$t_p = P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)

$= 250*23.625 / (2*20,000*1.20*0.85 + 0.40*|250|)$

$= 0.1444"$

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 35,975 / (\pi*23.8125^2*20,000*1.20*0.85)$

$= 0.001"$

$t_w = 0.6*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.60*2,246.4 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0004"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0.1444 + 0.001 - (0.0004)$

$= \underline{0.145"}$

$t_{wc} = W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 2,246.4 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0007"$

$t_c = |t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

= |0.001 + (0.0007) - (0.1444)|
= 0.1427"

Hot Shut Down, Corroded, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = M / (π*R_m^2*S_t*K_s*E_c) (bending)
= 35,975 / (π*23.8125^2*20,000*1.20*0.85)
= 0.001"

t_w = 0.6*W / (2*π*R_m*S_t*K_s*E_c) (Weight)
= 0.60*2,246.4 / (2*π*23.8125*20,000*1.20*0.85)
= 0.0004"

t_t = t_p + t_m - t_w (total required, tensile)
= 0 + 0.001 - (0.0004)
= 0.0005"

t_{mc} = M / (π*R_m^2*S_c*K_s) (bending)
= 35,975 / (π*23.8125^2*14,898.49*1.20)
= 0.0011"

t_{wc} = W / (2*π*R_m*S_c*K_s) (Weight)
= 2,246.4 / (2*π*23.8125*14,898.49*1.20)
= 0.0008"

t_c = t_{mc} + t_{wc} - t_{pc} (total required, compressive)
= 0.0011 + (0.0008) - (0)
= 0.002"

Hot Shut Down, New, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = M / (π*R_m^2*S_t*K_s*E_c) (bending)
= 35,975 / (π*23.8125^2*20,000*1.20*0.85)
= 0.001"

t_w = 0.6*W / (2*π*R_m*S_t*K_s*E_c) (Weight)
= 0.60*2,246.4 / (2*π*23.8125*20,000*1.20*0.85)
= 0.0004"

t_t = t_p + t_m - t_w (total required, tensile)
= 0 + 0.001 - (0.0004)
= 0.0005"

t_{mc} = M / (π*R_m^2*S_c*K_s) (bending)
= 35,975 / (π*23.8125^2*14,898.49*1.20)
= 0.0011"

t_{wc} = W / (2*π*R_m*S_c*K_s) (Weight)
= 2,246.4 / (2*π*23.8125*14,898.49*1.20)
= 0.0008"

t_c = t_{mc} + t_{wc} - t_{pc} (total required, compressive)
= 0.0011 + (0.0008) - (0)
= 0.002"

Empty, Corroded, Wind, Bottom Seam

t_p = 0" (Pressure)

$t_m = M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)

$= 35,975 / (\pi * 23.8125^2 * 20,000 * 1.20 * 0.85)$

= 0.001"

$t_w = 0.6 * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)

$= 0.60 * 2,246.4 / (2 * \pi * 23.8125 * 20,000 * 1.20 * 0.85)$

= 0.0004"

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0 + 0.001 - (0.0004)$

= 0.0005"

$t_{mc} = M / (\pi * R_m^2 * S_c * K_s)$ (bending)

$= 35,975 / (\pi * 23.8125^2 * 14,898.49 * 1.20)$

= 0.0011"

$t_{wc} = W / (2 * \pi * R_m * S_c * K_s)$ (Weight)

$= 2,246.4 / (2 * \pi * 23.8125 * 14,898.49 * 1.20)$

= 0.0008"

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)

$= 0.0011 + (0.0008) - (0)$

= 0.002"

Empty, New, Wind, Bottom Seam

t_p = 0" (Pressure)

$t_m = M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)

$= 35,975 / (\pi * 23.8125^2 * 20,000 * 1.20 * 0.85)$

= 0.001"

$t_w = 0.6 * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)

$= 0.60 * 2,246.4 / (2 * \pi * 23.8125 * 20,000 * 1.20 * 0.85)$

= 0.0004"

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0 + 0.001 - (0.0004)$

= 0.0005"

$t_{mc} = M / (\pi * R_m^2 * S_c * K_s)$ (bending)

$= 35,975 / (\pi * 23.8125^2 * 14,898.49 * 1.20)$

= 0.0011"

$t_{wc} = W / (2 * \pi * R_m * S_c * K_s)$ (Weight)

$= 2,246.4 / (2 * \pi * 23.8125 * 14,898.49 * 1.20)$

= 0.0008"

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)

$= 0.0011 + (0.0008) - (0)$

= 0.002"

Hot Shut Down, Corroded, Weight & Eccentric Moments Only, Bottom Seam

t_p = 0" (Pressure)

$t_m = M / (\pi * R_m^2 * S_c * K_s)$ (bending)

$= 1{,}078 / (\pi*23.8125^2*14{,}898.49*1.00)$

$= 0"$

$t_w = W / (2*\pi*R_m*S_c*K_s)$ (Weight)

$= 2{,}246.4 / (2*\pi*23.8125*14{,}898.49*1.00)$

$= 0.001"$

$t_t = |t_p + t_m - t_w|$ (total, net compressive)

$= |0 + 0 - (0.001)|$

$= \underline{0.001"}$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)

$= 0 + (0.001) - (0)$

$= \underline{0.001"}$

Operating, Hot & Corroded, Seismic, Bottom Seam

$t_p = P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)

$= 250*23.625 / (2*20{,}000*1.20*0.85 + 0.40*|250|)$

$= 0.1444"$

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 46{,}276 / (\pi*23.8125^2*20{,}000*1.20*0.85)$

$= 0.0013"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.52*2{,}246.4 / (2*\pi*23.8125*20{,}000*1.20*0.85)$

$= 0.0004"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0.1444 + 0.0013 - (0.0004)$

$= \underline{0.1453"}$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 1.08*2{,}246.4 / (2*\pi*23.8125*20{,}000*1.20*0.85)$

$= 0.0008"$

$t_c = |t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

$= |0.0013 + (0.0008) - (0.1444)|$

$= \underline{0.1423"}$

Operating, Hot & New, Seismic, Bottom Seam

$t_p = P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)

$= 250*23.625 / (2*20{,}000*1.20*0.85 + 0.40*|250|)$

$= 0.1444"$

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 46{,}276 / (\pi*23.8125^2*20{,}000*1.20*0.85)$

$= 0.0013"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.52*2{,}246.4 / (2*\pi*23.8125*20{,}000*1.20*0.85)$

$= 0.0004"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0.1444 + 0.0013 - (0.0004)$

$= \underline{0.1453"}$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 1.08*2,246.4 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0008"$

$t_c = |t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

$= |0.0013 + (0.0008) - (0.1444)|$

$= \underline{0.1423"}$

Hot Shut Down, Corroded, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 46,276 / (\pi*23.8125^2*20,000*1.20*0.85)$

$= 0.0013"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.52*2,246.4 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0004"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0 + 0.0013 - (0.0004)$

$= \underline{0.0009"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)

$= 46,276 / (\pi*23.8125^2*14,898.49*1.20)$

$= 0.0015"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)

$= 1.08*2,246.4 / (2*\pi*23.8125*14,898.49*1.20)$

$= 0.0009"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)

$= 0.0015 + (0.0009) - (0)$

$= \underline{0.0024"}$

Hot Shut Down, New, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 46,276 / (\pi*23.8125^2*20,000*1.20*0.85)$

$= 0.0013"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.52*2,246.4 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0004"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0 + 0.0013 - (0.0004)$

$= \underline{0.0009"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)

$= 46,276 / (\pi*23.8125^2*14,898.49*1.20)$

$= 0.0015"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)

$= 1.08*2,246.4 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0009"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0.0015 + (0.0009) - (0)$
$= \underline{0.0024"}$

Empty, Corroded, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)
$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)
$= 33,793 / (\pi*23.8125^2*20,000*1.20*0.85)$
$= 0.0009"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
$= 0.52*2,246.4 / (2*\pi*23.8125*20,000*1.20*0.85)$
$= 0.0004"$

$t_t = t_p + t_m - t_w$ (total required, tensile)
$= 0 + 0.0009 - (0.0004)$
$= \underline{0.0005"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)
$= 33,793 / (\pi*23.8125^2*14,898.49*1.20)$
$= 0.0011"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)
$= 1.08*2,246.4 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0009"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0.0011 + (0.0009) - (0)$
$= \underline{0.002"}$

Empty, New, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)
$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)
$= 33,793 / (\pi*23.8125^2*20,000*1.20*0.85)$
$= 0.0009"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
$= 0.52*2,246.4 / (2*\pi*23.8125*20,000*1.20*0.85)$
$= 0.0004"$

$t_t = t_p + t_m - t_w$ (total required, tensile)
$= 0 + 0.0009 - (0.0004)$
$= \underline{0.0005"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)
$= 33,793 / (\pi*23.8125^2*14,898.49*1.20)$
$= 0.0011"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)
$= 1.08*2,246.4 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0009"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0.0011 + (0.0009) - (0)$

= 0.002"

SHELL RG 1

ASME Section VIII Division 1, 2017 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, ln. 33)		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		250	150	-20
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		1.73	48	1
Test horizontal		1.71	47.3125	1
Dimensions				
Outer Diameter		48"		
Length		120"		
Nominal Thickness		0.375"		
Corrosion	**Inner**	0"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		**Capacity (US gal)**
New		1,874.07		910.88
Corroded		1,874.07		910.88
Radiography				
Longitudinal seam		Spot UW-11(b) Type 1		
Top Circumferential seam		Spot UW-11(a)(5)(b) Type 1		
Bottom Circumferential seam		Spot UW-11(a)(5)(b) Type 1		

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	0.0625" + 0" = 0.0625"
Design thickness due to internal pressure (t)	0.3533"
Design thickness due to combined loadings + corrosion	0.1478"
Rated MDMT	-39.9 °F

UCS-66 Material Toughness Requirements	
Governing thickness, t_g =	0.375"
Exemption temperature from Fig UCS-66 Curve B =	-20°F
t_r = 251.73*24 / (20,000*0.85 + 0.4*251.73) =	0.3533"
Stress ratio = t_r*E* / (t_n - c) = 0.3533*0.85 / (0.375 - 0) =	0.8008
Reduction in MDMT, T_R from Fig UCS-66.1 =	19.9°F
MDMT = max[MDMT - T_R, -55] = max[-20 - 19.9 , -55] =	-39.9°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

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

t = $P*R_o / (S*E + 0.40*P)$ + Corrosion
= 251.73*24 / (20,000*0.85 + 0.40*251.73) + 0
= 0.3533"

% Extreme fiber elongation - UCS-79(d)

EFE = $(50*t / R_f)*(1 - R_f / R_o)$
= $(50*0.375 / 23.8125)*(1 - 23.8125 / \infty)$
= 0.7874%

The extreme fiber elongation does not exceed 5%.

Thickness Required Due to Pressure + External Loads								
Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S_t	S_c					
Operating, Hot & Corroded	250	20,000	14,898	150	0	Wind	0.1474	0.139
						Seismic	0.1478	0.1386
Operating, Hot & New	250	20,000	14,898	150	0	Wind	0.1474	0.139
						Seismic	0.1478	0.1386
Hot Shut Down, Corroded	0	20,000	14,898	150	0	Wind	0.003	0.0062
						Seismic	0.0034	0.0066
Hot Shut Down, New	0	20,000	14,898	150	0	Wind	0.003	0.0062
						Seismic	0.0034	0.0066
Empty, Corroded	0	20,000	14,898	70	0	Wind	0.003	0.0062
						Seismic	0.0022	0.0053
Empty, New	0	20,000	14,898	70	0	Wind	0.003	0.0062
						Seismic	0.0022	0.0053
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	20,000	14,898	150	0	Weight	0.0015	0.0027

Allowable Compressive Stress, Hot and Corroded- S_{cHC}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$
= 0.001953

B = 14,898 psi

S = 20,000 / 1.00 = 20,000 psi

S_{cHC} = min(B, S) = 14,898 psi

Allowable Compressive Stress, Hot and New- S_{cHN}

S_{cHN} = S_{cHC}
= 14,898 psi

Allowable Compressive Stress, Cold and New- S_{cCN}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$
= 0.001953

B = 14,898 psi

S = 20,000 / 1.00 = 20,000 psi

S_{cCN} = min(B, S) = 14,898 psi

Allowable Compressive Stress, Cold and Corroded- S_{cCC}

S_{cCC} = S_{cCN}
= 14,898 psi

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$

= 0.001953

B = 14,898 psi

S = 20,000 / 1.00 = 20,000 psi

S_{cVC} = min(B, S) = <u>14,898 psi</u>

<u>Operating, Hot & Corroded, Wind, Bottom Seam</u>

t_p = $P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)

= 250*23.625 / (2*20,000*1.20*0.85 + 0.40*|250|)

= 0.1444"

t_m = $M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

= 142,347 / (π*23.8125^2*20,000*1.20*0.85)

= 0.0039"

t_w = $0.6*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

= 0.60*4,638.7 / (2*π*23.8125*20,000*1.20*0.85)

= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)

= 0.1444 + 0.0039 - (0.0009)

= <u>0.1474"</u>

t_{wc} = $W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

= 4,638.7 / (2*π*23.8125*20,000*1.20*0.85)

= 0.0015"

t_c = $|t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

= |0.0039 + (0.0015) - (0.1444)|

= <u>0.139"</u>

<u>Operating, Hot & New, Wind, Bottom Seam</u>

t_p = $P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)

= 250*23.625 / (2*20,000*1.20*0.85 + 0.40*|250|)

= 0.1444"

t_m = $M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

= 142,347 / (π*23.8125^2*20,000*1.20*0.85)

= 0.0039"

t_w = $0.6*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

= 0.60*4,638.7 / (2*π*23.8125*20,000*1.20*0.85)

= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)

= 0.1444 + 0.0039 - (0.0009)

= <u>0.1474"</u>

t_{wc} = $W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

= 4,638.7 / (2*π*23.8125*20,000*1.20*0.85)

= 0.0015"

t_c = $|t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

= |0.0039 + (0.0015) - (0.1444)|
= 0.139"

Hot Shut Down, Corroded, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)
= $142,347 / (\pi * 23.8125^2 * 20,000 * 1.20 * 0.85)$
= 0.0039"

t_w = $0.6 * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)
= $0.60 * 4,638.7 / (2 * \pi * 23.8125 * 20,000 * 1.20 * 0.85)$
= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= 0 + 0.0039 - (0.0009)
= 0.003"

t_{mc} = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)
= $142,347 / (\pi * 23.8125^2 * 14,898.49 * 1.20)$
= 0.0045"

t_{wc} = $W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $4,638.7 / (2 * \pi * 23.8125 * 14,898.49 * 1.20)$
= 0.0017"

t_c = $t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
= 0.0045 + (0.0017) - (0)
= 0.0062"

Hot Shut Down, New, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)
= $142,347 / (\pi * 23.8125^2 * 20,000 * 1.20 * 0.85)$
= 0.0039"

t_w = $0.6 * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)
= $0.60 * 4,638.7 / (2 * \pi * 23.8125 * 20,000 * 1.20 * 0.85)$
= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= 0 + 0.0039 - (0.0009)
= 0.003"

t_{mc} = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)
= $142,347 / (\pi * 23.8125^2 * 14,898.49 * 1.20)$
= 0.0045"

t_{wc} = $W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $4,638.7 / (2 * \pi * 23.8125 * 14,898.49 * 1.20)$
= 0.0017"

t_c = $t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
= 0.0045 + (0.0017) - (0)
= 0.0062"

Empty, Corroded, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)
= $142,347 / (\pi * 23.8125^2 * 20,000 * 1.20 * 0.85)$
= 0.0039"

t_w = $0.6 * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)
= $0.60 * 4,638.7 / (2 * \pi * 23.8125 * 20,000 * 1.20 * 0.85)$
= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= 0 + 0.0039 - (0.0009)
= 0.003"

t_{mc} = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)
= $142,347 / (\pi * 23.8125^2 * 14,898.49 * 1.20)$
= 0.0045"

t_{wc} = $W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $4,638.7 / (2 * \pi * 23.8125 * 14,898.49 * 1.20)$
= 0.0017"

t_c = $t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
= 0.0045 + (0.0017) - (0)
= 0.0062"

Empty, New, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)
= $142,347 / (\pi * 23.8125^2 * 20,000 * 1.20 * 0.85)$
= 0.0039"

t_w = $0.6 * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)
= $0.60 * 4,638.7 / (2 * \pi * 23.8125 * 20,000 * 1.20 * 0.85)$
= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= 0 + 0.0039 - (0.0009)
= 0.003"

t_{mc} = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)
= $142,347 / (\pi * 23.8125^2 * 14,898.49 * 1.20)$
= 0.0045"

t_{wc} = $W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $4,638.7 / (2 * \pi * 23.8125 * 14,898.49 * 1.20)$
= 0.0017"

t_c = $t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
= 0.0045 + (0.0017) - (0)
= 0.0062"

Hot Shut Down, Corroded, Weight & Eccentric Moments Only, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)

$= 15{,}258 / (\pi * 23.8125^2 * 14{,}898.49 * 1.00)$

$= 0.0006"$

$t_w = W / (2 * \pi * R_m * S_c * K_s)$ (Weight)

$= 4{,}638.7 / (2 * \pi * 23.8125 * 14{,}898.49 * 1.00)$

$= 0.0021"$

$t_t = |t_p + t_m - t_w|$ (total, net compressive)

$= |0 + 0.0006 - (0.0021)|$

$= \underline{0.0015"}$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)

$= 0.0006 + (0.0021) - (0)$

$= \underline{0.0027"}$

Operating, Hot & Corroded, Seismic, Bottom Seam

$t_p = P * R / (2 * S_t * K_s * E_c + 0.40 * |P|)$ (Pressure)

$= 250 * 23.625 / (2 * 20{,}000 * 1.20 * 0.85 + 0.40 * |250|)$

$= 0.1444"$

$t_m = M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)

$= 151{,}745 / (\pi * 23.8125^2 * 20{,}000 * 1.20 * 0.85)$

$= 0.0042"$

$t_w = (0.6 - 0.14 * S_{DS}) * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)

$= 0.52 * 4{,}638.7 / (2 * \pi * 23.8125 * 20{,}000 * 1.20 * 0.85)$

$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0.1444 + 0.0042 - (0.0008)$

$= \underline{0.1478"}$

$t_{wc} = (1 + 0.14 * S_{DS}) * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)

$= 1.08 * 4{,}638.7 / (2 * \pi * 23.8125 * 20{,}000 * 1.20 * 0.85)$

$= 0.0016"$

$t_c = |t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

$= |0.0042 + (0.0016) - (0.1444)|$

$= \underline{0.1386"}$

Operating, Hot & New, Seismic, Bottom Seam

$t_p = P * R / (2 * S_t * K_s * E_c + 0.40 * |P|)$ (Pressure)

$= 250 * 23.625 / (2 * 20{,}000 * 1.20 * 0.85 + 0.40 * |250|)$

$= 0.1444"$

$t_m = M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)

$= 151{,}745 / (\pi * 23.8125^2 * 20{,}000 * 1.20 * 0.85)$

$= 0.0042"$

$t_w = (0.6 - 0.14 * S_{DS}) * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)

$= 0.52 * 4{,}638.7 / (2 * \pi * 23.8125 * 20{,}000 * 1.20 * 0.85)$

$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0.1444 + 0.0042 - (0.0008)$

$= \underline{0.1478"}$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 1.08*4,638.7 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0016"$

$t_c = |t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

$= |0.0042 + (0.0016) - (0.1444)|$

$= \underline{0.1386"}$

Hot Shut Down, Corroded, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 151,745 / (\pi*23.8125^2*20,000*1.20*0.85)$

$= 0.0042"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.52*4,638.7 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0 + 0.0042 - (0.0008)$

$= \underline{0.0034"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)

$= 151,745 / (\pi*23.8125^2*14,898.49*1.20)$

$= 0.0048"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)

$= 1.08*4,638.7 / (2*\pi*23.8125*14,898.49*1.20)$

$= 0.0019"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)

$= 0.0048 + (0.0019) - (0)$

$= \underline{0.0066"}$

Hot Shut Down, New, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 151,745 / (\pi*23.8125^2*20,000*1.20*0.85)$

$= 0.0042"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.52*4,638.7 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0 + 0.0042 - (0.0008)$

$= \underline{0.0034"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)

$= 151,745 / (\pi*23.8125^2*14,898.49*1.20)$

$= 0.0048"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)

$= 1.08*4,638.7 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0019"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0.0048 + (0.0019) - (0)$
$= \underline{0.0066"}$

Empty, Corroded, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)
$= 110,326 / (\pi*23.8125^2*20,000*1.20*0.85)$
$= 0.003"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
$= 0.52*4,638.7 / (2*\pi*23.8125*20,000*1.20*0.85)$
$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)
$= 0 + 0.003 - (0.0008)$
$= \underline{0.0022"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)
$= 110,326 / (\pi*23.8125^2*14,898.49*1.20)$
$= 0.0035"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)
$= 1.08*4,638.7 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0019"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0.0035 + (0.0019) - (0)$
$= \underline{0.0053"}$

Empty, New, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)
$= 110,326 / (\pi*23.8125^2*20,000*1.20*0.85)$
$= 0.003"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
$= 0.52*4,638.7 / (2*\pi*23.8125*20,000*1.20*0.85)$
$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)
$= 0 + 0.003 - (0.0008)$
$= \underline{0.0022"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)
$= 110,326 / (\pi*23.8125^2*14,898.49*1.20)$
$= 0.0035"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)
$= 1.08*4,638.7 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0019"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0.0035 + (0.0019) - (0)$

= 0.0053"

Straight Flange on BOTTOM HEAD

ASME Section VIII Division 1, 2017 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, ln. 33)		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		250	150	-20
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		1.8	50	1
Test horizontal		1.71	47.3125	1
Dimensions				
Outer Diameter		48"		
Length		2"		
Nominal Thickness		0.375"		
Corrosion	**Inner**	0"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		**Capacity (US gal)**
New		31.76		15.18
Corroded		31.76		15.18
Radiography				
Longitudinal seam		Seamless No RT		
Top Circumferential seam		Spot UW-11(a)(5)(b) Type 1		

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	0.0625" + 0" = 0.0625"
Design thickness due to internal pressure (t)	0.3007"
Design thickness due to combined loadings + corrosion	0.1478"
Rated MDMT	-39.8 °F

UCS-66 Material Toughness Requirements	
Governing thickness, t_g =	0.375"
Exemption temperature from Fig UCS-66 Curve B =	-20°F
t_r = 251.8*24 / (20,000*1 + 0.4*251.8) =	0.3007"
Stress ratio = t_r*E* / (t_n - c) = 0.3007*1 / (0.375 - 0) =	0.8017
Reduction in MDMT, T_R from Fig UCS-66.1 =	19.8°F
MDMT = max[MDMT - T_R, -55] = max[-20 - 19.8 , -55] =	-39.8°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

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

t = $P*R_o / (S*E + 0.40*P)$ + Corrosion
= 251.8*24 / (20,000*1.00 + 0.40*251.8) + 0
= 0.3007"

% Extreme fiber elongation - UCS-79(d)

EFE = $(50*t / R_f)*(1 - R_f / R_o)$
= $(50*0.375 / 23.8125)*(1 - 23.8125 / \infty)$
= 0.7874%

The extreme fiber elongation does not exceed 5%.

Thickness Required Due to Pressure + External Loads								
Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S_t	S_c					
Operating, Hot & Corroded	250	20,000	14,898	150	0	Wind	0.1475	0.1389
						Seismic	0.1478	0.1385
Operating, Hot & New	250	20,000	14,898	150	0	Wind	0.1475	0.1389
						Seismic	0.1478	0.1385
Hot Shut Down, Corroded	0	20,000	14,898	150	0	Wind	0.0031	0.0063
						Seismic	0.0034	0.0067
Hot Shut Down, New	0	20,000	14,898	150	0	Wind	0.0031	0.0063
						Seismic	0.0034	0.0067
Empty, Corroded	0	20,000	14,898	70	0	Wind	0.0031	0.0063
						Seismic	0.0023	0.0054
Empty, New	0	20,000	14,898	70	0	Wind	0.0031	0.0063
						Seismic	0.0023	0.0054
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	20,000	14,898	150	0	Weight	0.0015	0.0027

Allowable Compressive Stress, Hot and Corroded- S_{cHC}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$
= 0.001953

B = 14,898 psi

S = 20,000 / 1.00 = 20,000 psi

S_{cHC} = min(B, S) = 14,898 psi

Allowable Compressive Stress, Hot and New- S_{cHN}

S_{cHN} = S_{cHC}
= 14,898 psi

Allowable Compressive Stress, Cold and New- S_{cCN}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$
= 0.001953

B = 14,898 psi

S = 20,000 / 1.00 = 20,000 psi

S_{cCN} = min(B, S) = 14,898 psi

Allowable Compressive Stress, Cold and Corroded- S_{cCC}

S_{cCC} = S_{cCN}
= 14,898 psi

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC}, (table CS-2)

A = $0.125 / (R_o / t)$
= $0.125 / (24 / 0.375)$

= 0.001953

B = 14,898 psi

S = 20,000 / 1.00 = 20,000 psi

S_{cVC} = min(B, S) = <u>14,898 psi</u>

<u>Operating, Hot & Corroded, Wind, Bottom Seam</u>

t_p = $P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)
= 250*23.625 / (2*20,000*1.20*0.85 + 0.40*|250|)
= 0.1444"

t_m = $M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)
= 144,377 / (π*23.8125^2*20,000*1.20*0.85)
= 0.004"

t_w = $0.6*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
= 0.60*4,670.4 / (2*π*23.8125*20,000*1.20*0.85)
= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= 0.1444 + 0.004 - (0.0009)
= <u>0.1475"</u>

t_{wc} = $W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
= 4,670.4 / (2*π*23.8125*20,000*1.20*0.85)
= 0.0015"

t_c = $|t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)
= |0.004 + (0.0015) - (0.1444)|
= <u>0.1389"</u>

<u>Operating, Hot & New, Wind, Bottom Seam</u>

t_p = $P*R / (2*S_t*K_s*E_c + 0.40*|P|)$ (Pressure)
= 250*23.625 / (2*20,000*1.20*0.85 + 0.40*|250|)
= 0.1444"

t_m = $M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)
= 144,377 / (π*23.8125^2*20,000*1.20*0.85)
= 0.004"

t_w = $0.6*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
= 0.60*4,670.4 / (2*π*23.8125*20,000*1.20*0.85)
= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= 0.1444 + 0.004 - (0.0009)
= <u>0.1475"</u>

t_{wc} = $W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
= 4,670.4 / (2*π*23.8125*20,000*1.20*0.85)
= 0.0015"

t_c = $|t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

= |0.004 + (0.0015) - (0.1444)|
= 0.1389"

Hot Shut Down, Corroded, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)
= $144,377 / (\pi * 23.8125^2 * 20,000 * 1.20 * 0.85)$
= 0.004"

t_w = $0.6 * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)
= $0.60 * 4,670.4 / (2 * \pi * 23.8125 * 20,000 * 1.20 * 0.85)$
= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= 0 + 0.004 - (0.0009)
= 0.0031"

t_{mc} = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)
= $144,377 / (\pi * 23.8125^2 * 14,898.49 * 1.20)$
= 0.0045"

t_{wc} = $W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $4,670.4 / (2 * \pi * 23.8125 * 14,898.49 * 1.20)$
= 0.0017"

t_c = $t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
= 0.0045 + (0.0017) - (0)
= 0.0063"

Hot Shut Down, New, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)
= $144,377 / (\pi * 23.8125^2 * 20,000 * 1.20 * 0.85)$
= 0.004"

t_w = $0.6 * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)
= $0.60 * 4,670.4 / (2 * \pi * 23.8125 * 20,000 * 1.20 * 0.85)$
= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= 0 + 0.004 - (0.0009)
= 0.0031"

t_{mc} = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)
= $144,377 / (\pi * 23.8125^2 * 14,898.49 * 1.20)$
= 0.0045"

t_{wc} = $W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $4,670.4 / (2 * \pi * 23.8125 * 14,898.49 * 1.20)$
= 0.0017"

t_c = $t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
= 0.0045 + (0.0017) - (0)
= 0.0063"

Empty, Corroded, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)
= $144,377 / (\pi * 23.8125^2 * 20,000 * 1.20 * 0.85)$
= 0.004"

t_w = $0.6 * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)
= $0.60 * 4,670.4 / (2 * \pi * 23.8125 * 20,000 * 1.20 * 0.85)$
= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= 0 + 0.004 - (0.0009)
= <u>0.0031"</u>

t_{mc} = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)
= $144,377 / (\pi * 23.8125^2 * 14,898.49 * 1.20)$
= 0.0045"

t_{wc} = $W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $4,670.4 / (2 * \pi * 23.8125 * 14,898.49 * 1.20)$
= 0.0017"

t_c = $t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
= 0.0045 + (0.0017) - (0)
= <u>0.0063"</u>

Empty, New, Wind, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)
= $144,377 / (\pi * 23.8125^2 * 20,000 * 1.20 * 0.85)$
= 0.004"

t_w = $0.6 * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)
= $0.60 * 4,670.4 / (2 * \pi * 23.8125 * 20,000 * 1.20 * 0.85)$
= 0.0009"

t_t = $t_p + t_m - t_w$ (total required, tensile)
= 0 + 0.004 - (0.0009)
= <u>0.0031"</u>

t_{mc} = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)
= $144,377 / (\pi * 23.8125^2 * 14,898.49 * 1.20)$
= 0.0045"

t_{wc} = $W / (2 * \pi * R_m * S_c * K_s)$ (Weight)
= $4,670.4 / (2 * \pi * 23.8125 * 14,898.49 * 1.20)$
= 0.0017"

t_c = $t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
= 0.0045 + (0.0017) - (0)
= <u>0.0063"</u>

Hot Shut Down, Corroded, Weight & Eccentric Moments Only, Bottom Seam

t_p = 0" (Pressure)

t_m = $M / (\pi * R_m^2 * S_c * K_s)$ (bending)

$= 15{,}258 / (\pi * 23.8125^2 * 14{,}898.49 * 1.00)$

$= 0.0006"$

$t_w = W / (2 * \pi * R_m * S_c * K_s)$ (Weight)

$= 4{,}670.4 / (2 * \pi * 23.8125 * 14{,}898.49 * 1.00)$

$= 0.0021"$

$t_t = |t_p + t_m - t_w|$ (total, net compressive)

$= |0 + 0.0006 - (0.0021)|$

$= \underline{0.0015"}$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)

$= 0.0006 + (0.0021) - (0)$

$= \underline{0.0027"}$

Operating, Hot & Corroded, Seismic, Bottom Seam

$t_p = P * R / (2 * S_t * K_s * E_c + 0.40 * |P|)$ (Pressure)

$= 250 * 23.625 / (2 * 20{,}000 * 1.20 * 0.85 + 0.40 * |250|)$

$= 0.1444"$

$t_m = M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)

$= 153{,}753 / (\pi * 23.8125^2 * 20{,}000 * 1.20 * 0.85)$

$= 0.0042"$

$t_w = (0.6 - 0.14 * S_{DS}) * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)

$= 0.52 * 4{,}670.4 / (2 * \pi * 23.8125 * 20{,}000 * 1.20 * 0.85)$

$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0.1444 + 0.0042 - (0.0008)$

$= \underline{0.1478"}$

$t_{wc} = (1 + 0.14 * S_{DS}) * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)

$= 1.08 * 4{,}670.4 / (2 * \pi * 23.8125 * 20{,}000 * 1.20 * 0.85)$

$= 0.0016"$

$t_c = |t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

$= |0.0042 + (0.0016) - (0.1444)|$

$= \underline{0.1385"}$

Operating, Hot & New, Seismic, Bottom Seam

$t_p = P * R / (2 * S_t * K_s * E_c + 0.40 * |P|)$ (Pressure)

$= 250 * 23.625 / (2 * 20{,}000 * 1.20 * 0.85 + 0.40 * |250|)$

$= 0.1444"$

$t_m = M / (\pi * R_m^2 * S_t * K_s * E_c)$ (bending)

$= 153{,}753 / (\pi * 23.8125^2 * 20{,}000 * 1.20 * 0.85)$

$= 0.0042"$

$t_w = (0.6 - 0.14 * S_{DS}) * W / (2 * \pi * R_m * S_t * K_s * E_c)$ (Weight)

$= 0.52 * 4{,}670.4 / (2 * \pi * 23.8125 * 20{,}000 * 1.20 * 0.85)$

$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0.1444 + 0.0042 - (0.0008)$

$= \underline{0.1478"}$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 1.08*4,670.4 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0016"$

$t_c = |t_{mc} + t_{wc} - t_{pc}|$ (total, net tensile)

$= |0.0042 + (0.0016) - (0.1444)|$

$= \underline{0.1385"}$

Hot Shut Down, Corroded, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 153,753 / (\pi*23.8125^2*20,000*1.20*0.85)$

$= 0.0042"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.52*4,670.4 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0 + 0.0042 - (0.0008)$

$= \underline{0.0034"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)

$= 153,753 / (\pi*23.8125^2*14,898.49*1.20)$

$= 0.0048"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)

$= 1.08*4,670.4 / (2*\pi*23.8125*14,898.49*1.20)$

$= 0.0019"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)

$= 0.0048 + (0.0019) - (0)$

$= \underline{0.0067"}$

Hot Shut Down, New, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)

$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)

$= 153,753 / (\pi*23.8125^2*20,000*1.20*0.85)$

$= 0.0042"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)

$= 0.52*4,670.4 / (2*\pi*23.8125*20,000*1.20*0.85)$

$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)

$= 0 + 0.0042 - (0.0008)$

$= \underline{0.0034"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)

$= 153,753 / (\pi*23.8125^2*14,898.49*1.20)$

$= 0.0048"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)

$= 1.08*4,670.4 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0019"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0.0048 + (0.0019) - (0)$
$= \underline{0.0067"}$

Empty, Corroded, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)
$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)
$= 111,508 / (\pi*23.8125^2*20,000*1.20*0.85)$
$= 0.0031"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
$= 0.52*4,670.4 / (2*\pi*23.8125*20,000*1.20*0.85)$
$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)
$= 0 + 0.0031 - (0.0008)$
$= \underline{0.0023"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)
$= 111,508 / (\pi*23.8125^2*14,898.49*1.20)$
$= 0.0035"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)
$= 1.08*4,670.4 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0019"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0.0035 + (0.0019) - (0)$
$= \underline{0.0054"}$

Empty, New, Seismic, Bottom Seam

$t_p = 0"$ (Pressure)
$t_m = M / (\pi*R_m^2*S_t*K_s*E_c)$ (bending)
$= 111,508 / (\pi*23.8125^2*20,000*1.20*0.85)$
$= 0.0031"$

$t_w = (0.6 - 0.14*S_{DS})*W / (2*\pi*R_m*S_t*K_s*E_c)$ (Weight)
$= 0.52*4,670.4 / (2*\pi*23.8125*20,000*1.20*0.85)$
$= 0.0008"$

$t_t = t_p + t_m - t_w$ (total required, tensile)
$= 0 + 0.0031 - (0.0008)$
$= \underline{0.0023"}$

$t_{mc} = M / (\pi*R_m^2*S_c*K_s)$ (bending)
$= 111,508 / (\pi*23.8125^2*14,898.49*1.20)$
$= 0.0035"$

$t_{wc} = (1 + 0.14*S_{DS})*W / (2*\pi*R_m*S_c*K_s)$ (Weight)
$= 1.08*4,670.4 / (2*\pi*23.8125*14,898.49*1.20)$
$= 0.0019"$

$t_c = t_{mc} + t_{wc} - t_{pc}$ (total required, compressive)
$= 0.0035 + (0.0019) - (0)$

= 0.0054"

BOTTOM HEAD

ASME Section VIII Division 1, 2017 Edition				
Component		Ellipsoidal Head		
Material		SA-516 70 (II-D p. 18, ln. 33)		
Attached To		SHELL RG 1		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		250	150	-20
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		2.23	61.8438	1
Test horizontal		1.71	47.375	1
Dimensions				
Outer Diameter		48"		
Head Ratio		2		
Minimum Thickness		0.3125"		
Corrosion	**Inner**	0"		
	Outer	0"		
Length L_{sf}		2"		
Nominal Thickness t_{sf}		0.375"		
Weight and Capacity				
		Weight (lb)[1]		**Capacity (US gal)[1]**
New		263.8		75.43
Corroded		263.8		75.43
Radiography				
Category A joints		Seamless No RT		
Head to shell seam		Spot UW-11(a)(5)(b) Type 1		

[1] includes straight flange

Results Summary	
Governing condition	internal pressure
Minimum thickness per UG-16	0.0625" + 0" = 0.0625"
Design thickness due to internal pressure (t)	0.2993"
Straight Flange governs MDMT	-39.8 °F

Factor K		
$K = (1/6)*[2 + (D / (2*h))^2]$		
Corroded	$K = (1/6)*[2 + (47.375 / (2*11.8438))^2]$	1
New	$K = (1/6)*[2 + (47.375 / (2*11.8438))^2]$	1

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

$t = P*D_o*K / (2*S*E + 2*P*(K - 0.1)) + Corrosion$
$= 252.23*48*1 / (2*20,000*1 + 2*252.23*(1 - 0.1)) + 0$
$= 0.2993"$

% Extreme fiber elongation - UCS-79(d)

$EFE = (75*t / R_f)*(1 - R_f / R_o)$
$= (75*0.375 / 8.2413)*(1 - 8.2413 / \infty)$
$= 3.4127\%$

The extreme fiber elongation does not exceed 5%.

