UOP RUSSELL LLC
Tulsa, Oklahoma

JOB NO:	J-447	TAG NO:	V-492	DATE:	11/29/2010
CLIENT:	UOP Russell	S.O./P.O. NO:		BY:	JRG
SUBJECT:	60 MMScfd Cryo Plant	SERVICE:	Cold Drain Tank		

PRESSURE VESSELS

MECHANICAL DESIGN

Type (vertical, horizontal, tower)	Horizontal
Diameter: (inch)	72" ID
S/S Length (ft-inch)	24'-0"
CL Vessel Height (ft-inch)	5'-0"
Design Pressure (psig)	150
Design Temperature (°F)	150
MDMT (°F) @ Pressure (psig)	-200 @ 150
Corrosion Allowance (inch)	0
Radiography	RT-3 min.
PWHT Req'd?	No
Wind / Seismic Code ▲	ASCE 7-10 / ASCE 7-10
Wind Code ▲	Cf=0.7, V=120 mph, Exp. C, Cat. III
Seismic Code	Site D, I=1.25, S_S=100% , S_1=40%
Insulation	None
Fireproof	No
Code	ASME VIII, Div I
Code Stamp Req'd	Yes
Sandblast / Paint	None
Ladder / Platform Clips Req'd?	No
Pipe Supports Req'd?	No

PROCESS DESIGN

Operating Pressure (psia)	35
Operating Temperature (°F)	-134
Vapor Flow (Lb/Hr)	
Vapor Density (Lb/cf)	
Liquid Flow (Lb/Hr)	
Liquid Density (Lb/cf)	
Liquid Residence Time (Min)	

MIST PAD

Req'd :	No	Diameter:	
Overall Thk:		Pad Thk:	
Removable:		Grid Matl:	
Wire Diameter:		Mesh Matl:	316SS

MATERIAL SPECIFICATIONS

Shell	SA-	240-304
Head	SA-	240-304
Nozzle Necks	SA-	312-TP304
Flanges	SA-	182 F-304
Couplings	SA-	182 F-304
Studs	SA-	193 Gr. B8
Nuts	SA-	194 Gr. 8
Wear Plate / Saddle	SA-	304

NOZZLES

SERVICE	MK	QTY	SIZE	RATING	FACE & TYPE	NOZZLE APPURTENANCES
Inlet	A	1	12."	150	RF FLG	Diverter
Vapor Out	B	1	12."	150	RF FLG	
LG	C	2	1."	150	RF FLG	
Drain	D	1	1."	150	RF FLG	
TI	E	1	1."	150	RF FLG	
Liquid Out	F	1	2."	150	RF FLG	Vortex Breaker
LSHH	G	2	1."	150	RF FLG	

INTERNALS AND APPURTENANCES

PACKING	Size (in.)	Type	Bed Height (ft.)
Top			
Middle			
Bottom			

PLATFORMS	Quantity	Angle / Area
Access:		(deg)
Stepoff:		(deg)
Other:		(Sq.Ft.)

	DOME	BOOT
Diameter (in):		
Length (in):		
with flanges		

TRAYS	Quantity	No. of Passes	Weldins by:

Platepack Length (inch):

Total Ladder Length (ft):

Qty Break Flg Pairs:	
Qty of Hat Trays:	
Weir Plate:	No
Wave Baffle:	No
Nat'l Board Req'd:	Yes
Charcoal Bed Height (ft):	
Qty Catalyst bed Supports:	

NOTES: 1) Duplicate of PO 247-16

REVISION	A		0		▲ 1			
ENGINEER/DATE	JRG	11/29/10	JRG	7/14/11	BH	11/21/11		
ISSUED FOR	RFQ		Purchase		Revised			

LEWIS INDUSTRIES CORPORATION

816 N. 5TH STREET, COLLINSVILLE, OKLA. 74021

Date Printed: 01/09/17

CUSTOMER

UOP Russell LLC
7050 South Yale, Ste. 210
Tulsa, Oklahoma 74136

VESSEL LOCATION

UOP Russell LLC
7050 South Yale, Ste 210
Tulsa, Oklahoma 74136

VESSEL DESCRIPTION

72" I.D. X 24'-0" SM/SM HORIZ STAINLESS STEEL COLD DRAIN TANK

Vessel designed per the ASME Boiler & Pressure Vessel Code,
Section VIII Division 1, 2015 Edition
Vessel is ASME Code Stamped

Job No:
175019
Vessel Number:
TAG #V-492
Purchase Order No.:
4500754178

NAMEPLATE INFORMATION

MAWP: 150 PSI at 150 Deg. F
MDMT -200 Deg. F at 150 PSI
Serial Number(s): 175019
National Board Number(s): 2869

Radiography: RT-3
Postweld Heat Treated: NO
Construction Types: W

Signatures

Quality Control Mgr: George E Lewis **Date:** 1/24/17

Authorized Inspector: ____________________ **Date:** 3/14/17

National Board Number: 2869

Mfr. Representative: Date: 3-14-17

Authorized Inspector: DC Date: 3-14-17

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 Lewis Industries Corporation, 816 North 5th Street, Collinsville, Oklahoma 74021
(Name and address of Manufacturer)

2. Manufactured for UOP Russell LLC, 7050 South Yale, Ste. #210, Tulsa, Oklahoma 74136
(Name and address of Purchaser)

3. Location of installation Unknown
(Name and address)

4. Type Horizontal Tank (Horizontal or vertical, tank) 175019 (Manufacturer's serial number) (CRN) SC6-302 A, B, & C (Drawing number) 2869 (National Board number) 2017 (Year built)

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

6. Shell SA-240-304 (Material spec. number, grade) .375 (Nominal thickness) 0 (Corr. allow.) 72" (Inner diameter) 24' [Length (overall)]

Body Flanges on Shells

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

7. Seams TYPE 1 [Long. (welded, dbl., sngl., lap, butt)] SPOT [R.T. (spot or full)] 85 (Eff., %) - (H.T. temp.) - (Time, hr) TYPE 1 [Girth (welded, dbl., sngl., lap, butt)] SPOT [R.T. (spot or full)] 85 (Eff., %) 3 (No. of courses)

8. Heads: (a) Material SA-240-304 (Spec. no., grade) (b) Material SA-240-304 (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)	(L) END	.330	0	-	-	2:1	-	-	-	Concave
(b)	(R) END	.330	0	-	-	2:1	-	-	-	Concave

Body Flanges on Heads

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

9. MAWP 150 (Internal) - (External) at max. temp. 150 (Internal) - (External).

Min. design metal temp. -200 at 150. Hydro., pneu., or comb. test pressure HYDRO 200.

Proof test -.

10. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
Inlet	1	12"	RFWN	SA-312-TP304	SA-182-F304	.406	0	SA-312-TP304(W)	UW16.1(c)	TYPE 1	Head
Outlet	1	12"	RFWN	SA-312-TP304	SA-182-F304	.406	0	SA-312-TP304(W)	UW16.1(c)	TYPE 1	Shell
Connection	1	2"	RFLWN	-	SA-182-F304	CL150	0	-	UW16.1(c)	-	Shell
Connections	2	1"	RFLWN	-	SA-182-F304	CL150	0	-	UW16.1(c)	-	Head
Connections	4	1"	RFLWN	-	SA-182-F304	CL150	0	-	UW16.1(c)	-	Shell

11. Supports: Skirt NO (Yes or no) Lugs - (Number) Legs - (Number) Other SADDLES (Describe) Attached SHELL/WELDED (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: ITEM #6 SHELL: P & M INDUSTRIES, INC., SN: 1701005-1 THRU 3, ITEM #8 HEADS: FORT WORTH F & D HEAD CO., SN.
(Name of part, item number, Manufacturer's name and identifying stamp)
194494-1 & 194494-2, SAFETY VALVE(S) SUPPLIED BY OTHERS PER UG-125(a), IMPACT TESTING EXEMPT PER UHA-51(d)(1)(a)

(04/14)

National Board Number: 2869

Mfr. Representative: DP Date: 3-14-17
Authorized Inspector: DC Date: 3-14-17

FORM U-1A (Back)

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 24,989 expires 08/03/17.

Date 3/14/17 Co. name Lewis Industries Corporation (Manufacturer) Signed George E Lewis (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Lewis Industries Corporation at Collinsville, Oklahoma.

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by OneCIS Insurance Company have inspected the component described in this Manufacturer's Data Report on 3-14-17, 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 3-14-17 Signed (Authorized Inspector) Commissions NB 15483A [National Board (incl. endorsements)]

(04/14)

TRAVELER

Job No.: 175019 Dimensions: 72"I.D. X 24'-0"SM/SM Hydro Press.: 200 PSI

Serial No.: 175019 RT: 3 P.W.H.T.: N/A

National Board No.: 2869 M.A.W.P.: 150 Other NDE: N/A

* A. I. Inspection Points A. I. Review Date 3-14-17	Q. C. Initial/Date	A. I. Initial/Date
1. Design Calculations	Ja 1-24-17	DC 2-21-17
2. Drawings	Ja 1-24-17	DC
3. Welding Procedure Specification (WPS) Qualified	Ja 1-24-17	DC
4. Welder/Welding Operator Qualified (WPQ)	Ja 1-24-17	DC
5.		
6. Longitudinal Joint Fit-up		
7. Tack Welds	Ja 3-9-17	—
8. Out of Roundness	Ja 1-24-17	DC 2-21-17
9. Plate for Nonconformity	Ja 1-24-17	DC
10. Circumferential Joint Fit-up	Ja 1-26-17	DC
11. Layout Prior to Cutting	Ja 1-26-17	DC
12. Internal Welding	Ja 3-2-17	
13. No.1 Head to Shell Fit-up	Ja 3-1-17	DC 3-14-17
14. Closing Head Fit-up	Ja 3-2-17	DC
15. Nozzle/Coupling Fit-up	Ja 2-27-17	DC
16.		
17. Longitudinal Weld Seam		
18.		
19. Circumferential Weld Seams	Ja 3-8-17	DC 3-14-17
20.		
21. Radiographs RS-①②③④	Ja 2-8-17	DC 2-21-17
22. Radiographs of Repaired Areas		
23. Nozzle/Coupling Welds	Ja 3-9-17	DC 3-14-17
24. Air Test Repads	Ja 3-9-17	
25.NDE (Other Than Radiograph)		
26.		
27. Post Weld Heat Treatment		
28. Final Inspection	DB 3-14-17	DC 3-14-17
29. Mill Test Reports/Certificates of Compliance	DB 3-14-17	DC
30. Hydrostatic Test	DB 3-14-17	DC
31. Code Stamping – Nameplate	DB 3-14-17	DC
32. Nameplate Attached to Vessel	DB 3-14-17	DC
33. Manufacturer's Data Report Signed	DB 3-14-17	DC
34. Vessel File Compiled	DB 3-14-17	