Support Skirt #1

ASME Section VIII Division 1, 2017 Edition				
Component		Support Skirt		
Skirt is Attached To		BOTTOM HEAD		
Skirt Attachment Offset		8.8279" down from the top seam		
Material		SA-516 70 (II-D p. 18, ln. 33)		
		Impact Tested[1]	**Normalized**	**Fine Grain Practice**
		No	No	No
Design Temperature				
Internal		150°F		
Dimensions				
Inner Diameter	**Top**	39.5"		
	Botttom	39.5"		
Length (includes base ring thickness)		16.17"		
Nominal Thickness		0.25"		
Corrosion	**Inner**	0"		
	Outer	0"		
Weight				
New		138.45 lb		
Corroded		138.45 lb		
Joint Efficiency				
Top		0.55		
Bottom		0.8		

[1] Impact testing requirements are not checked for supports

Skirt design thickness, largest of the following + corrosion = 0.0156 in

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

The skirt thickness of 0.25 in is adequate.

Results Summary							
Loading	Condition	Tensile or Compressive Side	Governing Skirt Location	Temperature (°F)	Allowable Stress (psi)	Calculated Stress/E (psi)	Required thickness (in)
Wind	operating, corroded	Tensile	top	150	20,000	586.46	0.0073
		Compressive	bottom		13,976.44	823.99	0.0147
	empty, corroded	Tensile	top	70	20,000	715.94	0.0089
		Compressive	bottom		13,976.44	705.3	0.0126
Seismic	operating, corroded	Tensile	top	150	20,000	679.2	0.0085
		Compressive	bottom		13,976.44	872.82	0.0156
	empty, corroded	Tensile	top	70	20,000	527.74	0.0066
		Compressive	bottom		13,976.44	577.32	0.0103

Loading due to wind, operating & corroded

Windward side (tensile)

Required thickness, tensile stress at base:

$t = -0.6*W / (\pi*D*S_t*E) + 48*M / (\pi*D^2*S_t*E)$
$= -0.6*8,747.54 / (\pi*39.75*20,000*0.8) + 48*14,059.1 / (\pi*39.75^2*20,000*0.8)$
$= 0.0059$ in

Required thickness, tensile stress at the top:

$t = -0.6*W_t / (\pi*D_t*S_t*E) + 48*M_t / (\pi*D_t^2*S_t*E)$
$= -0.6*8,609.09 / (\pi*39.75*20,000*0.55) + 48*12,616.8 / (\pi*39.75^2*20,000*0.55)$
$= \underline{0.0073}$ in

Leeward side (compressive)

Required thickness, compressive stress at base:

$t = W / (\pi*D*S_c*E_c) + 48*M / (\pi*D^2*S_c*E_c)$
$= 8,747.54 / (\pi*39.75*13,976*1) + 48*14,059.1 / (\pi*39.75^2*13,976*1)$
$= \underline{0.0147}$ in

Required thickness, compressive stress at the top:

$t = W_t / (\pi*D_t*S_c*E_c) + 48*M_t / (\pi*D_t^2*S_c*E_c)$
$= 8,609.09 / (\pi*39.75*13,976*1) + 48*12,616.8 / (\pi*39.75^2*13,976*1)$
$= 0.0137$ in

Loading due to wind, empty & corroded

Windward side (tensile)

Required thickness, tensile stress at base:

$t = -0.6*W / (\pi*D*S_t*E) + 48*M / (\pi*D^2*S_t*E)$
$= -0.6*5{,}042.06 / (\pi*39.75*20{,}000*0.8) + 48*14{,}059.1 / (\pi*39.75^2*20{,}000*0.8)$
$= 0.007$ in

Required thickness, tensile stress at the top:

$t = -0.6*W_t / (\pi*D_t*S_t*E) + 48*M_t / (\pi*D_t^2*S_t*E)$
$= -0.6*4{,}903.62 / (\pi*39.75*20{,}000*0.55) + 48*12{,}616.8 / (\pi*39.75^2*20{,}000*0.55)$
$= \underline{0.0089}$ in

Leeward side (compressive)

Required thickness, compressive stress at base:

$t = W / (\pi*D*S_c*E_c) + 48*M / (\pi*D^2*S_c*E_c)$
$= 5{,}042.06 / (\pi*39.75*13{,}976*1) + 48*14{,}059.1 / (\pi*39.75^2*13{,}976*1)$
$= \underline{0.0126}$ in

Required thickness, compressive stress at the top:

$t = W_t / (\pi*D_t*S_c*E_c) + 48*M_t / (\pi*D_t^2*S_c*E_c)$
$= 4{,}903.62 / (\pi*39.75*13{,}976*1) + 48*12{,}616.8 / (\pi*39.75^2*13{,}976*1)$
$= 0.0115$ in

Loading due to seismic, operating & corroded

Tensile side

Required thickness, tensile stress at base:

$t = -(0.6 - 0.14*S_{DS})*W / (\pi*D*S_t*E) + 48*M / (\pi*D^2*S_t*E)$
$= -(0.6 - 0.14*0.55)*8{,}747.54 / (\pi*39.75*20{,}000*0.8) + 48*14{,}763.9 / (\pi*39.75^2*20{,}000*0.8)$
$= 0.0066$ in

Required thickness, tensile stress at the top:

$t = -(0.6 - 0.14*S_{DS})*W_t / (\pi*D_t*S_t*E) + 48*M_t / (\pi*D_t^2*S_t*E)$
$= -(0.6 - 0.14*0.55)*8{,}609.09 / (\pi*39.75*20{,}000*0.55) + 48*13{,}386.6 / (\pi*39.75^2*20{,}000*0.55)$
$= \underline{0.0085}$ in

Compressive side

Required thickness, compressive stress at base:

$t = (1 + 0.14*S_{DS})*W / (\pi*D*S_c*E_c) + 48*M / (\pi*D^2*S_c*E_c)$
$= (1 + 0.14*0.55)*8{,}747.54 / (\pi*39.75*13{,}976*1) + 48*14{,}763.9 / (\pi*39.75^2*13{,}976*1)$
$= \underline{0.0156}$ in

Required thickness, compressive stress at the top:

$$t = (1 + 0.14*S_{DS})*W_t / (\pi*D_t*S_c*E_c) + 48*M_t / (\pi*D_t^2*S_c*E_c)$$
$$= (1 + 0.14*0.55)*8{,}609.09 / (\pi*39.75*13{,}976*1) + 48*13{,}386.6 / (\pi*39.75^2*13{,}976*1)$$
$$= 0.0146 \text{ in}$$

Loading due to seismic, empty & corroded

Tensile side

Required thickness, tensile stress at base:

$$t = -(0.6 - 0.14*S_{DS})*W / (\pi*D*S_t*E) + 48*M / (\pi*D^2*S_t*E)$$
$$= -(0.6 - 0.14*0.55)*5{,}042.06 / (\pi*39.75*20{,}000*0.8) + 48*10{,}428.9 / (\pi*39.75^2*20{,}000*0.8)$$
$$= 0.005 \text{ in}$$

Required thickness, tensile stress at the top:

$$t = -(0.6 - 0.14*S_{DS})*W_t / (\pi*D_t*S_t*E) + 48*M_t / (\pi*D_t^2*S_t*E)$$
$$= -(0.6 - 0.14*0.55)*4{,}903.62 / (\pi*39.75*20{,}000*0.55) + 48*9{,}628 / (\pi*39.75^2*20{,}000*0.55)$$
$$= \underline{0.0066} \text{ in}$$

Compressive side

Required thickness, compressive stress at base:

$$t = (1 + 0.14*S_{DS})*W / (\pi*D*S_c*E_c) + 48*M / (\pi*D^2*S_c*E_c)$$
$$= (1 + 0.14*0.55)*5{,}042.06 / (\pi*39.75*13{,}976*1) + 48*10{,}428.9 / (\pi*39.75^2*13{,}976*1)$$
$$= \underline{0.0103} \text{ in}$$

Required thickness, compressive stress at the top:

$$t = (1 + 0.14*S_{DS})*W_t / (\pi*D_t*S_c*E_c) + 48*M_t / (\pi*D_t^2*S_c*E_c)$$
$$= (1 + 0.14*0.55)*4{,}903.62 / (\pi*39.75*13{,}976*1) + 48*9{,}628 / (\pi*39.75^2*13{,}976*1)$$
$$= 0.0097 \text{ in}$$

Skirt Buckling Check per ASCE 15.7.10.5

4.4.12.2.b Allowable Axial Compressive Membrane Stress		
$M_x = L / (R_o*t)^{0.5}$		(4.4.124)
cbar = 2.64	for $M_x \le 1.5$	(4.4.69)
$cbar = 3.13 / M_x^{0.42}$	for $1.5 < M_x < 15$	(4.4.70)
cbar = 1	for $M_x \ge 15$	(4.4.71)
$C_x = \min[409*cbar / (389 + D_o / t) , 0.9]$	for $D_o / t < 1247$	(4.4.67)
$C_x = 0.25*cbar$	for $1247 \le D_o / t \le 2000$	(4.4.68)
$F_{xe} = C_x*E_y*t / D_o$		(4.4.66)
$F_{xa2} = F_{xe} / FS$		(4.4.65)
$F_{xa1} = S_y / FS$	for $D_o / t \le 135$	(4.4.62)
$F_{xa1} = 466*S_y / [FS*(331 + D_o / t)]$	for $135 < D_o / t < 600$	(4.4.63)
$F_{xa1} = 0.5*S_y / FS$	for $600 \le D_o / t \le 2000$	(4.4.64)
$F_{xa} = \min[F_{xa1} , F_{xa2}]$		(4.4.61)
$\lambda_c = K_u*L_u / (\pi*r_g)*(F_{xa}*FS / E_y)^{0.5}$		(4.4.125)
New / Corroded		
$D_o / t = 40 / (0.875*0.25) =$		160
$M_x = 16.17 / (20*0.875*0.25)^{0.5} =$		7.2314
$cbar = 3.13 / M_x^{0.42} =$		1.3635
$C_x = \min[409*1.3635 / (389 + 40 / (0.875*0.25)) , 0.9] =$		0.9
Operating Hot & Corroded		
$F_{xe} = 0.9*29.03E+06*0.875*0.25 / 40 =$		163,298 psi
$F_{xa1} = 466*35,700 / [1*(331 + 40 / 0.875*0.25)] =$		33,882 psi
$F_{xa2} = 163,298 / 1 =$		163,298 psi
$F_{xa} = \min[33,882 , 163,298] =$		33,882 psi
$\lambda_c = 2.1*279.1542 / (\pi*14.054)*(33,882*1 / 29.03E+06)^{0.5} =$		0.4536
Operating Hot & New		
$F_{xe} = 0.9*29.03E+06*0.875*0.25 / 40 =$		163,298 psi
$F_{xa1} = 466*35,700 / [1*(331 + 40 / 0.875*0.25)] =$		33,882 psi
$F_{xa2} = 163,298 / 1 =$		163,298 psi
$F_{xa} = \min[33,882 , 163,298] =$		33,882 psi
$\lambda_c = 2.1*279.1542 / (\pi*14.054)*(33,882*1 / 29.03E+06)^{0.5} =$		0.4536
Empty Cold & Corroded		
$F_{xe} = 0.9*29.4E+06*0.875*0.25 / 40 =$		165,375 psi
$F_{xa1} = 466*38,000 / [1*(331 + 40 / 0.875*0.25)] =$		36,065 psi

F_{xa2} = 165,375 / 1 =	165,375 psi
F_{xa} = min[36,065 , 165,375] =	36,065 psi
λ_c = 2.1*279.1542 / (π*14.054)*(36,065*1 / 29.4E+06)$^{0.5}$ =	0.465
Empty Cold & New	
F_{xe} = 0.9*29.4E+06*0.875*0.25 / 40 =	165,375 psi
F_{xa1} = 466*38,000 / [1*(331 + 40 / 0.875*0.25)] =	36,065 psi
F_{xa2} = 165,375 / 1 =	165,375 psi
F_{xa} = min[36,065 , 165,375] =	36,065 psi
λ_c = 2.1*279.1542 / (π*14.054)*(36,065*1 / 29.4E+06)$^{0.5}$ =	0.465

4.4.12.2.c Compressive Bending Stress		
$\gamma = S_y * D_o / (E_y * t)$		(4.4.78)
$F_{ba} = F_{xa}$	for $135 \le D_o / t \le 2000$	(4.4.74)
$F_{ba} = 466 * S_y / [FS * (331 + D_o / t)]$	for $100 \le D_o / t < 135$	(4.4.75)
$F_{ba} = 1.081 * S_y / FS$	for $D_o / t < 100$ and $\gamma \ge 0.11$	(4.4.76)
$F_{ba} = S_y * (1.4 - 2.9 * \gamma) / FS$	for $D_o / t < 100$ and $\gamma < 0.11$	(4.4.77)
Operating Hot & Corroded		
D_o / t = 40 / (0.875*0.25) =		160
γ = 35,700*40 / (29.03E+06*0.875*0.25) =		0.1968
$F_{ba} = F_{xa}$ =		33,882 psi
Operating Hot & New		
D_o / t = 40 / (0.875*0.25) =		160
γ = 35,700*40 / (29.03E+06*0.875*0.25) =		0.1968
$F_{ba} = F_{xa}$ =		33,882 psi
Empty Cold & Corroded		
D_o / t = 40 / (0.875*0.25) =		160
γ = 38,000*40 / (29.4E+06*0.875*0.25) =		0.2068
$F_{ba} = F_{xa}$ =		36,065 psi
Empty Cold & New		
D_o / t = 40 / (0.875*0.25) =		160
γ = 38,000*40 / (29.4E+06*0.875*0.25) =		0.2068
$F_{ba} = F_{xa}$ =		36,065 psi

4.4.12.2.d Allowable Shear Stress		
$C_v = 4.454$	for $M_x \le 1.5$	(4.4.81)
$C_v = (9.64 / M_x^2)*(1 + 0.0239*M_x^3)^{0.5}$	for $1.5 < M_x < 26$	(4.4.82)
$C_v = 1.492 / M_x^{0.5}$	for $26 \le M_x < 4.347*(D_o / t)$	(4.4.83)
$C_v = 0.716*(t / D_o)^{0.5}$	for $M_x \ge 4.347*(D_o / t)$	(4.4.84)
$\alpha_v = 0.8$	for $D_o / t \le 500$	(4.4.85)
$\alpha_v = 1.389 - 0.218*\log_{10}(D_o / t)$	for $D_o / t > 500$	(4.4.86)
$\eta_v = 1$	for $F_{ve} / S_y \le 0.48$	(4.4.87)
$\eta_v = 0.43*(S_y / F_{ve}) + 0.1$	for $0.48 < F_{ve} / S_y < 1.7$	(4.4.88)
$\eta_v = 0.6*(S_y / F_{ve})$	for $F_{ve} / S_y \ge 1.7$	(4.4.89)
$F_{ve} = \alpha_v*C_v*E_y*(t / D_o)$		(4.4.80)
$F_{va} = \eta_v*F_{ve} / FS$		(4.4.79)
Operating Hot & Corroded		
$D_o / t = 40 / (0.875*0.25) =$		160
$M_x = 16.17 / (20*0.875*0.25)^{0.5} =$		7.2314
$F_{ve} / S_y = 84,777 / 35,700 =$		2.3747
$C_v = (9.64 / 7.2314^2)*(1 + 0.0239*7.2314^3)^{0.5} =$		0.5841
$\alpha_v = 0.8 =$		0.8
$\eta_v = 0.6*(35,700 / 84,777) =$		0.2527
$F_{ve} = 0.8*0.5841*29.03E+06*(0.875*0.25 / 40) =$		84,777 psi
$F_{va} = 0.2527*84,777 / 1 =$		21,420 psi
Operating Hot & New		
$D_o / t = 40 / (0.875*0.25) =$		160
$M_x = 16.17 / (20*0.875*0.25)^{0.5} =$		7.2314
$F_{ve} / S_y = 84,777 / 35,700 =$		2.3747
$C_v = (9.64 / 7.2314^2)*(1 + 0.0239*7.2314^3)^{0.5} =$		0.5841
$\alpha_v = 0.8 =$		0.8
$\eta_v = 0.6*(35,700 / 84,777) =$		0.2527
$F_{ve} = 0.8*0.5841*29.03E+06*(0.875*0.25 / 40) =$		84,777 psi
$F_{va} = 0.2527*84,777 / 1 =$		21,420 psi
Empty Cold & Corroded		
$D_o / t = 40 / (0.875*0.25) =$		160
$M_x = 16.17 / (20*0.875*0.25)^{0.5} =$		7.2314
$F_{ve} / S_y = 85,856 / 38,000 =$		2.2594
$C_v = (9.64 / 7.2314^2)*(1 + 0.0239*7.2314^3)^{0.5} =$		0.5841
$\alpha_v = 0.8 =$		0.8

η_v = 0.6*(38,000 / 85,856) =	0.2656
F_{ve} = 0.8*0.5841*29.4E+06*(0.875*0.25 / 40) =	85,856 psi
F_{va} = 0.2656*85,856 / 1 =	22,800 psi
Empty Cold & New	
D_o / t = 40 / (0.875*0.25) =	160
M_x = 16.17 / (20*0.875*0.25)$^{0.5}$ =	7.2314
F_{ve} / S_y = 85,856 / 38,000 =	2.2594
C_v = (9.64 / 7.2314^2)*(1 + 0.0239*7.2314^3)$^{0.5}$ =	0.5841
α_v = 0.8 =	0.8
η_v = 0.6*(38,000 / 85,856) =	0.2656
F_{ve} = 0.8*0.5841*29.4E+06*(0.875*0.25 / 40) =	85,856 psi
F_{va} = 0.2656*85,856 / 1 =	22,800 psi

4.4.12.2.i Axial Compression, Bending Moment, and Shear		
f_b = M / S		(4.4.119)
f_a = F / A		(4.4.120)
f_v = V*sin[ϕ] / A		(4.4.122)
K_s = 1 - (f_v / F_{va})^2		(4.4.105)
F_e = π^2*E_y / (K_u*L_u / r_g)^2		(4.4.110)
Δ = C_m / (1 - f_a*FS / F_e)		(4.4.109)
F_{ca} = F_{xa}*[1 - 0.74*(λ_c - 0.15)]$^{0.3}$	for 0.15 < λ_c < 1.2	(4.4.72)
f_a / (K_s*F_{ca}) + 8*Δ*f_b / (9*K_s*F_{ba}) ≤ 1	for f_a / (K_s*F_{ca}) ≥ 0.2	(4.4.112)
f_a / (2*K_s*F_{ca}) + Δ*f_b / (K_s*F_{ba}) ≤ 1	for f_a / (K_s*F_{ca}) < 0.2	(4.4.113)
New / Corroded		
r_g = 0.25*(40^2 + 39.5^2)$^{0.5}$ =		14.054"
A = π*(40^2 - 39.5^2) / 4 =		31.22 in^2
S = π*(40^4 - 39.5^4) / (32*40) =		308.3177 in^3
Operating Hot & Corroded		
Seismic ASCE 15.7.10.5	f_b = 246,556.7 / 308.3177 =	800 psi
	f_a = 8,747.54 / 31.22 =	280 psi
	f_v = 1,461.16*sin[90] / 31.22 =	47 psi
	K_s = 1 - (47 / 21,420)^2 =	1
	F_e = π^2*29.03E+06 / (2.1*279.1542 / 14.054)^2 =	164,677 psi
	Δ = 1 / (1 - 280*1 / 164,677) =	1.0017
	F_{ca} = 33,882*[1 - 0.74*(0.4536 - 0.15)]$^{0.3}$ =	31,392 psi
	f_a / (K_s*F_{ca}) = 280 / (1*31,392) =	0.0089

	280 / (2*1*31,392) + 1.0017*800 / (1*33,882) =	0.0281
	Combined load check passes.	
Operating Hot & New		
Seismic ASCE 15.7.10.5	f_b = 246,556.7 / 308.3177 =	800 psi
	f_a = 8,747.54 / 31.22 =	280 psi
	f_v = 1,461.16*sin[90] / 31.22 =	47 psi
	K_s = 1 - (47 / 21,420)^2 =	1
	F_e = π^2*29.03E+06 / (2.1*279.1542 / 14.054)^2 =	164,677 psi
	Δ = 1 / (1 - 280*1 / 164,677) =	1.0017
	F_{ca} = 33,882*[1 - 0.74*(0.4536 - 0.15)]$^{0.3}$ =	31,392 psi
	f_a / (K_s*F_{ca}) = 280 / (1*31,392) =	0.0089
	280 / (2*1*31,392) + 1.0017*800 / (1*33,882) =	0.0281
	Combined load check passes.	
Empty Cold & Corroded		
Seismic ASCE 15.7.10.5	f_b = 172,241.8 / 308.3177 =	559 psi
	f_a = 5,042.06 / 31.22 =	162 psi
	f_v = 849.76*sin[90] / 31.22 =	27 psi
	K_s = 1 - (27 / 22,800)^2 =	1
	F_e = π^2*29.4E+06 / (2.1*279.1542 / 14.054)^2 =	166,771 psi
	Δ = 1 / (1 - 162*1 / 166,771) =	1.001
	F_{ca} = 36,065*[1 - 0.74*(0.465 - 0.15)]$^{0.3}$ =	33,305 psi
	f_a / (K_s*F_{ca}) = 162 / (1*33,305) =	0.0048
	162 / (2*1*33,305) + 1.001*559 / (1*36,065) =	0.0179
	Combined load check passes.	
Empty Cold & New		
Seismic ASCE 15.7.10.5	f_b = 172,241.8 / 308.3177 =	559 psi
	f_a = 5,042.06 / 31.22 =	162 psi
	f_v = 849.76*sin[90] / 31.22 =	27 psi
	K_s = 1 - (27 / 22,800)^2 =	1
	F_e = π^2*29.4E+06 / (2.1*279.1542 / 14.054)^2 =	166,771 psi
	Δ = 1 / (1 - 162*1 / 166,771) =	1.001
	F_{ca} = 36,065*[1 - 0.74*(0.465 - 0.15)]$^{0.3}$ =	33,305 psi
	f_a / (K_s*F_{ca}) = 162 / (1*33,305) =	0.0048
	162 / (2*1*33,305) + 1.001*559 / (1*36,065) =	0.0179
	Combined load check passes.	

Skirt Base Ring #1

Inputs	
Base configuration	single base plate without gussets
Base plate material	SA-516-70
Base plate allowable stress, S_p	20,000 psi
Foundation compressive strength	1,658 psi
Concrete ultimate 28-day strength	3,000 psi
Bolt circle, BC	44.125"
Base plate inner diameter, D_i	34.625"
Base plate outer diameter, D_o	46.625"
Base plate thickness, t_b	0.5"
Anchor Bolts	
Material	
Allowable stress, S_b	20,000 psi
Bolt size and type	0.75" coarse threaded
Number of bolts, N	4
Corrosion allowance (applied to root radius)	0"
Anchor bolt clearance	0.375"
Bolt root area (corroded), A_b	0.3 in^2
Diameter of anchor bolt holes, d_b	1.125"
Initial bolt preload	0% (0 psi)
Bolt at 0°	No

Results Summary							
Load	Vessel condition	Base V (lb_f)	Base M (lb_f-ft)	W (lb)	Required bolt area (in^2)	t_r Base (in)	Foundation bearing stress (psi)
Wind	operating, corroded	1,098.4	14,059.1	8,855.5	0.1248	0.3689	82.67
Wind	operating, new	1,098.4	14,059.1	8,855.5	0.1248	0.3689	82.67
Wind	empty, corroded	1,098.4	14,059.1	5,150.1	0.1525	0.3627	79.94
Wind	empty, new	1,098.4	14,059.1	5,150.1	0.1525	0.3627	79.94
Seismic	operating, corroded	1,022.8	14,763.9	8,855.5	0.1429	0.3995	96.99
Seismic	operating, new	1,022.8	14,763.9	8,855.5	0.1429	0.3995	96.99
Seismic	empty, corroded	594.8	10,428.9	5,150.1	0.1081	0.3314	66.72
Seismic	empty, new	594.8	10,428.9	5,150.1	0.1081	0.3314	66.72

Anchor bolt load (operating, corroded + Wind)

P = -0.6*W / N + 48 * M / (N*BC)
= -0.6*8,855.54 / 4 + 48 * 14,059.1 / (4*44.125)
= 2,495.12 lb_f

Required area per bolt = P / S_b = 0.1248 in^2

The area provided (0.302 in^2) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, operating, corroded + Wind)

Base plate width, t_c:	6	in
Average base plate diameter, d:	40.625	in
Base plate elastic modulus, E_s:	29.0E+06	psi
Base plate yield stress, S_y:	38,000	psi

E_c = 57,000*Sqr(3,000) = 3,122,019 psi

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

t_s = (N*A_b) / (π*d)
= (4*0.302) / (π*40.625)
= 0.0095 in

From table 12.4 for k = 0.15839:

K_1 = 2.7533, K_2 = 1.0792
L_1 = 13.8762, L_2 = 26.2443, L_3 = 5.1241

Total tensile force on bolting

T = (12*M - 0.6*W *(L_1 + L_3)) / (L_2 + L_3)
= (12*14,059.1 - 0.6*8,855.54 *(13.8762 + 5.1241)) / (26.2443 + 5.1241)
= 2,159.97 lb_f

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

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

= 2,159.97 / (0.0095 * (40.625 / 2) * 2.7533)
= 4,080 psi

Total compressive load on foundation

C_c = T + W + Bolt Preload
= 2,159.97 + 8,855.54 + 0
= 11,015.51 lb_f

Foundation bearing stress

$f_c = C_c / (((t_c - t_s) + n*t_s)*(d / 2)*K_2)$
= 11,015.51 / (((6 - 0.0095) + 9.2889*0.0095)*(40.625 / 2)*1.0792)
= 83 psi

As f_c <= 1,658 psi the base plate width is satisfactory.

$k = 1 / (1 + f_s / (n*f_c))$
= 1 / (1 + 4,080 / (9.2889*83))
= 0.15839

Base plate required thickness (operating, corroded + Wind)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
= $(3*83*3.3125^2 / 20{,}000)^{0.5}$
= 0.3689 in

The base plate thickness is satisfactory.

Anchor bolt load (operating, new + Wind)

P = -0.6*W / N + 48 * M / (N*BC)
= -0.6*8,855.54 / 4 + 48 * 14,059.1 / (4*44.125)
= 2,495.12 lb_f

Required area per bolt = P / S_b = 0.1248 in^2

The area provided (0.302 in^2) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, operating, new + Wind)

Base plate width, t_c:	6	in
Average base plate diameter, d:	40.625	in
Base plate elastic modulus, E_s:	29.0E+06	psi
Base plate yield stress, S_y:	38,000	psi

E_c = 57,000*Sqr(3,000) = 3,122,019 psi

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

$t_s = (N*A_b) / (\pi*d)$
= (4*0.302) / (π*40.625)
= 0.0095 in

From table 12.4 for k = 0.15839:

K_1 = 2.7533, K_2 = 1.0792
L_1 = 13.8762, L_2 = 26.2443, L_3 = 5.1241

Total tensile force on bolting

$T = (12*M - 0.6*W*(L_1 + L_3)) / (L_2 + L_3)$
$= (12*14{,}059.1 - 0.6*8{,}855.54*(13.8762 + 5.1241)) / (26.2443 + 5.1241)$
$= 2{,}159.97\ lb_f$

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

$f_s = T / (t_s * (d / 2) * K_1)$
$= 2{,}159.97 / (0.0095 * (40.625 / 2) * 2.7533)$
$= 4{,}080$ psi

Total compressive load on foundation

$C_c = T + W + \text{Bolt Preload}$
$= 2{,}159.97 + 8{,}855.54 + 0$
$= 11{,}015.51\ lb_f$

Foundation bearing stress

$f_c = C_c / (((t_c - t_s) + n*t_s)*(d / 2)*K_2)$
$= 11{,}015.51 / (((6 - 0.0095) + 9.2889*0.0095)*(40.625 / 2)*1.0792)$
$= \underline{83}$ psi

As $f_c <= 1{,}658$ psi the base plate width is satisfactory.

$k = 1 / (1 + f_s / (n*f_c))$
$= 1 / (1 + 4{,}080 / (9.2889*83))$
$= 0.15839$

Base plate required thickness (operating, new + Wind)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
$= (3*83*3.3125^2 / 20{,}000)^{0.5}$
$= \underline{0.3689}$ in

The base plate thickness is satisfactory.

Anchor bolt load (empty, corroded + Wind)

$P = -0.6*W / N + 48 * M / (N*BC)$
$= -0.6*5{,}150.06 / 4 + 48 * 14{,}059.1 / (4*44.125)$
$= 3{,}050.94\ lb_f$

Required area per bolt = $P / S_b = \underline{0.1525}\ in^2$

The area provided (0.302 in^2) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, empty, corroded + Wind)

Base plate width, t_c:	6	in
Average base plate diameter, d:	40.625	in
Base plate elastic modulus, E_s:	29.0E+06	psi
Base plate yield stress, S_y:	38,000	psi

$E_c = 57{,}000*Sqr(3{,}000) = 3{,}122{,}019$ psi

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

$t_s = (N*A_b) / (\pi*d)$
$= (4*0.302) / (\pi*40.625)$
$= 0.0095$ in

From table 12.4 for k = 0.105318:

$K_1 = 2.8747$, $K_2 = 0.875$
$L_1 = 16.0325$, $L_2 = 27.7418$, $L_3 = 3.4132$

Total tensile force on bolting

$T = (12*M - 0.6*W*(L_1 + L_3)) / (L_2 + L_3)$
$= (12*14{,}059.1 - 0.6*5{,}150.06*(16.0325 + 3.4132)) / (27.7418 + 3.4132)$
$= 3{,}486.49$ lb_f

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

$f_s = T / (t_s * (d / 2) * K_1)$
$= 3{,}486.49 / (0.0095 * (40.625 / 2) * 2.8747)$
$= 6{,}308$ psi

Total compressive load on foundation

$C_c = T + W +$ Bolt Preload
$= 3{,}486.49 + 5{,}150.06 + 0$
$= 8{,}636.55$ lb_f

Foundation bearing stress

$f_c = C_c / (((t_c - t_s) + n*t_s)*(d / 2)*K_2)$
$= 8{,}636.55 / (((6 - 0.0095) + 9.2889*0.0095)*(40.625 / 2)*0.875)$
$= \underline{80}$ psi

As $f_c <= 1{,}658$ psi the base plate width is satisfactory.

$k = 1 / (1 + f_s / (n*f_c))$
$= 1 / (1 + 6{,}308 / (9.2889*80))$
$= 0.105318$

Base plate required thickness (empty, corroded + Wind)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
$= (3*80*3.3125^2 / 20{,}000)^{0.5}$
$= \underline{0.3627}$ in

The base plate thickness is satisfactory.

Anchor bolt load (empty, new + Wind)

$P = -0.6*W / N + 48 * M / (N*BC)$
$= -0.6*5{,}150.06 / 4 + 48 * 14{,}059.1 / (4*44.125)$
$= 3{,}050.94$ lb_f

Required area per bolt = $P / S_b = \underline{0.1525}$ in^2

The area provided (0.302 in^2) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, empty, new + Wind)

Base plate width, t_c:	6	in
Average base plate diameter, d:	40.625	in
Base plate elastic modulus, E_s:	29.0E+06	psi
Base plate yield stress, S_y:	38,000	psi

E_c = 57,000*Sqr(3,000) = 3,122,019 psi

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

$t_s = (N*A_b) / (\pi*d)$
= (4*0.302) / (π*40.625)
= 0.0095 in

From table 12.4 for k = 0.105318:

K_1 = 2.8747, K_2 = 0.875
L_1 = 16.0325, L_2 = 27.7418, L_3 = 3.4132

Total tensile force on bolting

$T = (12*M - 0.6*W *(L_1 + L_3)) / (L_2 + L_3)$
= (12*14,059.1 - 0.6*5,150.06 *(16.0325 + 3.4132)) / (27.7418 + 3.4132)
= 3,486.49 lb_f

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

$f_s = T / (t_s * (d / 2) * K_1)$
= 3,486.49 / (0.0095 * (40.625 / 2) * 2.8747)
= 6,308 psi

Total compressive load on foundation

$C_c = T + W +$ Bolt Preload
= 3,486.49 + 5,150.06 + 0
= 8,636.55 lb_f

Foundation bearing stress

$f_c = C_c / (((t_c - t_s) + n*t_s)*(d / 2)*K_2)$
= 8,636.55 / (((6 - 0.0095) + 9.2889*0.0095)*(40.625 / 2)*0.875)
= 80 psi

As f_c <= 1,658 psi the base plate width is satisfactory.

$k = 1 / (1 + f_s / (n*f_c))$
= 1 / (1 + 6,308 / (9.2889*80))
= 0.105318

Base plate required thickness (empty, new + Wind)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
= $(3*80*3.3125^2 / 20,000)^{0.5}$
= 0.3627 in

The base plate thickness is satisfactory.

Anchor bolt load (operating, corroded + Seismic)

$P = -(0.6 - 0.14*S_{DS})*W / N + 48 * M / (N*BC)$
$= -(0.6 - 0.14*0.55)*8,855.54 / 4 + 48 * 14,763.9 / (4*44.125)$
$= 2,857.26\ lb_f$

Required area per bolt = P / S_b = 0.1429 in^2

The area provided (0.302 in^2) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, operating, corroded + Seismic)

Base plate width, t_c:	6	in
Average base plate diameter, d:	40.625	in
Base plate elastic modulus, E_s:	29.0E+06	psi
Base plate yield stress, S_y:	38,000	psi

$E_c = 57,000*Sqr(3,000) = 3,122,019$ psi

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

$t_s = (N*A_b) / (\pi*d)$
$= (4*0.302) / (\pi*40.625)$
$= 0.0095$ in

From table 12.4 for k = 0.145484:

$K_1 = 2.7824$, $K_2 = 1.0328$
$L_1 = 14.4005$, $L_2 = 26.6126$, $L_3 = 4.7087$

Total tensile force on bolting

$T = (12*M - (0.6 - 0.14*S_{DS})*W *(L_1 + L_3)) / (L_2 + L_3)$
$= (12*14,763.9 - (0.6 - 0.14*0.55)*8,855.54 *(14.4005 + 4.7087)) / (26.6126 + 4.7087)$
$= 2,830.78\ lb_f$

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

$f_s = T / (t_s * (d / 2) * K_1)$
$= 2,830.78 / (0.0095 * (40.625 / 2) * 2.7824)$
$= 5,292$ psi

Total compressive load on foundation

$C_c = T + (1 + 0.14*S_{DS})*W$ + Bolt Preload
$= 2,830.78 + (1 + 0.14*0.55)*8,855.54 + 0$
$= 12,368.2\ lb_f$

Foundation bearing stress

$f_c = C_c / (((t_c - t_s) + n*t_s)*(d / 2)*K_2)$
$= 12,368.2 / (((6 - 0.0095) + 9.2889*0.0095)*(40.625 / 2)*1.0328)$
$= 97$ psi

As f_c <= 1,658 psi the base plate width is satisfactory.

$k = 1 / (1 + f_s / (n*f_c))$
$= 1 / (1 + 5,292 / (9.2889*97))$

= 0.145484

Base plate required thickness (operating, corroded + Seismic)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
$= (3*97*3.3125^2 / 20{,}000)^{0.5}$
= 0.3995 in

The base plate thickness is satisfactory.

Anchor bolt load (operating, new + Seismic)

$P = -(0.6 - 0.14*S_{DS})*W / N + 48 * M / (N*BC)$
$= -(0.6 - 0.14*0.55)*8{,}855.54 / 4 + 48 * 14{,}763.9 / (4*44.125)$
$= 2{,}857.26$ lb$_f$

Required area per bolt = P / S_b = 0.1429 in^2

The area provided (0.302 in^2) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, operating, new + Seismic)

Base plate width, t_c:	6	in
Average base plate diameter, d:	40.625	in
Base plate elastic modulus, E_s:	29.0E+06	psi
Base plate yield stress, S_y:	38,000	psi

$E_c = 57{,}000*Sqr(3{,}000) = 3{,}122{,}019$ psi

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

$t_s = (N*A_b) / (\pi*d)$
$= (4*0.302) / (\pi*40.625)$
= 0.0095 in

From table 12.4 for k = 0.145484:

$K_1 = 2.7824$, $K_2 = 1.0328$
$L_1 = 14.4005$, $L_2 = 26.6126$, $L_3 = 4.7087$

Total tensile force on bolting

$T = (12*M - (0.6 - 0.14*S_{DS})*W *(L_1 + L_3)) / (L_2 + L_3)$
$= (12*14{,}763.9 - (0.6 - 0.14*0.55)*8{,}855.54 *(14.4005 + 4.7087)) / (26.6126 + 4.7087)$
$= 2{,}830.78$ lb$_f$

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

$f_s = T / (t_s * (d / 2) * K_1)$
$= 2{,}830.78 / (0.0095 * (40.625 / 2) * 2.7824)$
= 5,292 psi

Total compressive load on foundation

$C_c = T + (1 + 0.14*S_{DS})*W$ + Bolt Preload
$= 2{,}830.78 + (1 + 0.14*0.55)*8{,}855.54 + 0$
$= 12{,}368.2$ lb$_f$

Foundation bearing stress

$f_c = C_c / (((t_c - t_s) + n*t_s)*(d / 2)*K_2)$
$= 12{,}368.2 / (((6 - 0.0095) + 9.2889*0.0095)*(40.625 / 2)*1.0328)$
$= \underline{97}$ psi

As f_c <= 1,658 psi the base plate width is satisfactory.

$k = 1 / (1 + f_s / (n*f_c))$
$= 1 / (1 + 5{,}292 / (9.2889*97))$
$= 0.145484$

Base plate required thickness (operating, new + Seismic)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
$= (3*97*3.3125^2 / 20{,}000)^{0.5}$
$= \underline{0.3995}$ in

The base plate thickness is satisfactory.

Anchor bolt load (empty, corroded + Seismic)

$P = -(0.6 - 0.14*S_{DS})*W / N + 48 * M / (N*BC)$
$= -(0.6 - 0.14*0.55)*5{,}150.06 / 4 + 48 * 10{,}428.9 / (4*44.125)$
$= 2{,}162.81$ lb_f

Required area per bolt = $P / S_b = \underline{0.1081}$ in^2

The area provided (0.302 in^2) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, empty, corroded + Seismic)

Base plate width, t_c:	6	in
Average base plate diameter, d:	40.625	in
Base plate elastic modulus, E_s:	29.0E+06	psi
Base plate yield stress, S_y:	38,000	psi

$E_c = 57{,}000*Sqr(3{,}000) = 3{,}122{,}019$ psi

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

$t_s = (N*A_b) / (\pi*d)$
$= (4*0.302) / (\pi*40.625)$
$= 0.0095$ in

From table 12.4 for k = 0.125674:

$K_1 = 2.8276$, $K_2 = 0.9579$
$L_1 = 15.2053$, $L_2 = 27.173$, $L_3 = 4.0703$

Total tensile force on bolting

$T = (12*M - (0.6 - 0.14*S_{DS})*W *(L_1 + L_3)) / (L_2 + L_3)$
$= (12*10{,}428.9 - (0.6 - 0.14*0.55)*5{,}150.06 *(15.2053 + 4.0703)) / (27.173 + 4.0703)$
$= 2{,}343.8$ lb_f

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

$f_s = T / (t_s * (d / 2) * K_1)$
$= 2,343.8 / (0.0095 * (40.625 / 2) * 2.8276)$
$= 4,311$ psi

Total compressive load on foundation

$C_c = T + (1 + 0.14*S_{DS})*W + \text{Bolt Preload}$
$= 2,343.8 + (1 + 0.14*0.55)*5,150.06 + 0$
$= 7,890.42$ lb$_f$

Foundation bearing stress

$f_c = C_c / (((t_c - t_s) + n*t_s)*(d / 2)*K_2)$
$= 7,890.42 / (((6 - 0.0095) + 9.2889*0.0095)*(40.625 / 2)*0.9579)$
$= \underline{67}$ psi

As $f_c <= 1,658$ psi the base plate width is satisfactory.

$k = 1 / (1 + f_s / (n*f_c))$
$= 1 / (1 + 4,311 / (9.2889*67))$
$= 0.125674$

Base plate required thickness (empty, corroded + Seismic)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
$= (3*67*3.3125^2 / 20,000)^{0.5}$
$= \underline{0.3314}$ in

The base plate thickness is satisfactory.

Anchor bolt load (empty, new + Seismic)

$P = -(0.6 - 0.14*S_{DS})*W / N + 48 * M / (N*BC)$
$= -(0.6 - 0.14*0.55)*5,150.06 / 4 + 48 * 10,428.9 / (4*44.125)$
$= 2,162.81$ lb$_f$

Required area per bolt = $P / S_b = \underline{0.1081}$ in^2

The area provided (0.302 in^2) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, empty, new + Seismic)

Base plate width, t_c:	6	in
Average base plate diameter, d:	40.625	in
Base plate elastic modulus, E_s:	29.0E+06	psi
Base plate yield stress, S_y:	38,000	psi

$E_c = 57,000*Sqr(3,000) = 3,122,019$ psi

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

$t_s = (N*A_b) / (\pi*d)$
$= (4*0.302) / (\pi*40.625)$
$= 0.0095$ in

From table 12.4 for k = 0.125674:

$K_1 = 2.8276$, $K_2 = 0.9579$
$L_1 = 15.2053$, $L_2 = 27.173$, $L_3 =$

Total tensile force on bolting

$T = (12*M - (0.6 - 0.14*S_{DS})*W*(L_1 + L_3)) / (L_2 + L_3)$
$= (12*10,428.9 - (0.6 - 0.14*0.55)*5,150.06*(15.2053 + 4.0703)) / (27.173 + 4.0703)$
$= 2,343.8\ lb_f$

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

$f_s = T / (t_s * (d / 2) * K_1)$
$= 2,343.8 / (0.0095 * (40.625 / 2) * 2.8276)$
$= 4,311$ psi

Total compressive load on foundation

$C_c = T + (1 + 0.14*S_{DS})*W + \text{Bolt Preload}$
$= 2,343.8 + (1 + 0.14*0.55)*5,150.06 + 0$
$= 7,890.42\ lb_f$

Foundation bearing stress

$f_c = C_c / (((t_c - t_s) + n*t_s)*(d / 2)*K_2)$
$= 7,890.42 / (((6 - 0.0095) + 9.2889*0.0095)*(40.625 / 2)*0.9579)$
$= \underline{67}$ psi

As f_c <= 1,658 psi the base plate width is satisfactory.

$k = 1 / (1 + f_s / (n*f_c))$
$= 1 / (1 + 4,311 / (9.2889*67))$
$= 0.125674$

Base plate required thickness (empty, new + Seismic)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
$= (3*67*3.3125^2 / 20,000)^{0.5}$
$= \underline{0.3314}$ in

The base plate thickness is satisfactory.

Foundation bearing stress

$f_c = C_c / (((t_c - t_s) + n*t_s)*(d / 2)*K_2)$
$= 12{,}368.2 / (((6 - 0.0095) + 9.2889*0.0095)*(40.625 / 2)*1.0328)$
$= \underline{97}$ psi

As f_c <= 1,658 psi the base plate width is satisfactory.

$k = 1 / (1 + f_s / (n*f_c))$
$= 1 / (1 + 5{,}292 / (9.2889*97))$
$= 0.145484$

Base plate required thickness (operating, new + Seismic)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
$= (3*97*3.3125^2 / 20{,}000)^{0.5}$
$= \underline{0.3995}$ in

The base plate thickness is satisfactory.

Anchor bolt load (empty, corroded + Seismic)

$P = -(0.6 - 0.14*S_{DS})*W / N + 48 * M / (N*BC)$
$= -(0.6 - 0.14*0.55)*5{,}150.06 / 4 + 48 * 10{,}428.9 / (4*44.125)$
$= 2{,}162.81$ lb_f

Required area per bolt = $P / S_b = \underline{0.1081}$ in^2

The area provided (0.302 in^2) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, empty, corroded + Seismic)

Base plate width, t_c:	6	in
Average base plate diameter, d:	40.625	in
Base plate elastic modulus, E_s:	29.0E+06	psi
Base plate yield stress, S_y:	38,000	psi

$E_c = 57{,}000*Sqr(3{,}000) = 3{,}122{,}019$ psi

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

$t_s = (N*A_b) / (\pi*d)$
$= (4*0.302) / (\pi*40.625)$
$= 0.0095$ in

From table 12.4 for k = 0.125674:

$K_1 = 2.8276$, $K_2 = 0.9579$
$L_1 = 15.2053$, $L_2 = 27.173$, $L_3 = 4.0703$

Total tensile force on bolting

$T = (12*M - (0.6 - 0.14*S_{DS})*W *(L_1 + L_3)) / (L_2 + L_3)$
$= (12*10{,}428.9 - (0.6 - 0.14*0.55)*5{,}150.06 *(15.2053 + 4.0703)) / (27.173 + 4.0703)$
$= 2{,}343.8$ lb_f

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

$f_s = T / (t_s * (d / 2) * K_1)$
$= 2,343.8 / (0.0095 * (40.625 / 2) * 2.8276)$
$= 4,311$ psi

Total compressive load on foundation

$C_c = T + (1 + 0.14*S_{DS})*W + \text{Bolt Preload}$
$= 2,343.8 + (1 + 0.14*0.55)*5,150.06 + 0$
$= 7,890.42$ lb$_f$

Foundation bearing stress

$f_c = C_c / (((t_c - t_s) + n*t_s)*(d / 2)*K_2)$
$= 7,890.42 / (((6 - 0.0095) + 9.2889*0.0095)*(40.625 / 2)*0.9579)$
$= \underline{67}$ psi

As f_c <= 1,658 psi the base plate width is satisfactory.

$k = 1 / (1 + f_s / (n*f_c))$
$= 1 / (1 + 4,311 / (9.2889*67))$
$= 0.125674$

Base plate required thickness (empty, corroded + Seismic)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
$= (3*67*3.3125^2 / 20,000)^{0.5}$
$= \underline{0.3314}$ in

The base plate thickness is satisfactory.

Anchor bolt load (empty, new + Seismic)

$P = -(0.6 - 0.14*S_{DS})*W / N + 48 * M / (N*BC)$
$= -(0.6 - 0.14*0.55)*5,150.06 / 4 + 48 * 10,428.9 / (4*44.125)$
$= 2,162.81$ lb$_f$

Required area per bolt = $P / S_b = \underline{0.1081}$ in^2

The area provided (0.302 in^2) by the specified anchor bolt is adequate.

Support calculations (Jawad & Farr chapter 12, empty, new + Seismic)

Base plate width, t_c:	6	in
Average base plate diameter, d:	40.625	in
Base plate elastic modulus, E_s:	29.0E+06	psi
Base plate yield stress, S_y:	38,000	psi

$E_c = 57,000*Sqr(3,000) = 3,122,019$ psi

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

$t_s = (N*A_b) / (\pi*d)$
$= (4*0.302) / (\pi*40.625)$
$= 0.0095$ in

From table 12.4 for k = 0.125674:

$K_1 = 2.8276$, $K_2 = 0.9579$
$L_1 = 15.2053$, $L_2 = 27.173$, $L_3 =$

Total tensile force on bolting

$T = (12*M - (0.6 - 0.14*S_{DS})*W*(L_1 + L_3)) / (L_2 + L_3)$
$= (12*10,428.9 - (0.6 - 0.14*0.55)*5,150.06*(15.2053 + 4.0703)) / (27.173 + 4.0703)$
$= 2,343.8\ lb_f$

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

$f_s = T / (t_s * (d / 2) * K_1)$
$= 2,343.8 / (0.0095 * (40.625 / 2) * 2.8276)$
$= 4,311$ psi

Total compressive load on foundation

$C_c = T + (1 + 0.14*S_{DS})*W + \text{Bolt Preload}$
$= 2,343.8 + (1 + 0.14*0.55)*5,150.06 + 0$
$= 7,890.42\ lb_f$

Foundation bearing stress

$f_c = C_c / (((t_c - t_s) + n*t_s)*(d / 2)*K_2)$
$= 7,890.42 / (((6 - 0.0095) + 9.2889*0.0095)*(40.625 / 2)*0.9579)$
$= \underline{67}$ psi

As f_c <= 1,658 psi the base plate width is satisfactory.

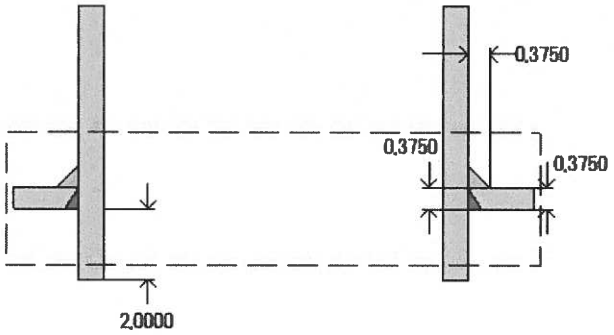
$k = 1 / (1 + f_s / (n*f_c))$
$= 1 / (1 + 4,311 / (9.2889*67))$
$= 0.125674$

Base plate required thickness (empty, new + Seismic)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
$= (3*67*3.3125^2 / 20,000)^{0.5}$
$= \underline{0.3314}$ in

The base plate thickness is satisfactory.

INLET (C1)

ASME Section VIII Division 1, 2017 Edition	
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	SHELL RG 2
Orientation	270°
Nozzle center line offset to datum line	147"
End of nozzle to shell center	30"
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. 10)
Inside diameter, new	5.761"
Pipe nominal wall thickness	0.432"
Pipe minimum wall thickness[1]	0.378"
Corrosion allowance	0"
Projection available outside vessel, Lpr	2.5"
Internal projection, h_{new}	2"
Projection available outside vessel to flange face, Lf	6"
Local vessel minimum thickness	0.375"
Liquid static head included	0 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Lower fillet, Leg_{43}	0"
Nozzle to vessel groove weld	0.375"

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

ASME B16.5-2013 Flange	
Description	NPS 6 Class 150 WN A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 388, ln. 32)
Blind included	No
Rated MDMT	-32.3°F
Liquid static head	0 psi
MAWP rating	272.5 psi @ 150°F
MAP rating	285 psi @ 70°F
Hydrotest rating	450 psi @ 70°F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	None UW-11(c) Type 1
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -32.3°F (Coincident ratio = 0.8772) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements Nozzle At Intersection	
Governing thickness, t_g =	0.375"
Exemption temperature from Fig UCS-66 Curve B =	-20°F
t_r = 250*24 / (20,000*1 + 0.4*250) =	0.2985"
Stress ratio = t_r*E* / (t_n - c) = 0.2985*1 / (0.375 - 0) =	0.796
Reduction in MDMT, T_R from Fig UCS-66.1 =	20.4°F
MDMT = max[MDMT - T_R, -55] = max[-20 - 20.4 , -55] =	-40.4°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

UCS-66 Material Toughness Requirements Nozzle	
t_r = 250*2.8805 / (17,100*1 - 0.6*250) =	0.0425"
Stress ratio = t_r*E* / (t_n - c) = 0.0425*1 / (0.378 - 0) =	0.1124
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 250 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
1.7571	1.8683	0.4311	0.6244	0.6926	--	0.1202	0.245	0.378

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

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

Calculations for internal pressure 250 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(5.761, 2.8805 + (0.432 - 0) + (0.375 - 0))
= 5.761 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.375 - 0), 2.5*(0.432 - 0) + 0)
= 0.9375 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(2, 2.5*(0.375 - 0), 2.5*(0.432 - 0 - 0))
= 0.9375 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 250*2.8805 / (17,100*1 - 0.6*250)
= 0.0425 in

Required thickness t_r from UG-37(a)

t_r = P*R_o / (S*E + 0.4*P)
= 250*24 / (20,000*1 + 0.4*250)
= 0.2985 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*R_o / (S*E + 0.4*P)$
= $250*24 / (20{,}000*0.85 + 0.4*250)$
= 0.3509 in

Area required per UG-37(c)

Allowable stresses: S_n = 17,100, S_v = 20,000 psi

f_{r1} = lesser of 1 or S_n / S_v = 0.855

f_{r2} = lesser of 1 or S_n / S_v = 0.855

A = $d*t_r*F + 2*t_n*t_r*F*(1 - f_{r1})$
= $5.761*0.2985*1 + 2*0.432*0.2985*1*(1 - 0.855)$
= <u>1.7571</u> in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= <u>0.4311</u> in^2

= $d*(E_1*t - F*t_r) - 2*t_n*(E_1*t - F*t_r)*(1 - f_{r1})$
= $5.761*(1*0.375 - 1*0.2985) - 2*0.432*(1*0.375 - 1*0.2985)*(1 - 0.855)$
= 0.4311 in^2

= $2*(t + t_n)*(E_1*t - F*t_r) - 2*t_n*(E_1*t - F*t_r)*(1 - f_{r1})$
= $2*(0.375 + 0.432)*(1*0.375 - 1*0.2985) - 2*0.432*(1*0.375 - 1*0.2985)*(1 - 0.855)$
= 0.1139 in^2

A_2 = smaller of the following= <u>0.6244</u> in^2

= $5*(t_n - t_m)*f_{r2}*t$
= $5*(0.432 - 0.0425)*0.855*0.375$
= 0.6244 in^2

= $5*(t_n - t_m)*f_{r2}*t_n$
= $5*(0.432 - 0.0425)*0.855*0.432$
= 0.7193 in^2

A_3 = smaller of the following= <u>0.6926</u> in^2

= $5*t*t_i*f_{r2}$
= $5*0.375*0.432*0.855$
= <u>0.6926</u> in^2

= $5*t_i*t_i*f_{r2}$
= $5*0.432*0.432*0.855$
= <u>0.7978</u> in^2

$= 2*h*t_i*f_{r2}$
$= 2*2*0.432*0.855$
$= \underline{1.4774}$ in^2

$A_{41} = Leg^2*f_{r2}$
$= 0.375^2*0.855$
$= \underline{0.1202}$ in^2

Area $= A_1 + A_2 + A_3 + A_{41}$
$= 0.4311 + 0.6244 + 0.6926 + 0.1202$
$= \underline{1.8683}$ in^2

As Area >= A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.375 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min} = \underline{0.25}$ in
$t_{c(actual)} = 0.7*Leg = 0.7*0.375 = 0.2625$ in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$t_{a\ UG-27} = P*R_n / (S_n*E - 0.6*P) + Corrosion$
$= 250*2.8805 / (17{,}100*1 - 0.6*250) + 0$
$= 0.0425$ in

$t_a = max[\ t_{a\ UG-27}\ ,\ t_{a\ UG-22}\ ]$
$= max[\ 0.0425\ ,\ 0\ ]$
$= 0.0425$ in

$t_{b1} = P*R_o / (S*E + 0.4*P) + Corrosion$
$= 250*24 / (20{,}000*1 + 0.4*250) + 0$
$= 0.2985$ in

$t_{b1} = max[\ t_{b1}\ ,\ t_{b\ UG16}\ ]$
$= max[\ 0.2985\ ,\ 0.0625\ ]$
$= 0.2985$ in

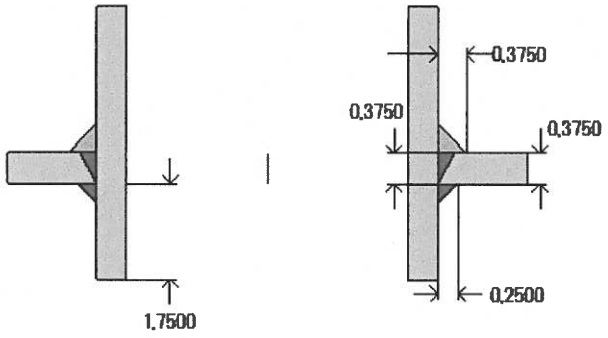
$t_b = min[\ t_{b3}\ ,\ t_{b1}\ ]$
$= min[\ 0.245\ ,\ 0.2985\ ]$
$= 0.245$ in

$t_{UG-45} = max[\ t_a\ ,\ t_b\ ]$
$= max[\ 0.0425\ ,\ 0.245\ ]$
$= \underline{0.245}$ in

Available nozzle wall thickness new, t_n = 0.875*0.432 = 0.378 in

The nozzle neck thickness is adequate.

WATER OUTLET (C2)

ASME Section VIII Division 1, 2017 Edition	
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	SHELL RG 1
Orientation	90°
Nozzle center line offset to datum line	0"
End of nozzle to shell center	25"
Passes through a Category A joint	No
Nozzle	
Description	NPS 3 Class 3000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 19)
Inside diameter, new	3.5"
Nominal wall thickness	0.375"
Corrosion allowance	0"
Projection available outside vessel, Lpr	1"
Internal projection, h_{new}	1.75"
Local vessel minimum thickness	0.375"
Liquid static head included	1.69 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Lower fillet, Leg_{43}	0.25"
Nozzle to vessel groove weld	0.375"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 251.69*1.75 / (20,000*1 - 0.6*251.69) =	0.0222"
Stress ratio = t_r*E* / (t_n - c) = 0.0222*1 / (0.375 - 0) =	0.0592
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 251.69 psi @ 150 °F							The nozzle passes UG-44	
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	0.375

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

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

Calculations for internal pressure 251.69 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(3.5, 1.75 + (0.375 - 0) + (0.375 - 0))
= 3.5 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.375 - 0), 2.5*(0.375 - 0) + 0)
= 0.9375 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(1.75, 2.5*(0.375 - 0), 2.5*(0.375 - 0 - 0))
= 0.9375 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 251.6875*1.75 / (20,000*1 - 0.6*251.6875)
= 0.0222 in

Required thickness t_r from UG-37(a)

t_r = P*R_o / (S*E + 0.4*P)
= 251.6875*24 / (20,000*1 + 0.4*251.6875)
= 0.3005 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*R_o / (S*E + 0.4*P)$
= $251.6875*24 / (20{,}000*0.85 + 0.4*251.6875)$
= 0.3532 in

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

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.375 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min}$ = 0.25 in
$t_{c(actual)}$ = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-44 Thickness Check - ASME B16.11 Coupling

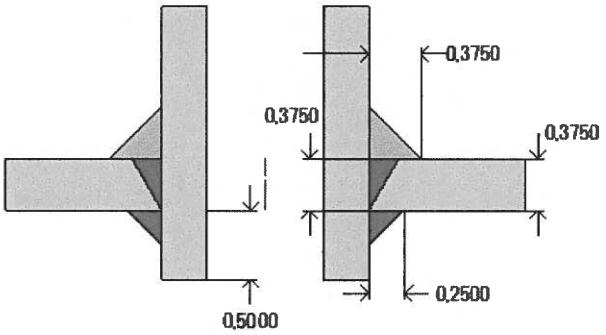
$t_{a\ App\ 1\text{-}1}$ = $P*R_o / (S_n*E + 0.4*P)$ + Corrosion
= $251.6875*2.125 / (20{,}000*1 + 0.4*251.6875) + 0$
= 0.0266 in

$t_{a\ UG\text{-}44}$ = $max[\ t_{a\ App\ 1\text{-}1}\ ,\ t_{b\ UG16}\ ]$
= max[0.0266 , 0.0625]
= 0.0625 in

Available nozzle wall thickness new, t_n = 0.375 in

The nozzle neck thickness is adequate.

GAUGE GLASS (C3B)

ASME Section VIII Division 1, 2017 Edition

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

Location and Orientation	
Located on	SHELL RG 1
Orientation	135°
Nozzle center line offset to datum line	57"
End of nozzle to shell center	25"
Passes through a Category A joint	No
Nozzle	
Description	NPS 0.5 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 19)
Inside diameter, new	0.84"
Nominal wall thickness	0.33"
Corrosion allowance	0"
Projection available outside vessel, Lpr	1"
Internal projection, h_{new}	0.5"
Local vessel minimum thickness	0.375"
Liquid static head included	0 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Lower fillet, Leg_{43}	0.25"
Nozzle to vessel groove weld	0.375"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 250*0.42 / (20,000*1 - 0.6*250) =	0.0053"
Stress ratio = t_r*E^* / (t_n - c) = 0.0053*1 / (0.33 - 0) =	0.016
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 250 psi @ 150 °F							The nozzle passes UG-44	
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	0.33

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.231	0.2625	weld size is adequate

Calculations for internal pressure 250 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(0.84, 0.42 + (0.33 - 0) + (0.375 - 0))
= 1.125 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.375 - 0), 2.5*(0.33 - 0) + 0)
= 0.825 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(0.5, 2.5*(0.375 - 0), 2.5*(0.33 - 0 - 0))
= 0.5 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 250*0.42 / (20,000*1 - 0.6*250)
= 0.0053 in

Required thickness t_r from UG-37(a)

t_r = P*R_o / (S*E + 0.4*P)
= 250*24 / (20,000*1 + 0.4*250)

= 0.2985 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*R_o / (S*E + 0.4*P)$
= 250*24 / (20,000*0.85 + 0.4*250)
= 0.3509 in

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

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.33 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min}$ = 0.231 in
$t_{c(actual)}$ = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-44 Thickness Check - ASME B16.11 Coupling

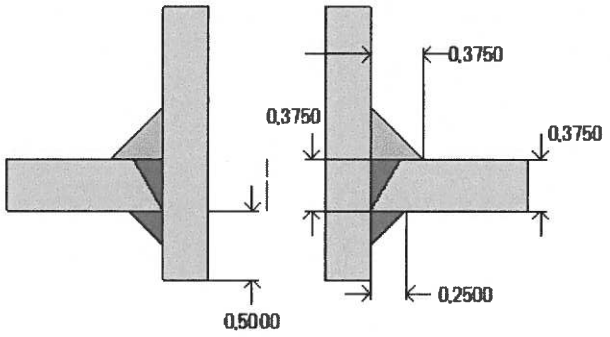
$t_{a\ App\ 1\text{-}1}$ = $P*R_o / (S_n*E + 0.4*P)$ + Corrosion
= 250*0.75 / (20,000*1 + 0.4*250) + 0
= 0.0093 in

$t_{a\ UG\text{-}44}$ = max[$t_{a\ App\ 1\text{-}1}$, $t_{b\ UG16}$]
= max[0.0093 , 0.0625]
= 0.0625 in

Available nozzle wall thickness new, t_n = 0.33 in

The nozzle neck thickness is adequate.

GAUGE GLASS (C3A)

ASME Section VIII Division 1, 2017 Edition	
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	SHELL RG 1
Orientation	135°
Nozzle center line offset to datum line	7"
End of nozzle to shell center	25"
Passes through a Category A joint	No
Nozzle	
Description	NPS 0.5 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 19)
Inside diameter, new	0.84"
Nominal wall thickness	0.33"
Corrosion allowance	0"
Projection available outside vessel, Lpr	1"
Internal projection, h_{new}	0.5"
Local vessel minimum thickness	0.375"
Liquid static head included	1.39 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Lower fillet, Leg_{43}	0.25"
Nozzle to vessel groove weld	0.375"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 251.39*0.42 / (20,000*1 - 0.6*251.39) =	0.0053"
Stress ratio = t_r*E* / (t_n - c) = 0.0053*1 / (0.33 - 0) =	0.0161
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 251.39 psi @ 150 °F							The nozzle passes UG-44	
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	0.33

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.231	0.2625	weld size is adequate

Calculations for internal pressure 251.39 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(0.84, 0.42 + (0.33 - 0) + (0.375 - 0))
= 1.125 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.375 - 0), 2.5*(0.33 - 0) + 0)
= 0.825 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(0.5, 2.5*(0.375 - 0), 2.5*(0.33 - 0 - 0))
= 0.5 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 251.3869*0.42 / (20,000*1 - 0.6*251.3869)
= 0.0053 in

Required thickness t_r from UG-37(a)

t_r = P*R_o / (S*E + 0.4*P)
= 251.3869*24 / (20,000*1 + 0.4*251.3869)

= 0.3002 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*R_o / (S*E + 0.4*P)$
= 251.3869*24 / (20,000*0.85 + 0.4*251.3869)
= 0.3528 in

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

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.33 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min}$ = 0.231 in
$t_{c(actual)}$ = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-44 Thickness Check - ASME B16.11 Coupling

$t_{a\ App\ 1\text{-}1}$ = $P*R_o / (S_n*E + 0.4*P)$ + Corrosion
= 251.3869*0.75 / (20,000*1 + 0.4*251.3869) + 0
= 0.0094 in

$t_{a\ UG\text{-}44}$ = max[$t_{a\ App\ 1\text{-}1}$, $t_{b\ UG16}$]
= max[0.0094 , 0.0625]
= 0.0625 in

Available nozzle wall thickness new, t_n = 0.33 in

The nozzle neck thickness is adequate.

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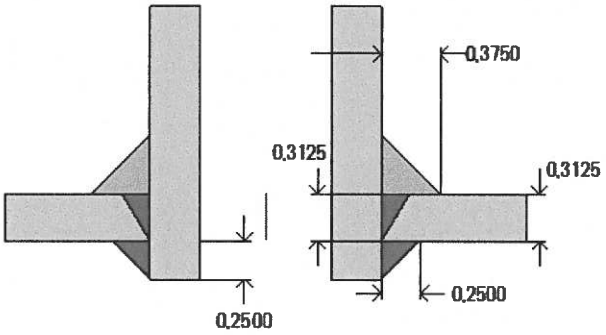	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	TOP HEAD
Orientation	90°
End of nozzle to datum line	253"
Calculated as hillside	Yes
Distance to head center, R	7"
Passes through a Category A joint	No
Nozzle	
Description	NPS 0.5 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 19)
Inside diameter, new	0.84"
Nominal wall thickness	0.33"
Corrosion allowance	0"
Opening chord length	0.85"
Projection available outside vessel, Lpr	2.2632"
Internal projection, h_{new}	0.25"
Local vessel minimum thickness	0.3125"
Liquid static head included	0 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Lower fillet, Leg_{43}	0.25"
Nozzle to vessel groove weld	0.3125"

UCS-66 Material Toughness Requirements Nozzle At Intersection	
Governing thickness, t_g =	0.3125"
Exemption temperature from Fig UCS-66 Curve B =	-20°F
t_r = 250*0.9*48 / (2*20,000*1 + 0.8*250) =	0.2687"
Stress ratio = t_r*E* / (t_n - c) = 0.2687*1 / (0.3125 - 0) =	0.8597
Reduction in MDMT, T_R from Fig UCS-66.1 =	14°F
MDMT = max[MDMT - T_R, -55] = max[-20 - 14 , -55] =	-34°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

UCS-66 Material Toughness Requirements Nozzle	
t_r = 250*0.42 / (20,000*1 - 0.6*250) =	0.0053"
Stress ratio = t_r*E* / (t_n - c) = 0.0053*1 / (0.33 - 0) =	0.016
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 250 psi @ 150 °F							The nozzle passes UG-44	
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	0.33

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.2188	0.2625	weld size is adequate

Calculations for internal pressure 250 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(0.85, 0.425 + (0.33 - 0) + (0.3125 - 0))
= 1.0675 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.3125 - 0), 2.5*(0.33 - 0) + 0)
= 0.7813 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(0.25, 2.5*(0.3125 - 0), 2.5*(0.33 - 0 - 0))
= 0.25 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 250*0.42 / (20,000*1 - 0.6*250)
= 0.0053 in

Required thickness t_r from UG-37(a)(c)

t_r = P*K_1*D_o / (2*S*E + 0.8*P)
= 250*0.9*48 / (2*20,000*1 + 0.8*250)

= 0.2687 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*D_o*K / (2*S*E + 2*P*(K - 0.1))$
= $250*48*1 / (2*20,000*1 + 2*250*(1 - 0.1))$
= 0.2967"

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

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.3125 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min}$ = 0.2188 in
$t_{c(actual)}$ = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-44 Thickness Check - ASME B16.11 Coupling

Interpretation VIII-1-83-66 has been applied.