S-447

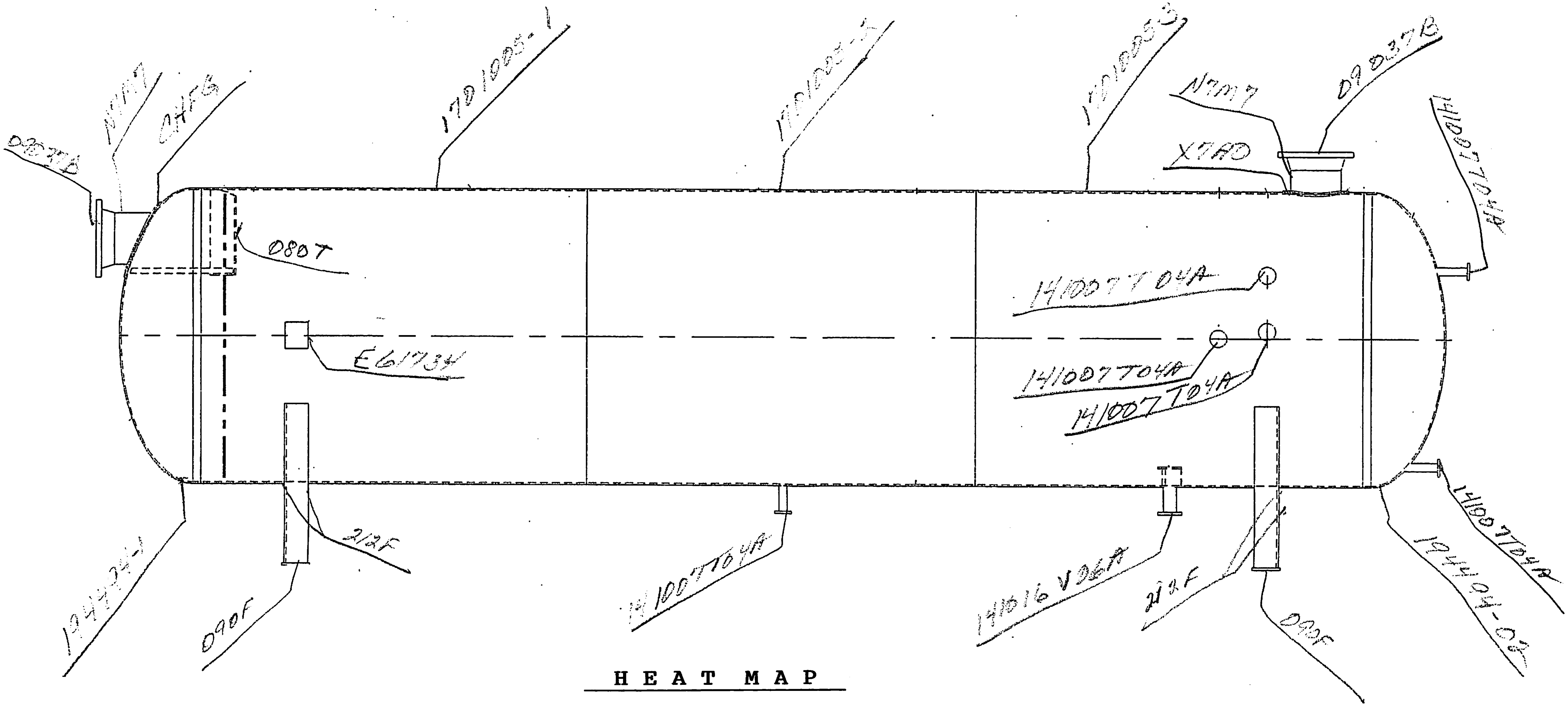
P.O. #
4500754178

LIC # 175019

Tag #
V-492

ITEM #	QTY.	DESCRIPTION	COMMENTS	MATERIAL	WEIGHT	
1	1	HEAD 2:1 ELLIP. 72" I.D. (0.33" MIN THK) W/2" SF	HEAD #1	SA-240-304	754	194494-1
2	1	HEAD 2:1 ELLIP. 72" I.D. (0.33" MIN THK) W/2" SF	HEAD #2	SA-240-304	754	194494-2
3	3	R&W CYLINDER 72" I.D. x 8'-0" LG. (0.375" THK) BBE	SHELL #1,#2,#3	SA-240-304	6960	1701005-1,
						2 & 3
5	6	FLANGE, 1" 150# RFLWN x 9" LG.	C1,C2,D,E,G1,G2	SA-182-F-304	44	141007704A
6	1	FLANGE, 2" 150# RFLWN x 9" LG.	F	SA-182-F-304	16	141016V06A
7	2	FLANGE, 12" 150# RFWN S/40S	A,B	SA-182-F-304	240	09037B
8	1	PLATE, 3/8" THK. x 12 7/8" ID x 20 3/4" OD (FORM TO MATCH HEAD, HILLSIDE)	A	SA-240-304	23	CHFG
9	1	PIPE, 12" S/40S x 10 7/8" LG. BBE	A	SA-312-TP304(W)	49	N7M7
10	1	PLATE, 3/8" THK. x 12 7/8" ID x 16 3/4" OD (ROLL TO 36 3/8" ISR)	B	SA-240-304	10	X7H0
11	1	PIPE, 12" S/40S x 6 1/2" LG PExBE	B	SA-312-TP304(W)	29	N7M7
12	2	PLATE, 5/8" THK x 66" LG x 7" WD W/(2) HOLES (SEE DETAIL "C")	SADDLE	SA-240-304	163	690F
13	2	PLATE, 1/2" THK x 77" W x 3'-3 1/16" LG (BEND & CUT PER DETAIL "C")	SADDLE	SA-240-304	853	212F
14	4	PLATE, 1/2" THK x 5 1/2" W x 1'-9 9/16" LG. (CUT PER DETAIL "C")	SADDLE	SA-240-304	67	212F
15	1	PLATE, 1/4" THK x 6"OD	VORTEX BREAKER	SA-240-304	2	0807
16	3	PLATE, 1/4" THK x 3/4" W x 4" LG	VORTEX BREAKER	SA-240-304	1	0807
△2 17	2	PLATE, 1/2" THK x 12" W. x 1'-9" LG. (TRIM PER DETAIL "B")	INLET DIVERTER	SA-240-304	71	212F
△2 18	2	PIPE, 1" XH x 2'-1 7/8" LG. BBE (CUT PER DETAIL "B")	INLET DIVERTER	SA-312-TP304(W)	9	E61734
19	1	PLATE, 1/4" x 6" x 6"	NAMEPLATE	SA-240-304	3	0807
20	1	PLATE, 1/4" THK x 2 3/4" x 6"	NAMEPLATE	SA-240-304	2	0807

PKR 3/1/17

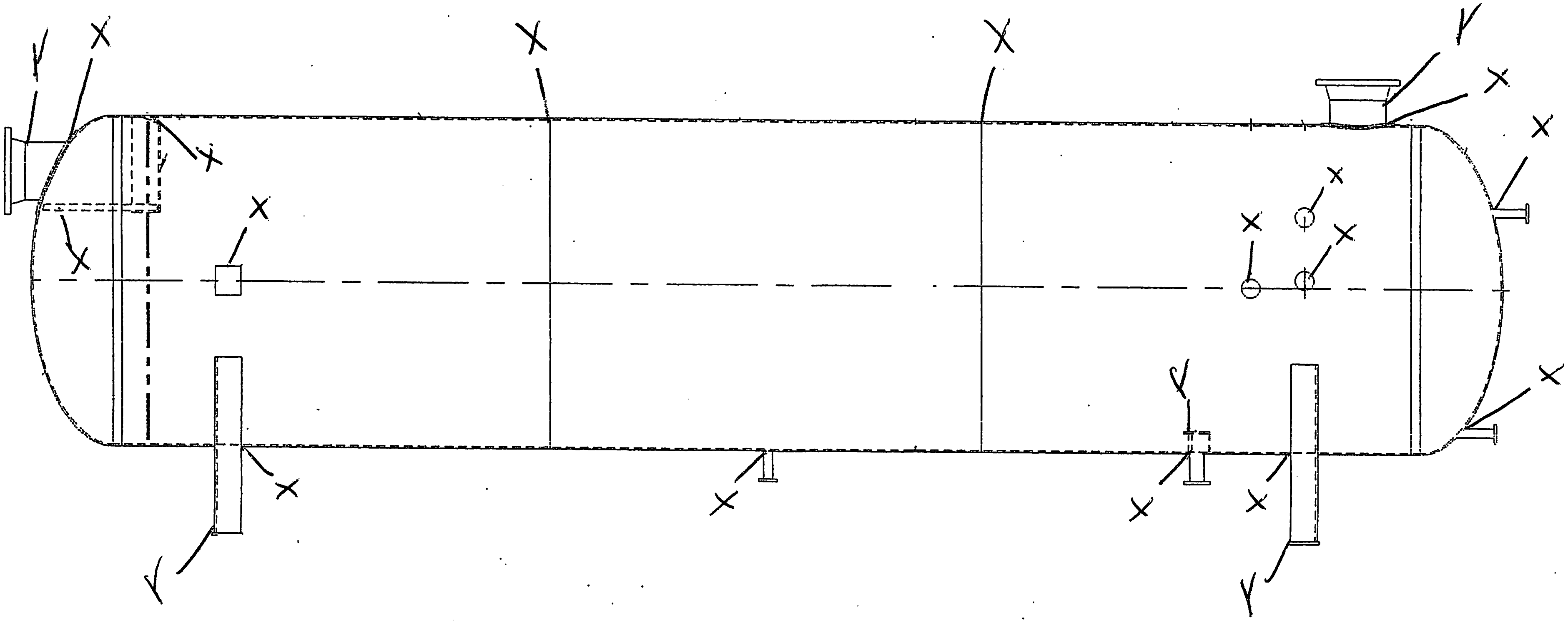


HEAT MAP

LIC #175019

UOP TAG #V-492

PKR 3/1/17

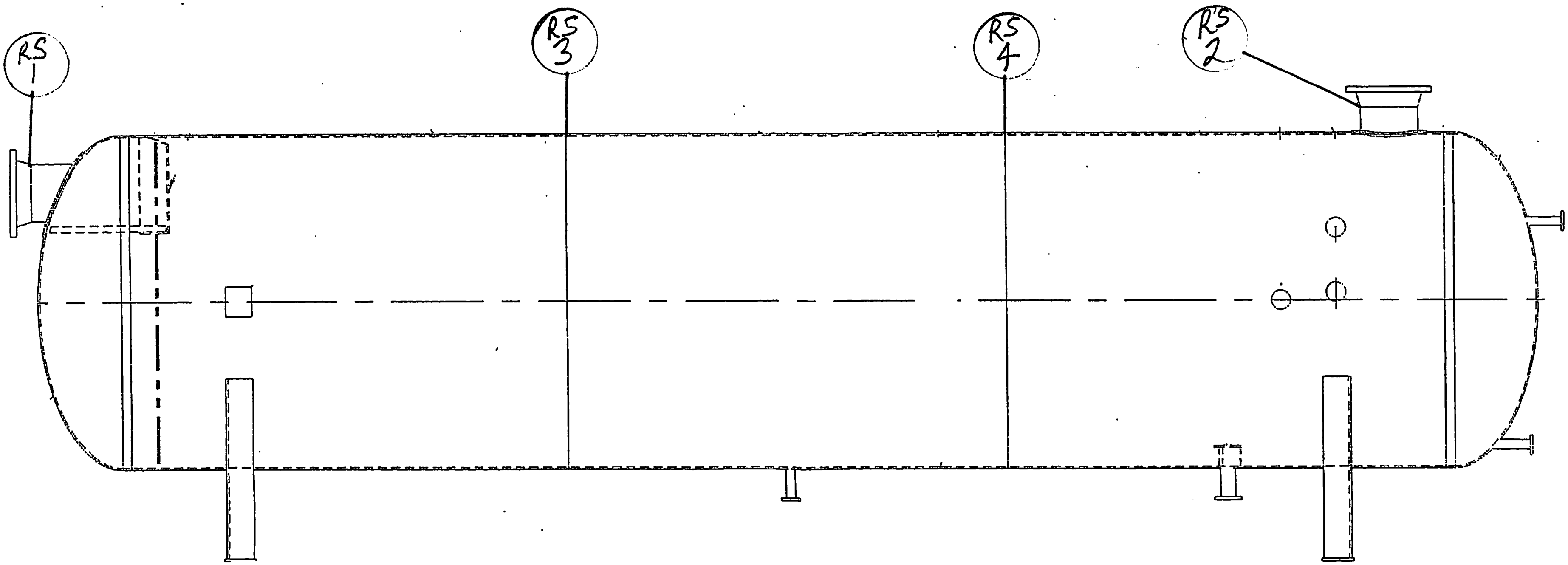


WELD MAP

LIC #175019

UOP TAG #V-492

PKR 3/13/17



X - R A Y   M A P

LIC #175019

UOP TAG #V-492

PKR 3/13/17

S-447 V-492

AMERICAN PIPING INSPECTION, INC.
17110 East Pine
Tulsa, Oklahoma 74116
(918) 234-6300 FAX (918) 234-6301