$t_{a\ App\ 1-1}$ = $P*R_o / (S_n*E + 0.4*P)$ + Corrosion
= $250*0.75 / (20,000*1 + 0.4*250)$ + 0
= 0.0093 in

$t_{a\ UG-44}$ = max[$t_{a\ App\ 1-1}$, $t_{b\ UG16}$]
= max[0.0093 , 0.0625]
= 0.0625 in

Available nozzle wall thickness new, t_n = 0.33 in

The nozzle neck thickness is adequate.

DRAIN (C5)

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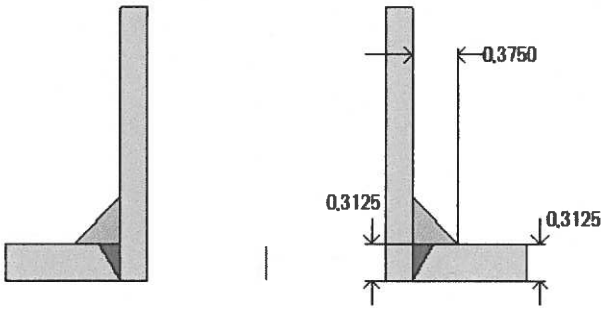	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	BOTTOM HEAD
Orientation	90°
End of nozzle to datum line	-19.5625"
Calculated as hillside	No
Distance to head center, R	0"
Passes through a Category A joint	No
Nozzle	
Description	NPS 2 Sch 80 (XS)
Access opening	No
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 10)
Inside diameter, new	1.939"
Pipe nominal wall thickness	0.218"
Pipe minimum wall thickness[1]	0.1908"
Corrosion allowance	0"
Projection available outside vessel, Lpr	2.4211"
Local vessel minimum thickness	0.3125"
Liquid static head included	2.32 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.3125"

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

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

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 252.32 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.1348	0.1908

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})	0.1526	0.2625	weld size is adequate

Calculations for internal pressure 252.32 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(1.939, 0.9695 + (0.218 - 0) + (0.3125 - 0))
= 1.939 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.3125 - 0), 2.5*(0.218 - 0) + 0)
= 0.545 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 252.3192*0.9695 / (17,100*1 - 0.6*252.3192)
= 0.0144 in

Required thickness t_r from UG-37(a)(c)

t_r = P*K_1*D_o / (2*S*E + 0.8*P)
= 252.3192*0.9*48 / (2*20,000*1 + 0.8*252.3192)
= 0.2711 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*D_o*K / (2*S*E + 2*P*(K - 0.1))
= 252.32*48*1 / (2*20,000*1 + 2*252.32*(1 - 0.1))
= 0.2994"

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

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.218 in
$t_{c(min)}$ = lesser of 0.25 or 0.7*t_{min} = 0.1526 in
$t_{c(actual)}$ = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$t_{a\ UG\text{-}27}$ = $P*R_n / (S_n*E - 0.6*P)$ + Corrosion
= 252.3305*0.9695 / (17,100*1 - 0.6*252.3305) + 0
= 0.0144 in

t_a = max[$t_{a\ UG\text{-}27}$, $t_{a\ UG\text{-}22}$]
= max[0.0144 , 0]
= 0.0144 in

t_{b1} = 0.2994 in

t_{b1} = max[t_{b1} , $t_{b\ UG16}$]
= max[0.2994 , 0.0625]
= 0.2994 in

t_b = min[t_{b3} , t_{b1}]
= min[0.1348 , 0.2994]
= 0.1348 in

$t_{UG\text{-}45}$ = max[t_a , t_b]
= max[0.0144 , 0.1348]
= 0.1348 in

Available nozzle wall thickness new, t_n = 0.875*0.218 = 0.1908 in

The nozzle neck thickness is adequate.

GAS OUTLET (C6)

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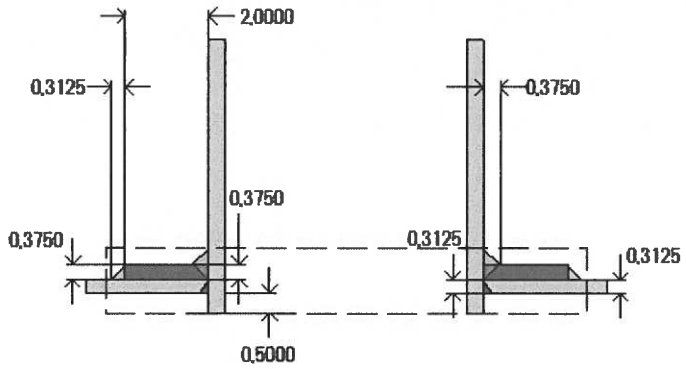

Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	TOP HEAD
Orientation	0°
End of nozzle to datum line	259"
Calculated as hillside	No
Distance to head center, R	0"
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. 10)
Inside diameter, new	5.761"
Pipe nominal wall thickness	0.432"
Pipe minimum wall thickness[1]	0.378"
Corrosion allowance	0"
Projection available outside vessel, Lpr	4.4601"
Internal projection, h_{new}	0.5"
Projection available outside vessel to flange face, Lf	7.9601"
Local vessel minimum thickness	0.3125"
Liquid static head included	0 psi
Longitudinal joint efficiency	1
Reinforcing Pad	
Material specification	SA-516 70 (II-D p. 18, ln. 33)
Diameter, D_p	10.625"

Thickness, t_e	0.375"
Is split	Yes
Butt welds tested to confirm full penetration	Yes
Joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Outer fillet, Leg_{42}	0.3125"
Lower fillet, Leg_{43}	0"
Nozzle to vessel groove weld	0.3125"
Pad groove weld	0.375"

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

ASME B16.5-2013 Flange	
Description	NPS 6 Class 150 WN A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 388, ln. 32)
Blind included	No
Rated MDMT	-32.3°F
Liquid static head	0 psi
MAWP rating	272.5 psi @ 150°F
MAP rating	285 psi @ 70°F
Hydrotest rating	450 psi @ 70°F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	None UW-11(c) Type 1
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -32.3°F (Coincident ratio = 0.8772) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements Nozzle At Intersection	
Governing thickness, t_g =	0.375"
Exemption temperature from Fig UCS-66 Curve B =	-20°F
t_r = 250*0.9*48 / (2*20,000*1 + 0.8*250) =	0.2687"
Stress ratio = t_r*E* / (t_n - c) = 0.2687*1 / (0.3125 - 0) =	0.8597
Reduction in MDMT, T_R from Fig UCS-66.1 =	14°F
MDMT = max[MDMT - T_R, -55] = max[-20 - 14 , -55] =	-34°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

UCS-66 Material Toughness Requirements Nozzle	
t_r = 250*2.8805 / (17,100*1 - 0.6*250) =	0.0425"
Stress ratio = t_r*E* / (t_n - c) = 0.0425*1 / (0.378 - 0) =	0.1124
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 =	0.375"
Exemption temperature from Fig UCS-66 Curve B =	-20°F
t_r = 250*0.9*48 / (2*20,000*1 + 0.8*250) =	0.2687"
Stress ratio = t_r*E* / (t_n - c) = 0.2687*1 / (0.3125 - 0) =	0.8597
Reduction in MDMT, T_R from Fig UCS-66.1 =	14°F
MDMT = max[MDMT - T_R, -55] = max[-20 - 14 , -55] =	-34°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 250 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
1.5814	2.8547	0.2471	0.5203	0.3694	1.5	0.2179	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
27,333.87	44,764	101,415.81	24,814.2	138,585	56,768.2	99,242.42

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})	0.1562	0.2188	weld size is adequate

Calculations for internal pressure 250 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(5.761, 2.8805 + (0.432 - 0) + (0.3125 - 0))
= 5.761 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.3125 - 0), 2.5*(0.432 - 0) + 0.375)
= 0.7813 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(0.5, 2.5*(0.3125 - 0), 2.5*(0.432 - 0 - 0))
= 0.5 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 250*2.8805 / (17,100*1 - 0.6*250)
= 0.0425 in

Required thickness t_r from UG-37(a)(c)

t_r = $P*K_1*D_o / (2*S*E + 0.8*P)$
= $250*0.9*48 / (2*20,000*1 + 0.8*250)$
= 0.2687 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*D_o*K / (2*S*E + 2*P*(K - 0.1))$
= $250*48*1 / (2*20,000*1 + 2*250*(1 - 0.1))$
= 0.2967"

Area required per UG-37(c)

Allowable stresses: S_n = 17,100, S_v = 20,000, S_p = 20,000 psi

f_{r1} = lesser of 1 or S_n / S_v = 0.855

f_{r2} = lesser of 1 or S_n / S_v = 0.855

f_{r3} = lesser of f_{r2} or S_p / S_v = 0.855

f_{r4} = lesser of 1 or S_p / S_v = 1

A = $d*t_r*F + 2*t_n*t_r*F*(1 - f_{r1})$
= $5.761*0.2687*1 + 2*0.432*0.2687*1*(1 - 0.855)$
= 1.5814 in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= 0.2471 in^2

= $d*(E_1*t - F*t_r) - 2*t_n*(E_1*t - F*t_r)*(1 - f_{r1})$
= $5.761*(1*0.3125 - 1*0.2687) - 2*0.432*(1*0.3125 - 1*0.2687)*(1 - 0.855)$
= 0.2471 in^2

= $2*(t + t_n)*(E_1*t - F*t_r) - 2*t_n*(E_1*t - F*t_r)*(1 - f_{r1})$
= $2*(0.3125 + 0.432)*(1*0.3125 - 1*0.2687) - 2*0.432*(1*0.3125 - 1*0.2687)*(1 - 0.855)$
= 0.0598 in^2

A_2 = smaller of the following= 0.5203 in^2

= $5*(t_n - t_m)*f_{r2}*t$
= $5*(0.432 - 0.0425)*0.855*0.3125$
= 0.5203 in^2

= $2*(t_n - t_m)*(2.5*t_n + t_e)*f_{r2}$
= $2*(0.432 - 0.0425)*(2.5*0.432 + 0.375)*0.855$
= 0.9691 in^2

A_3 = smaller of the following= 0.3694 in^2

$= 5*t*t_i*f_{r2}$
$= 5*0.3125*0.432*0.855$
$= \underline{0.5771}$ in^2

$= 5*t_i*t_i*f_{r2}$
$= 5*0.432*0.432*0.855$
$= \underline{0.7978}$ in^2

$= 2*h*t_i*f_{r2}$
$= 2*0.5*0.432*0.855$
$= \underline{0.3694}$ in^2

$A_{41} = Leg^2*f_{r3}$
$= 0.375^2*0.855$
$= \underline{0.1202}$ in^2

$A_{42} = Leg^2*f_{r4}$
$= 0.3125^2*1$
$= \underline{0.0977}$ in^2

$A_5 = (D_p - d - 2*t_n)*t_e*f_{r4}*E_p$
$= (10.625 - 5.761 - 2*0.432)*0.375*1*1$
$= \underline{1.5}$ in^2

Area $= A_1 + A_2 + A_3 + A_{41} + A_{42} + A_5$
$= 0.2471 + 0.5203 + 0.3694 + 0.1202 + 0.0977 + 1.5$
$= \underline{2.8547}$ in^2

As Area >= A the reinforcement is adequate.

UW-16(c)(2) Weld Check

Inner fillet: t_{min} = lesser of 0.75 or t_n or t_e = 0.375 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min}$ = $\underline{0.25}$ in
$t_{c(actual)}$ = $0.7*Leg = 0.7*0.375 = 0.2625$ in

Outer fillet: t_{min} = lesser of 0.75 or t_e or t = 0.3125 in
$t_{w(min)}$ = $0.5*t_{min}$ = $\underline{0.1562}$ in
$t_{w(actual)}$ = $0.7*Leg = 0.7*0.3125 = 0.2188$ in

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$t_{a\ UG-27} = P*R_n / (S_n*E - 0.6*P) + Corrosion$
$= 250*2.8805 / (17{,}100*1 - 0.6*250) + 0$

$= 0.0425$ in

$t_a = \max[t_{a\ UG-27} , t_{a\ UG-22}]$
$= \max[0.0425 , 0]$
$= 0.0425$ in

$t_{b1} = 0.2967$ in

$t_{b1} = \max[t_{b1} , t_{b\ UG16}]$
$= \max[0.2967 , 0.0625]$
$= 0.2967$ in

$t_b = \min[t_{b3} , t_{b1}]$
$= \min[0.245 , 0.2967]$
$= 0.245$ in

$t_{UG-45} = \max[t_a , t_b]$
$= \max[0.0425 , 0.245]$
$= \underline{0.245}$ in

Available nozzle wall thickness new, $t_n = 0.875*0.432 = 0.378$ in

The nozzle neck thickness is adequate.

Allowable stresses in joints UG-45 and UW-15(c)

Groove weld in tension:	0.74*20,000 = 14,800 psi
Nozzle wall in shear:	0.7*17,100 = 11,970 psi
Inner fillet weld in shear:	0.49*17,100 = 8,379 psi
Outer fillet weld in shear:	0.49*20,000 = 9,800 psi
Upper groove weld in tension:	0.74*20,000 = 14,800 psi

Strength of welded joints:

(1) Inner fillet weld in shear
$(\pi / 2)$*Nozzle OD*Leg*$S_i = (\pi / 2)*6.625*0.375*8,379 = 32,698.6$ lb$_f$

(2) Outer fillet weld in shear
$(\pi / 2)$*Pad OD*Leg*$S_o = (\pi / 2)*10.625*0.3125*9,800 = 51,112.24$ lb$_f$

(3) Nozzle wall in shear
$(\pi / 2)$*Mean nozzle dia*t_n*$S_n = (\pi / 2)*6.193*0.432*11,970 = 50,303.58$ lb$_f$

(4) Groove weld in tension
$(\pi / 2)$*Nozzle OD*t_w*$S_g = (\pi / 2)*6.625*0.3125*14,800 = 48,130.18$ lb$_f$

(6) Upper groove weld in tension
$(\pi / 2)$*Nozzle OD*t_w*$S_g = (\pi / 2)*6.625*0.375*14,800 = 57,756.22$ lb$_f$

Loading on welds per UG-41(b)(1)

$W = (A - A_1 + 2*t_n*f_{r1}*(E_1*t - F*t_r))*S_v$
$= (1.5814 - 0.2471 + 2*0.432*0.855*(1*0.3125 - 1*0.2687))*20,000$
$= \underline{27,333.87}$ lb$_f$

$W_{1\text{-}1} = (A_2 + A_5 + A_{41} + A_{42})*S_v$
$= (0.5203 + 1.5 + 0.1202 + 0.0977)*20{,}000$
$= \underline{44{,}764}\ lb_f$

$W_{2\text{-}2} = (A_2 + A_3 + A_{41} + A_{43} + 2*t_n*t*f_{r1})*S_v$
$= (0.5203 + 0.3694 + 0.1202 + 0 + 2*0.432*0.3125*0.855)*20{,}000$
$= \underline{24{,}814.2}\ lb_f$

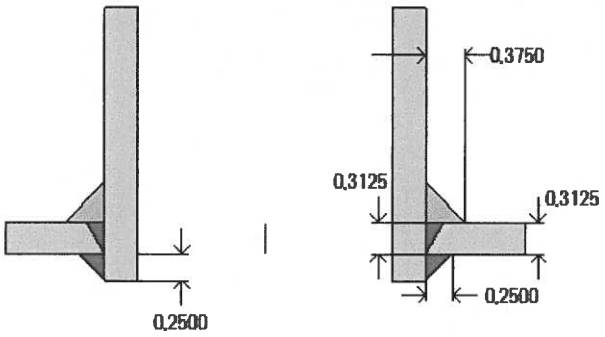
$W_{3\text{-}3} = (A_2 + A_3 + A_5 + A_{41} + A_{42} + A_{43} + 2*t_n*t*f_{r1})*S_v$
$= (0.5203 + 0.3694 + 1.5 + 0.1202 + 0.0977 + 0 + 2*0.432*0.3125*0.855)*20{,}000$
$= \underline{56{,}768.2}\ lb_f$

Load for path 1-1 lesser of W or $W_{1\text{-}1}$ = 27,333.87 lb_f
Path 1-1 through (2) & (3) = 51,112.24 + 50,303.58 = $\underline{101{,}415.81}\ lb_f$
Path 1-1 is stronger than W so it is acceptable per UG-41(b)(2).

Load for path 2-2 lesser of W or $W_{2\text{-}2}$ = 24,814.2 lb_f
Path 2-2 through (1), (4), (6) = 32,698.6 + 48,130.18 + 57,756.22 = $\underline{138{,}585}\ lb_f$
Path 2-2 is stronger than $W_{2\text{-}2}$ so it is acceptable per UG-41(b)(1).

Load for path 3-3 lesser of W or $W_{3\text{-}3}$ = 27,333.87 lb_f
Path 3-3 through (2), (4) = 51,112.24 + 48,130.18 = $\underline{99{,}242.42}\ lb_f$
Path 3-3 is stronger than W so it is acceptable per UG-41(b)(2).

SAFETY HEAD (C7)

ASME Section VIII Division 1, 2017 Edition	
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	TOP HEAD
Orientation	270°
End of nozzle to datum line	248"
Calculated as hillside	Yes
Distance to head center, R	20"
Passes through a Category A joint	No
Nozzle	
Description	NPS 2 Class 3000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 19)
Inside diameter, new	2.375"
Nominal wall thickness	0.3125"
Corrosion allowance	0"
Opening chord length	3.0339"
Projection available outside vessel, Lpr	1.256"
Internal projection, h_{new}	0.25"
Local vessel minimum thickness	0.3125"
Liquid static head included	0 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Lower fillet, Leg_{43}	0.25"
Nozzle to vessel groove weld	0.3125"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 250*1.1875 / (20,000*1 - 0.6*250) =	0.015"
Stress ratio = t_r*E* / (t_n - c) = 0.015*1 / (0.3125 - 0) =	0.0479
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 250 psi @ 150 °F							The nozzle passes UG-44	
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	0.3125

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})	0.2188	0.2625	weld size is adequate

Calculations for internal pressure 250 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(3.0339, 1.517 + (0.3125 - 0) + (0.3125 - 0))
= 3.0339 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.3125 - 0), 2.5*(0.3125 - 0) + 0)
= 0.7813 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(0.25, 2.5*(0.3125 - 0), 2.5*(0.3125 - 0 - 0))
= 0.25 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 250*1.1875 / (20,000*1 - 0.6*250)
= 0.015 in

Required thickness t_r from UG-37(a)

t_r = P*D_o*K / (2*S*E + 2*P*(K - 0.1))
= 250*48*1 / (2*20,000*1 + 2*250*(1 - 0.1))
= 0.2967"

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

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.3125 in
$t_{c(min)}$ = lesser of 0.25 or 0.7*t_{min} = 0.2188 in
$t_{c(actual)}$ = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-44 Thickness Check - ASME B16.11 Coupling

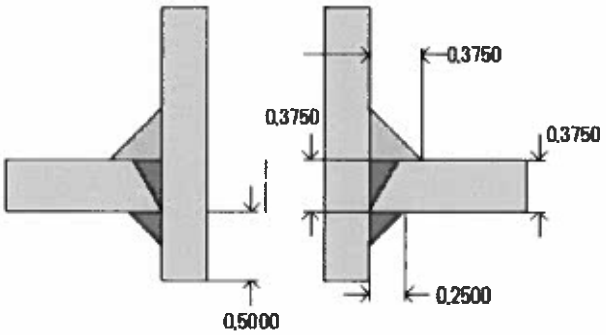
Interpretation VIII-1-83-66 has been applied.

$t_{a\ App\ 1\text{-}1}$ = $P*R_o / (S_n*E + 0.4*P)$ + Corrosion
= 250*1.5 / (20,000*1 + 0.4*250) + 0
= 0.0187 in

$t_{a\ UG\text{-}44}$ = max[$t_{a\ App\ 1\text{-}1}$, $t_{b\ UG16}$]
= max[0.0187 , 0.0625]
= 0.0625 in

Available nozzle wall thickness new, t_n = 0.3125 in

The nozzle neck thickness is adequate.

ASME Section VIII Division 1, 2017 Edition	
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	SHELL RG 1
Orientation	90°
Nozzle center line offset to datum line	69"
End of nozzle to shell center	25"
Passes through a Category A joint	No
Nozzle	
Description	NPS 0.5 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 19)
Inside diameter, new	0.84"
Nominal wall thickness	0.33"
Corrosion allowance	0"
Projection available outside vessel, Lpr	1"
Internal projection, h_{new}	0.5"
Local vessel minimum thickness	0.375"
Liquid static head included	0 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Lower fillet, Leg_{43}	0.25"
Nozzle to vessel groove weld	0.375"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 250*0.42 / (20,000*1 - 0.6*250) =	0.0053"
Stress ratio = t_r*E` / (t_n - c) = 0.0053*1 / (0.33 - 0) =	0.016
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 250 psi @ 150 °F							The nozzle passes UG-44	
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	0.33

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.231	0.2625	weld size is adequate

Calculations for internal pressure 250 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(0.84, 0.42 + (0.33 - 0) + (0.375 - 0))
= 1.125 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.375 - 0), 2.5*(0.33 - 0) + 0)
= 0.825 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(0.5, 2.5*(0.375 - 0), 2.5*(0.33 - 0 - 0))
= 0.5 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 250*0.42 / (20,000*1 - 0.6*250)
= 0.0053 in

Required thickness t_r from UG-37(a)

t_r = P*R_o / (S*E + 0.4*P)
= 250*24 / (20,000*1 + 0.4*250)

= 0.2985 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*R_o / (S*E + 0.4*P)$
= 250*24 / (20,000*0.85 + 0.4*250)
= 0.3509 in

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

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.33 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min}$ = 0.231 in
$t_{c(actual)}$ = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-44 Thickness Check - ASME B16.11 Coupling

$t_{a\ App\ 1\text{-}1}$ = $P*R_o / (S_n*E + 0.4*P)$ + Corrosion
= 250*0.75 / (20,000*1 + 0.4*250) + 0
= 0.0093 in

$t_{a\ UG\text{-}44}$ = max[$t_{a\ App\ 1\text{-}1}$, $t_{b\ UG16}$]
= max[0.0093 , 0.0625]
= 0.0625 in

Available nozzle wall thickness new, t_n = 0.33 in

The nozzle neck thickness is adequate.

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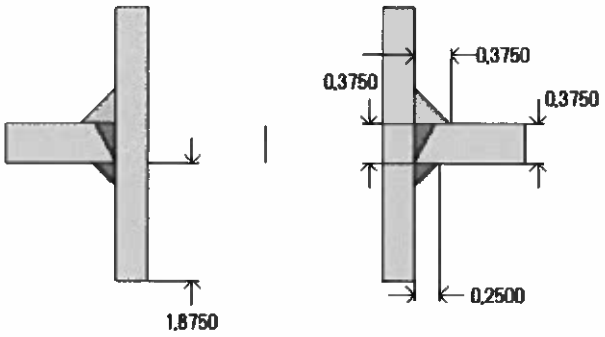	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	SHELL RG 1
Orientation	90°
Nozzle center line offset to datum line	39"
End of nozzle to shell center	25"
Passes through a Category A joint	No
Nozzle	
Description	NPS 2 Class 3000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 19)
Inside diameter, new	2.375"
Nominal wall thickness	0.3125"
Corrosion allowance	0"
Projection available outside vessel, Lpr	1"
Internal projection, h_{new}	1.875"
Local vessel minimum thickness	0.375"
Liquid static head included	0.26 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Lower fillet, Leg_{43}	0.25"
Nozzle to vessel groove weld	0.375"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 250.26*1.1875 / (20,000*1 - 0.6*250.26) =	0.015"
Stress ratio = t_r*E' / (t_n - c) = 0.015*1 / (0.3125 - 0) =	0.0479
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 250.26 psi @ 150 °F							The nozzle passes UG-44	
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	0.3125

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})	0.2188	0.2625	weld size is adequate

Calculations for internal pressure 250.26 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(2.375, 1.1875 + (0.3125 - 0) + (0.375 - 0))
= 2.375 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.375 - 0), 2.5*(0.3125 - 0) + 0)
= 0.7813 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(1.875, 2.5*(0.375 - 0), 2.5*(0.3125 - 0 - 0))
= 0.7813 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 250.2594*1.1875 / (20,000*1 - 0.6*250.2594)
= 0.015 in

Required thickness t_r from UG-37(a)

t_r = P*R_o / (S*E + 0.4*P)
= 250.2594*24 / (20,000*1 + 0.4*250.2594)
= 0.2988 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*R_o / (S*E + 0.4*P)$
= 250.2594*24 / (20,000*0.85 + 0.4*250.2594)
= 0.3512 in

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

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.3125 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min}$ = 0.2188 in
$t_{c(actual)}$ = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-44 Thickness Check - ASME B16.11 Coupling

$t_{a\ App\ 1\text{-}1}$ = $P*R_o / (S_n*E + 0.4*P)$ + Corrosion
= 250.2594*1.5 / (20,000*1 + 0.4*250.2594) + 0
= 0.0187 in

$t_{a\ UG\text{-}44}$ = $max[t_{a\ App\ 1\text{-}1} , t_{b\ UG16}]$
= max[0.0187 , 0.0625]
= 0.0625 in

Available nozzle wall thickness new, t_n = 0.3125 in

The nozzle neck thickness is adequate.

RELIEF (C13)

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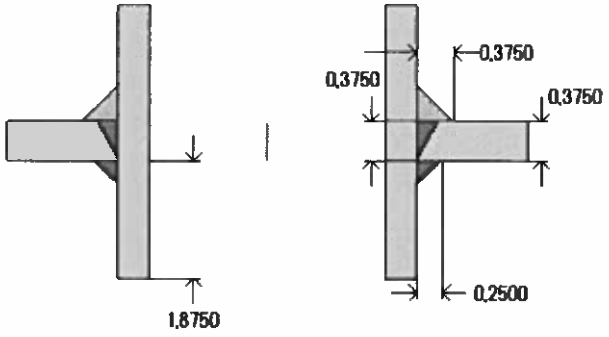
Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL RG 2
Orientation	90°
Nozzle center line offset to datum line	221"
End of nozzle to shell center	25"
Passes through a Category A joint	No

Nozzle	
Description	NPS 2 Class 3000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 19)
Inside diameter, new	2.375"
Nominal wall thickness	0.3125"
Corrosion allowance	0"
Projection available outside vessel, Lpr	1"
Internal projection, h_{new}	1.875"
Local vessel minimum thickness	0.375"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

Welds	
Inner fillet, Leg_{41}	0.375"
Lower fillet, Leg_{43}	0.25"
Nozzle to vessel groove weld	0.375"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 250*1.1875 / (20,000*1 - 0.6*250) =	0.015"
Stress ratio = t_r*E' / (t_n - c) = 0.015*1 / (0.3125 - 0) =	0.0479
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 250 psi @ 150 °F							The nozzle passes UG-44	
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	0.3125

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})	0.2188	0.2625	weld size is adequate

Calculations for internal pressure 250 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(2.375, 1.1875 + (0.3125 - 0) + (0.375 - 0))
= 2.375 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.375 - 0), 2.5*(0.3125 - 0) + 0)
= 0.7813 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(1.875, 2.5*(0.375 - 0), 2.5*(0.3125 - 0 - 0))
= 0.7813 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 250*1.1875 / (20,000*1 - 0.6*250)
= 0.015 in

Required thickness t_r from UG-37(a)

t_r = P*R_o / (S*E + 0.4*P)
= 250*24 / (20,000*1 + 0.4*250)
= 0.2985 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*R_o / (S*E + 0.4*P)$
= $250*24 / (20{,}000*0.85 + 0.4*250)$
= 0.3509 in

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

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.3125 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min}$ = 0.2188 in
$t_{c(actual)}$ = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-44 Thickness Check - ASME B16.11 Coupling

$t_{a\ App\ 1\text{-}1}$ = $P*R_o / (S_n*E + 0.4*P)$ + Corrosion
= $250*1.5 / (20{,}000*1 + 0.4*250) + 0$
= 0.0187 in

$t_{a\ UG\text{-}44}$ = $max[\ t_{a\ App\ 1\text{-}1}\ ,\ t_{b\ UG16}\ ]$
= max[0.0187 , 0.0625]
= 0.0625 in

Available nozzle wall thickness new, t_n = 0.3125 in

The nozzle neck thickness is adequate.

WATER LEVEL LOW (C14)

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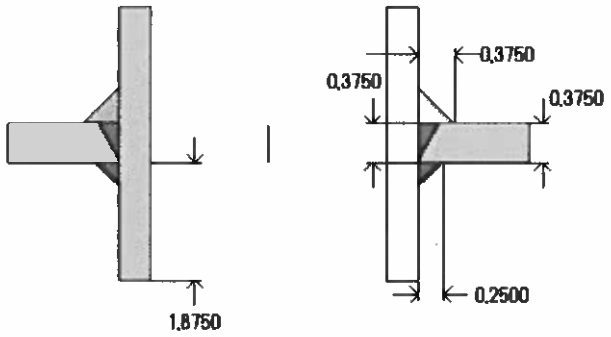
Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL RG 1
Orientation	240°
Nozzle center line offset to datum line	9"
End of nozzle to shell center	25"
Passes through a Category A joint	No
Nozzle	
Description	NPS 2 Class 3000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 19)
Inside diameter, new	2.375"
Nominal wall thickness	0.3125"
Corrosion allowance	0"
Projection available outside vessel, Lpr	1"
Internal projection, h_{new}	1.875"
Local vessel minimum thickness	0.375"
Liquid static head included	1.34 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Lower fillet, Leg_{43}	0.25"
Nozzle to vessel groove weld	0.375"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 251.34*1.1875 / (20,000*1 - 0.6*251.34) =	0.015"
Stress ratio = t_r*E' / (t_n - c) = 0.015*1 / (0.3125 - 0) =	0.0481
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 251.34 psi @ 150 °F							The nozzle passes UG-44	
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	0.3125

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})	0.2188	0.2625	weld size is adequate

Calculations for internal pressure 251.34 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(2.375, 1.1875 + (0.3125 - 0) + (0.375 - 0))
= 2.375 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.375 - 0), 2.5*(0.3125 - 0) + 0)
= 0.7813 in

Inner Normal Limit of reinforcement per UG-40

L_i = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(1.875, 2.5*(0.375 - 0), 2.5*(0.3125 - 0 - 0))
= 0.7813 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 251.3424*1.1875 / (20,000*1 - 0.6*251.3424)
= 0.015 in

Required thickness t_r from UG-37(a)

t_r = P*R_o / (S*E + 0.4*P)
= 251.3424*24 / (20,000*1 + 0.4*251.3424)
= 0.3001 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*R_o / (S*E + 0.4*P)$
= $251.3424*24 / (20{,}000*0.85 + 0.4*251.3424)$
= 0.3528 in

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

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.3125 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min}$ = 0.2188 in
$t_{c(actual)}$ = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-44 Thickness Check - ASME B16.11 Coupling

$t_{a\ App\ 1\text{-}1}$ = $P*R_o / (S_n*E + 0.4*P)$ + Corrosion
= $251.3424*1.5 / (20{,}000*1 + 0.4*251.3424) + 0$
= 0.0188 in

$t_{a\ UG\text{-}44}$ = $max[\ t_{a\ App\ 1\text{-}1}\ ,\ t_{b\ UG16}\ ]$
= max[0.0188 , 0.0625]
= 0.0625 in

Available nozzle wall thickness new, t_n = 0.3125 in

The nozzle neck thickness is adequate.

OIL LEVEL HIGH (C15)

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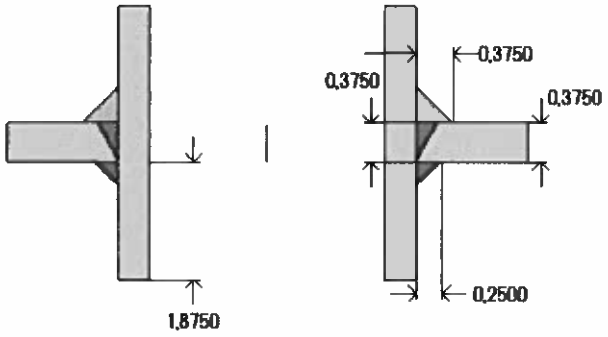
Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL RG 1
Orientation	240°
Nozzle center line offset to datum line	45"
End of nozzle to shell center	25"
Passes through a Category A joint	No
Nozzle	
Description	NPS 2 Class 3000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 19)
Inside diameter, new	2.375"
Nominal wall thickness	0.3125"
Corrosion allowance	0"
Projection available outside vessel, Lpr	1"
Internal projection, h_{new}	1.875"
Local vessel minimum thickness	0.375"
Liquid static head included	0.04 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Lower fillet, Leg_{43}	0.25"
Nozzle to vessel groove weld	0.375"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 250.04*1.1875 / (20,000*1 - 0.6*250.04) =	0.015"
Stress ratio = t_r*E' / (t_n - c) = 0.015*1 / (0.3125 - 0) =	0.0479
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 250.04 psi @ 150 °F							The nozzle passes UG-44	
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	0.3125

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})	0.2188	0.2625	weld size is adequate

Calculations for internal pressure 250.04 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(2.375, 1.1875 + (0.3125 - 0) + (0.375 - 0))
= 2.375 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.375 - 0), 2.5*(0.3125 - 0) + 0)
= 0.7813 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(1.875, 2.5*(0.375 - 0), 2.5*(0.3125 - 0 - 0))
= 0.7813 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 250.0429*1.1875 / (20,000*1 - 0.6*250.0429)
= 0.015 in

Required thickness t_r from UG-37(a)

t_r = P*R_o / (S*E + 0.4*P)
= 250.0429*24 / (20,000*1 + 0.4*250.0429)
= 0.2986 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*R_o / (S*E + 0.4*P)$
= 250.0429*24 / (20,000*0.85 + 0.4*250.0429)
= 0.3509 in

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

UW-16(c) Weld Check

Fillet weld: t_{min} = lesser of 0.75 or t_n or t = 0.3125 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min}$ = 0.2188 in
$t_{c(actual)}$ = 0.7*Leg = 0.7*0.375 = 0.2625 in

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-44 Thickness Check - ASME B16.11 Coupling

$t_{a\ App\ 1\text{-}1}$ = $P*R_o / (S_n*E + 0.4*P)$ + Corrosion
= 250.0429*1.5 / (20,000*1 + 0.4*250.0429) + 0
= 0.0187 in

$t_{a\ UG\text{-}44}$ = max[$t_{a\ App\ 1\text{-}1}$, $t_{b\ UG16}$]
= max[0.0187 , 0.0625]
= 0.0625 in

Available nozzle wall thickness new, t_n = 0.3125 in

The nozzle neck thickness is adequate.

MANWAY (M1)

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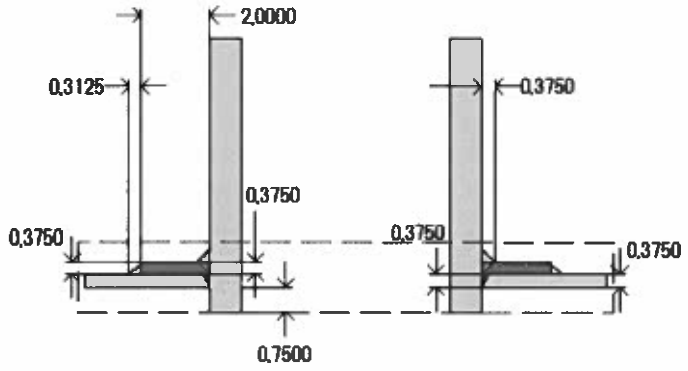	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	SHELL RG 1
Orientation	180°
Nozzle center line offset to datum line	9"
End of nozzle to shell center	30"
Passes through a Category A joint	No
Nozzle	
Description	NPS 18 Sch 80
Access opening	Yes
Material specification	SA-106 B Smls pipe (II-D p. 14, ln. 10)
Inside diameter, new	16.124"
Pipe nominal wall thickness	0.938"
Pipe minimum wall thickness[1]	0.8208"
Corrosion allowance	0"
Projection available outside vessel, Lpr	5.062"
Internal projection, h_{new}	0.75"
Projection available outside vessel to flange face, Lf	6"
Local vessel minimum thickness	0.375"
Liquid static head included	1.59 psi
Longitudinal joint efficiency	1
Reinforcing Pad	
Material specification	SA-516 70 (II-D p. 18, ln. 33)
Diameter, D_p	22"
Thickness, t_e	0.375"

Is split	Yes
Butt welds tested to confirm full penetration	No
Butt welds located at least 45° from long seam	Yes
Joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Outer fillet, Leg_{42}	0.3125"
Lower fillet, Leg_{43}	0"
Nozzle to vessel groove weld	0.375"
Pad groove weld	0.375"

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

ASME B16.5-2013 Flange	
Description	NPS 18 Class 150 SO A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 388, ln. 32)
Blind included	Yes
Rated MDMT	-31.8°F
Liquid static head	1.3 psi
MAWP rating	272.5 psi @ 150°F
MAP rating	285 psi @ 70°F
Hydrotest rating	450 psi @ 70°F
External fillet weld leg (UW-21)	0.85" (0.85" min)
Internal fillet weld leg (UW-21)	0.938" (0.25" min)
PWHT performed	No
Impact Tested	No
UW-21 Flange Welds	
$X_{min} = min[1.4*t_n , g_0] = [1.4*0.938 , 0.85] =$	0.85"
External $Leg_{min} = X_{min} + C_o / 0.7 = 0.85 + 0 / 0.7 =$	0.85"
Internal $Leg_{min} = min[t_n , 0.25" + C_i / 0.7] = min[0.938 , 0.25 + 0 / 0.7] =$	0.25"
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -31.8°F (Coincident ratio = 0.8818) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements Nozzle At Intersection	
Governing thickness, t_g =	0.375"
Exemption temperature from Fig UCS-66 Curve B =	-20°F
t_r = 251.59*24 / (20,000*1 + 0.4*251.59) =	0.3004"
Stress ratio = t_r*E˙ / (t_n - c) = 0.3004*1 / (0.375 - 0) =	0.8011
Reduction in MDMT, T_R from Fig UCS-66.1 =	19.9°F
MDMT = max[MDMT - T_R, -55] = max[-20 - 19.9 , -55] =	-39.9°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

UCS-66 Material Toughness Requirements Nozzle	
t_r = 251.59*8.062 / (17,100*1 - 0.6*251.59) =	0.1197"
Stress ratio = t_r*E˙ / (t_n - c) = 0.1197*1 / (0.8208 - 0) =	0.1458
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 =	0.375"
Exemption temperature from Fig UCS-66 Curve B =	-20°F
t_r = 251.59*24 / (20,000*1 + 0.4*251.59) =	0.3004"
Stress ratio = t_r*E˙ / (t_n - c) = 0.3004*1 / (0.375 - 0) =	0.8011
Reduction in MDMT, T_R from Fig UCS-66.1 =	19.9°F
MDMT = max[MDMT - T_R, -55] = max[-20 - 19.9 , -55] =	-39.9°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 251.59 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
4.9254	5.4153	1.1826	1.3118	1.203	1.5	0.2179	0.1197	0.8208

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
77,248.43	60,594	406,749.46	64,729.55	402,686.6	96,683.55	262,754.95

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})	0.1875	0.2188	weld size is adequate

Calculations for internal pressure 251.59 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(16.124, 8.062 + (0.938 - 0) + (0.375 - 0))
= 16.124 in

Outer Normal Limit of reinforcement per UG-40

L_H = MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)
= MIN(2.5*(0.375 - 0), 2.5*(0.938 - 0) + 0.375)
= 0.9375 in

Inner Normal Limit of reinforcement per UG-40

L_I = MIN(h, 2.5*(t - C), 2.5*(t_i - C_n - C))
= MIN(0.75, 2.5*(0.375 - 0), 2.5*(0.938 - 0 - 0))
= 0.75 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 251.5905*8.062 / (17,100*1 - 0.6*251.5905)
= 0.1197 in

Required thickness t_r from UG-37(a)

t_r = $P*R_o / (S*E + 0.4*P)$
= $251.5905*24 / (20{,}000*1 + 0.4*251.5905)$
= 0.3004 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = $P*R_o / (S*E + 0.4*P)$
= $251.5905*24 / (20{,}000*0.85 + 0.4*251.5905)$
= 0.3531 in

Area required per UG-37(c)

Allowable stresses: S_n = 17,100, S_v = 20,000, S_p = 20,000 psi

f_{r1} = lesser of 1 or S_n / S_v = 0.855

f_{r2} = lesser of 1 or S_n / S_v = 0.855

f_{r3} = lesser of f_{r2} or S_p / S_v = 0.855

f_{r4} = lesser of 1 or S_p / S_v = 1

A = $d*t_r*F + 2*t_n*t_r*F*(1 - f_{r1})$
= $16.124*0.3004*1 + 2*0.938*0.3004*1*(1 - 0.855)$
= <u>4.9254</u> in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= <u>1.1826</u> in^2

= $d*(E_1*t - F*t_r) - 2*t_n*(E_1*t - F*t_r)*(1 - f_{r1})$
= $16.124*(1*0.375 - 1*0.3004) - 2*0.938*(1*0.375 - 1*0.3004)*(1 - 0.855)$
= 1.1826 in^2

= $2*(t + t_n)*(E_1*t - F*t_r) - 2*t_n*(E_1*t - F*t_r)*(1 - f_{r1})$
= $2*(0.375 + 0.938)*(1*0.375 - 1*0.3004) - 2*0.938*(1*0.375 - 1*0.3004)*(1 - 0.855)$
= 0.1756 in^2

A_2 = smaller of the following= <u>1.3118</u> in^2

= $5*(t_n - t_m)*f_{r2}*t$
= $5*(0.938 - 0.1197)*0.855*0.375$
= 1.3118 in^2

= $2*(t_n - t_m)*(2.5*t_n + t_e)*f_{r2}$
= $2*(0.938 - 0.1197)*(2.5*0.938 + 0.375)*0.855$
= 3.8061 in^2

A_3 = smaller of the following= <u>1.203</u> in^2

$= 5*t*t_i*f_{r2}$
$= 5*0.375*0.938*0.855$
$= \underline{1.5037}$ in^2

$= 5*t_i*t_i*f_{r2}$
$= 5*0.938*0.938*0.855$
$= \underline{3.7613}$ in^2

$= 2*h*t_i*f_{r2}$
$= 2*0.75*0.938*0.855$
$= \underline{1.203}$ in^2

$A_{41} = Leg^2*f_{r3}$
$= 0.375^2*0.855$
$= \underline{0.1202}$ in^2

$A_{42} = Leg^2*f_{r4}$
$= 0.3125^2*1$
$= \underline{0.0977}$ in^2

$A_5 = (D_p - d - 2*t_n)*t_e*f_{r4}*E_p$
$= (22 - 16.124 - 2*0.938)*0.375*1*1$
$= \underline{1.5}$ in^2

Area $= A_1 + A_2 + A_3 + A_{41} + A_{42} + A_5$
$= 1.1826 + 1.3118 + 1.203 + 0.1202 + 0.0977 + 1.5$
$= \underline{5.4153}$ in^2

As Area >= A the reinforcement is adequate.

UW-16(c)(2) Weld Check

Inner fillet: t_{min} = lesser of 0.75 or t_n or t_e = 0.375 in
$t_{c(min)}$ = lesser of 0.25 or $0.7*t_{min}$ = $\underline{0.25}$ in
$t_{c(actual)} = 0.7*Leg = 0.7*0.375 = 0.2625$ in

Outer fillet: t_{min} = lesser of 0.75 or t_e or t = 0.375 in
$t_{w(min)} = 0.5*t_{min} = \underline{0.1875}$ in
$t_{w(actual)} = 0.7*Leg = 0.7*0.3125 = 0.2188$ in

UG-45 Nozzle Neck Thickness Check (Access Opening)

$t_{a\ UG-27} = P*R_n / (S_n*E - 0.6*P) + Corrosion$
$= 251.5905*8.062 / (17,100*1 - 0.6*251.5905) + 0$
$= 0.1197$ in

$t_a = max[\ t_{a\ UG-27}\ ,\ t_{a\ UG-22}\ ]$

= max[0.1197 , 0]
= 0.1197 in

Available nozzle wall thickness new, t_n = 0.875*0.938 = 0.8208 in

The nozzle neck thickness is adequate.

Allowable stresses in joints UG-45 and UW-15(c)

Groove weld in tension:	0.74*20,000 = 14,800 psi
Nozzle wall in shear:	0.7*17,100 = 11,970 psi
Inner fillet weld in shear:	0.49*17,100 = 8,379 psi
Outer fillet weld in shear:	0.49*20,000 = 9,800 psi
Upper groove weld in tension:	0.74*20,000 = 14,800 psi

Strength of welded joints:

(1) Inner fillet weld in shear
$(\pi / 2)$*Nozzle OD*Leg*S_i = $(\pi / 2)$*18*0.375*8,379 = 88,841.49 lb_f

(2) Outer fillet weld in shear
$(\pi / 2)$*Pad OD*Leg*S_o = $(\pi / 2)$*22*0.3125*9,800 = 105,832.4 lb_f

(3) Nozzle wall in shear
$(\pi / 2)$*Mean nozzle dia*t_n*S_n = $(\pi / 2)$*17.062*0.938*11,970 = 300,917.05 lb_f

(4) Groove weld in tension
$(\pi / 2)$*Nozzle OD*t_w*S_g = $(\pi / 2)$*18*0.375*14,800 = 156,922.55 lb_f

(6) Upper groove weld in tension
$(\pi / 2)$*Nozzle OD*t_w*S_g = $(\pi / 2)$*18*0.375*14,800 = 156,922.55 lb_f

Loading on welds per UG-41(b)(1)

$W = (A - A_1 + 2*t_n*f_{r1}*(E_1*t - F*t_r))*S_v$
= (4.9254 - 1.1826 + 2*0.938*0.855*(1*0.375 - 1*0.3004))*20,000
= <u>77,248.43</u> lb_f

$W_{1-1} = (A_2 + A_5 + A_{41} + A_{42})*S_v$
= (1.3118 + 1.5 + 0.1202 + 0.0977)*20,000
= <u>60,594</u> lb_f

$W_{2-2} = (A_2 + A_3 + A_{41} + A_{43} + 2*t_n*t*f_{r1})*S_v$
= (1.3118 + 1.203 + 0.1202 + 0 + 2*0.938*0.375*0.855)*20,000
= <u>64,729.55</u> lb_f

$W_{3-3} = (A_2 + A_3 + A_5 + A_{41} + A_{42} + A_{43} + 2*t_n*t*f_{r1})*S_v$
= (1.3118 + 1.203 + 1.5 + 0.1202 + 0.0977 + 0 + 2*0.938*0.375*0.855)*20,000
= <u>96,683.55</u> lb_f

Load for path 1-1 lesser of W or W_{1-1} = 60,594 lb_f

Path 1-1 through (2) & (3) = 105,832.4 + 300,917.05 = 406,749.46 lb_f
Path 1-1 is stronger than W_{1-1} so it is acceptable per UG-41(b)(1).

Load for path 2-2 lesser of W or W_{2-2} = 64,729.55 lb_f
Path 2-2 through (1), (4), (6) = 88,841.49 + 156,922.55 + 156,922.55 = 402,686.6 lb_f
Path 2-2 is stronger than W_{2-2} so it is acceptable per UG-41(b)(1).

Load for path 3-3 lesser of W or W_{3-3} = 77,248.43 lb_f
Path 3-3 through (2), (4) = 105,832.4 + 156,922.55 = 262,754.95 lb_f
Path 3-3 is stronger than W so it is acceptable per UG-41(b)(2).

Liquid Level

ASME Section VIII Division 1, 2017 Edition	
Location from Datum (in)	45
Operating Liquid Specific Gravity	1

Lift Lug Design

Customer: MARATHON OIL	By: MLR
SHOP ORDER 18165	Date: 1/22/2018
Item: LATER	

Inputs

Lug Length "A"	7 in.		
Lug Thk. "T"	0.5 in.	**Erection Wt.:**	5,500 lbs
Width "D"	6 in.	Impact factor:	150%
Hole dia. "E"	1.5 in.	Number of lugs:	2
Projection "L"	4 in.		
Radius "R"	3 in.		
Weld size "W"	0.375 in.	Material:	SA-516-70
		Sy:	38,000 psi

Check Weld

Fillet weld size

P = (Wt)(impct factor)/(# of lugs)

P = 4,125 lb

Sw = (0.49)(20000)= 9800 psi

Fillet Size: P/(total weld length * Sw)

Fillet Size: 0.032 inches Use 0.375 inch fillet

Check lug in bending

Z = $(D^2 * thk)/6$

Z = 3.0000 in^3

M= P * L = 16,500 in-lb

S1 =	M / Z	Sa =	0.66 Sy	66% yield
S1 =	5,500 psi	Sa =	25,080 psi	

S < Sa, Bending Stress OK

Check shear tear-out at pin

Area = T(R - 1/2 E)

Area = 1.125 in^2

S2 =	P / Area	Sa =	0.4 Sy	40% yield
S2 =	3,667 psi	Sa =	15,200 psi	

S < Sa, Shear Stress OK

Check bearing at pin

Area = (E - 0.25)T *assume pin is 1/4" smaller than hole*

Area = 0.6250 in^2

S =	P / Area	Sa =	0.9 Sy	90% yield
S =	6,600 psi	Sa =	34,200 psi	

S < Sa, Bearing Stress OK

Check lug in bending - weak axis

Z = (thk² * D)/6

Z = 0.2500 in³

M = P * L * sin 10 = 2,865 in-lb

S4 =	M / Z	Sa =	0.66 Sy	66% yield
S4 =	11,461 psi	Sa =	25,080 psi	

S < Sa, Bending Stress OK

Unity Check

S5= S1/SA + S4/SA

S5= 0.68

S5 < 1, Bending Stress OK

MOORE CONTROL SYSTEMS, INC.
Instrument & Electrical Engineering & Design • Construction • Service
Phone: 281-392-7747 www.moore-control.com

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Katy, Tx 77494

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Katy, Tx 77494

Baytown: 14827 I-10 East
Baytown, Tx 77523

SECTION 7

HYDROSTATIC TRAVELER W/CHART

MOORE CONTROL SYSTEMS, INC.
Instrument & Electrical Engineering & Design • Construction • Service

PO BOX 677, KATY, TEXAS 77494
PHONE: 281-392-7747 FAX: 281-392-7727
WEB: www.moore-control.com

HYDROSTATIC TEST REPORT

MCSI PROJECT No.: 18165 DATE: 5/22/2018
CUSTOMER: MARATHON
CUSTOMER P.O. No.: N/A
UNIT DESCRIPTION: PHASE SEPARATOR
DRAWING NUMBER: 18165-9

SPECIAL INSPECTION REQUIREMENTS: TESTED PER ASME SEC. VIII DIV.1 2017

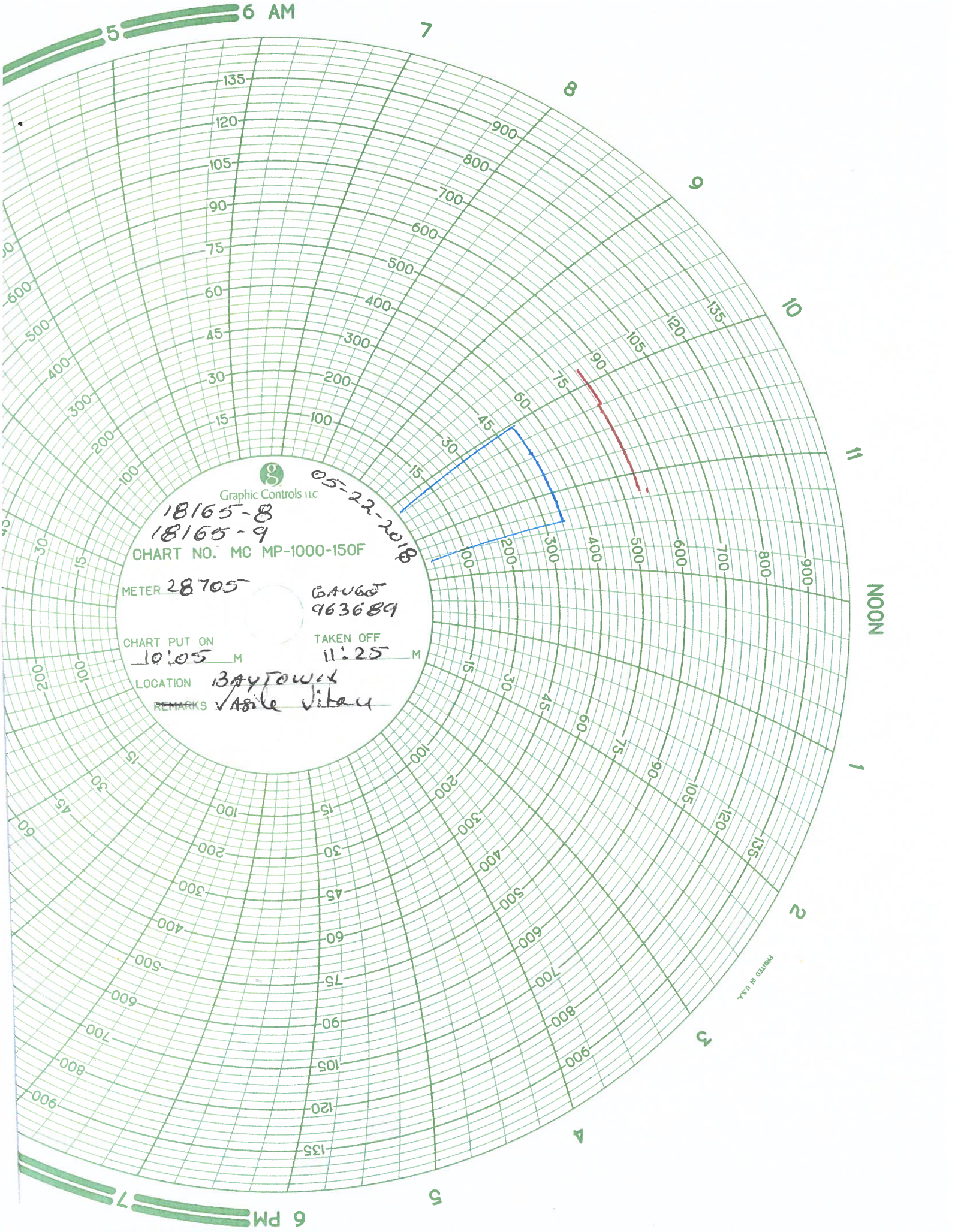
MAWP: 250 PSI
TEST PRESSURE: 325 PSI
REQ'D. DURATION: 60 min TEST GAUGE USED: 963689
START TIME: 10:05
END TIME: 11:25
CHART REQUIRED: YES RECORDER USED: 28705

NOTE: UNIT PRESSURE TO BE CHECKED EVERY 15 MINUTES

	OBSERVED PRESSURE	INITIALS
1ST TEST PERIOD:	340	BY: VV
2ND TEST PERIOD:	340	BY: VV
3RD TEST PERIOD:	342	BY: VV
4TH TEST PERIOD:	342	BY: VV

CONDUCTED BY: Amado Martinez DATE: 05-22-2018
OBSERVED BY: Vasile Vitan DATE: 05-22-2018
THIRD PARTY: (IF APPLICABLE) DATE:

NOTES:
1). PH Test as required
2). Test Requires: (1) Pressure Gauge - (1) Pressure Recorder - (1) Temperature Recorder
3). Calibration Records Required For All Equipment.


6 AM
NOON
6 PM
Graphic Controls LLC
05-22-2018
18165-8
18165-9
CHART NO. MC MP-1000-150F
METER 28705
GAUGE 963689
CHART PUT ON 10:05 M
TAKEN OFF 11:25 M
LOCATION Baytown
REMARKS Vista Vitals
PRINTED IN U.S.A.

O.G.M.E. Oil & Gas Measurement Equipment O.G.M.E.

5227 DCW ROAD 77040 * P O BOX 55641 * HOUSTON, TX 77255 * PH. (713) 263 9740 * FAX (713) 263 9741 * E MAIL - sales@ogme.net

INSTRUMENT CERTIFICATION

DATE OF CALIBRATION: 1-29-18

CERTIFICATION DUE DATE: 7-29-18

CUSTOMER: MOORE CONTROL SYSTEMS

OGME JOB NUMBER: 22742

TYPE OF INSTRUMENT: DUAL PEN CHART RECORDER

RANGE: 0-1,000 PSI X 150° F.

ACCURACY +/-: 1%

SERIAL NUMBER: 28705

THE ABOVE INSTRUMENT HAS BEEN CERTIFIED IN ACCORDANCE WITH OGME QC MANUAL LATEST REVISION.
ALL STANDARDS TRACABLE TO U.K.A.S. (UNITED KINGDOM NATIONAL STANDARDS LAB) OR N.I.S.T.
(UNITED STATES NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY) IN ACCORDANCE WITH A.N.S.I. Z540.3 (2008)

TEMP.CALIBRATED TO MASTER KESSLER THERMOMETER SN# 441806 TRACEABLE TO NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY TEMPERATURE: 32.00°F.REFERENCE: ICE BATH TRANSFER STANDARDS:N/A, ICE POINT PER NIST SPEC PUB 819; TEMPERATURE: 120.00°F. REFERENCE: NIST THERMOMETER STANDARDS: 2Z9150 & 9C8073 TEMPERATURE: 212.00°F.REFERENCE: NIST THERMOMETER 40350, TRANSFER STANDARDS: 3B2847 & 2Y6628

PEN #1

DEAD WEIGHT	INSTRUMENT
0 PSI	0 PSI
200 PSI	200 PSI
500 PSI	500 PSI
800 PSI	800 PSI
1,000 PSI	1,000 PSI
600 PSI	600 PSI
400 PSI	400 PSI
0 PSI	0 PSI

PEN #2

STANDARD	TEMPERATURE
0 °F.	0 °F.
75 °F.	75 °F.
150 °F.	150 °F.
75 °F.	75 °F.
0 °F.	0 °F.

N.I.S.T. AND UKAS TRACABLE STANDARDS

MANUFACTURER	SERIAL NUMBER	RANGE	ACCURACY	CERTIFICATION DUE DATE
D.H. BUDENBURG (MOD. 3/283)	25509	1,000-60,000 PSI	0.05%	5/15/2022
* D.H. BUDENBURG (MOD. 558)	26490	10-2,000 PSI	0.03%	5/26/2021
AMETEK RK (RK160WC)	85345	4" WC-1600" WC	0.05%	3/4/2020
* OMEGA TEMPERATURE READER	T43306/ZB1534	0-450°F.	0.25°F.	5/18/2020
RTD'S SERIAL NUMBERS: L (C44PW-38-1) M (30445) H (C44PW-37-1)				

* INDICATES MASTER STANDARD USED FOR THIS INSTRUMENT

CALIBRATION TECH: [signature]

QUALITY CONTROL INSPECTOR: Steven P Holmes

INSP. Q.C.

The Meter Shop, Inc
6934 Signat Dr.
Houston Texas 77041

Certificate of Calibration

For Instrument: Crystal 1KPSIXP2I Digital Test Gauge
Serial Number: 963689
Certification/Asset Number: 3693
Measurement Standards : NIST
RMA / Work Order: 2591-DD
P.O.:

CUSTOMER: Moore Control Sys
1435 Katy Flewellen rd
Katy Tx 77494

The Meter Shop certifies that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure unless otherwise noted). It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration complies with MIL-STD-45662A and ANSI/NCSL Z540.3-2013. and ISO/IEC 17025: 2005. All calibrations are done in-house unless other wise noted.

Where applicable,the expanded uncertainty of measurement at the time of test is given in the following pages. They are calculated in accordance with the method described in the ISO Guide to the Expression of Uncertainty (GUM). The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k, such that the confidence level approximates 95%.

 See attached report of Calibration for data results.

CALIBRATION INFORMATION

Cal Date	19 Jan 2018	Temperature	23.0°C	Pass	Y
Next Cal Due:	18 Jan 2019	Humidity	45 %	Seals OK	Tech: John

Remarks: FOUND-LEFT

Cal Procedure: Met/Cal: Torque T.O.33K6-4-2193-1 Revision:

STANDARDS USED FOR CALIBRATION

Asset Number	Description	Cal. Date	Due Date
7388	Ametek GaugeCalHP 300-15 000 PSI	26 Jan 2017	26 Jan 2018

Approved by: John Brown Lab Manager

Signed JOHN BROWN

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Katy, Tx 77494

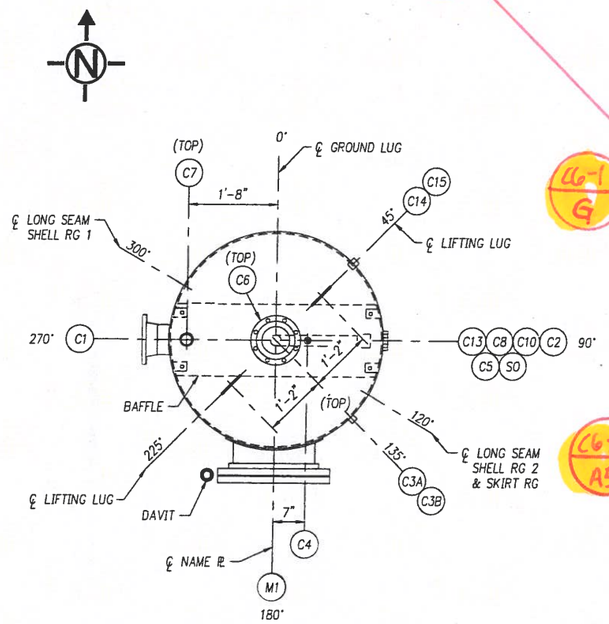
Mailing: P.O. Box 677
Katy, Tx 77494

Baytown: 14827 I-10 East
Baytown, Tx 77523

SECTION 8

WELD MAP

2/15/2018 1:38:57 PM



PLAN

WORKLINE

ALL DIMENSIONS ARE MEASURED FROM THIS LINE UNLESS NOTED OTHERWISE

C/S = Circle Seam
F/P = Flange to Pipe
L/L = Lifting Lug
RP = Reinforcement Pad

WELD MAP

ISSUED FOR CONSTRUCTION
MCSI #: 18165 DATE: 2/19/18

NO	REVISION DESCRIPTION	DATE	BY	CHK'D
0	ISSUED FOR CONSTRUCTION	2/14/18	MLR	RR
A	ISSUED FOR APPROVAL	1/22/18	MLR	RR

REFERENCE DRAWING | DRAWING DESCRIPTION

MCSI MOORE CONTROL SYSTEMS, INC.
KATY, TEXAS
(281) 392-7747
WWW.MOORE-CONTROL.COM

CARLSBAD, NEW MEXICO

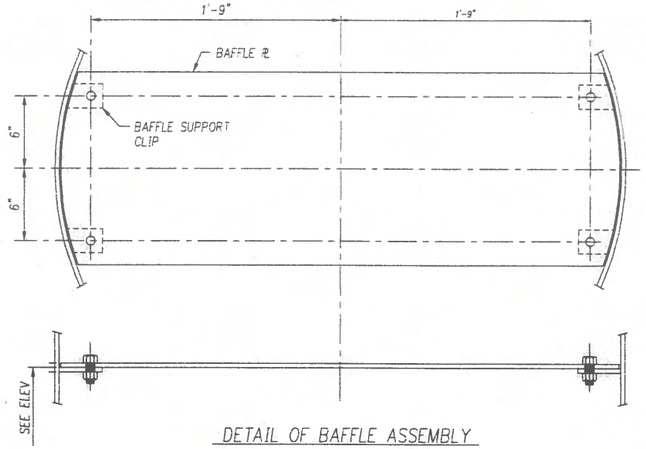
CUSTOMER: MARATHON OIL CO. | AFE/CUSTOMER JOB NO: *

VERTICAL 2 PHASE SEPARATOR FABRICATION DRAWING

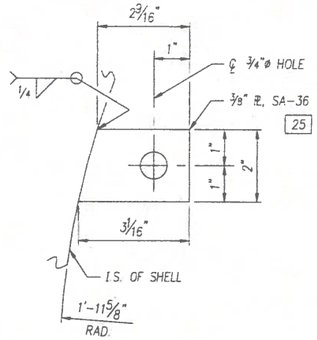
DRAWN BY	DATE	SCALE	MCSI JOB NO
MLR	1/22/18	*	18165

DRAWING NO	SHEET	REV
18165-XXXX SHT 2	2 OF	0

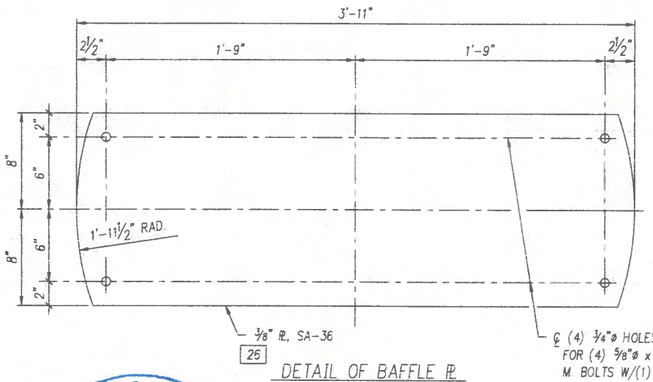
X:\MOORE CONTROLS\18165 - MARATHON SCRUBBER\18165.DWG



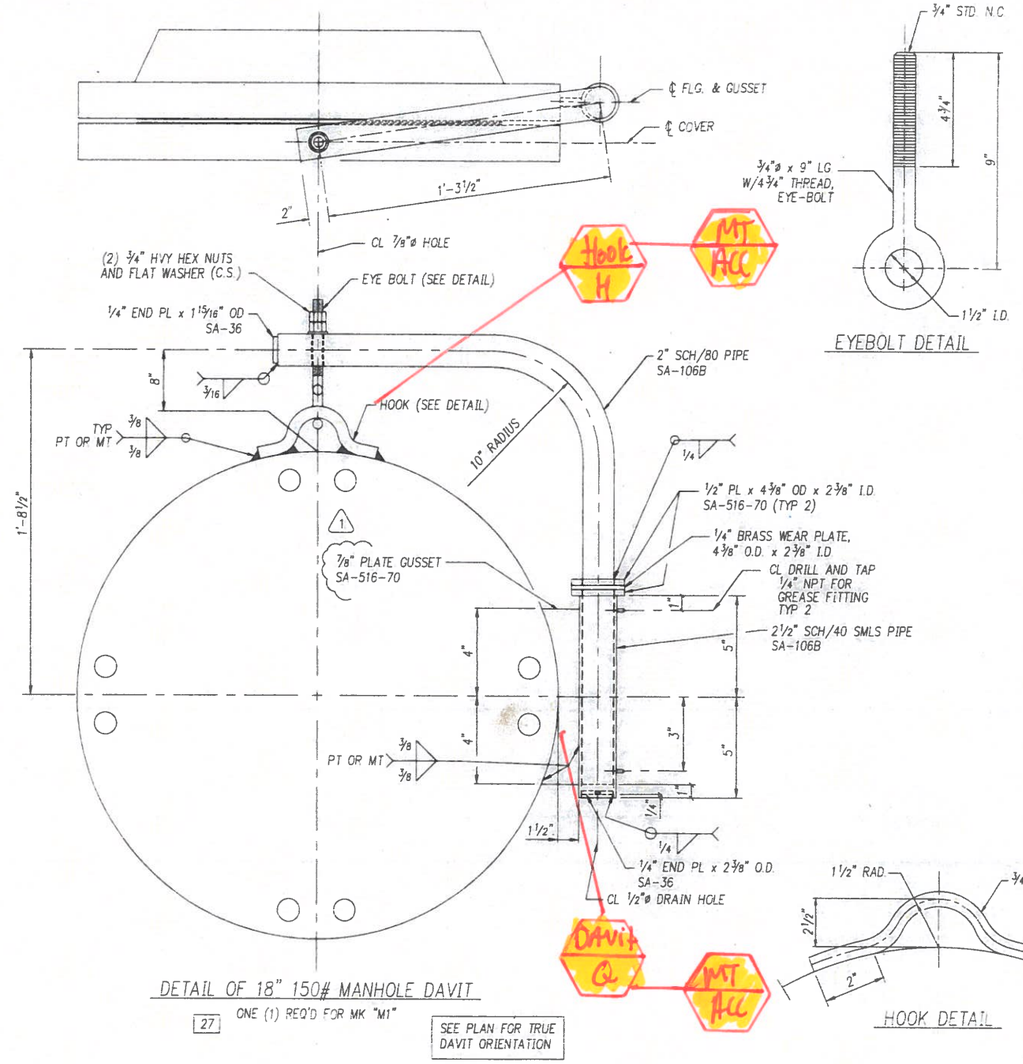
DETAIL OF BAFFLE ASSEMBLY



DETAIL OF BAFFLE SUPPORT CLIP
FOUR (4) REQ'D



DETAIL OF BAFFLE ℄
ONE (1) REQ'D



DETAIL OF 18" 150# MANHOLE DAVIT
27
ONE (1) REQ'D FOR MK "M1"

SEE PLAN FOR TRUE DAVIT ORIENTATION

EYEBOLT DETAIL

HOOK DETAIL

QUALITY CONTROL
MAY 0 4 2018
Kw
QC 1

MCS-GM/FC-P1
MCS-GT-1

AS BUILT

ISSUED FOR CONSTRUCTION 2
MCSI #: 18165 DATE: 4/23/18

REFERENCE DRAWING	DRAWING DESCRIPTION	NO	REVISION DESCRIPTION	DATE	BY	CHK'D
		1	REVISED AS BUILT	4/23/18	MLR	RR
		0	ISSUED FOR CONSTRUCTION	3/20/18	MAK	RR
		A	ISSUED FOR APPROVAL	2/14/18	MLR	RR

MOORE CONTROL SYSTEMS, INC.
KATY, TEXAS
(281) 392-7747
WWW.MOORE-CONTROL.COM

CARLSBAD, NEW MEXICO

CUSTOMER: MARATHON OIL CO
AFE/CUSTOMER JOB NO:

VERTICAL 2 PHASE SEPARATOR FABRICATION DRAWING

DRAWN BY	DATE	SCALE	MCSI JOB NO
MLR	2/14/18		18165

DRAWING NO: 18165-XXXX SHT 4
SHEET: 4 OF
REV: 1

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Baytown: 14827 I-10 East
Baytown, Tx 77523

SECTION 9

WPS / PQR's

Moore Control Systems

1435 Katy Flewellen, Katy, TX 77494

ASME - Welding Procedure Specification (WPS)

WeldOffice WPS

WPS record number	MCS-GM/FC-P1	Revision 0	Qualified to	ASME Section IX
Date	10/6/2014		Company name	Moore Control Systems
Supporting PQR(s)	Q137841 - Rev 0			
Reference docs.				