TECHNIQUE / INSPECTION REPORT

DATE 1-18-17 DAY Wed

CUSTOMER DATA

NAME [redacted] Lewis
ADDRESS
PHONE ATTN:
W.O. # 175019 P.O. #
JOB LOCATION Collins ville OK
DESCRIPTION RT
MATERIAL TYPE:

DEFECT CODE

AB – ARC BURN
AI – ALIGNED INDICATION
BT – BURN THROUGH
CON – CONCAVITY
CRACK – CRACK
HB – HOLLOW BEAD
IF – INADEQUATE FUSION
IP – INCOMPLETE PENETRATION
MA – MISALIGNMENT
POR – POROSITY
SLI – SLAG INCLUSION
SLL – SLAG LINE
SURF – SURFACE INDICATION
UCE – UNDERCUT EXTERNAL
UCI – UNDERCUT INTERNAL

ABBREVIATED TERMS

SOD = SOURCE TO OBJECT DISTANCE
OFD = SOURCE SIDE OF OBJECT TO FILM DISTANCE
OD = OUTER DIAMETER
WT = WELD THICKNESS
WR = WELD REINFORCEMENT
REP = REPAIR
RES = RESHOOT
BM = BASE MATERIAL
RET = RETAKE

	WELD/FILM NUMBER	JOB NUMBER 175019	OD	BM	WR	WT	WITHIN STD'S		# FILM	FILM SIZE / MFG / TYPE	SOD	OFD	IQI S-F	# EXP	DEFECT LOCATION
							YES	NO							
1	RS1	1-2	12"	.406	.125	.531	✓		1	3½x10 F80	6.5	.531	B	1	
2	RS2	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21															
22															
23															
24															
25															
26														1-17-17	
27															
28															
29															
30															

METHOD RT
SOURCE SIZE DIAG. .146
ISOTOPE IR192
NO. CURIES 89
DEV. TIME 5 min
DEV. TEMP 68°
DENSITY 2.4
NO. OF WELDS 2
FT. LONG SEAMS
STANDARDS ASME SEC VIII
PERDIEM
NO. OF FILM 2
FILM/CASSETTE 1
EXPOSURE: DBL WALL [✓ S. WALL]
VIEWING: DBL WALL [✓ S. WALL]
MR/R 3
SCREENS .005
TRUCK NO. / SHOP 100
REPORT NO. 1 OF 1
PAGE NO. 1 OF 1
TECH. HOURS
ASST. HOURS
TRAVEL HOURS
TOTAL HOURS
MILEAGE
FILM INTERPRETER
COMPANY REPRESENTATIVE
SIGNATURE CERTIFIES TIME & MATERIALS CORRECT
ASST. NAME Marcus O'Neal
ASNT LEVEL II
NDT TECHNICIAN Jesse Graham
ASNT LEVEL II
SIGNATURE

197221

rev. 5/08

AMERICAN PIPING INSPECTION, INC. ASSUMES NO RESPONSIBILITY
FOR LOSSES OF ANY KIND DUE TO INTERPRETATION

J-447 U-492

AMERICAN PIPING INSPECTION, INC.

17110 East Pine
Tulsa, Oklahoma 74116
(918) 234-6300 FAX (918) 234-6301

TECHNIQUE / INSPECTION REPORT

DATE 2-8-17 DAY Wed.

CUSTOMER DATA

NAME Lewis
ADDRESS
PHONE ATTN:
W.O. # 175019 P.O. #
JOB LOCATION Collinsville, Ok
DESCRIPTION RT
MATERIAL TYPE:

DEFECT CODE

AB – ARC BURN	**HB** – HOLLOW BEAD	**SLI** – SLAG INCLUSION
AI – ALIGNED INDICATION	**IF** – INADEQUATE FUSION	**SLL** – SLAG LINE
BT – BURN THROUGH	**IP** – INCOMPLETE PENETRATION	**SURF** – SURFACE INDICATION
CON – CONCAVITY	**MA** – MISALIGNMENT	**UCE** – UNDERCUT EXTERNAL
CRACK – CRACK	**POR** – POROSITY	**UCI** – UNDERCUT INTERNAL

ABBREVIATED TERMS

SOD = SOURCE TO OBJECT DISTANCE
OFD = SOURCE SIDE OF OBJECT TO FILM DISTANCE
OD = OUTER DIAMETER
REP = REPAIR
RET = RETAKE
WT = WELD THICKNESS
RES = RESHOOT
WR = WELD REINFORCEMENT
BM = BASE MATERIAL

	WELD/FILM NUMBER	JOB NUMBER 175019	OD	BM	WR	WT	WITHIN STD'S		# FILM	FILM SIZE / MFG / TYPE	SOD	OFD	IQI S-F	# EXP	DEFECT LOCATION
							YES	NO							
1	RS3	1-2	72"	.375	.125	.500	✓		1	3½x10F80	22"	.500	B	1	
2	RS4	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21															
22															
23															
24															
25															
26															JR 2-8-17
27															
28															
29															REVIEWED D. Colvin
30															

METHOD RT
SOURCE SIZE DIAG. .146
ISOTOPE IR192
NO. CURIES 32
DEV. TIME 5min
DEV. TEMP 68°
DENSITY 2.4
NO. OF WELDS 2
FT. LONG SEAMS
STANDARDS ASME SecVIII
PERDIEM
NO. OF FILM 2
FILM/CASSETTE 1
EXPOSURE: DBL WALL [✓ S. WALL]
VIEWING: DBL WALL [✓ S. WALL]
MR/R 3
SCREENS .005
TRUCK NO. / SHOP 100
REPORT NO. 1 OF 1
PAGE NO. 1 OF 1
TECH. HOURS
ASST. HOURS
TRAVEL HOURS
TOTAL HOURS
MILEAGE
FILM INTERPRETER
ASST. NAME Marcie O'Neal
ASNT LEVEL II
COMPANY REPRESENTATIVE
NDT TECHNICIAN Jesse Graham
ASNT LEVEL II
SIGNATURE CERTIFIES TIME & MATERIALS CORRECT
SIGNATURE

Rev. 5/08

AMERICAN PIPING INSPECTION, INC. ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO INTERPRETATION

207585

LEWIS *INDUSTRIES CORPORATION*
816 N. 5TH STREET
COLLINSVILLE, OKLAHOMA 74021 (918) 371-2596

HYDROSTATIC TEST CERTIFICATION

This Vessel was hydrostatic tested with satisfactory results in accordance with the A.S.M.E. Code, Section VIII, Division 1, paragraph UG-99.

JOB NUMBER: 175019

ITEM NUMBER: 72" I,D. X 24'-0" SM/SM HORIZ. STAINLESS STEEL COLD DRAIN TANK
J-447 TAG #V-492

CUSTOMER: UOP RUSSELL LLC

PURCHASE ORDER NUMBER: 4500754178

MAX. ALLOW. WORKING PRESS.:

SHELL SIDE: 150 **P.S.I.**

TUBE SIDE: **P.S.I.**

TEST PRESSURE:

SHELL SIDE: 200 **P.S.I.**

TUBE SIDE: **P.S.I.**

HOLDING TIME ONE (1) **HR(S)**

TEST GAUGE SERIAL NUMBER L400-1 400#

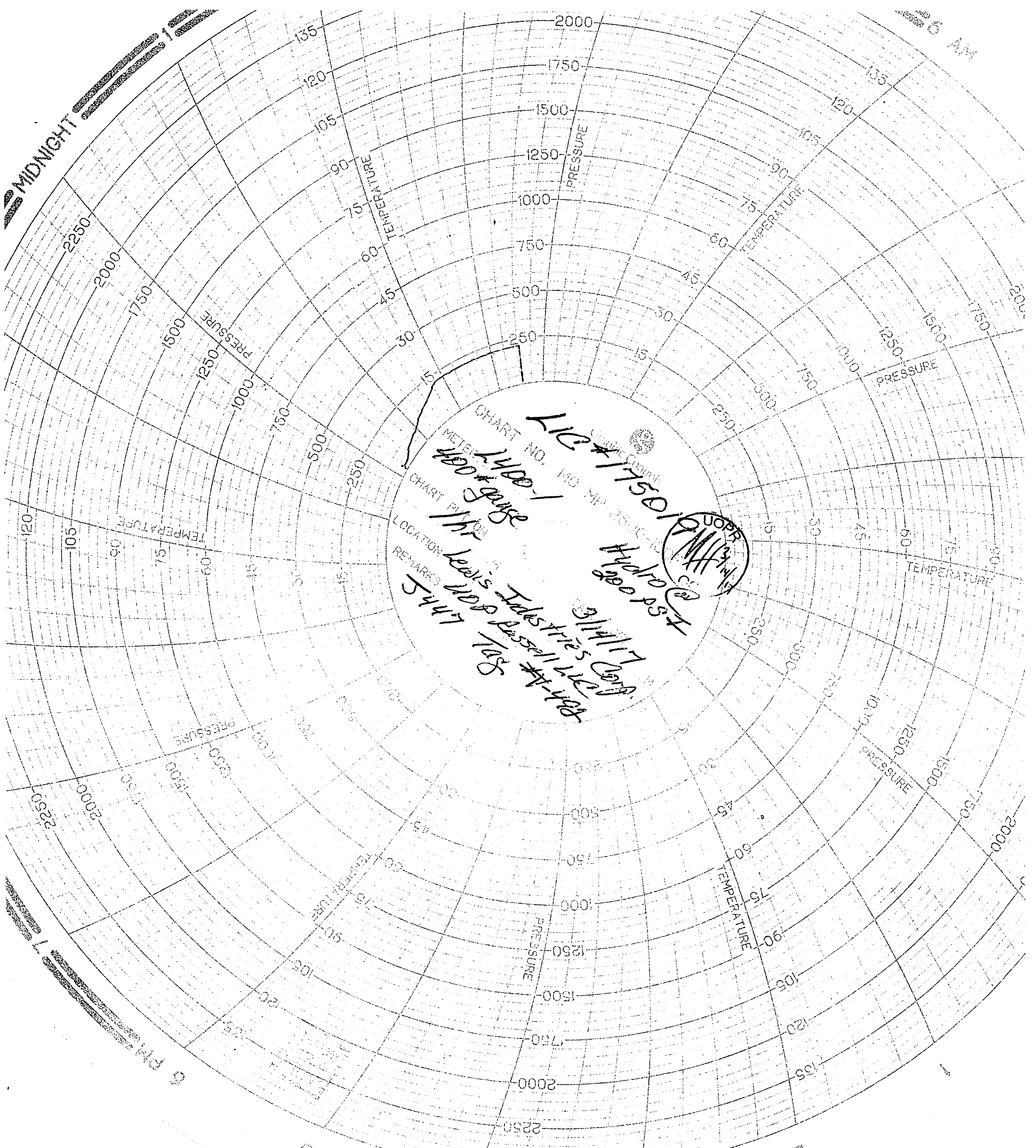
SPECIAL INSTRUCTIONS: WITH CHART

Quality Control Manager: George E Lewis **Date** 3-14-17

Authorized Inspector: **Date** 3-14-17

REVIEWED
D. Colvin
[illegible]

Customer Inspector: UOPR MH QC **Date** 3/14/17



LIC #175019

CHART NO. MC MP-2500

METER 1400-1 400# gauge

Hydro @ 200 PSI

CHART PUT ON 1 hr

3/14/17

LOCATION Lewis Industries Corp. UOP Russell LLC

REMARKS 5447 Tag #-468

UOPR 3/14/17 CC

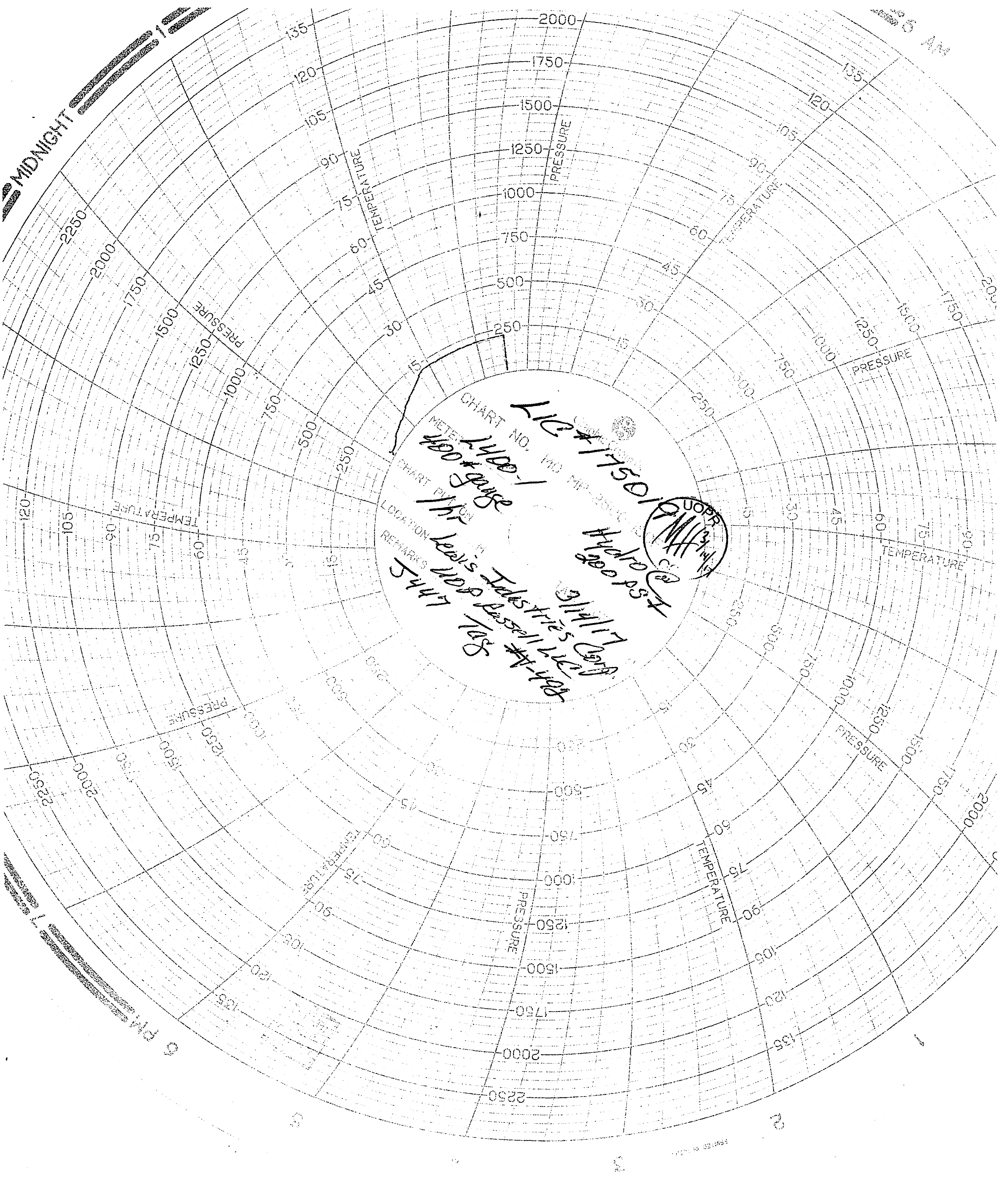


CHART NO. MP-2500 LIC #175019

METER 1400-1 Hydro Co

400# gauge 200 PSI

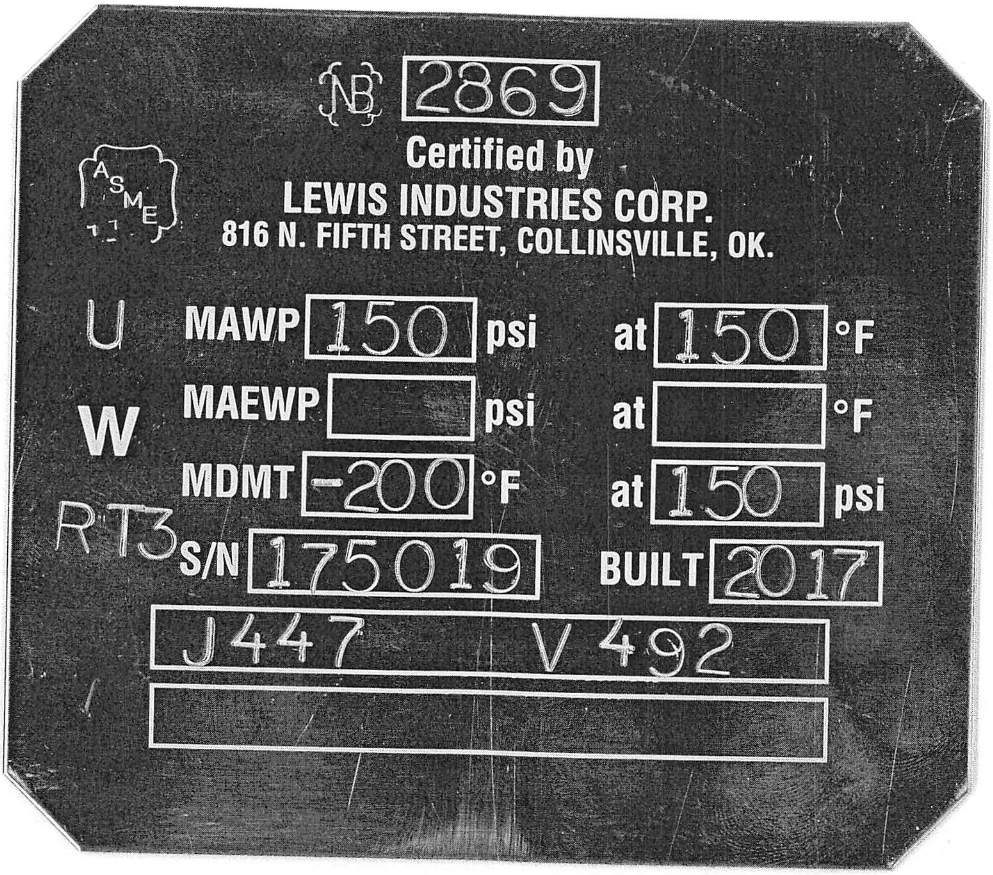
CHART PUT ON 1hr 3/14/17

LOCATION Lewis Industries Corp.

REMARKS UOP Russell LLC #A-428

5447 Tag

UOPR 3/14/17



NB 2869

Certified by

LEWIS INDUSTRIES CORP.

816 N. FIFTH STREET, COLLINSVILLE, OK.

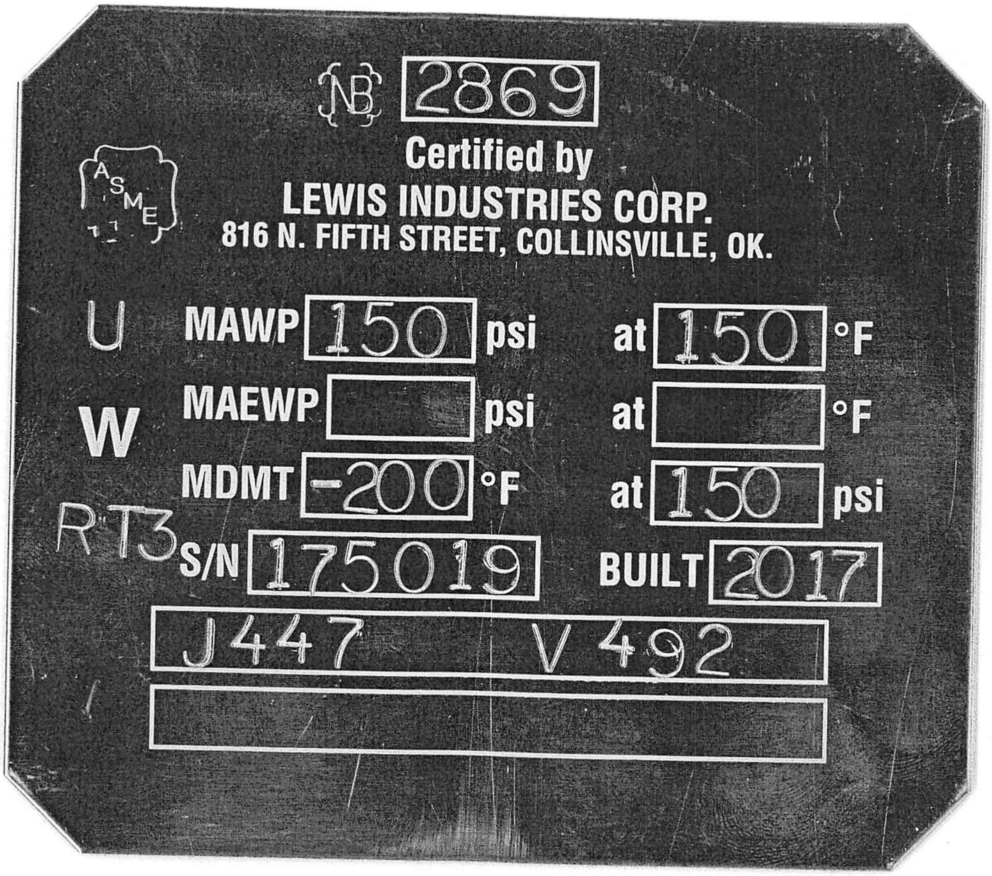
U **MAWP** 150 **psi** **at** 150 **°F**

W **MAEWP** **psi** **at** **°F**

MDMT -200 **°F** **at** 150 **psi**

RT3 **S/N** 175019 **BUILT** 2017

J447 V 492



NB 2869

Certified by
LEWIS INDUSTRIES CORP.
816 N. FIFTH STREET, COLLINSVILLE, OK.