Scope	Groove, fillet, no PWHT (As-welded)
Joint	Joint details for this welding procedure specification in: JOINTS section of this WPS, Production drawings, Engineering specifications, Reference documents

BASE METALS (QW-403)

Type	Carbon steel (P1)	P-no. 1	Grp-no. Any
Welded to	Carbon steel (P1)	P-no. 1	Grp-no. Any
Backing:	With or without	P-no. 1	Grp-no. Any
Retainers	None		
Notes	See pg 3 for additional base metal thickness limits		

THICKNESS RANGE QUALIFIED (in.)

	As-welded		With PWHT	
	Min.	Max.	Min.	Max.
Complete pen.	0.188	2.00	-	-
Impact tested	-	-	-	-
Partial pen.	0.188	2.00	-	-
Fillet welds	no min.	no max.	-	-

DIAMETER RANGE QUALIFIED (in.)

	As-welded		With PWHT	
	Min.	Max.	Min.	Max.
Nominal pipe size	no min.	no max.	-	-

FILLER METALS (QW-404)

THICKNESS RANGE QUALIFIED (in.)

	SFA	Classification	F-no.	A-no.	Chemical analysis or Trade name	As-welded Min.	As-welded Max.	With PWHT Min.	With PWHT Max.
GMAW	5.18	ER70S-6	6	=>	Chem per AWS classification	no min.	0.165	-	-
FCAW	5.20	E71T-1M	6	=>	Chem per AWS classification	no min.	2.00	-	-
Sup. filler	-	-	-	-	-	- None -			

WELDING PROCEDURE

			GMAW	FCAW
Welding process			GMAW	FCAW
Type			Semi-automatic	Semi-automatic
Minimum preheat/interpass temperature		(°F)	70	70
Maximum interpass temperature		(°F)	600	600
Filler metal size		(in.)	.035	.045
Layer number			Any	Any
Position			All positions	All positions
Weld progression			Uphill or Downhill	Uphill
Current/polarity			DCEP (reverse polarity)	DCEP (reverse polarity)
Amperes			70 - 150	150 - 250
Volts			17 - 22	22 - 28
Travel speed		(in./min)	3 - 14	4 - 16
Maximum heat input		(kJ/in.)	-	-
Wire feed speed		(in./min)	100 - 300	200 - 500
Arc transfer mode			Short-circuiting	Spray
Shielding:	Gas type		75% Argon, 25% CO2	75% Argon, 25% CO2
	Flow rate	(cfh)	30 - 50	30 - 50
Trailing:	Gas type		None	None
	Flow rate	(cfh)	-	-
Backing:	Gas type		None	None
	Flow rate	(cfh)	-	-
String or weave			Stringer or Weave	Stringer or Weave
Orifice/gas cup size			3/8" - 5/8"	3/8" - 3/4"
C.T.W.D		(in.)	1/4 - 1/2	5/8" - 1"
Multi/Single pass per side			Multiple passes	Multiple passes
Maximum pass thickness		(in.)	No pass greater than 1/2"	No pass greater than 1/2"
Weld deposit chemistry				
Notes			Bare solid wire	Flux cored wire

Moore Control Systems

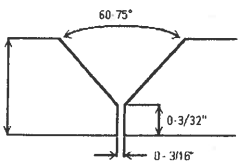
1435 Katy Flewellen, Katy, TX 77494

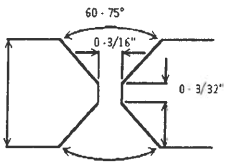
ASME - Welding Procedure Specification (WPS)

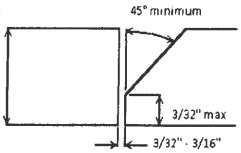
WeldOffice WPS

WPS record number	MCS-GM/FC-P1	Revision 0	Qualified to	ASME Section IX
Date	10/6/2014		Company name	Moore Control Systems

JOINTS (QW-402) Typical joint(s). See actual production drawings and engineering specifications for details.







PREHEAT TABLE

Applicable standard	
ASME B31.1	70 (°F) minimum 200 (°F) when the nominal weld thk. does not exceed 3/4 in., but any of the base metals in the joint exceeds 1 in. 250 (°F) when the nominal thickness of a weld joint exceeds 3/4 in.
ASME B31.3	70 (°F) for thickness less than 1 (in.) and specified minimum tensile strength not over 71000 (psi) 175 (°F) for 1 (in.) and greater thickness, or if specified minimum tensile strength is over 71000 (psi)
ASME Section I	70 (°F) minimum 200 (°F) when the nominal weld thk. does not exceed 3/4 in., but any of the base metals in the joint exceeds 1 in. 250 (°F) when the nominal thickness of a weld joint exceeds 3/4 in.
ASME Section VIII Div. 1	70 (°F) minimum 175 (°F) for thickness over 1 (in.) and specified maximum carbon content over 0.30%. 200 (°F) for thickness over 1.25 (in.)

TECHNIQUE (QW-410)

Peening	None
Surface preparation	Grind to bright metal. Wire brushing as required.
Initial/interpass cleaning	Brushing and Grinding
Back gouging method	Air Carbon Arc and/or Grinding when required.

NOTES

JOINT NOTES

- When used, weld backing may be base metal, weld metal, or another metal with a composition matching the base metal.
- The maximum misalignment allowed at the weld joint is 1/16" per side.

- WELD JOINT DESCRIPTIONS SHOWN ARE NOT INCLUSIVE OF ALL THOSE FOUND ON A JOB. WELD JOINT DESIGN REFERENCE IN AN ENGINEERING SPECIFICATION OR A DESIGN DRAWING SHALL TAKE PRECEDENCE OVER WELD JOINTS SHOWN IN THIS WPS.

FILLET WELDS

- Fillet welds of all sizes are qualified on all base metal thicknesses and all diameters. Fillet welds will utilize base metal backing.

Welder Testing, Inc.

Name	Signature
David Peloquin	David Peloquin
Date	
10/7/2014	

QC Representative

Name	Signature
Steven Stamp	Steven Stamp
Date	
7/10/15	

WPS record number	MCS-GM/FC-P1	Revision 0	Qualified to	ASME Section IX
Date	10/6/2014		Company name	Moore Control Systems

P1 Base metal with no PWHT - Thickness Limitations

- For ASME Section I applications, the maximum thickness allowed to be welded with no PWHT is 1.500"
  Note- Material over .750" may only be welded per the requirements of Section I table PW-39-1.
- For ASME Section VIII applications, the maximum thickness allowed to be welded with no PWHT is 1.500"
  Note- Material over 1.25" may only be welded when a 200°F or greater preheat is applied and maintained.
- For ASME B31.1 applications, the maximum thickness allowed to be welded with no PWHT is 1.500"
  Note- Material over .750" may only be welded per the requirements of B31.1 table 132
- For ASME B31.3 applications, the maximum thickness allowed to be welded with no PWHT is .750"
- For ASME B31.8 applications, the maximum thickness allowed to be welded with no PWHT is 1.250"

CLEANING / JOINT PREPARATION

- The surface of the parts to be welded shall be clean and free of scale, rust, oil, grease, and other deleterious foreign material for a distance of at least 1" from the welding joint preparation..
- The joint should be de-greased using a suitable organic solvent (eg- Acetone, Carbon tetrachloride, or Trichloroethylene) when required. The area shall be completely dried before welding.
- During welding, each run of a multi-pass weld shall be cleaned before depositing the next weld pass. Detrimental oxide shall be removed from the weld metal contact area when weld metal is to be deposited over a previously welded surface.
- For double welded joints, the back side of the joint shall be cleaned/gouged to sound metal prior to welding.
- Preliminary and interpass cleaning may be performed by wire brushing, and / or by grinding.
- When welding is completed, remove all slag and projections.

PREHEAT / INTERPASS TEMPERATURE

- Minimum preheat must be maintained during all thermal cutting, tacking, and welding operations.
- Preheat base metal as required to remove any moisture.
  Welding shall not be performed when the base metal surface is wet or damp.
- Preheat and interpass temperatures shall be checked by the use of thermocouples, temperature indicating crayons, pyrometers, or other suitable methods.

PROCESS NOTES

- Open root welds made from one side shall utilize GMAW welding for the root bead.

MOORE CONTROL SYSTEMS, INC.

(See QW-201.1, Section IX, ASME Boiler and Pressure Vessel Code) WPS page A

Welding Procedure Specification No. MCS-SAW-2-P1 Date 09/19/17

WPS Rev. No. 1 WPS Rev. Date 12/27/17

Supporting PQR No.(s) 17-09-111807 By Kenneth Withers Kenneth Withers

Welding Process(es) GMAW-S, FCAW, SAW Types Semi-Auto, Machine

(Automatic, Manual, Machine or Semi-Auto)

JOINT (QW-402)

Joint Design: Butt Joint

Backing (Yes): Fill - Yes (No): Root - No

Backing Material (Type): Fill - Weld Metal

Retainers: None

Details

Full penetration welded joints
Longitudinal & Circumferential Seams
Nozzle / Pipe Circumferential Seams
Single or Double Vee Groove
Groove Angle: 50° Min. Incl'd.
Root Opening: 1/4" ± 1/8"
Root Face: As needed

BASE METALS (QW-403)

P-No. 1 Gr. No. 1 or 2 to P-No. 1 Gr. No. 1 or 2

OR

Specification type and grade: SA-516-70, SA-106 Gr B, SA-105

to Specification type and grade: SA-516-70, SA-106 Gr B, SA-105

Thickness Range:

Base Metal: Groove XX Fillet XX Other

3/16" - 1-1/2" (5/8" min w/ impacts)

Deposited Weld Metal: GMAW-S .1875" max.; FCAW 1/4"; SAW 1-1/2" max.

Pipe Diameter Range: 8" min.

Max. pass size: 1/2"

Other: Fillet: Any size, any thickness

FILLER METALS (QW-404)

Welding Process(es): Root pass only

	GMAW-S	FCAW	SAW
F-No.	6	6	6
A-No.	1	1	1
Spec. No. (SFA)	5.18	5.20	5.17
AWS No. (Class)	ER70S-6	E71T-1M	EM14K (Lincoln LA-71)
Size of filler metals	.035"	0.045"	Noted WPS B
Electrode-Flux (Class)	N/A	N/A	F7P6-EM14K
Flux Tradename	N/A	N/A	Lincoln 880M
Consumable Insert	N/A	N/A	N/A

All consumables shall conform to H8 or less.
No supplemental powder or filler metal. No alloy material used.
Lincoln 880M flux - neutral. Recrushed slag not used.
FCAW - Flux cored wire, Mn 1.6 max., Si 1.0 max. (Brand - Kobelco Frontiarc 711)
GMAW-S ER70S-6 - Solid / Bare wire, Mn 1.6 max., Si 1.0 max.

POSITIONS (QW-405)

Position(s) of Groove: Root pass only

Welding Progression: GMAW-S: 1G, 2G, 3G*; FCAW, SAW: 1G

Position(s) of Fillet: Up ____ Down * SAW: 1F

PREHEAT (QW-406)

Preheat Temperature: 100°F min.; for material 1-1/4" to 1-1/2" thick use 200°F

Interpass Temperature: 600°F max.

Preheat Maintenance: Fuel Gas torch and/or weld process.

Continuous or special heating where applicable should be recorded): Minimum preheat to be maintained while welding

Preheat shall extend a minimum distance of 3" on each side of the weld.

MOORE CONTROL SYSTEMS, INC.

WPS # MCS-SAW-2-P1

POSTWELD HEAT TREAT (QW-407)

Temperature Range	PWHT not performed
Time Range	
Heating rate	
Cooling rate	

GAS (QW-408)

	Gas(es)	Percent Composition Mixture	Flow Rate	SFA 5.3
Shielding	C25	75% Ar 25% CO2	25-60	SG-AC
Trailing	None			
Backing	None			

Shielding gas for GMAW-S and FCAW processes

ELECTRICAL CHARACTERISTICS (QW-409)

Current AC or DC: DC Polarity: Reverse

Weld Layer(s)	Process	Filler Metal Class	Filler Metal Diameter	Current Type Polarity	Current Amp Range	Volt Range	Travel Speed Range IPM	Max. Heat Input
Root	GMAW-S	ER70S-6	.035"	DCEP	90-100	18-20	5-12	24,000
Hot Pass	FCAW	E71T-1M	0.045"	DCEP	240-260	24-31	10-16	48,360
Fill	SAW	EM14K	3/32"	DCEP	250-450	28-32	14-20	61,714
or Fill	SAW	EM14K	1/8"	DCEP	250-520	28-32	14-20	71,314 Joules /in.
Reverse side: Carbon-arc and/or grind to sound metal if accessible								
Reverse side - Fill with SAW or FCAW process shown above								

Tungsten Electrode Size And Type	N/A
Mode of Metal Transfer for GMAW	Short Circuiting Arc - See note on WPS page C
Electrode Wire feed speed range	140 - 240 IPM

TECHNIQUE (QW-410)

String or Weave Bead	String
Orifice or Gas Cup Size	GMAW-S 3/8" to 1/2"
Cleaning	Chipping hammer, wire brush, grinding as needed: Initial cleaning to be a minimum of 1/2" back from weld preparation. See additional notes on WPS page C
Method of Back Gouging	Carbon-arc and grinding to sound metal, none for skirt to head
Oscillation	None Peening: None
Contact Tube to Work Distance	GMAW-S: 1/2" - 3/4" ; SAW: 1" - 1-1/4"
Multiple or Single Pass (per side)	Multiple
Multiple or Single Electrodes	Single electrode: All processes
Other	Visual inspection shall be performed as a minimum.

MOORE CONTROL SYSTEMS, INC.

WELDING PROCEDURE SPECIFICATION ADDITIONAL WELD JOINT DETAILS

Company Name: Moore Control Systems, Inc.
By: Kenneth Withers
Welding Procedure Specification No.: MCS-SAW-2-P1
Date: 09/19/17
Supporting PQR No.(s): 17-09-111807
Revision No.: 1
Date: 12/27/17
Welding Process(es): GMAW-S, FCAW, SAW
Types: Semi-Auto, Machine
(Automatic, Manual, Machine or Semi-Auto)

TYPICAL PRODUCTION WELD JOINTS

Skirt to head : If applicable
Flat faced fillet
Number of passes as required

Nozzle Circle Seams
Single Vee
Groove Angle: 52° Min. Incl'd.
Root Opening: 3/32" Min.
Root Face: 1/8" Max.

Feather the ends of the tacks

Cleaning: Surfaces to be welded shall be clean and free from paint, oil, dirt, scale, oxides and other foreign material detrimental to welding for at least 1/2" from joint preparation surfaces.

Reverse side of a welded joint - GMAW-S process used as a root pass will be inspected and ground if accessible.
The back side of longitudinal seams can be backgouged, ground and backwelded as needed.

Upon completion, the vessel/pipe shall be thoroughly cleaned and shall be free from grease, weld spatter, scale, slag, and any other foreign matter.

Moore Control Systems

1435 Katy Flewellen, Katy, TX 77494

ASME - Welding Procedure Specification (WPS)

WeldOffice WPS

WPS record number	MCS-GM/FC-P1	Revision 1	Qualified to	ASME Section IX
Date	2/15/2017		Company name	Moore Control Systems
Supporting PQR(s)	Q137841 - Rev 0 PQ153365 - Rev 0			
Reference docs				

Scope	Groove, fillet, no PWHT (As-welded)
Joint	Joint detail for this welding procedure specification in: JOINTS section of this WPS. Production drawings. Engineering specifications. Reference documents

BASE METALS (QW-403)

Type	Carbon steel (P1)	P-no 1	Grp-no Any
Welded to	Carbon steel (P1)	P-no 1	Grp-no Any
Backing	With or without	P-no 1	Grp-no Any
Retainers	None		
Notes	See pg 3 for additional base metal thickness limits		

THICKNESS RANGE QUALIFIED

	As-welded Min.	As-welded Max.	With PWHT Min.	With PWHT Max.
Complete pen.	0.188	2.00	-	-
Impact tested	-	-	-	-
Partial pen.	0.188	2.00	-	-
Fillet welds	no min	no max.	-	-

DIAMETER RANGE QUALIFIED (in.)

	As-welded Min.	As-welded Max.	With PWHT Min.	With PWHT Max.
Nominal pipe size	no min.	no max.	-	-

FILLER METALS (QW-404)

	SFA	Classification	F-no	A-no	Chemical analysis or Trade name
GMAW	5.18	ER70S-6	6	1	Mn = 1.6% max / Si = 1.0% max
FCAW	5.20	E71T-1M	6	1	Mn = 1.6% Max
Sup. filler	-	-	-	-	-

THICKNESS RANGE QUALIFIED (in.)

As-welded Min.	As-welded Max.	With PWHT Min.	With PWHT Max.
no min	0.165	-	-
no min	2.00	-	-
- None -			

WELDING PROCEDURE

		GMAW	FCAW
Welding process		GMAW	FCAW
Type		Semi-automatic	Semi-automatic
Minimum preheat/interpass temperature	(°F)	70	70
Maximum interpass temperature	(°F)	600	600
Filler metal size	(in.)	.035	.045
Layer number		Any	Any
Position		All positions	All positions
Weld progression		Uphill or Downhill	Uphill
Current/polarity		DCEP (reverse polarity)	DCEP (reverse polarity)
Amperes		70 - 150	150 - 250
Volts		17 - 22	22 - 29
Travel speed	(in./min)	3 - 14	4 - 16
Maximum heat input	(kJ/in.)	-	-
Wire feed speed	(in./min)	100 - 300	200 - 500
Arc transfer mode		Short-circuiting	Spray
Shielding: Gas type		75% Argon, 25% CO2	75% Argon, 25% CO2
Shielding: Flow rate	(cfh)	30 - 50	30 - 50
Trailing: Gas type		None	None
Trailing: Flow rate	(cfh)	-	-
Backing: Gas type		None	None
Backing: Flow rate	(cfh)	-	-
String or weave		Stringer or Weave	Stringer or Weave
Orifice/gas cup size		3/8" - 5/8"	3/8" - 3/4"
C.T.W.D.	(in.)	1/4 - 1/2	5/8" - 1"
Multi/Single pass per side		Multiple passes	Multiple passes
Maximum pass thickness	(in.)	No pass greater than 1/2"	No pass greater than 1/2"
Weld deposit chemistry			
Notes		Bare solid wire	Flux cored wire

Moore Control Systems

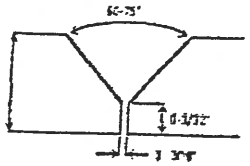
1435 Katy Flewellen, Katy, TX 77494

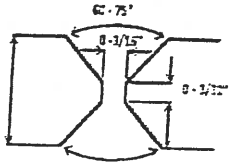
ASME - Welding Procedure Specification (WPS)

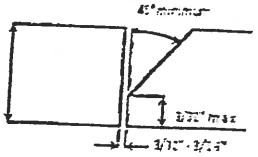
WeldOffice WPS

WPS record number	MCS-GM/FC-P1	Revision 1	Qualified to	ASME Section IX
Date	2/15/2017		Company name	Moore Control Systems

JOINTS (QW-402) Typical joint(s). See actual production drawings and engineering specifications for details.







PREHEAT TABLE

Applicable standard	
ASME B31.1	70 (°F) minimum 200 (°F) when the nominal material thickness (as defined in para 132.4.3) exceeds 1 in.
ASME B31.3	70 (°F) minimum 200 (°F) when the nominal material thickness (as defined in para 331.1.3(c)) exceeds 1 in.
ASME Section	70 (°F) minimum 200 (°F) when the nominal weld thk. does not exceed 3/4 in., but any of the base metals in the joint exceeds 1 in. 250 (°F) when the nominal thickness of a weld joint exceeds 3/4 in.
ASME Section VIII Div. 1	70 (°F) minimum 175 (°F) for thickness over 1 (in.) and specified maximum carbon content over 0.30% 200 (°F) for thickness over 1.25 (in.)

TECHNIQUE (QW-410)

Peening	None
Surface preparation	Grind to bright metal. Wire brushing as required.
Initial/interpass cleaning	Brushing and Grinding
Back gouging method	Air Carbon Arc and/or Grinding when required

NOTES

JOINT NOTES

- When used, weld backing may be base metal, weld metal, or another metal with a composition matching the base metal.
- The maximum misalignment allowed at the weld joint is 1/16" per side

- WELD JOINT DESCRIPTIONS SHOWN ARE NOT INCLUSIVE OF ALL THOSE FOUND ON A JOB. WELD JOINT DESIGN REFERENCE IN AN ENGINEERING SPECIFICATION OR A DESIGN DRAWING SHALL TAKE PRECEDENCE OVER WELD JOINTS SHOWN IN THIS WPS

FILLET WELDS

- Fillet welds of all sizes are qualified on all base metal thicknesses and all diameters. Fillet welds will utilize base metal backing

Documentation by Welder Testing, Inc

Name	Signature
David Pelcquin	
Date	
2/15/2017	

Company Representative

Name	Signature
Kenneth Withers	
Date	
15 Feb. 2017	

WPS record number	MCS-GM/FC-P1	Revision 1	Qualified to	ASME Section IX
Date	2/15/2017		Company name	Moore Control Systems

P1 Base metal with no PWHT - Thickness Limitations
- For ASME Section I applications, the maximum thickness allowed to be welded with no PWHT is 1.500"
  Note- Material over .750" thick may only be welded if the CE does not exceed 0.45, and no single weld pass exceeds .250".
- For ASME Section VIII applications, the maximum thickness allowed to be welded with no PWHT is 1.500"
- For ASME B31.8 applications, the maximum thickness allowed to be welded with no PWHT is 1.250"

CLEANING / JOINT PREPARATION
- The surface of the parts to be welded shall be clean and free of scale, rust, oil, grease, and other deleterious foreign material for a distance of at least 1" from the welding joint preparation..
- The joint should be de-greased using a suitable organic solvent (eg- Acetone, Carbon tetrachloride, or Trichloroethylene) when required. The area shall be completely dried before welding.
- During welding, each run of a multi-pass weld shall be cleaned before depositing the next weld pass. Detrimental oxide shall be removed from the weld metal contact area when weld metal is to be deposited over a previously welded surface.
- For double welded joints, the back side of the joint shall be cleaned/gouged to sound metal prior to welding.
- Preliminary and interpass cleaning may be performed by wire brushing, and / or by grinding.
- When welding is completed, remove all slag and projections.

PREHEAT / INTERPASS TEMPERATURE
- Minimum preheat must be maintained during all thermal cutting, tacking, and welding operations.
- Preheat base metal as required to remove any moisture.
  Welding shall not be performed when the base metal surface is wet or damp.
- Preheat and interpass temperatures shall be checked by the use of thermocouples, temperature indicating crayons, pyrometers, or other suitable methods.

PROCESS NOTES
- Open root welds made from one side shall utilize GMAW welding for the root bead.

MOORE CONTROL SYSTEMS, INC.
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Baytown, Tx 77523

SECTION 10

WELDER QUALIFICATON RECORDS

WELDER TESTING, INC.
502 West 13th Street, Deer Park, TX 77536
Phone (281) 930-9966 Fax (281) 478-0010

QW-484 A Suggested Format For Welder Performance Qualifications (WPQ)
(See QW-301.1, Section IX, ASME Boiler and Pressure Vessel Code)

A5

Welder's Name: ELISEO PEREYRA Identification no: 4755

Test Description

Identification of WPS followed: MCS-GM FC-P1 Test Coupon [X] Production Weld [ ]

Base Material Type Grade: SA-516 Grade 70 Base Material Thickness: 1.00"

Welding Variables (QW-350)	Actual Test Values	Range Qualified	Actual Test Values	Range Qualified
Welding process(es)	FCAW	FCAW		
Type (Manual, Semi-auto, etc.)	Semi-Auto	Semi-Auto		
Backing (With / Without)	With(backweld)	With backing		
Base metal (P no. to P no.)	1	P1-P15E,P34,P41-P49		
[ ] Pipe [X] Plate	-	Plate & Pipe 2.875"od & Larger		
Filler metal or Electrode SFA no.	5.20			
Filler metal or Electrode Classification	E71T-1M			
Filler metal F no.	6	6		
Filler metal product form	N/A	N/A		
Consumable insert	N/A	N/A		
Weld deposit thickness (3 layers min?)	1.00"(yes)	Unlimited		
Welding position (2G, 5G, 3F, etc.)	3G	Flat & Vertical(NI)		
Vertical progression (Up or down)	Up	Up		
Inert gas backing	Without	With or Without gas backing		
GMAW transfer mode	Spray	Globular & Spray		
GTAW Current Type / Polarity	N/A	N/A		

Other: Note 1: Groove welds on pipe 24"od & smaller are qualified in Flat position only. Fillet welds are qualified in Horizontal positions.

Notes:

- Fillet welds - All base metal thicknesses, fillet sizes, and diameters qualified (QW-452.6)
- Double welded groove welds are considered welding with backing (QW-402.4)
- The omission of inert backing gas does not require requalification for welding fillet welds, double welded butt joints, and single welded butt joints with backing. (QW-408.8. [This exception does not apply to P51 through 53, P61, P62, or P101 materials])

RESULTS

[X] QW-462.2 Side bends [ ] QW-462.3(a) Transverse Root & Face Bends [ ] QW-462.3(b) Longitudinal Bends

[ ] QW-462.5(c) Pipe bend specimen, Corrosion resistant overlay [ ] QW-462.5(d) Pipe bend specimen, Corrosion resistant overlay

[ ] QW-462.5(b) Pipe specimen - Macro test for fusion [ ] QW-462.5(e) Plate specimen - Macro test for fusion

Specimen No.	Results	Specimen No.	Results	Specimen No.	Results
Side Bend 1	SATISFACTORY				
Side Bend 2	SATISFACTORY				

Visual Examination Results (QW-302.4) [X] Satisfactory [ ] Unsatisfactory

Alternative Volumetric Examination (QW-191) [ ] RT [ ] UT [ ] Satisfactory [ ] Unsatisfactory

Fillet weld - Fracture test (QW-181.2)_____ Length & percent defects _____

[ ] Fillet welds in plate [QW-462.4(b)] [ ] Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184)_____ Fillet size (in)_____ X_____ Concavity/Convexity(in)_____

Other tests performed _____

Welding Test conducted By: Moore Control Systems

Mechanical tests conducted by: Welder Testing, Inc. Laboratory Test No.: 171620(WELDED OFF-SITE)

We certify that the statements in this record are correct and that the coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code

Prepared By: David Peloquin Certified By: Kenneth White

Organization: Welder Testing, Inc. Organization: Moore Control Systems

Date: 3/8/2018 Date: 3-8-2018

QW-484 A

Result of test: [X] Pass [ ] Fail

WELDER TESTING, INC.
502 West 13th Street, Deer Park, TX 77536
Phone (281) 930-9966 Fax (281) 478-0010

QW-484A Suggested Format For Welder Performance Qualifications (WPQ)
(See QW-301, Section IX, ASME Boiler and Pressure Vessel Code)

Welder's Name: OSIEL HERNANDEZ Identification no: 11

Test Description

Identification of WPS followed: MCS-GM&FC-P1 Test Coupon [X] Production Weld [ ]

Base Material Type/Grade: SA-106 Grade B Base Material Thickness: .864"

Welding Variables (QW-350)	Process 1 Actual Test Values	Process 1 Range Qualified	Process 2 Actual Test Values	Process 2 Range Qualified
Welding process(es)	GMAW	GMAW	FCAW	FCAW
Type (Manual, Semi-auto, etc.)	Semi-Auto	Semi-Auto	Semi-Auto	Semi-Auto
Backing (With / Without)	Without	With or Without backing	With(weld metal)	With backing
Base metal (P no. to P no.)	1	P1-P15E,P34,P41-P49		
[X] Pipe [ ] Plate	6.625"od	2.875"od & larger pipe & plate		
Filler metal or Electrode SFA no.	5.18		5.20	
Filler metal or Electrode Classification	ER70S-6		E71T-1M	
Filler metal F no.	6	6	6	6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Weld deposit thickness (3 layers min?)	.125"[n/a]	.1375"max	.739"[n/a]	Unlimited
Welding position (2G, 5G, 3F, etc.)	6G	All Positions	6G	All Positions
Vertical progression (Up or down)	Down	Down	Up	Up
Inert gas backing	Without	With or Without gas backing	Without	With or Without gas backing
GMAW transfer mode	Short Circuiting	Short Circuiting	Spray	Globular & Spray
GTAW Current Type /Polarity	N/A	N/A	N/A	N/A

Other:

Notes

- Fillet welds - All base metal thicknesses, fillet sizes, and diameters qualified (QW-452.6)
- Double welded groove welds are considered welding with backing (QW-402.4)
- The omission of inert backing gas does not require requalification for welding fillet welds, double welded butt joints, and single welded butt joints with backing. (QW-408.8) [This exception does not apply to P51through 53, P61, P62, or P101 materials]

RESULTS

[X] QW-462.2 Side bends [X] QW-462.3(a) Transverse Root & Face Bends [ ] QW-462.3(b) Longitudinal Bends

[ ] QW-462.5(c) Pipe bend specimen, Corrosion resistant overlay [ ] QW-462.5(d) Plate bend specimen, Corrosion resistant overlay

[ ] QW-462.5(b) Pipe specimen - Macro test for fusion [ ] QW-462.5(e) Plate specimen - Macro test for fusion

Specimen No.	Results	Specimen No.	Results	Specimen No.	Results
Side Bend 1	SATISFACTORY	Side Bend 3	SATISFACTORY		
Side Bend 2	SATISFACTORY	Side Bend 4	SATISFACTORY		

Visual Examination Results (QW-302.4) [X] Satisfactory [ ] Unsatisfactory

Alternative Volumetric Examination (QW-191) [ ] RT [ ] UT [ ] Satisfactory [ ] Unsatisfactory

Fillet weld - Fracture test (QW-181.2) Length & percent defects

[ ] Fillet welds in plate [QW-462.4(b)] [ ] Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) Fillet size (in) X Concavity/Convexity(in)

Other tests performed

Welding Test conducted By: Moore Control Systems, Inc.

Mechanical tests conducted by: Welder Testing, Inc Laboratory Test No.: 169906(WELDED OFF-SITE)

We certify that the statements in this record are correct and that the coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code

Prepared By: David Peloquin Certified By: Kenneth Wilson

Organization: Welder Testing, Inc. Organization: Moore Control Systems, Inc.