U **MAWP** 150 **psi** **at** 150 **°F**
W **MAEWP** **psi** **at** **°F**
MDMT -200 **°F** **at** 150 **psi**
RT3 **S/N** 175019 **BUILT** 2017
J447 V492

Rev 1
3-26-15 by JB

UOP
A Honeywell Company

Inspection and Test Plan - ITP Vessel Equipment - New Manufacture UOPR SF-005

Quality Management System

Job Number : 175019 **Equipment Number :** J447/V-492 **Date :** 01/09/17

ITP Prepared By : **ITP Reviewed By** **Date :**

Customer Name : UOP RUSSELL LLC **Customer Phone Number :** **Customer E Mail :**

Customer Approval Signature : **Date :**

Surveillance Action Codes

H-Hold W- Witness M-Monitor V-Verify P-Process D-Documentation N- No Action

1)Hold: Activity is required to be witnessed by UOP Honeywell...designated as on hold, pending formal authorization/approval to proceed further

2)Witness: Activity is required to be witnessed by customer/customer representative(s).In the event they cannot attend, activity may proceed

3)Monitor: Activity may be surveyed by UOP Honeywell at UOP Honeywell's discretion

4)Verify: Results of activity will be verified by UOP Honeywell and/or Customer/Customer Representative

5)Process: Activity is identified as a point of process, preformed by Vendor

6)Documentation: Activity is required to be documented, this shall include all pertinent measured values, by the Vender and submitted to UOPR before proceeding and upon completion for review/verification

* Note: Location of activity to be preformed at vendor shop unless noted otherwise.

No	Acceptance Criteria	UOP Notes to Fabricator	Activity Information	Code
			Description	UOP
1			Pre-Inspection Meeting	H
2	UOP QMS/ASME Sec 8		Review Vendor Inspection and Test Plan (ITP)/Traveler	V
A	PO	Advise UOPR Inspector	Notification of Job Start	M
B	PO/ASME Sec 2		Review of MTR's per Bill of Material	V
C	ASME Sec 8 & 5		Review Radiographs and Reader Sheet	V
D	ASME Sec 5		Monitor Liquid Penetrant/Magnetic Particle Examinations	M
E	ASME Sec 8		Monitor Pneumatic tests of repads	V
F	ASME Sec 8		Head Fit-up(s) Top/Bottom - Inspect for mis-alignment	H
G	UOPR Drawing		Internal Inspection (Final Weld out)	H
H	ASME Sec 8/ITP		Out of Roundness, Code allowable and Internals Vendors Criteria	H
I	Drawings		Final Dimensional Inspection (Before stress)	H
J	Drawings		External Piping Supports Present and Match Drawing if Applicable	P
K	Drawings		Lift and Tailing Lugs Present and Match Drawing if Applicable	H
L	Drawings		(After stress) Re-check Nozzle levelness and flange face's	H
M	ASME Sec 8		Hydrostatic/Pneumatic Pressure Test - *** Recorder with chart required**	H
N	Drawings		Review of Final Documentation package	H
O	Drawings/ASME Sec 8		Nameplate Stamped with ASME Mark, NB/ CRN Registration Number as Required	H
P	ASME Sec 8/Data Sheet		Nameplate Stamped with Process Conditions Matching Drawings	W

UOPR
3/14/17
QC

Rev 1
3-26-15 by JB

uop
A Honeywell Company

Inspection and Test Plan - ITP **Vessel Equipment - New Manufacture** **UOPR SF-005**

Quality Management System

ob Number : 175019 **Equipment Number :** J447/V–492 **Date :** 01/09/17

Q	ASME Sec 8/Data Sheet		ASME Data Reports (U-1a or Equivalent)	W
R	Drawing/Paint Spec		Paint Applied Per Drawing (If Applicable)	H
S	PO/Fabricator Spec		Final preparation for shipment after paint (If Applicable)	H
A	Fabricator Drawings		Fit up and weld in of distributors (If Applicable)	H
C	Fabricator Drawings		Distributor depth, width, hole count & size, levelness after erection (If Applicable)	H
D	Drawings		Fit up, Weld in and Assembly of Demister (If Applicable)	H
E	PO/UOPR Standard		Knitted mesh should be oversized to fit snuggly (compressing) (If Applicable)	H
F	Drawings/PO		Verify packing type, size and material	H
G	Drawings		Verify installation of any internal piping/ Size of piping # of openings if applicable, and size of opening (If Applicable)	H
H	Drawing		Inspect all nozzles, manways, and welded in supports/clips for orientation and elevation.	H

*** Hold Points require 48 hour notification**

*** Weekend Inspection and testing Hold Points require 72 hour notification**

Honeywell UOPR Equipment	**Inspection Release**	(Project Document) Rev. - - - - Page 1 of 1

UOPR PROJECT:	Name: LEWIS INDUSTRIES CORP.	Number: J447
Technical Document(s):	Applicable codes/Drawings/Customer requirements	
Equipment Description:	HORIZ. STAINLESS STEEL COLD DRAIN TANK	
UOP Primary Contacts:	Position : QA/QC Manager Name :James Bogue Phone: 918-370-0932 Email: James.bogue@honeywell.com	
UOP Backup Contacts:	Position: Lead CWI Name: Matthew Hensinger Phone: 918-314-0010 Email: Matt.hensinger@honeywell.com	
UOP CONTRACT INSPECTION:	Company: Inspector: Location: Email address: Cell:	Coordinator: Matthew Hensinger Location: UOPR Tulsa office Email address: Matt.hensinger@honeywell.com Phone: 918-314-0010
SUPPLIER:	Company: LEWIS INDUSTRIES Inspection Location: COLLINSVILLE Office Phone: 918/371-2596	QA Contact Name: GEORGE LEWIS Phone: Email:
UOPR PO No. to External Supplier:	4500754178	
PO Delivery Date :		
SCOPE OF INSPECTION:	Inspection of the equipment described per the applicable documents:	
Date of shop visit:		
Applicable Documents:	ITP, Third Party Inspection Report	
Communications:	Email communications with UOPR on any items requiring UOPR clarification. Items requiring immediate resolution, please contact UOPR directly by e-mail. For any items not in compliance, please notify the supplier directly by email and copy UOPR.	
Supplier Test Report Review:	UOPR/Third Party inspector to stamp test reports after review and acceptance by the supplier and the inspector.	
Inspection Report Frequency and Additional Instructions		
Inspection Report distribution (to and copy) :	**UOPR QA/QC-Project Management** UOPR MH 3/14/17 QC	

Issued by:		**Date:**	
Reviewed by:		**Date:**	
Acknowledged by:		**Date:**	

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 FORT WORTH F & D HEAD CO. 3040 E. PEDEN ROAD FORT WORTH, TEXAS 76179 (Name and address of Manufacturer)

2. Manufactured for BUILT FOR STOCK (Name and address of Purchaser)

3. Location of installation UNKNOWN (Name and address)

4. Type: 72" ID X .500 ELLIPSOIDAL HEADS (Description of vessel part (shell, two-piece head, tube bundle)) 194494-1 & 2 (Manufacturer's serial No.) XXX (CRN)

XXX (National Board Number) 194494 (Drawing No.) N/A (Drawing prepared by) 2017 (Year built)

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

6. Shell: (a) No. of course(s): (b) Overall length (ft & in.):

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

Body Flanges on Shells									Bolting			
No.	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Location	Num & Size	Bolting Material	Washer (OD,ID,th)	Washer Material

7. Heads: (a) SA240-304/304L (NO HT) (Mat'l Spec. No., Grade or Type) (H.T.-Time &Temp) (b) (Mat'l Spec. No., Grade or Type) (H.T.-Time & Temp)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)		.330				2:1						1	FULL	
(b)														

Body Flanges on Heads									Bolting			
	Location	Type	I.D.	O.D.	Flange Thk	Min Hub Thk	Material	How Attached	Num & Size	Bolting Material	Washer (OD,ID,th)	Washer Material
(a)												
(b)												

8. MAWP N/A (internal) N/A (external) psi at max. temp N/A (internal) N/A (external) °F Min. design metal temp. N/A °F at N/A psi

9. Impact test NONE (Indicate yes or no and the component(s) impact tested) at test temperature of N/A °F.

10. Hydro., pneu., or comb. test press. NONE Proof test N/A

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. Supports: Skirt XXX (Yes or No) Lugs XXX (No.) Legs XXX (No.) Others N/A (Describe) Attached XXX (Where and How)

14. Remarks 1. NO DESIGN FUNCTION PERFORMED 2. NO PRESSURE TESTING PERFORMED

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of material, construction, and workmanship of this pressure vessel part conform to the ASME BOILER AND PRESSURE VESSEL CODE Section VIII, Division 1. U Certificate of Authorization No. 10625 Expires 09/07/2017

Date 2/14/17 Name FORT WORTH F & D HEAD CO. (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 FEB 16, 2017, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 2-16-17 Signed (Authorized Inspector) Commissions NB#9757 [National Board (including endorsements)]

P-32468

NAS NORTH AMERICAN STAINLESS

6870 Highway 42 East
Ghent, KY 41045-9615
(502) 347-6000

METALLURGICAL TEST REPORT

Certificate: 230125 01

Customer: 0535 025

Mail To:
RYERSON, INC.
1502 CHAMPION DRIVE
CARROLLTON, TX 75006

Ship To:
RYERSON, INC.
1502 CHAMPION DRIVE
CARROLLTON, TX 75006

Date: 10/20/2016 **Page:** 2

Steel: 304/304L

Finish: HRAP

Your Order: M1734099

NAS Order: AN 0724105 01

Corrosion: ASTM A262/15 A 180Bend-OK

PRODUCT DESCRIPTION:

STAINLESS STEEL PLATE, HRAP; UNS 30400/30403
ASTM A240/15b,A480/15,A666/15;ASME SA240/15,SA480/15,SA666/15
CHEM ONLY ON FOLLOWING ASTM: A276/16,A479/16,A484/15,A312/16
CHEM ONLY ON FOLLOWING ASME: SA312/13,SA479/13
AMS 5511H/5513J XMRK; MIL-S-5059D AMD3(X CRN MEAS); MIL-S-4043B
NACE MR0175/ISO 15156-3:2009 A, MR0103/07;QQS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; RoHS 1 & 2 Compliant
Material is Free of Radioactive Contamination
Steel Making Process: EAF, AOD, & Cont. Casting
Product Mfg.by a Quality Mgt.Sys. in Conf. w/ISO 9001
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

Product ID #	Coil #	Thickness	Width	Weight	--------Length-------		Mark	Pieces	COMMODITY CODE
09174M CA	* 09174M CA	.5000	60.0000	2,100	PLATE	240.00	1	1	49841 - CHNT

CHEMICAL ANALYSIS

CM(Country of Melt) ES(Spain) US(United States) ZA(South Africa) JP(Japan)

Lab Accreditation Bureau, ISO/IEC 17025, Certificate# L2323

Chemical Analysis per ASTM A751/14a

HEAT	CM	C %	CR %	CU %	MN %	MO %	N %	NI %	P %	S %
174M	US	.0103	18.1195	.3915	1.8030	.3205	.0770	8.0295	.0305	.0010 - CHNT
		SI %								
		.2740								

MECHANICAL PROPERTIES

Product ID #	Coil #	loc	dir	UTS KSI	20C .2% YS KSI	20C ELONG %-2"	% Hard RB	A 262 'E' Pr E	R of A %
09174M CA	09174M CA	F	T	80.30	37.68	55.00	81.50	OK	66.32 - CHNT

Po 41642

Q.C. By
J.D.

NAS hereby certifies that the analysis on this certification is correct. Based upon the results and the accuracy of the test methods used, the material meets the specifications stated. These results relate only to the items tested and this report cannot be reproduced, except in its entirety, without the written approval of NAS.