Date: 12/29/2017 Date: 12-29-17

QW-484A

Result of test: [X] Pass [ ] Fail

WELDER TESTING, INC.
502 West 13th Street, Deer Park, TX 77536
Phone (281) 930-9966 Fax (281) 478-0010

(K)

QW-484A Suggested Format For Welder Performance Qualifications (WPQ)
(See QW-301, Section IX, ASME Boiler and Pressure Vessel Code)

Welder's Name: EDGAR GUTTERREZ Identification no: XXX-XX-3352

Test Description

Identification of WPS followed: MCS-GM/FC-P1 Test Coupon [X] Production Weld [ ]

Base Material Type/Grade : SA-106 Grade B Base Material Thickness : .344"

Welding Variables (QW-350)	Actual Test Values	Range Qualified	Actual Test Values	Range Qualified
Welding process(es)	GMAW	GMAW	FCAW	FCAW
Type (Manual, Semi-auto, etc.)	Semi-Auto	Semi-Auto	Semi-Auto	Semi-Auto
Backing (With / Without)	None	With or Without	Weld Metal	With backing
Base metal (P no. to P no.)	1	P1-P15F,P34,P41-P49		
[X] Pipe [ ] Plate	2.375"od	1.00"od & larger pipe & plate		
Filler metal or Electrode SFA no.	5.18		5.20	
Filler metal or Electrode Classification	ER70S-6		E71T-1M	
Filler metal F no.	6	6	6	6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Weld deposit thickness (3 layers min?)	.150"[n/a]	.165"max	.194"[n/a]	.388"max
Welding position (2G, 5G, 3F, etc.)	6G	All Positions	6G	All Positions
Vertical progression (Up or down)	Up	Up	Up	Up
Inert gas backing	None	With or Without	None	With or Without
GMAW transfer mode	Short Circuiting	Short Circuiting	Spray	Globular, Spray, Pulsed
GTAW Current Type /Polarity	N/A	N/A	N/A	N/A

Other:

Notes

- Fillet welds - All base metal thicknesses, fillet sizes, and diameters qualified. (QW-452.6)
- Double welded groove welds are considered welding with backing (QW-402.4)
- The omission of inert backing gas does not require requalification for welding fillet welds, double welded butt joints, and single welded butt joints with backing. (QW-408.8) [This exception does not apply to P51through 53, P61, P62, or P101 materials]

RESULTS

[ ] QW-462.2 Side bends [X] QW-462.3(a) Transverse Root & Face Bends [ ] QW-462.3(b) Longitudinal Bends

[ ] QW-462.5(c) Pipe bend specimen, Corrosion resistant overlay [ ] QW-462.5(d) Pipe bend specimen, Corrosion resistant overlay

[ ] QW-462.5(b) Pipe specimen - Macro test for fusion [ ] QW-462.5(e) Plate specimen - Macro test for fusion

Specimen No.	Results	Specimen No.	Results	Specimen No.	Results
Root Bend 1	SATISFACTORY	Face Bend 1	SATISFACTORY		
Root Bend 2	SATISFACTORY	Face Bend 2	SATISFACTORY		

Visual Examination Results (QW-302.4) [X] Satisfactory [ ] Unsatisfactory

Alternative Volumetric Examination (QW-191) [ ] RT [ ] UT [ ] Satisfactory [ ] Unsatisfactory

Fillet weld - Fracture test (QW-181.2) Length & percent defects

[ ] Fillet welds in plate [QW-462.4(b)] [ ] Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) Fillet size (in) X Concavity/Convexity(in)

Other tests performed

Welding Test conducted By: Moore Control Systems

Mechanical tests conducted by: Welder Testing, Inc. Laboratory Test No.: 170280(WELDED OFF-SITE)

We certify that the statements in this record are correct and that the coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code

Prepared By: David Peloquin Certified By: Kenneth Wither

Organization: Welder Testing, Inc. Organization: Moore Control Systems

Date: 1/19/2018 Date: 1-19-2018

QW-484A

Result of test: [X] Pass [ ] Fail

WELDER TESTING, INC.
502 West 13th Street, Deer Park, TX 77536
Phone (281) 930-9966 Fax (281) 478-0010

QW-484A Suggested Format For Welder Performance Qualifications (WPQ)
(See QW-301, Section IX, ASME Boiler and Pressure Vessel Code)

(K)

Welder's Name: EDGAR GUTIERREZ Identification no: XXX-XX-3352

Test Description

Identification of WPS followed: MCS-GM&FC-P1 Test Coupon [X] Production Weld [ ]

Base Material Type/Grade : SA-106 Grade B Base Material Thickness : .864"

Welding Variables (QW-350)	Process 1 Actual Test Values	Process 1 Range Qualified	Process 2 Actual Test Values	Process 2 Range Qualified
Welding process(es)	GMAW	GMAW	FCAW	FCAW
Type (Manual, Semi-auto, etc.)	Semi-Auto	Semi-Auto	Semi-Auto	Semi-Auto
Backing (With / Without)	Without	With or Without backing	With(weld metal)	With backing
Base metal (P no. to P no.)	1	P1-P15F,P34,P41-P49		
[X] Pipe [ ] Plate	6.625"od	2.875"od & larger pipe & plate		
Filler metal or Electrode SFA no.	5.18		5.20	
Filler metal or Electrode Classification	ER70S-6		E71T-1M	
Filler metal F no.	6	6	6	6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Weld deposit thickness (3 layers min?)	.125"[n/a]	.1375"max	.739"[n/a]	Unlimited
Welding position (2G, 5G, 3F, etc.)	6G	All Positions	6G	All Positions
Vertical progression (Up or down)	Down	Down	Up	Up
Inert gas backing	Without	With or Without gas backing	Without	With or Without gas backing
GMAW transfer mode	Short Circuiting	Short Circuiting	Spray	Globular & Spray
GTAW Current Type /Polarity	N/A	N/A	N/A	N/A

Other:

Notes

- Fillet welds - All base metal thicknesses, fillet sizes, and diameters qualified. (QW-452.6)
- Double welded groove welds are considered welding with backing (QW-402.4)
- The omission of inert backing gas does not require requalification for welding fillet welds, double welded butt joints, and single welded butt joints with backing. (QW-408.8) [This exception does not apply to P51through 53, P61, P62, or P101 materials]

RESULTS

[X] QW-462.2 Side bends [X] QW-462.3(a) Transverse Root & Face Bends [ ] QW-462.3(b) Longitudinal Bends

[ ] QW-462.5(c) Pipe bend specimen, Corrosion resistant overlay [ ] QW-462.5(d) Plate bend specimen, Corrosion resistant overlay

[ ] QW-462.5(b) Pipe specimen - Macro test for fusion [ ] QW-462.5(e) Plate specimen - Macro test for fusion

Specimen No.	Results	Specimen No.	Results	Specimen No.	Results
Side Bend 1	SATISFACTORY	Side Bend 3	SATISFACTORY		
Side Bend 2	SATISFACTORY	Side Bend 4	SATISFACTORY		

Visual Examination Results (QW-302.4) [X] Satisfactory [ ] Unsatisfactory

Alternative Volumetric Examination (QW-191) [ ] RT [ ] UT [ ] Satisfactory [ ] Unsatisfactory

Fillet weld - Fracture test (QW-181.2) Length & percent defects

[ ] Fillet welds in plate [QW-462.4(b)] [ ] Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) Fillet size (in) X Concavity/Convexity(in)

Other tests performed

Welding Test conducted By: Moore Control Systems, Inc.

Mechanical tests conducted by: Welder Testing, Inc. Laboratory Test No.: 170279(WELDED OFF-SITE)

We certify that the statements in this record are correct and that the coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code

Prepared By: David Peloquin Certified By: Kenneth Withers

Organization: Welder Testing, Inc. Organization: Moore Control Systems, Inc.

Date: 1/19/2018 Date: 1-19-2018

QW-484A

Result of test: [X] Pass [ ] Fail

QW-484 WELDER, WELDING OPERATOR QUALIFICATION TEST RECORD

(See QW-301, ASME Section IX)

Welder's name: JUAN CARLOS ROSTRO Stencil: Q

Welding process(es) used: FCAW Type: Semi-Auto

WPS followed by welder during welding of test coupon: MCS-GM/FC-P1

Base material(s) welded: SA-36 Thickness: 3/4"

Manual or Semiautomatic Variables for Each Process (QW-350)	Actual Values	Range Qualified
Backing Material (QW-402) (metal, weld metal, flux, etc.)	Weld metal	With backing
ASME P-No. (QW-403)	3/4"	P1 thru P15F, P34, and P4X
Plate or Pipe (enter diameter, if pipe)	Plate	Plate and pipe 2-7/8" O.D. and over
		Groove: Flat only for pipe less than 24"
Filler metal specification(QW-404)		
SFA No.	5.20	All with SFA 5.20, 5.22, 5.29
Classification	E71T-1 / T-9	All with SFA 5.20, 5.22, 5.29
Filler metal F-No.	6	All with SFA 5.20, 5.22, 5.29
Consumable insert for GTAW	N/A	N/A
Weld deposit thickness	3/4"	Max. to be welded
Welding position (QW-405)	3G	Groove: F, V
		Fillet: F, H, V
Welding progression	Vertical Up	Flat, Vertical Up
Backing gas for GTAW or GMAW: (QW-408)	N/A	N/A
GMAW / FCAW transfer mode (QW-409)	Spray	Globular, Spray or Pulsating arc
GTAW welding current type/polarity	N/A	N/A
Machine Welding Variables (QW-360)		
Direct / remote visual control	N/A	N/A
Automatic voltage control (GTAW)	N/A	N/A
Automatic joint tracking	N/A	N/A
Welding Position (1G, 5G, etc.)	N/A	N/A
Consumable insert	N/A	N/A
Backing Material (metal, weld metal, flux, etc.)	N/A	N/A

Guided Bend Test Results
QW-462.2, QW-462.3 (a) & (b))

TYPE AND FIG. NO.	RESULT
2 Side bends per QW-462.2	Satisfactory

Visual examination results (QW-302.4): Satisfactory

Radiographic test results (QW-304 and QW-305): None

Welding test conducted by: Moore Control Systems, Inc

Mechanical tests conducted by: Moore Control Systems, Inc.

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

MOORE CONTROL SYSTEMS, INC

Date: 10/26/15 By: Kenneth Withers

Kenneth Withers

(1G) F=FLAT, (2G) H=HORIZONTAL, (3G) V=VERTICAL, (4G) O=OVERHEAD

WELDER TESTING, INC.
502 West 13th Street, Deer Park, TX 77536
Phone (281) 930-9966 Fax (281) 478-0010

QW-484A Suggested Format For Welder Performance Qualifications (WPQ)
(See QW-301, Section IX, ASME Boiler and Pressure Vessel Code)

Q

Welder's Name: Carlos Rostro Identification no: XXX-XX-6131

Identification of WPS followed: Test Description MCS-GM/FC-P1 Test Coupon ☒ Production Weld ☐

Base Material Type/Grade : SA-36 Base Material Thickness : .375"

Welding Variables (QW-350)	Actual Test Values	Range Qualified	Actual Test Values	Range Qualified
Welding process(es)	GMAW	GMAW	FCAW	FCAW
Type (Manual, Semi-auto, etc.)	Semi-Auto	Semi-Auto	Semi-Auto	Semi-Auto
Backing (With / Without)	None	With or Without	Weld Metal	With backing
Base metal (P no. to P no.)	1	P1-P15F, P34, P41-P49		
☐ Pipe ☒ Plate	–	Plate & Pipe 2.875"od & Larger		
Filler metal or Electrode SFA no.	5.18		5.20	
Filler metal or Electrode Classification	ER70S-6		E71T-1M	
Filler metal F no.	6	6	6	6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Weld deposit thickness (3 layers min?)	.125"[n/a]	.1375" max	.250"[n/a]	.500" max
Welding position (2G, 5G, 3F, etc.)	1G	Flat	1G	Flat
Vertical progression (Up or down)	N/A	N/A	N/A	N/A
Inert gas backing	None	With or Without	None	With or Without
GMAW transfer mode	Short Circuiting	Short Circuiting	Spray	Globular & Spray
GTAW Current Type /Polarity	N/A	N/A	N/A	N/A

Other:

Notes

- Fillet welds - All base metal thicknesses, fillet sizes, and diameters qualified. (QW-452.6)
- Double welded groove welds are considered welding with backing (QW-402.4)
- The omission of inert backing gas does not require requalification for welding fillet welds, double welded butt joints, and single welded butt joints with backing. (QW-408.8) [This exception does not apply to P51through 53, P61, P62, or P101 materials]

RESULTS

☒ QW-462.2 Side bends ☐ QW-462.3(a) Transverse Root & Face Bends ☐ QW-462.3(b) Longitudinal Bends

☐ QW-462.5(c) Pipe bend specimen, Corrosion resistant overlay ☐ QW-462.5(d) Pipe bend specimen, Corrosion resistant overlay

☐ QW-462.5(b) Pipe specimen - Macro test for fusion ☐ QW-462.5(e) Plate specimen - Macro test for fusion

Specimen No.	Results	Specimen No.	Results	Specimen No.	Results
Side Bend 1	SATISFACTORY				
Side Bend 2	SATISFACTORY				

Visual Examination Results (QW-302.4) ☒ Satisfactory ☐ Unsatisfactory

Alternative Volumetric Examination (QW-191) ☐ RT ☐ UT ☐ Satisfactory ☐ Unsatisfactory

Fillet weld - Fracture test (QW-181.2) Length & percent defects

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) Fillet size (in) X Concavity/Convexity(in)

Other tests performed

Welding Test conducted By: Moore Control Systems

Mechanical tests conducted by: Welder Testing, Inc. Laboratory Test No.: 138406

We certify that the statements in this record are correct and that the coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code

Prepared By: David Peloquin Certified By: Kenneth Walther

Organization: Welder Testing, Inc. Organization: Moore Control Systems

Date: 10/16/2014 Date: 03 Aug 2015

QW-484A

Q

QW-484 WELDER, WELDING OPERATOR QUALIFICATION TEST RECORD

(See QW-301, ASME Section IX)

Welder's name: Juan Carlos Restro — Stencil: Q

Welding process(es) used: SAW — Type: Machine

WPS followed by welder during welding of test coupon: MOS-SAW-P1

Base material(s) welded: SA-516-70 — Thickness: 1.2"

Manual or Semiautomatic Variables for Each Process (QW-350)	Actual Values	Range Qualified
Backing Material (QW-402) (metal, weld metal, flux, etc.)	Weld Metal	With backing
ASME P-No. (QW-403)	1	P1 thru P15 and P4X
Plate or Pipe (enter diameter, if pipe)	Plate	Plate and pipe over 24" O.D.
Filler metal specification(QW-404)		
SFA No.	5.17	All with SFA 5.9, 5.17, 5.23
Classification	EM13K	Any with F6
Filler metal F-No.	6	Any with F6
Consumable insert for GTAW	N/A	N/A
Weld deposit thickness	1/2"	Max. to be welded
Welding position (QW-405)	1G	1G Flat
NUMBER OF LAYERS(QW-452.1(b))	minimum of three	
Welding progression	N/A	N/A
Backing gas for GTAW or GMAW: (QW-408)	N/A	N/A
GMAW / FCAW transfer mode (QW-409)	N/A	N/A
GTAW welding current type/polarity	N/A	N/A

Machine Welding Variables (QW-360)		
Direct / remote visual control	Direct	Direct
Automatic voltage control (GTAW)	N/A	N/A
Automatic joint tracking	None	None
Welding Position (1G, 5G, etc.)	1G	1G
Consumable insert	None	None
Backing Material (metal, weld metal, flux, etc.)	Weld Meta	With backing

Guided Bend Test Results
QW-462.2, QW-462.3 (a) & (b)

TYPE AND FIG. NO.	RESULT

Visual examination results (QW-302.4): Satisfactory

Radiographic test results (QW-304 and QW-305): Circumferential Seam C2, Job # 14-777, Tag # V-5510, 48" O.D. - Satisfactory No Defects

Test conducted by: Radiography performed by IRIS NDT

Mechanical tests conducted by: N/A

We certify that the statements in this record are correct and that the test coupons were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Date: 02/22/16

By: Kenneth Withers

MOORE CONTROL SYSTEMS, INC.

KENNETH WITHERS

(1G) F=FLAT, (2G) H=HORIZONTAL, (3G) V=VERTICAL, (4G) O=OVERHEAD

WELDER TESTING, INC.
502 West 13th Street, Deer Park, TX 77536
Phone (281) 930-9966 Fax (281) 478-0010

QW-484A Suggested Format For Welder Performance Qualifications (WPQ)
(See QW-301, Section IX, ASME Boiler and Pressure Vessel Code)

Welder's Name: RAMON LOPEZ Identification no.: XXX-XX-1728

Test Description

Identification of WPS followed: MCS-GMAFC-P1 Test Coupon: ☒ Production Weld: ☐

Base Material Type/Grade: SA-106 Grade B Base Material Thickness: .344"

Welding Variables (QW-350)	Actual Test Values	Range Qualified	Actual Test Values	Range Qualified
Welding process(es)	GMAW	GMAW	FCAW	FCAW
Type (Manual, Semi-auto, etc.)	Semi-Auto	Semi-Auto	Semi-Auto	Semi-Auto
Backing (With / Without)	None	With or Without	Weld Metal	With backing
Base metal (P no. to P no.)	1	P1-P15F,P34,P41-P49		
☒ Pipe ☐ Plate	2.375"od	1.05"od & larger pipe & plate		
Filler metal or Electrode SFA no.	5.18		5.20	
Filler metal or Electrode Classification	ER70S-6		E71T-1M	
Filler metal F no.	6	6	6	6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Weld deposit thickness (3 layers min*)	.150"[n/a]	.165"max	.194"[n/a]	.388"max
Welding position (2G, 5G, 3F, etc.)	6G	All Positions	6G	All Positions
Vertical progression (Up or down)	Up	Up	Up	Up
Inert gas backing	None	With or Without	None	With or Without
GMAW transfer mode	Short Circuiting	Short Circuiting	Spray	Globular, Spray, Pulsed
GTAW Current Type/Polarity	N/A	N/A	N/A	N/A

Other:

Notes

- Fillet welds - All base metal thicknesses, fillet sizes, and diameters qualified (QW-452.6)
- Double welded groove welds are considered welding with backing (QW-402.4)
- The omission of inert backing gas does not require requalification for welding fillet welds, double welded butt joints, and single welded butt joints with backing (QW-403.5) [This exception does not apply to P51 through 53, P61, P62, or P101 materials]

RESULTS

☐ QW-462.2 Side bends ☒ QW-462.3(a) Transverse Root & Face Bends ☐ QW-462.3(b) Longitudinal Bends

☐ QW-462.5(c) Pipe bend specimen, Corrosion resistant overlay ☐ QW-462.5(d) Pipe bend specimen, Corrosion resistant overlay

☐ QW-462.5(b) Pipe specimen - Macro test for fusion ☐ QW-462.5(e) Plate specimen - Macro test for fusion

Specimen No.	Results	Specimen No.	Results	Specimen No.	Results
Root Bend 1	SATISFACTORY	Face Bend 1	SATISFACTORY		
Root Bend 2	SATISFACTORY	Face Bend 2	SATISFACTORY		

Visual Examination Results (QW-302.4) ☒ Satisfactory ☐ Unsatisfactory

Alternative Volumetric Examination (QW-191) ☐ RT ☐ UT ☐ Satisfactory ☐ Unsatisfactory

Fillet weld - Fracture test (QW-181.2): Length & percent defects:

☐ Fillet welds in plate [QW-462.4(b)] ☐ Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184): Fillet size (in.): X Concavity/Convexity (in.):

Other tests performed:

Welding Test conducted By: Moore Control Systems

Mechanical tests conducted by: Welder Testing, Inc. Laboratory Test No.: 170478 (WELDED OFF-SITE)

We certify that the statements in this record are correct and that the coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code

Prepared By: David Peloquin Certified By: Kenneth Wither

Organization: Welder Testing, Inc. Organization: Moore Control Systems

Date: 1/26/2018 Date: 1-26-2018

QW-484A Result of test: ☒ Pass ☐ Fail

WELDER TESTING, INC.
502 West 13th Street, Deer Park, TX 77536
Phone (281) 930-9966 Fax (281) 478-0010

(Y)

QW-484A Suggested Format For Welder Performance Qualifications (WPQ)
(See QW-301, Section IX, ASME Boiler and Pressure Vessel Code)

Welder's Name: RAMON LOPEZ Identification no: XXX-XX-1728

Test Description

Identification of WPS followed: MCS-GM&FC-P1 Test Coupon [X] Production Weld [ ]

Base Material Type/Grade: SA-106 Grade B Base Material Thickness: .864"

Welding Variables (QW-350)	Process 1 Actual Test Values	Process 1 Range Qualified	Process 2 Actual Test Values	Process 2 Range Qualified
Welding process(es)	GMAW	GMAW	FCAW	FCAW
Type (Manual, Semi-auto, etc.)	Semi-Auto	Semi-Auto	Semi-Auto	Semi-Auto
Backing (With / Without)	Without	With or Without backing	With(weld metal)	With backing
Base metal (P no. to P no.)	1	P1-P15F,P34,P41-P49		
[X] Pipe [ ] Plate	6.625"od	2.875"od & larger pipe & plate		
Filler metal or Electrode SFA no	5.18		5.20	
Filler metal or Electrode Classification	ER70S-6		E71T-1M	
Filler metal F no	6	6	6	6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Weld deposit thickness (3 layers min?)	.125"[n/a]	.1375"max	.739"[n/a]	Unlimited
Welding position (2G, 5G, 3F, etc.)	6G	All Positions	6G	All Positions
Vertical progression (Up or down)	Down	Down	Up	Up
Inert gas backing	Without	With or Without gas backing	Without	With or Without gas backing
GMAW transfer mode	Short Circuiting	Short Circuiting	Spray	Globular & Spray
GTAW Current Type /Polarity	N/A	N/A	N/A	N/A

Other:

Notes:

- Fillet welds - All base metal thicknesses, fillet sizes, and diameters qualified. (QW-452.6)
- Double welded groove welds are considered welding with backing (QW-402.4)
- The omission of inert backing gas does not require requalification for welding fillet welds, double welded butt joints, and single welded butt joints with backing. (QW-403.8) [This exception does not apply to P51through 53, P61, P62, or P101 materials]

RESULTS

[X] QW-462.2 Side bends [X] QW-462.3(a) Transverse Root & Face Bends [ ] QW-462.3(b) Longitudinal Bends

[ ] QW-462.5(c) Pipe bend specimen, Corrosion resistant overlay [ ] QW-462.5(d) Plate bend specimen, Corrosion resistant overlay

[ ] QW-462.5(b) Pipe specimen - Macro test for fusion [ ] QW-462.5(e) Plate specimen - Macro test for fusion

Specimen No.	Results	Specimen No.	Results	Specimen No.	Results
Side Bend 1	SATISFACTORY	Side Bend 3	SATISFACTORY		
Side Bend 2	SATISFACTORY	Side Bend 4	SATISFACTORY		

Visual Examination Results (QW-302.4) [X] Satisfactory [ ] Unsatisfactory

Alternative Volumetric Examination (QW-191) [ ] RT [ ] UT [ ] Satisfactory [ ] Unsatisfactory

Fillet weld - Fracture test (QW-181.2) Length & percent defects

[ ] Fillet welds in plate [QW-462.4(b)] [ ] Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) Fillet size (in) X Concavity/Convexity(in)

Other tests performed

Welding Test conducted By: Moore Control Systems, Inc.

Mechanical tests conducted by: Welder Testing, Inc. Laboratory Test No.: 170479(WELDED OFF-SITE)

We certify that the statements in this record are correct and that the coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code

Prepared By: David Peloquin Certified By: Kenneth Wilbur

Organization: Welder Testing, Inc. Organization: Moore Control Systems, Inc.

Date: 1/26/2018 Date: 1-26-2018

QW-484A Result of test: [X] Pass [ ] Fail

(2)

WELDER TESTING, INC.

502 West 13th Street, Deer Park, TX 77536
Phone (281) 930-9966 Fax (281) 478-0010

QW-484A Suggested Format For Welder Performance Qualifications (WPQ)
(See QW-301, Section IX, ASME Boiler and Pressure Vessel Code)

Welder's Name: RODOLFO AGUILAR Identification no: XXX-XX-4339

Test Description

Identification of WPS followed: MCS-GM&FC-P1 Test Coupon: [X] Production Weld: [ ]

Base Material Type/Grade: SA-106 Grade B Base Material Thickness: .864"

Welding Variables (QW-350)	Process 1 Actual Test Values	Process 1 Range Qualified	Process 2 Actual Test Values	Process 2 Range Qualified
Welding process(es)	GMAW	GMAW	FCAW	FCAW
Type (Manual, Semi-auto, etc.)	Semi-Auto	Semi-Auto	Semi-Auto	Semi-Auto
Backing (With / Without)	Without	With or Without backing	With(weld metal)	With backing
Base metal (P no. to P no.)	1	P1-P15E,P34 P41-P49		
[X] Pipe [ ] Plate	6.625"od	2.875"od & larger pipe & plate		
Filler metal or Electrode SFA no.	5.18		5.20	
Filler metal or Electrode Classification	ER70S-6		E71T-1M	
Filler metal F no.	6	6	6	6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Weld deposit thickness (3 layers min?)	.125"(nom)	.1375"max	.739"(nom)	Unlimited
Welding position (2G, 5G, 3F, etc.)	6G	All Positions	6G	All Positions
Vertical progression (Up or down)	Down	Down	Up	Up
Inert gas backing	Without	With or Without gas backing	Without	With or Without gas backing
GMAW transfer mode	Short Circuiting	Short Circuiting	Spray	Globular & Spray
GTAW Current Type/Polarity	N/A	N/A	N/A	N/A

Other:

Notes:

- Fillet welds - All base metal thicknesses, fillet sizes and diameters qualified (QW-452.6)
- Double welded groove welds are considered welding with backing (QW-402.4)
- The omission of inert backing gas does not require requalification for welding fillet welds, double welded butt joints and single welded butt joints with backing (QW-408.8). [This exception does not apply to P51 through 53, P61, P62, or P101 materials]

RESULTS

[X] QW-462.2 Side bends [X] QW-462.3(a) Transverse Root & Face Bends [ ] QW-462.3(b) Longitudinal Bends

[ ] QW-462.5(c) Pipe bend specimen, Corrosion resistant overlay [ ] QW-462.5(d) Plate bend specimen, Corrosion resistant overlay

[ ] QW-462.5(b) Pipe specimen - Macro test for fusion [ ] QW-462.5(e) Plate specimen - Macro test for fusion

Specimen No.	Results	Specimen No.	Results	Specimen No.	Results
Side Bend 1	SATISFACTORY	Side Bend 3	SATISFACTORY		
Side Bend 2	SATISFACTORY	Side Bend 4	SATISFACTORY		

Visual Examination Results (QW-302.4) [X] Satisfactory [ ] Unsatisfactory

Alternative Volumetric Examination (QW-191) [ ] RT [ ] UT [ ] Satisfactory [ ] Unsatisfactory

Fillet weld - Fracture test (QW-181.2): Length & percent defects:

[ ] Fillet welds in plate [QW-462.4(b)] [ ] Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184): Fillet size (in): X Concavity/Convexity (in):

Other tests performed:

Welding Test conducted By: Moore Control Systems, Inc.

Mechanical tests conducted by: Welder Testing, Inc. Laboratory Test No.: 170427(WELDED OFF-SITE)

We certify that the statements in this record are correct and that the coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code

Prepared By: David Peloquin Certified By: Kenneth Wilson

Organization: Welder Testing, Inc. Organization: Moore Control Systems, Inc.

Date: 1/26/2018 Date: 1-26-2018

QW-484A

Result of test: [X] Pass [ ] Fail

WELDER TESTING, INC.
502 West 13th Street, Deer Park, TX 77536
Phone (281) 930-9966 Fax (281) 478-0010

(2)

QW-484 A Suggested Format For Welder Performance Qualifications (WPQ)
(See QW-301, Section IX, ASME Boiler and Pressure Vessel Code)

Welder's Name: RODOLFO AGUILAR Identification no.: XXX-XX-4339

Test Description

Identification of WPS followed: MCS-GMAW-FC-P1 Test Coupon [X] Production Weld [ ]

Base Material Type/Grade: SA-106 Grade B Base Material Thickness: .344"

Welding Variables (QW-350)	Actual Test Values	Range Qualified	Actual Test Values	Range Qualified
Welding process(es)	GMAW	GMAW	FCAW	FCAW
Type (Manual, Semi-auto, etc.)	Semi-Auto	Semi-Auto	Semi-Auto	Semi-Auto
Backing (With / Without)	None	With or Without	Weld Metal	With backing
Base metal (P no. to P no.)	1	P1-P15F,P34,P41-P49		
[X] Pipe [ ] Plate	2.375"od	1.00"od & larger pipe & plate		
Filler metal or Electrode SFA no.	5.18		5.20	
Filler metal or Electrode Classification	ER70S-6		E71T-1M	
Filler metal F no.	6	6	6	6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Weld deposit thickness (3 layers min?)	.150"[n/a]	.165"max	.194"[n/a]	.338"max
Welding position (2G, 5G, 3F, etc.)	6G	All Positions	6G	All Positions
Vertical progression (Up or down)	Up	Up	Up	Up
Inert gas backing	None	With or Without	None	With or Without
GMAW transfer mode	Short Circuiting	Short Circuiting	Spray	Globular, Spray, Pulsed
GTAW Current Type/Polarity	N/A	N/A	N/A	N/A

Other:

Notes:

- Fillet welds - All base metal thicknesses, fillet sizes, and diameters qualified (QW-452.6)
- Double welded groove welds are considered welding with backing (QW-402.4)
- The omission of inert backing gas does not require requalification for welding fillet welds, double welded butt joints, and single welded butt joints with backing. (QW-408.8) [This exception does not apply to P51through 53, P61, P62, or P101 materials]

RESULTS

[ ] QW-462.2 Side bends [X] QW-462.3(a) Transverse Root & Face Bends [ ] QW-462.3(b) Longitudinal Bends

[ ] QW-462.5(c) Pipe bend specimen, Corrosion resistant overlay [ ] QW-462.5(d) Pipe bend specimen, Corrosion resistant overlay

[ ] QW-462.5(b) Pipe specimen - Macro test for fusion [ ] QW-462.5(e) Plate specimen - Macro test for fusion

Specimen No.	Results	Specimen No	Results	Specimen No.	Results
Root Bend 1	SATISFACTORY	Face Bend 1	SATISFACTORY		
Root Bend 2	SATISFACTORY	Face Bend 2	SATISFACTORY		

Visual Examination Results (QW-302.4) [X] Satisfactory [ ] Unsatisfactory

Alternative Volumetric Examination (QW-191) [ ] RT [ ] UT [ ] Satisfactory [ ] Unsatisfactory

Fillet weld - Fracture test (QW-181.2) Length & percent defects

[ ] Fillet welds in plate [QW-462.4(b)] [ ] Fillet welds in pipe [QW-462.4(c)]

Macro examination (QW-184) Fillet size (in) X Concavity/Convexity(in)

Other tests performed

Welding Test conducted By: Moore Control Systems

Mechanical tests conducted by: Welder Testing, Inc. Laboratory Test No.: 170476(WELDED OFF-SITE)

We certify that the statements in this record are correct and that the coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code

Prepared By: David Peloquin Certified By: Kenneth Wilkes

Organization: Welder Testing, Inc. Organization: Moore Control Systems

Date: 1/26/2018 Date: 1-26-2018

QW-484A Result of test: [X] Pass [ ] Fail

MOORE CONTROL SYSTEMS, INC.
Instrument & Electrical Engineering & Design • Construction • Service
Phone: 281-392-7747 www.moore-control.com

Katy: 1435 Katy Flewellen
Katy, Tx 77494

Mailing: P.O. Box 677
Katy, Tx 77494

Baytown: 14827 I-10 East
Baytown, Tx 77523

SECTION 11

INSPECTION AND TEST PLAN

MOORE CONTROL SYSTEMS, INC.
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NON-APPLICABLE

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Baytown, Tx 77523

SECTION 12

COATING REPORT

COR PRO SYSTEMS

10555 W. Little York
Houston, TX 77041

CERTIFICATE OF COMPLIANCE

Certificate Date:
6/28/2018

This is to certify that the equipment described below was processed in compliance to the guidelines and/or specification requirements.

BB SWO# MOOCO-S21039-W29721-P3

Customer MOORE CONTROL SYSTEMS, INC.

PO Number 181655071J

Specification

Cor-Pro Systems, Rev. 0, SB: 2 Coat

System Description

SSPC-SP10, Near White Metal,, Nickel Slag (Green Diamond)/SHWN: Macropoxy 646 Fast Cure, Contrast/SHWN: Hi-Solids Polyurethane,

PO Item#	Qty	Part Number	Equipment Description	Trace Number
1	7	N/A	INTERNAL/EXTERNAL PAINTING (SITE JOB)	QUOTE # MOOCO120617R EV1, Job # 18165, SN: 4-10

Jonathan McBride
NACE CERTIFIED
COATING INSPECTOR
Level - 3 #269735

CPSO QC Sign: _____ Stamp: _____ Date: 6-28-18

3rd Party QC Sign: _____ Stamp: _____ Date: _____

COR-PRO SYSTEMS

Router

Equipment List MOOCO-EL19451
Purchase Order: 181655071J

Print

Customer:
MOORE CONTROL SYSTEMS, INC.

Production Order:
MOOCO-S21039-W29721-P3

Due Date:

Project Manager: Brandi M.

Order Creator: Brandi Madeley (KISC)

Specification

Cor-Pro Systems, Rev. 0, SB: 2 Coat

System Description

SSPC-SP10, Near White Metal,, Nickel Slag (Green Diamond)/SHWN: Macropoxy 646 Fast Cure, Contrast/SHWN: Hi-Solids Polyurethane, BLM Shale Green

Additional Instructions

N/A

Third Party Inspector Information

Equipment List

PO Item	Qty	Equipment Name	PartNumber	TraceNumber
1	7	INTERNAL/EXTERNAL PAINTING (SITE JOB)	N/A	QUOTE # MOOCO120617REV 1, Job # 18165, SN: 4-10

Stage	Contract Review
300 Activity	Job Traveler Creation
Processing Info:	Job Traveler Creation Info

Step Instructions and SOP

Review the receiving documents with the drawings, special instructions, specifications, quotes and purchase order. The Project Coordinator will enter the order and create the router, including all relevant information.

Router Results

Completed By: BM Date: 6 / 5 / 18 Time: 8:00 AM/PM (Circle One)

Stage	Contract Review
11100 Activity	Job Traveler Manager Review
Processing Info:	Job Traveler Manager Review

Step Instructions and SOP

Review and confirm that the router reflects all specification and customer requirements. Review the order for accuracy, clarity, and that all necessary documents are attached.

Router Results

Completed By: BM Date: 6 / 5 / 18 Time: 8:00 AM/PM (Circle One)

Stage	Tape
13100 Activity	Solvent Cleaning
Processing Info:	Solvent Clean - Hand Clean

Specification Requirements

Solvent Clean to the following Standard:SSPC-SP1. Use:Simple Green Original

Step Instructions and SOP

Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants from steel surfaces.
Remove oil or grease by wiping or scrubing the surface with rags or brushes wetted with solvent. Use clean solvent and clean rags or brushes for the final wiping.

Router Results

Completed By: Gabriel Edwards Tim Smith Date: 6 / 5 / 18 Time: 8:30 AM/PM (Circle One)

Stage	Tape

13102 Activity	**Masking**
Processing Info:	**Masking**

Special Project Instructions

There are No Special Instructions for the Masking Stage.

Step Instructions and SOP

Please mask the Equipment according to the Taping Instruction Document (TID). If there is no masking required, please "N/A" this step.

Router Results

Completed By: Andy Samuel Date: 6 / 5 / 18 Time: 8:30 AM/PM (Circle One)

Stage	**Blast**
14000 Activity	**Blasting**
Processing Info:	**Abrasive Blast**

Specification Requirements

SSPC-SP10, Near White Metal, - Nickel Slag (Green Diamond) -2.0-3.0 mils

Special Project Instructions

Enter any Special Instructions that apply to the Abrasive Blast

Step Instructions and SOP

Blast according to the SSPC standard. After completion of the Blast, verify the surface profile of the blast cleaned surface. One reading is required unless otherwise specified by the Customer or a Third Party Inspector.

Router Results

Scotch Tape Test: Pass: ✓ Fail: _____ Testex Tape:

Actual Average Anchor Profile: 2.7 mils

Air Temp: 90.3 Surface Temp: 89 %Humidity: 53% Dew Point: 72.6

Completed By: Tim Smith Date: 12 / 12 / 18 Time: 10:00 (AM)/PM (Circle One)

RESTORATION BLAST (if not applicable, N/A below section): Return items to specified surface cleanliness, due to time lapse.

Scotch Tape Test: Pass: _____ Fail: _____ N/A Testex Tape:

Actual Average Anchor Profile: _____ mils

Air Temp: _____ Surface Temp: _____ %Humidity: _____ Dew Point: _____

Completed By: _____ Date: _____ / _____ / _____ Time: _____ AM/PM (Circle One)

Stage	Paint Coat 1
15000 Activity	Inspection Test
Processing Info:	Existing Coating DFT or Base Metal Reading (BMR)

Step Instructions and SOP

Using a Dry Film Thickness gauge, record the gauge's reading of the existing coating or the bare metal. Record this on the router. The mils from this reading should be subtracted from the final Dry Film Thickness, to ensure that the coating thickness applied is in exact accordance with the customer's specifications.

Router Results

(Circle one) DFT or BMR: .60

Completed By: Tim Smith Date: 12 / 12 / 18 Time: 10:10 (AM)/PM (Circle One)

Stage	Paint Coat 1
15001 Activity	Coating Application
Processing Info:	Coating Information

Specification Requirements

SHWN: Macropoxy 646 Fast Cure, Contrast, 5.0-7.0 mils

Special Project Instructions
No Special Instructions

Step Instructions and SOP
Apply coating according to Manufacturer Product Data Sheet.