Technical Dept. Mgr.

KRIS LARK 10/20/2016

PKE 3/1/17

1117# 17580

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 P & M Industries, Inc. 4450 South Mingo Tulsa OK 74146-4703 USA (Name and address of Manufacturer)

2. Manufactured for UOP Russell, LLC 7050 South Yale Suite #210 Tulsa, OK 74136 (Name and address of Purchaser)

3. Location of installation Unknown (Name and address)

4. Type Rolled & welded cylinder [Description of vessel part (shell, two-piece head, tube bundle)] 1701005-1 thru 3 (Manufacturer's serial number) N/A (CRN)

N/A (National Board number) N/A (Drawing number) P & M Industries, Inc. (Drawing prepared by) 2017 (Year built)

5. ASME Code, Section VIII, Div. 1 2015 Edition [Edition and Addenda, if applicable (date)] N/A (Code Case number) None [Special service per UG-120(d)]

6. Shell: (a) Number of course(s) 1 (b) Overall length 8'-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	72" ID	8'-0"	SA240-304	3/8"	N/A	1	Full	-	-	-	-	None	None
2	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-

Body Flanges on Shells

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

7. Heads: (a) None (Material spec. number, grade or type) (H. T. - time and temp.) (b) None (Material spec. number, grade or type) (H. T. - time and temp.)

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

Body Flanges on Heads

									Bolting			
	Location	Type	ID	OD	Flange Thk	Min Hub Thk	Material	How Attached	Num & Size	Bolting Material	Washer (OD, ID, thk)	Washer Material
(a)	-	-	-	-	-	-	None	-	-	-	-	-
(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 - 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. Supports: Skirt No (Yes or no) Lugs None (Number) Legs None (Number) Other None (Describe) Attached - (Where and how)

14. Remarks No Design Calculations Performed

FORM U-2A (Back)

CERTIFICATE OF SHOP / FIELD COMPLIANCE

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

U Certificate of Authorization No. 25978 Expires 11/25/18

Date 1-13-17 Name P & M Industries, Inc. (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 Co. of Lynn, MA have inspected the pressure vessel part described in this Manufacturer's Data Report on 1-13-2017, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 1-13-2017 Signed (Authorized Inspector) Commissions NB 11158 OK 646 (National Board (incl. endorsements))

FORM U-4 MANUFACTURER'S DATA REPORT SUPPLEMENTARY SHEET

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

1. Manufactured and certified by P & M Industries, Inc. 4450 South Mingo Tulsa OK 74146-4703 USA
(Name and address of Manufacturer)

2. Manufactured for UOP Russell, LLC 7050 South Yale Suite #210 Tulsa, OK 74136
(Name and address of Purchaser)

3. Location of installation Unknown
(Name and address)

4. Type Rolled & Welded Cylinder (Horzizontal, vertical, or sphere) Unknown (Tank, separator, heat exch., etc.) 1701005-1 thru 3 (Manufacturer's serial number)

N/A (CRN) N/A (Drawing number) N/A (National Board Number) 2017 (Year built)

Data Report Item Number	Remarks
#14	Meets Requirements of ASME Section VIII Div 1, UG-79, UCS-79, UG-80
#14	*RT per UW-11(a)
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-

Certificate of Authorization: Type U No. 25978 Expires 11/25/18

Date 1-13-17 Name P & M Industries, Inc. (Manufacturer) Signed (Representative)

Date 1-13-2017 Name (Authorized Inspector) Commissions NB 11158 OK646 [National Board (incl. endorsements)]

[| 4500751484 | S447 | | N7M7] | [LN: 34] | T0379851-1 | BR1240S04/LX |

BRISMET

BRISTOL METALS, LLC

MILL TEST REPORT

RM ID NUMBER
131825

SALES ORDER / RLS
011955 / 4

CERT ID / REV
00117657 / 01

SOLD TO

INDUSTRIAL PIPING SPECIALISTS
606 N. 145TH EAST AVE
TULSA, OK 74116
USA

CUSTOMER P.O.	CUSTOMER PART	HEAT NO.
TP448390		N7M7

DESCRIPTION:312004003121200
12" WELDED PIPE SCHED 40S TP304/TP304L (UNS#S30400/S30403) A312 XRAY DOUBLE RANDOM LENGTH

CERTIFICATION REQUIREMENTS

ENGINEERING
ASTM A312-14b ASME SA312-13

HYDRO PRESSURE
900 PSI

HEAT TREAT
Annealed at1900 Deg F. and water quenched to below 800 Deg. F. in less than 3 minutes.

Chemical

C	Cr	Mn	Ni	N	P	Si	S
.0124	18.039	1.7	8.0195	.0848	.0325	.2825	.0102

Mechanical

TEST	UNITS	RESULTS
Tensile PSI	PSI	88950
Yield PSI	PSI	51680
Elong %		50.62

Hardness

RB89

TEST	RESULT
TG Bend	Pass

NDE

TEST	RESULT
100% Radiography	Pass

This report shall not be altered or reproduced, except in full, without the prior written approval of Bristol Metals LLC.
This test report represents the actual attributes of the items furnished and all items were manufactured, sampled, inspected, and tested in full compliance with applicable specifications and your purchase order.
Certification is in accordance with EN10204:2004 type 3.1.
Chemical content is % by weight. Mechanical test results are in English units (inches and pounds).
No weld repairs have been performed on the base material.
Hardness in accordance with NACE MR0175/ISO 15156-3:2009 and MR0103-2012 and material is free of cold work to enhance mechanical properties.
Pipe is Pickled and Passivated in accordance with ASTM A380.
Bristol Metals has a Quality Management System in place that is in compliance with ISO 9001:2008.
Bristol Metals does not add mercury during any manufacturing process.
NAFTA country of orgin: USA. Pipe/Tube Manufactured in the USA.
Raw Material Melt Source USA
FAR BAA - Complies, DFARS BAA - Complies, FAR TAA - Complies

Rick Duncan

Rick Duncan – Director of Technical Sales / Compliance

QF-576 qtc302z (v1.1)

Date Printed 03/05/2015

PKR 3/1/17
LIC# 175019

SNI.7580S304/L, SNI180S304/L, SNI.580S304/L

製品検査証明書
INSPECTION CERTIFICATE

新日鐵住金株式会社
NIPPON STEEL & SUMITOMO METAL CORPORATION

本社 HEAD OFFICE : 〒100-8071 東京都千代田区丸の内二丁目6番1号
:2-6-1 MARUNOUCHI, CHIYODA-KU, TOKYO 100-8071 JAPAN
大分製鉄所[光地区] OITA WORKS [HIKARI AREA] : 〒743-8510 山口県光市大字島田３４３４番地
:3434,SHIMATA,HIKARI-SHI,YAMAGUCHI,743-8510,JAPAN

注文者 SHIPPER: K&I TUBULAR CORPORATION
注文者照合番号 REFERENCE No.: HBS1700Y
契約番号 CONTRACT No.: 4-848-N3-5-X-E907
商品名 COMMODITY: COLD DRAWN SEAMLESS STAINLESS STEEL PIPE
規格 SPECIFICATION: ASTM A312/ASME SA-312 GRADE TP304/TP304L/ASTM A376/ASME SA-376 GRADE TP304

需要家 CUSTOMER: MARUBENI-ITOCHU TUBULARS AMERICA INC.
需要家管理番号 CUSTOMER'S CONTROL No.:
施主 CLIENT:

証明書番号 CERTIFICATE No.: 14120175-01
発行年月日 DATE OF ISSUE: 14-12-19

特記 NOTE: PO HR054732, A312-14, SA-312/A376/SA-376-13, NO WELD REPAIR, MERCURY NOT DETECTABLE, MIL-P-24691/3, A262/E, P ED97/23/EC, COUNTRY OF MELT: JAPAN, PICKLED & PASSIVATED

E07

行番 ITEM No.	寸法 SIZE	員数 NUMBER OF PRODUCT	質量 MASS Kg	U曲げ半径 U-BEND RADIUS (mm)	YEAR	検査番号 INSPECTION No. 製造番号 MANUFACTURING No.	規格区分 DIVISION OF STANDARD 製鋼番号 CAST No.	H P	化学成分 CHEMICAL COMPOSITION (%) X100 (*:X1,000 **:X10,000) C *	Si	Mn	P *	S *	Ni	Cr	Mo	CO			引張試験 TENSILE TEST TEST SPECIMEN *1	ORIENTATION *2	(GL 2") 耐力 YS KSI	引張強さ TS	伸び EL %	FLATTENING TEST	FLARING TEST	REVERSE FLATTENING TEST	硬さ試験 HARDNESS TEST HV	水圧試験 HYDROSTATIC TEST	CRT A262 PR. E		
							MIN							800	1800							30	75	35								
							MAX		35	·75	200	45	30	1100	2000													248				
01	N3/4"XS80SX21'*24'	6	92		4	9NLT87	E61734	H	25	48	105	33	2	801	1807		23			I	L	45	92	63	G			165		G		
01	"	89	1364		4	9NLT87	E61738	H	28	48	104	32	4	802	1803		23			I	L	43	91	62	G			158		G		
02	N1"XS80SX21'*24'	234	5289		4	9NLT86	E61734	H	25	48	105	33	2	801	1807		23			I I	L L	47 45	94 89	67 67	G G			157		G		
02	"	5	113		4	9NLT86	E61738	H	28	48	104	32	4	802	1803		23			I	L	46	90	67	G			163		G		
03	N1/2"XS80SX21'*24'	1	11		4	9NMT25	E57077	H	27	50	104	30	2	800	1807		22			I	L	45	91	60	G			167		G		

外観・寸法 VISUAL & DIMENSIONS : GOOD

非破壊検査 NON-DESTRUCTIVE INSPECTION
ET (A999 DRILLED HOLES) : G.

熱処理 HEAT TREATMENT
SH 2010DEG. F X 1MIN. W. Q.

CE MR0175/0103 ISO15156 HARDNESS ONLY
10204 3.1
E VALUE OF HYDROSTATIC TEST IS ASSURED BY
BSTITUTING N.D.I. FOR HYDROSTATIC TEST

注釈 NOTES
*1 JIS(4:No.4, 5:No.5, 1:No.11, A:No.12A, B:No.12B, C:No.13B), Strip(E:1/2in width, F:3/4in width, G:1in width), I:Full Section,
*2 L:縦方向 Longitudinal, T:横方向 Transverse, GL:標点距離 Gauge Length
YS:Yield Strength, TS:Tensile Strength, EL:Elongation, G:合格 Good
CIT:シャルピー衝撃試験 Charpy Impact Test, CRT:腐食試験 Corrosion Test
AGS / FGS: オーステナイト/フェライト結晶粒度 Austenitic / Ferritic Grain Size No.
SP: サルファプリント Sulphur Print, AP:透磁率 Amplitude Permeability
NMI: 非金属介在物 Non Metallic Inclusion, HNT: 焼入性試験 Hardenability Test
MDT: 脱炭層深さ試験 Measuring Decarburized Depth Test
H/P: 溶鋼分析/製品分析 Heat Analysis / Product Analysis
SH: 固溶化熱処理 Solution Heat-treatment, BT: 曲げ Bend Test
ET/UT/PT:渦流/超音波/浸透探傷試験 Eddy Crrent / Ultrasonic / Penetrant Test

上記注文品は、御指定の規格または仕様に従って製造され、その要求事項を満足していることを証明します。
WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MADE IN ACCORDANCE WITH THE RULES OF THE CONTRACT.
お問合せ先 CONTACT ADDRESS : PIPE-IPP@JP.NSSMC.COM

SURVEYOR TO

S. Saito
齊藤 俊太郎 SHUNTARO SAITO
大分製鉄所 品質保証室長
HEAD OF DEPARTMENT
QUALITY ASSURANCE DEPT.
OITA WORKS

PKR 3/1/17
LLN 175019

| 4500751484 | S447 | E61734 | [LN: 36] | T0379851-1 | SNI180S304/L |

製品検査証明書
INSPECTION CERTIFICATE

新日鐵住金株式会社
NIPPON STEEL & SUMITOMO METAL CORPORATION

本　　社：〒100-8071 東京都千代田区丸の内二丁目6番1号
HEAD OFFICE　:2-6-1 MARUNOUCHI, CHIYODA-KU, TOKYO 100-8071 JAPAN
大分製鐵所[光地区]：〒743-8510 山口県光市大字島田3434番地
OITA WORKS [HIKARI AREA]
:3434,SHIMATA,HIKARI-SHI,YAMAGUCHI,743-8510,JAPAN

注文者 SHIPPER: K&I TUBULAR CORPORATION
注文者照合番号 REFERENCE No.: HBS1700Y
契約番号 CONTRACT No.: 4-848-N3-5-X-E907
商品名 COMMODITY: COLD DRAWN SEAMLESS STAINLESS STEEL PIPE
規格 SPECIFICATION: ASTM A312/ASME SA-312 GRADE TP304/TP304L/ASTM A376/ASME SA-376 GRADE TP304

需要家 CUSTOMER: MARUBENI-ITOCHU TUBULARS AMERICA INC.
需要家管理番号 CUSTOMER'S CONTROL No.:
施主 CLIENT:

証明書番号 CERTIFICATE No.: 14120175-02E
発行年月日 DATE OF ISSUE: 14-12-19

特記 NOTE: PO HR054732, A312-14, SA-312/A376/SA-376-13, NO WELD REPAIR, MERCURY NOT DETECTABLE, MIL-P-24691/3, A262/E, P ED97/23/EC, COUNTRY OF MELT: JAPAN, PICKLED & PASSIVATED

E07

行番 ITEM No.	寸法 SIZE	員数 NUMBER OF PRODUCT	質量 MASS Kg	U曲げ半径 U-BEND RADIUS (mm)	検査番号 INSPECTION No. YEAR	製造番号 MANUFACTURING No.	規格区分 DIVISION OF STANDARD 製鋼番号 CAST No.	H/P	化学成分 CHEMICAL COMPOSITION (%) X100 (*:X1,000 **:X10,000) C *	SI	Mn	P *	S *	NI	Cr	Mo	CO			引張試験 TENSILE TEST (GL 2") *1 TEST SPECIMEN	*2 ORIENTATION	耐力 YS KSI	引張強さ TS	伸び EL %	FLATTENING TEST	FLARING TEST	REVERSE FLATTENING TEST	硬さ試験 HARDNESS TEST HV	水圧試験 HYDROSTATIC TEST	CRT A262 PR. E		
							MIN							800	1800							30	75	35								
							MAX		35	75	200	45	30	1100	2000													248				
03	N1/2"XS80SX21' *24'	96	1066		4	9NMT25	E61734	H	25	48	105	33	2	801	1807		23			I	L	43	91	62	G			149		G		

外観・寸法 VISUAL & DIMENSIONS : GOOD

非破壊検査 NON-DESTRUCTIVE INSPECTION
ET(A999 DRILLED HOLES):G.

熱処理 HEAT TREATMENT
SH　2010DEG.F X 1MIN.　W.Q.

E MR0175/0103 ISO15156 HARDNESS ONLY
0204 3.1
: VALUE OF HYDROSTATIC TEST IS ASSURED BY
STITUTING N.D.I. FOR HYDROSTATIC TEST

注釈 NOTES *1 JIS(4:No.4, 5:No.5, 1:No.11, A:No.12A, B:No.12B, C:No.13B), Strip(E:1/2in width, F:3/4in width, G:1in width), I:Full Section,
*2 L：縦方向 Longitudinal, T：横方向 Transverse, GL：標点距離 Gauge Length
YS:Yield Strength, TS:Tensile Strength, EL：Elongation, G：合格 Good
CIT: シャルピー衝撃試験 Charpy Impact Test, CRT: 腐食試験 Corrosion Test
AGS / FGS: オーステナイト/フェライト結晶粒度 Austenitic / Ferritic Grain Size No.
SP: サルファプリント Sulphur Print, AP: 透磁率 Amplitude Permeability.
NMI: 非金属介在物 Non Metallic Inclusion, HNT: 焼入性試験 Hardenability Test
MDT: 脱炭層深さ試験 Measuring Decarburized Depth Test
H / P: 溶鋼分析／製品分析 Heat Analysis / Product Analysis
SH: 固溶化熱処理 Solution Heat-treatment, BT: 曲げ Bend Test
ET/UT/PT: 渦流/超音波/浸透探傷試験 Eddy Crrent / Ultrasonic / Penetrant Test

上記注文品は、御指定の規格または仕様に従って製造され、その要求事項を満足していることを証明します。
WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MADE IN ACCORDANCE WITH THE RULES OF THE CONTRACT.
お問合せ先 CONTACT ADDRESS : PIPE-IPP@JP.NSSMC.COM

SURVEYOR TO

S. Saito
齊藤 俊太郎 SHUNTARO SAITO
大分製鐵所 品質保証室長
HEAD OF DEPARTMENT
QUALITY ASSURANCE DEPT.
OITA WORKS

PKR 31/1/17
LIC# 175019

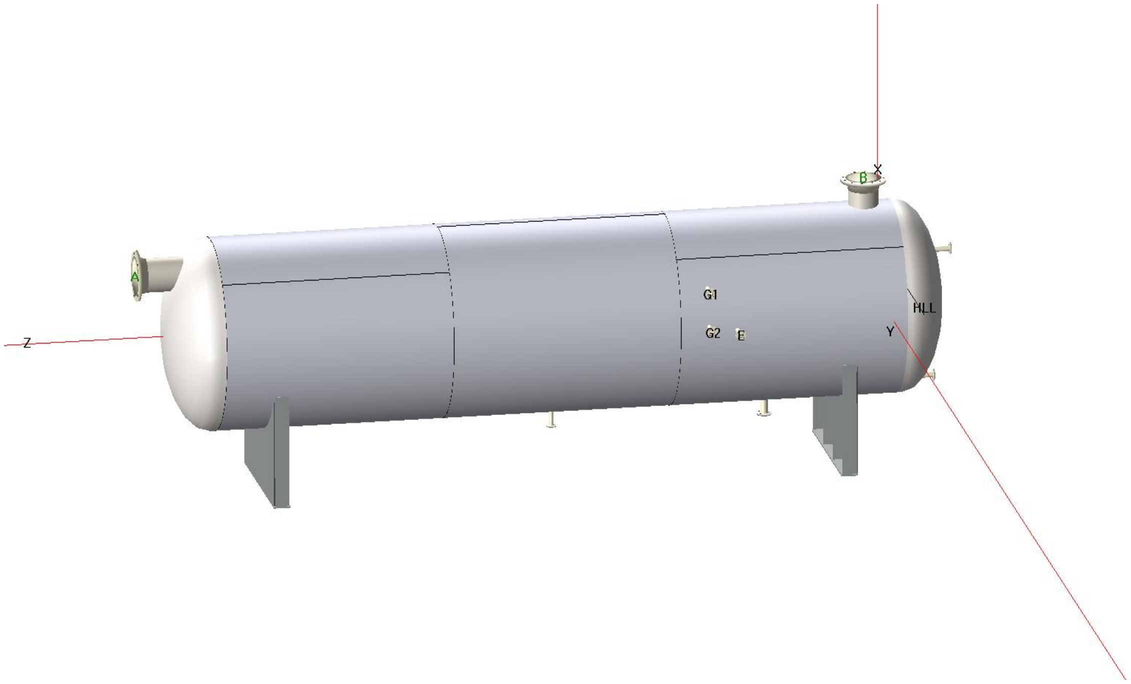
| 4500751484 | S447 | [E61734] | [LN: 36] | T0379851-1 | SNI180S304/L |

UOP Russell

7050 South Yale

Suite 210

Tulsa OK 74136



COMPRESS Pressure Vessel Design Calculations

Service:	Cold Drain Tank
Tag No:	V-492
Revision:	A
Designer & Date:	GAT 11/9/2016

Designed in accordance with UG-22

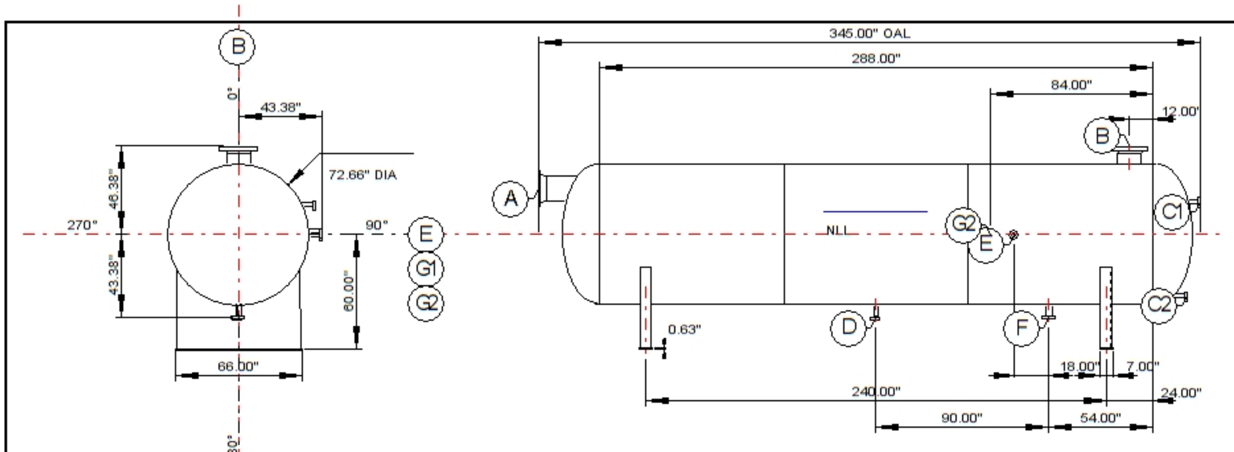
Reviewed: ABH 11/9/2016

Table of Contents

Table of Contents

Revision History

Revisions			
No.	**Date**	**Operator**	**Notes**
0	6/12/2014	GAT	New vessel created ASME Section VIII Division 1 [COMPRESS 2014 Build 7400]
1	3/ 2/2015	SHP	General Revision.
2	3/31/2015	SHP	Revised nozzle projections on B, D, F.
3	5/15/2015	ABM	- Moved location of nozzle F - Moved location of saddles. Now seperated by 20 ft.
4	5/12/2016	SHP	- Revised saddle plate thickness.
5	11/ 9/2016	GAT	Converted from ASME Section VIII Division 1, 2013 Edition to ASME Section VIII Division 1, 2015 Edition.