Router Results
Paint Batch Numbers: Part A: XM0468UR Part B: XM0868JB

Part C: N/A Part D: N/A

Air Temp: 94 Surface Temp: 93 %Humidity: 55% Dew Point: 74.3

Actual Min. WFT: 8 Actual Max WFT: 10

Completed By: Tim Smith Date: 6/6/18 Time: 12:00 AM/PM (Circle One)

Stage	Topcoat
18000 Activity	Inspection Test
Processing Info:	Pre Coat Inspection

Step Instructions and SOP
Inspect the previous coat visually for runs, dry spray, sags, blushes, pinholes, holidays, inclusions, mudcracking and any other defects where applicable.
Verify the Dry Film Thickness (DFT) is in accordance with the customer's requirements and/or per ISO 19840 and SSPC-PA 2.
Verify the coating extent, masking, and color of the previous coat are in adherence to instructions.
Verify the cure of the coating by testing in accordance with customer requirements and/or manufacturer recommendations.

Router Results
Accept: ✓ Reject: _____

Actual Min DFT: 5.0 Actual Max DFT: 8.5 Average DFT: 6.4

Cure Test: ✓ Pass _____ Fail

Completed By: Tim Smith Date: 6/7/18 Time: 10:00 AM/PM (Circle One)

Stage	Topcoat
18001 Activity	Coating Application
Processing Info:	Coating Information

Specification Requirements
SHWN: Hi-Solids Polyurethane, BLM SHALE GREEN, 3.0-4.0 mils

Special Project Instructions
No Special Instructions

Step Instructions and SOP

Apply coating according to Manufacturer Product Data Sheet.

Router Results

Paint Batch Numbers: Part A: XM1898 VC Part B: MQ0548HF

Part C: N/A Part D: N/A

Air Temp: 85.4 Surface Temp: 84.0 %Humidity: 73.1% Dew Point: 75.8

Actual Min. WFT: _____ Actual Max WFT: _____

Completed By: Tim Smith Date: 6/8/18 Time: 3:00 AM/(PM) (Circle One)

Stage	Quality Control - Final Inspection
20002 Activity	Inspection Test
Processing Info:	Final Inspection

Special Project Instructions

There are No Special Instructions for this Inspection Stage

Step Instructions and SOP

Quality Control Inspector will inspect the coating visually for runs, dry spray, sags, blushes, pinholes, holidays, inclusions, mud-cracking, color and any other defects that could occur.
Verify the Dry Film Thickness (DFT) is in accordance with the customer's requirements and/or per ISO 19840 and SSPC-PA 2.
Review the documentation and parts to ensure completeness.
After verifying that all is completed in accordance with the router, the inspector will sign off on all releases, certificates, reports, and inspection documents.

Router Results

Results: _____ Accept: ✓ Reject: _____

Actual Min DFT: 7.8 Actual Max DFT: 15 Average DFT: 12

Completed By: Jonnie Fuqua Date: 6/12/18 Time: 11:30 (AM)/PM (Circle One)

COR-PRO SYSTEMS

10555 W. Little York
Houston, TX 77041

CERTIFICATE OF COMPLIANCE

Certificate Date:
6/28/2018

This is to certify that the equipment described below was processed in compliance to the guidelines and/or specification requirements.

BB SWO# MOOCO-S21039-W29721-P1

Customer MOORE CONTROL SYSTEMS, INC.

PO Number 181655071J

Specification

Cor-Pro Systems, Rev. 0, SB: 1 Coat

System Description

SSPC-SP10, Near White Metal,, Nickel Slag (Green Diamond)/SHWN: Nova-Plate UHS,White

PO Item#	Qty	Part Number	Equipment Description	Trace Number
1	7	N/A	INTERNAL/EXTERNAL PAINTING (SITE JOB)	QUOTE # MOOCO120617R EV1, Job # 18165, SN: 4-10

Jonathan McBride
NACE CERTIFIED
COATING INSPECTOR
Level - 3 #269735

CPSO QC Sign: _____ Stamp: _____ Date: 6-28-18

3rd Party QC Sign: _____ Stamp: _____ Date: _____

COR-PRO SYSTEMS

Router

Equipment List MOOCO-EL19451

Purchase Order: 181655071J

Print

Customer:

MOORE CONTROL SYSTEMS, INC.

Production Order:

MOOCO-S21039-W29721-P1

Due Date:

Project Manager: Brandi M.

Order Creator: Brandi Madeley (KISC)

Specification

Cor-Pro Systems, Rev. 0, SB: 1 Coat

System Description

SSPC-SP10, Near White Metal,, Nickel Slag (Green Diamond)/SHWN: Nova-Plate UHS,White

Additional Instructions

N/A

Third Party Inspector Information

Equipment List

PO Item	Qty	Equipment Name	PartNumber	TraceNumber
1	7	INTERNAL/EXTERNAL PAINTING (SITE JOB)	N/A	QUOTE # MOOCO120617REV 1, Job # 18165, SN: 4-10

Stage	Contract Review
300 Activity	Job Traveler Creation
Processing Info:	Job Traveler Creation Info

Step Instructions and SOP

Review the receiving documents with the drawings, special instructions, specifications, quotes and purchase order. The Project Coordinator will enter the order and create the router, including all relevant information.

Router Results

Completed By: BM Date: 6/5/18 Time: 8:00 (AM)/PM (Circle One)

Stage	Contract Review
11100 Activity	Job Traveler Manager Review
Processing Info:	Job Traveler Manager Review

Step Instructions and SOP

Review and confirm that the router reflects all specification and customer requirements. Review the order for accuracy, clarity, and that all necessary documents are attached.

Router Results

Completed By: BM Date: 6/5/18 Time: 8:00 (AM)/PM (Circle One)

Stage	Tape
13100 Activity	Solvent Cleaning
Processing Info:	Solvent Clean - Hand Clean

Specification Requirements

Solvent Clean to the following Standard:SSPC-SP1. Use:Simple Green Original

Step Instructions and SOP

Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants from steel surfaces.
Remove oil or grease by wiping or scrubing the surface with rags or brushes wetted with solvent. Use clean solvent and clean rags or brushes for the final wiping.

Router Results

Completed By: Andy Samuel Date: 6/5/18 Time: 8:30 (AM)/PM (Circle One)

Stage	Tape

13102 Activity	Masking
Processing Info:	Masking

Special Project Instructions

There are No Special Instructions for the Masking Stage.

Step Instructions and SOP

Please mask the Equipment according to the Taping Instruction Document (TID). If there is no masking required, please "N/A" this step.

Router Results

Completed By: Gabriel Edwards Date: 12 / 5 / 18 Time: 8:30 (AM)/PM (Circle One)

Stage	Blast
14000 Activity	Blasting
Processing Info:	Abrasive Blast

Specification Requirements

SSPC-SP10, Near White Metal, - Nickel Slag (Green Diamond) -2.0-3.0 mils

Special Project Instructions

There are No Special Instructions for the Blast Stage.

Step Instructions and SOP

Blast according to the SSPC standard. After completion of the Blast, verify the surface profile of the blast cleaned surface. One reading is required unless otherwise specified by the Customer or a Third Party Inspector.

Router Results

Scotch Tape Test: Pass: ✓ Fail: _____ Testex Tape:

Actual Average Anchor Profile: 2.7 mils

Air Temp: 90.3 Surface Temp: 89 %Humidity: 53% Dew Point: 72.6

Completed By: Tim Smith Date: 6e / 6e / 18 Time: 10:00 (AM)/PM (Circle One)

RESTORATION BLAST (if not applicable, N/A below section): Return items to specified surface cleanliness, due to time lapse.

Scotch Tape Test: Pass: _____ Fail: N/A Testex Tape:

Actual Average Anchor Profile: _____ mils

Air Temp: _____ Surface Temp: _____ %Humidity: _____ Dew Point: _____

Completed By: _____ Date: _____/_____/_____ Time: _____AM/PM (Circle One)

Stage	Paint Coat 1
15000 Activity	Inspection Test
Processing Info:	Existing Coating DFT or Base Metal Reading (BMR)

Step Instructions and SOP

Using a Dry Film Thickness gauge, record the gauge's reading of the existing coating or the bare metal. Record this on the router. The mils from this reading should be subtracted from the final Dry Film Thickness, to ensure that the coating thickness applied is in exact accordance with the customer's specifications.

Router Results

(Circle one) DFT or BMR: .60

Completed By: Tim Smith Date: 6e / 6e / 18 Time: 10:10 (AM)/PM (Circle One)

Stage	Paint Coat 1
15001 Activity	Coating Application
Processing Info:	Coating Information

Specification Requirements

SHWN: Nova-Plate UHS,White,20.0-25.0 mils

Special Project Instructions
No Special Instructions

Step Instructions and SOP
Apply coating according to Manufacturer Product Data Sheet.

Router Results
Paint Batch Numbers: Part A: XM0178NV Part B: XM0098CV

Part C: N/A Part D: N/A

Air Temp: 95 Surface Temp: 94.5 %Humidity: 56% Dew Point: 75.1

Actual Min. WFT: 20 Actual Max WFT: 25

Completed By: Tim Smith Date: 6/6/18 Time: 1:00 AM (PM) (Circle One)

Stage	Quality Control - Final Inspection
20002 Activity	Inspection Test
Processing Info:	Final Inspection

Step Instructions and SOP
Quality Control Inspector will inspect the coating visually for runs, dry spray, sags, blushes, pinholes, holidays, inclusions, mud-cracking, color and any other defects that could occur.
Verify the Dry Film Thickness (DFT) is in accordance with the customer's requirements and/or per ISO 19840 and SSPC-PA 2.
Review the documentation and parts to ensure completeness.
After verifying that all is completed in accordance with the router, the inspector will sign off on all releases, certificates, reports, and inspection documents.

Router Results

Results: _____ Accept: ✓ Reject: _____

Actual Min DFT: 19.3 Actual Max DFT: 28 Average DFT: 24.4

Completed By: Lonni Fuqua Date: 6/12/18 Time: 11:30 (AM)/PM (Circle One)

MOORE CONTROL SYSTEMS, INC.
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SECTION 13

POST WELD HEAT TREATING REPORT W/CHART

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NON-APPLICABLE

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SECTION 14

AS-BUILTS

ITEM	QUANTITY	MATERIAL	DESCRIPTION	NORMALIZED	IMPACT TEST	PWHT
1	2	SA-516 70	CYLINDER - 48" OD x 3/8" WALL x 10'-0" LG	NO	NO	NO
2	2	SA-516 70	2:1 HEAD - 48" OD x 5/16" MIN (3/8" NOM) THICK, 2" SF, SF MIN THK = .3007"	NO	NO	NO
3	1	SA-516 70	SKIRT - 40" OD x 1'-6" LONG x 1/4" WALL	NO	NO	NO
4	1	SA-105	NOZZLE FLANGE - 18" 150# RFSO WITH BLIND FLANGE/GASKET AND BOLTING	NO	NO	NO
5	2	SA-105	NOZZLE FLANGE - 6" 150# RFWN, BORE = SCH 80	NO	NO	NO
6	3	SA-105	CPLG - 0.5" 6000# FULL CPLG	NO	NO	NO
7	1	SA-105	CPLG - 0.5" 6000# CPLG x 3" LG (TOE)	NO	NO	NO
8	1'-6"	SA-106 B SMLS PIPE	NOZZLE NECK - 2" SCH 80	NO	NO	NO
9	1	SA-105	CPLG - 2" 3000# CPLG x 6" LG (TOE)	NO	NO	NO
10	2	SA-105	CPLG - 2" 3000# FULL CPLG	NO	NO	NO
11	1	SA-105	CPLG - 3" 3000# FULL CPLG	NO	NO	NO
12	1'-2"	SA-106 B SMLS PIPE	NOZZLE NECK - 6" SCH 80	NO	NO	NO
13	1'-0"	SA-106 B SMLS PIPE	NOZZLE NECK - 18" SCH 80	NO	NO	NO
14	1	SA-516 70	REINFORCEMENT PAD - 10.625" OD x .375" THK (TOP HEAD)	NO	NO	NO
15	1	SA-516 70	REINFORCEMENT PAD - 22" OD x .375" THK	NO	NO	NO
16	1	SA-234-WPB	WELDELL - 2" SCH 80 L.R. 90°	NO	NO	NO
17	1	SA-234-WPB	WELDELL - 6" SCH 80 45°	NO	NO	NO
18	2	SA-105	CPLG - 0.75" 6000# FULL CPLG	NO	NO	NO

CONSTRUCTION DETAIL	
DESCRIPTION	DATA
MAWP (INT) @ DESIGN TEMP.	250 PSI @ 150°F
MDMT @ MAWP	-20/ @ 250 PSI
MAWP LIMITED BY	DESIGN
HYDROSTATIC TEST	325 PSI
CORROSION ALLOWANCE	0"
RADIOGRAPHY	RT-2
PWHT	NONE
CODE CASE(S)	NONE
CODE STAMP REQ'D	YES
NT'L BOARD REQ'D	YES
CONSTRUCTION CODE	ASME SEC. VIII DIV.1 2017
WPS(S)	BY MCSI
WIND CODE	ASCE-7 10
SEISMIC CODE	ASCE-7 10
WEIGHT	5,208 LBS

2

* SERIAL NO.	SERVICE	NB NO.
18165-1	VERTICAL 2-PHASE SEPARATOR	1
18165-2	VERTICAL 2-PHASE SEPARATOR	2
18165-3	VERTICAL 2-PHASE SEPARATOR	3
18165-4	VERTICAL 2-PHASE SEPARATOR	8
18165-5	VERTICAL 2-PHASE SEPARATOR	7
18165-6	VERTICAL 2-PHASE SEPARATOR	14
18165-7	VERTICAL 2-PHASE SEPARATOR	15
18165-8	VERTICAL 2-PHASE SEPARATOR	16
18165-9	VERTICAL 2-PHASE SEPARATOR	19
18165-10	VERTICAL 2-PHASE SEPARATOR	17

MARK	IDENTIFIER	SIZE	TYPE	CLASS	TYPE	A	B	C	D	E	F	TYPE	A	B	C	D	E
		FLANGE			NOZZLE STYLE							WELD					
C15	OIL LEVEL HIGH	.75	CPLG	6000#	3	1.05	.35	25	–	–	.5	4	.375	.375	.25	–	–
C14	WATER LEVEL LOW	.75	CPLG	6000#	3	1.05	.35	25	–	–	.5	4	.375	.375	.25	–	–
C13	RELIEF	2	CPLG	3000#	3	2.375	.3125	25	–	–	1.875	4	.375	.375	.25	–	–
C10	WATER LLC	2	CPLG	3000#	3	2.375	.3125	25	–	–	1.875	4	.375	.375	.25	–	–
C8	PI	0.5	CPLG	6000#	3	.84	.33	25	–	–	.5	4	.375	.375	.25	–	–
C7	SAFETY HEAD	2	CPLG	3000#	3	2.375	.3125	ELEV	–	–	.25	4	.375	.3125	.25	–	–
C6	GAS OUTLET	6	RFWN	150#	2	5.761	.432	ELEV	.375	10.625	.5	11	.375	.3125	.375	.3125	–
C5	DRAIN	2	CPLG	3000#	SEE DETAIL												
C4	SUPPLY GAS	0.5	CPLG	6000#	3	.84	.33	ELEV	–	–	.25	4	.375	.3125	.25	–	–
C3B	GAUGE GLASS	0.5	CPLG	6000#	3	.84	.33	25	–	–	.5	4	.375	.375	.25	–	–
C3A	GAUGE GLASS	0.5	CPLG	6000#	3	.84	.33	25	–	–	.5	4	.375	.375	.25	–	–
C2	WATER OUTLET	3	CPLG	3000#	3	3.5	.375	25	–	–	1.75	4	.375	.375	.25	–	–
C1	INLET	6	RFWN	150#	3	5.761	.432	30	–	–	2	4	.375	.375	.375	–	–
M1	MANWAY	18	RFSO	150#	4	16.124	.938	30	.375	22	.75	11	.375	.3125	.375	.375	–

NOZZLE SCHEDULE

NB * SEE TABLE

CERTIFIED BY: MCSI MOORE CONTROL SYSTEMS, INC. KATY, TEXAS

ASME U W RT-2

MAWP: 250 PSI @ 150 °F

MDMT: -20 °F @ 250 PSI

2018 YEAR BUILT

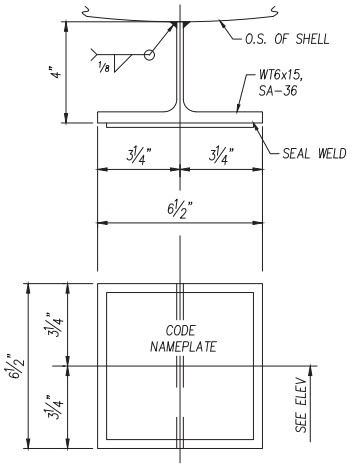
S/N: * SEE TABLE

TAG:

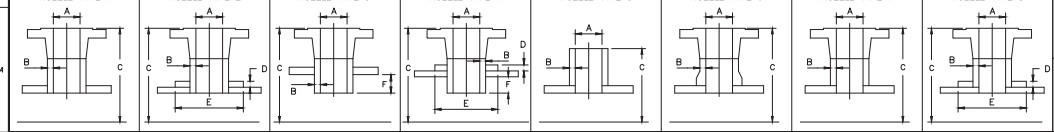
VERTICAL 2 PHASE SEPARATOR

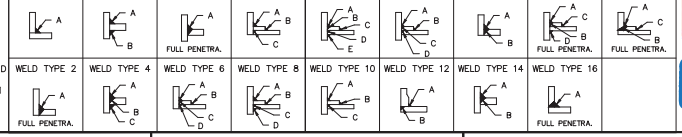
48"O.D. x 20'-0" S/S | CA: 0"

CODE NAMEPLATE



NAMEPLATE BRACKET DETAIL





ISSUED FOR CONSTRUCTION 2
MCSI #: 18165 DATE: 4/23/18

AS BUILT

TOLERANCE
CUTS ± 1/8"
ANGLES ± 1/2°
ASSY'S ± 1/4"

NO	REVISION DESCRIPTION	DATE	BY	CHK'D
2	REVISED AS BUILT	4/23/15	MLR	RR
1	REVISED C14/15 RATING	3/20/18	MAK	RR
0	ISSUED FOR CONSTRUCTION	2/14/18	MLR	RR
A	ISSUED FOR APPROVAL	1/22/18	MLR	RR

REFERENCE DRAWING | DRAWING DESCRIPTION

MCSI MOORE CONTROL SYSTEMS, INC.
KATY, TEXAS
(281) 392-7747 WWW.MOORE-CONTROL.COM

CARLSBAD, NEW MEXICO

CUSTOMER: MARATHON OIL CO. | AFE/CUSTOMER JOB NO: *

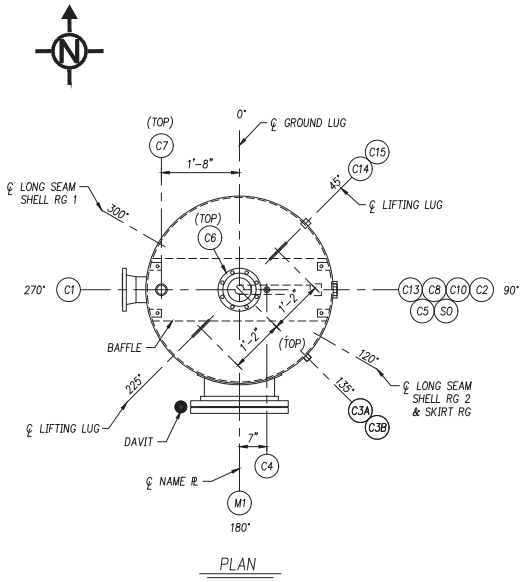
VERTICAL 2 PHASE SEPARATOR FABRICATION DRAWING

DRAWN BY	DATE	SCALE	MCSI JOB NO
MLR	1/22/18	*	18165

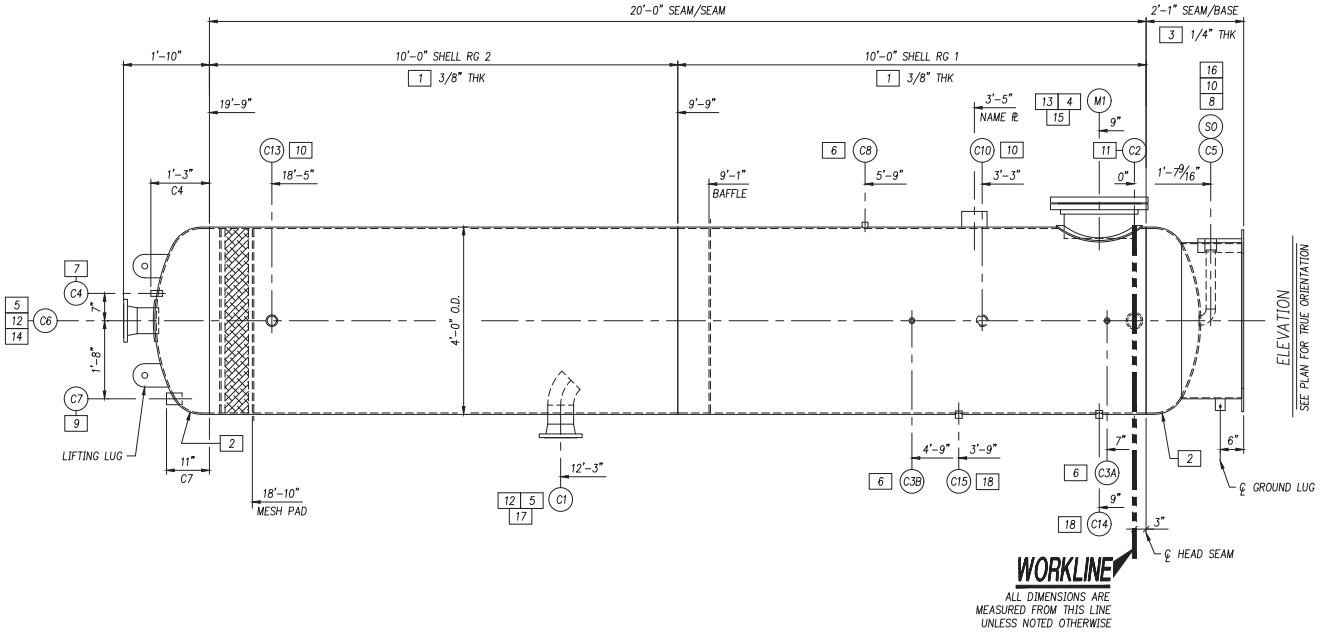
DRAWING NO: 18165-XXXX SHT 1 | SHEET 1 OF | REV 2

4/23/2018 12:43:26 PM

X:\MOORE CONTROLS\18165 - MARATHON SCRUBBER\18165.DWG



PLAN



WORKLINE

ALL DIMENSIONS ARE MEASURED FROM THIS LINE UNLESS NOTED OTHERWISE

AS BUILT

ISSUED FOR CONSTRUCTION 1

MCSI #: 18165 DATE: 3/20/18

NO	REVISION DESCRIPTION	DATE	BY	CHK'D
0	ISSUED FOR CONSTRUCTION	2/14/18	MLR	RR
A	ISSUED FOR APPROVAL	1/22/18	MLR	RR

REFERENCE DRAWING | DRAWING DESCRIPTION

MOORE CONTROL SYSTEMS, INC.
KATY, TEXAS
(281) 392-7747
WWW.MOORE-CONTROL.COM

CARLSBAD, NEW MEXICO

CUSTOMER: MARATHON OIL CO.
AFE/CUSTOMER JOB NO: *

VERTICAL 2 PHASE SEPARATOR
FABRICATION DRAWING

DRAWN BY	DATE	SCALE	MCSI JOB NO
MLR	1/22/18	*	18165

DRAWING NO: 18165-XXXX SHT 2 | SHEET: 2 OF | REV: 0

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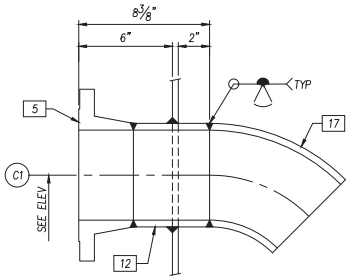
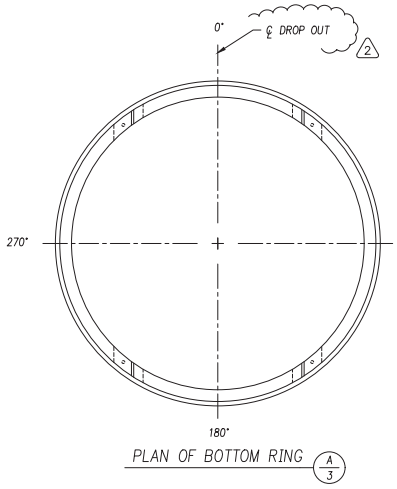
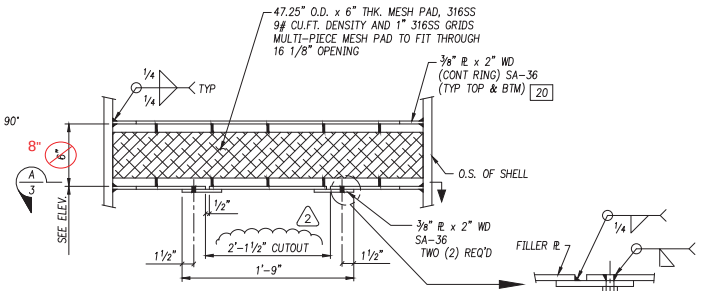


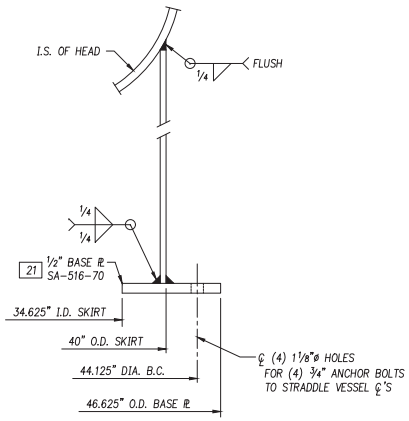
DETAIL OF 6" 150# NOZZLE MK "C1"
ONE (1) REQ'D



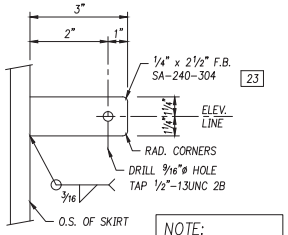
PLAN OF BOTTOM RING A/3



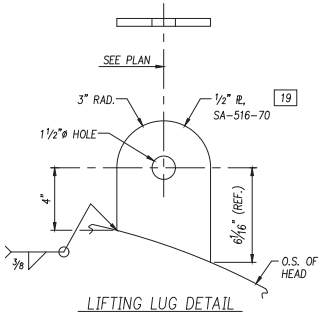
DEMISTER DETAIL
ONE (1) REQ'D



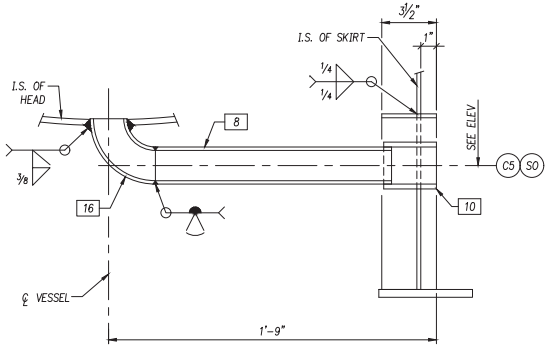
SKIRT & BASEPLATE DETAIL

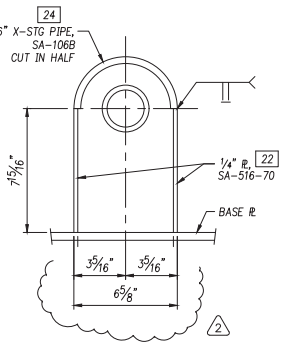


GROUNDING LUG DETAIL
ONE (1) REQ'D



LIFTING LUG DETAIL
TWO (2) REQ'D





DETAIL OF 2" 3000# CPLG MK "C5" & SKIRT SLEEVE MK "S0"
ONE (1) REQ'D

AS BUILT

ISSUED FOR CONSTRUCTION 2
MCSI #: 18165 DATE: 4/23/18

NO	REVISION DESCRIPTION	DATE	BY	CHK'D
2	REVISED AS BUILT	4/23/18	MLR	RR
1	REVISED MESH PAD DETAIL	3/27/18	MLR	RR
0	ISSUED FOR CONSTRUCTION	3/20/18	MAK	RR
A	ISSUED FOR APPROVAL	2/14/18	MLR	RR

REFERENCE DRAWING | DRAWING DESCRIPTION

MOORE CONTROL SYSTEMS, INC.
KATY, TEXAS
(281) 392-7747
WWW.MOORE-CONTROL.COM

CARLSBAD, NEW MEXICO
CUSTOMER: MARATHON OIL CO.
AFE/CUSTOMER JOB NO: *

VERTICAL 2 PHASE SEPARATOR
FABRICATION DRAWING
DRAWN BY: MLR | DATE: 2/14/18 | SCALE: * | MCSI JOB NO: 18165
DRAWING NO: 18165-XXX SHT 3 | SHEET: 3 OF | REV: 2

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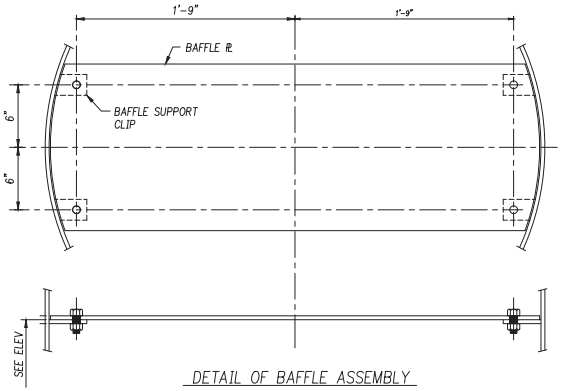
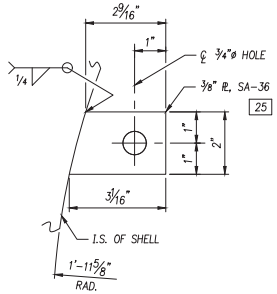
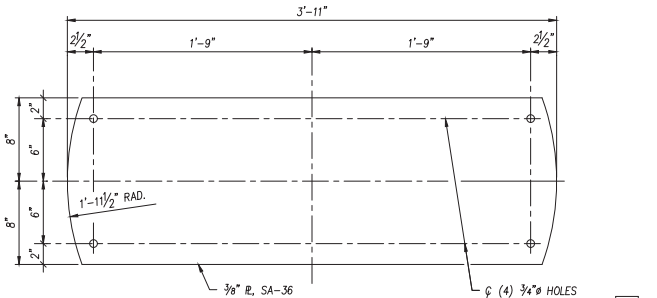


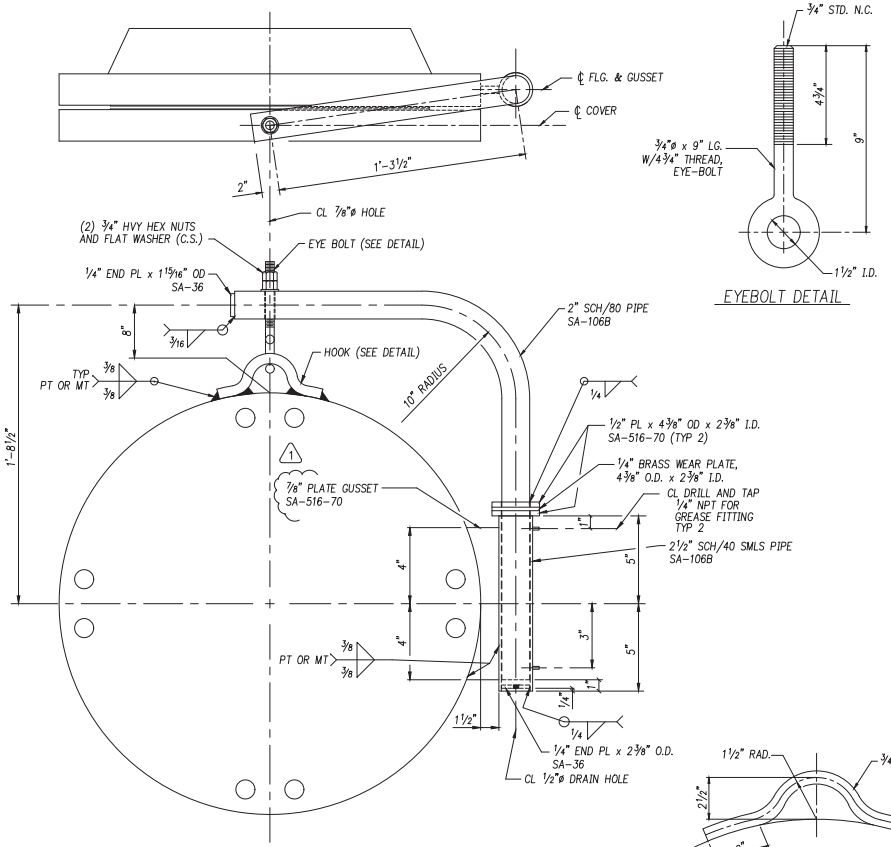
DETAIL OF BAFFLE ASSEMBLY



DETAIL OF BAFFLE SUPPORT CLIP
FOUR (4) REQ'D



DETAIL OF BAFFLE ℄
ONE (1) REQ'D



DETAIL OF 18" 150# MANHOLE DAVIT
27
ONE (1) REQ'D FOR MK "M1"

SEE PLAN FOR TRUE DAVIT ORIENTATION

EYEBOLT DETAIL

HOOK DETAIL

AS BUILT

ISSUED FOR CONSTRUCTION 2
MCSI #: 18165 DATE: 4/23/18

REFERENCE DRAWING	DRAWING DESCRIPTION	NO	REVISION DESCRIPTION	DATE	BY	CHK'D
		1	REVISED AS BUILT	4/23/18	MLR	RR
		0	ISSUED FOR CONSTRUCTION	3/20/18	MAK	RR
		A	ISSUED FOR APPROVAL	2/14/18	MLR	RR

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VERTICAL 2 PHASE SEPARATOR
FABRICATION DRAWING

DRAWN BY	DATE	SCALE	MCSI JOB NO
MLR	2/14/18	*	18165

DRAWING NO	SHEET	REV
18165-XXXX SHT 4	4 OF	1

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MOORE CONTROL SYSTEMS, INC.
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Katy: 1435 Katy Flewellen
Katy, Tx 77494

Mailing: P.O. Box 677
Katy, Tx 77494

Baytown: 14827 I-10 East
Baytown, Tx 77523

SECTION 15

NON-CONFORMATION REPORTS

MOORE CONTROL SYSTEMS, INC.
Instrument & Electrical Engineering & Design • Construction • Service
Phone: 281-392-7747 www.moore-control.com

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Katy, Tx 77494

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Katy, Tx 77494

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Baytown, Tx 77523

NON-APPLICABLE