DESIGN DATA

Design Pressure	150 psi
Vacuum Pressure	0 psi
Test Pressure (Shop)	200.15 psi
Design Temperature	150 °F
MDMT	-200 °F
Corrosion Allowance	0 "
Radiography	RT3
PWHT	None

Estimated Weights

Dry: 9,596 lb Wet: 42,603 lb

Weight at left saddle: 21,328 lb (Oper), 28,102 lb (Test)
Weight at right saddl 21,276 lb (Oper), 28,008 lb (Test)

Materials

Cylinder(s):	SA-240 304
Head(s):	SA-240 304
Transition(s):	
Support:	

NOZZLE SCHEDULE

MARK	NOZZLE	SIZE & SCH	FLANGE	MARK	NOZZLE	SIZE & SCH	FLANGE
C2	LG #2	2 OD x 0.5	NPS 1 LWN Class				
C1	LG #1	2 OD x 0.5	NPS 1 LWN Class				
G2	LSHH #2	2 OD x 0.5	NPS 1 LWN Class				
G1	LSHH #1	2 OD x 0.5	NPS 1 LWN Class				
F	Liquid Out	3.06 OD x 0.53	NPS 2 LWN Class				
E	TI	2 OD x 0.5	NPS 1 LWN Class				
B	Vapor Out	NPS 12 Sch 40S (S	NPS 12 WN Class				
D	Drain	2 OD x 0.5	NPS 1 LWN Class				
A	Inlet	NPS 12 Sch 40S (S	NPS 12 WN Class				

REVISIONS

REV	DATE	DESCRIPTION
0	06/12/2014	FOR APPROV

ABC Fabricators Inc.
2600 Washington Blvd.
Dallas, TX, 75204

DWN BY:
CHK BY:
DATE:

General Arrangeme

DWG NO 145685-1
Rev 0

SC6 V-492

Deficiencies Summary

Warnings Summary

Warnings for Drain (D)
NOTE: Suitable low temperature bolting material is required. (warning)

Warnings for Inlet (A)
NOTE: Suitable low temperature bolting material is required. (warning)

Warnings for LG #1 (C1)
NOTE: Suitable low temperature bolting material is required. (warning)

Warnings for LG #2 (C2)
NOTE: Suitable low temperature bolting material is required. (warning)

Warnings for Liquid Out (F)
NOTE: Suitable low temperature bolting material is required. (warning)

Warnings for LSHH #1 (G1)
NOTE: Suitable low temperature bolting material is required. (warning)

Warnings for LSHH #2 (G2)
NOTE: Suitable low temperature bolting material is required. (warning)

Warnings for TI (E)
NOTE: Suitable low temperature bolting material is required. (warning)

Warnings for Vapor Out (B)
NOTE: Suitable low temperature bolting material is required. (warning)

ASME B16.5 / B16.47 Flange Warnings Summary

Flange	Applicable Warnings
Inlet (A)	1, 2
Drain (D)	1, 2
Vapor Out (B)	1, 2
TI (E)	1, 2
Liquid Out (F)	1, 2
LSHH #1 (G1)	1, 2
LSHH #2 (G2)	1, 2
LG #1 (C1)	1, 2
LG #2 (C2)	1, 2

No.	Warning
1	You have selected a low strength bolt material SA-193 B8 1 Bolt. ASME B16.5 para. 5.4.2 requires gaskets for low strength bolts to be in accordance with Nonmandatory Appendix B, Table B-1, Group No. Ia.
2	For Class 150 flanges, ASME B16.5 para. 5.4.3 recommends gaskets to be in accordance with Nonmandatory Appendix B, Table B1, Group No. I.

Nozzle Schedule

Specifications									
Nozzle mark	Identifier	Size	Materials		Impact Tested	Normalized	Fine Grain	Flange	Blind
A	Inlet	NPS 12 Sch 40S (Std)	Nozzle	SA-312 TP304 Wld & smls pipe	No	No	No	NPS 12 Class 150 WN A182 F304	No
			Pad	SA-240 304	No	No	No		
B	Vapor Out	NPS 12 Sch 40S (Std)	Nozzle	SA-312 TP304 Wld & smls pipe	No	No	No	NPS 12 Class 150 WN A182 F304	No
			Pad	SA-240 304	No	No	No		
C1	LG #1	2 OD x 0.5	Nozzle	SA-182 F304 <= 5	No	No	No	NPS 1 Class 150 LWN A182 F304	No
C2	LG #2	2 OD x 0.5	Nozzle	SA-182 F304 <= 5	No	No	No	NPS 1 Class 150 LWN A182 F304	No
D	Drain	2 OD x 0.5	Nozzle	SA-182 F304 <= 5	No	No	No	NPS 1 Class 150 LWN A182 F304	No
E	TI	2 OD x 0.5	Nozzle	SA-182 F304 <= 5	No	No	No	NPS 1 Class 150 LWN A182 F304	No
F	Liquid Out	3.06 OD x 0.53	Nozzle	SA-182 F304 <= 5	No	No	No	NPS 2 Class 150 LWN A182 F304	No
G1	LSHH #1	2 OD x 0.5	Nozzle	SA-182 F304 <= 5	No	No	No	NPS 1 Class 150 LWN A182 F304	No
G2	LSHH #2	2 OD x 0.5	Nozzle	SA-182 F304 <= 5	No	No	No	NPS 1 Class 150 LWN A182 F304	No

Nozzle Summary

Dimensions

Nozzle mark	OD (in)	t_n (in)	Req t_n (in)	A_1?	A_2?	Shell			Reinforcement Pad		Corr (in)	A_a/A_r (%)
						Nom t (in)	Design t (in)	User t (in)	Width (in)	t_{pad} (in)		
A	12.75	0.375	0.3088	Yes	Yes	0.33*	0.2702		3.25	0.375	0	112.1
B	12.75	0.375	0.3099	Yes	Yes	0.375	0.2712		2	0.375	0	110.7
C1	2	0.5	0.1348	Yes	Yes	0.33*	N/A		N/A	N/A	0	Exempt
C2	2	0.5	0.1348	Yes	Yes	0.33*	N/A		N/A	N/A	0	Exempt
D	2	0.5	0.1348	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
E	2	0.5	0.1348	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
F	3.06	0.53	0.189	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
G1	2	0.5	0.1348	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt
G2	2	0.5	0.1348	Yes	Yes	0.375	N/A		N/A	N/A	0	Exempt

*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

Pressure Summary

Component Summary

Identifier	P Design (psi)	T Design (°F)	MAWP (psi)	MAP (psi)	MDMT (°F)	MDMT Exemption		Impact Tested
Ellipsoidal Head #1	150	150	153.96	155.69	-320	Note 1		No
Straight Flange on Ellipsoidal Head #1	150	150	174.25	175.98	-320	Note 2		No
Cylinder #1	150	150	174.25	175.98	-320	Note 2		No
Cylinder #2	150	150	174.25	175.98	-320	Note 2		No
Cylinder #3	150	150	174.25	175.98	-320	Note 2		No
Straight Flange on Ellipsoidal Head #2	150	150	174.25	175.98	-320	Note 2		No
Ellipsoidal Head #2	150	150	153.96	155.69	-320	Note 3		No
Saddle #1	150	150	153.96	N/A	N/A	N/A		N/A
Inlet (A)	150	150	158.95	158.95	-320	Nozzle	Note 4	No
						Pad	Note 2	No
Vapor Out (B)	150	150	157.86	157.86	-320	Nozzle	Note 4	No
						Pad	Note 2	No
LG #1 (C1)	150	150	203.5	203.5	-320	Note 2		No
LG #2 (C2)	150	150	181.59	183.16	-320	Note 2		No
Drain (D)	150	150	205.29	207.04	-320	Note 2		No
TI (E)	150	150	206.61	207.04	-320	Note 2		No
Liquid Out (F)	150	150	205.29	207.04	-320	Note 2		No
LSHH #1 (G1)	150	150	207.04	207.04	-320	Note 2		No
LSHH #2 (G2)	150	150	206.66	207.04	-320	Note 2		No

Chamber Summary

Design MDMT	-200 °F
Rated MDMT	-320 °F @ 153.96 psi
MAWP hot & corroded	153.96 psi @ 150 °F
MAP cold & new	155.69 psi @ 70 °F
(1) This pressure chamber is not designed for external pressure.	

Notes for MDMT Rating		
Note #	Exemption	Details
1.	Straight Flange governs MDMT	
2.	Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
3.	Straight Flange governs MDMT	
4.	Impact test exempt per UHA-51(g) (coincident ratio = 0.1415)	

Settings Summary

COMPRESS 2016 Build 7600	
ASME Section VIII Division 1, 2015 Edition	
Units	U.S. Customary
Datum Line Location	6.00" from right seam
Vessel Design Mode	Get Thickness from Pressure
Minimum thickness	0.0625" per UG-16(b)
Design for cold shut down only	No
Design for lethal service (full radiography required)	No
Design nozzles for	Design P only
Corrosion weight loss	100% of theoretical loss
UG-23 Stress Increase	1.20
Skirt/legs stress increase	1.0
Minimum nozzle projection	6"
Juncture calculations for $\alpha > 30$ only	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
Test liquid specific gravity	1.00
Maximum stress during test	90% of yield
Required Marking - UG-116	
UG-116(e) Radiography	RT3
UG-116(f) Postweld heat treatment	None
Code Cases\Interpretations	
Use Code Case 2547	No
Use Code Case 2695	No
Apply interpretation VIII-1-83-66	Yes
Apply interpretation VIII-1-86-175	Yes

Apply interpretation VIII-1-01-37	Yes
Apply interpretation VIII-1-01-150	No
Apply interpretation VIII-1-07-50	Yes
No UCS-66.1 MDMT reduction	No
No UCS-68(c) MDMT reduction	No
Disallow UG-20(f) exemptions	No
UG-22 Loadings	
UG-22(a) Internal or External Design Pressure	Yes
UG-22(b) Weight of the vessel and normal contents under operating or test conditions	Yes
UG-22(c) Superimposed static reactions from weight of attached equipment (external loads)	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	
License Key #	15664
Support Expires	October 22, 2016

Radiography Summary

UG-116 Radiography							
Component	**Longitudinal Seam**		**Left Circumferential Seam**		**Right Circumferential Seam**		**Mark**
	Category (Fig UW-3)	**Radiography / Joint Type**	**Category (Fig UW-3)**	**Radiography / Joint Type**	**Category (Fig UW-3)**	**Radiography / Joint Type**	
Ellipsoidal Head #1	N/A	Seamless No RT	N/A	N/A	B	Spot UW-11(b) / Type 1	RT3
Cylinder #1	A	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	RT3
Cylinder #2	A	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	RT3
Cylinder #3	A	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	RT3
Ellipsoidal Head #2	N/A	Seamless No RT	B	Spot UW-11(b) / Type 1	N/A	N/A	RT3
Nozzle	**Longitudinal Seam**		**Nozzle to Vessel Circumferential Seam**		**Nozzle free end Circumferential Seam**		
Inlet (A)	N/A	Seamless No RT	D	N/A / Type 7	C	Spot UW-11(b) / Type 1	RT3
Drain (D)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
Vapor Out (B)	A	Welded pipe	D	N/A / Type 7	C	Spot UW-11(b) / Type 1	RT3
TI (E)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
Liquid Out (F)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
LSHH #1 (G1)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
LSHH #2 (G2)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
LG #1 (C1)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
LG #2 (C2)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
Nozzle Flange	**Longitudinal Seam**		**Flange Face**		**Nozzle to Flange Circumferential Seam**		
ASME B16.5/16.47 flange attached to Inlet (A)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	Spot UW-11(b) / Type 1	RT3
ASME B16.5/16.47 flange attached to Drain (D)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
ASME B16.5/16.47 flange attached to Vapor Out (B)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	Spot UW-11(b) / Type 1	RT3
ASME B16.5/16.47 flange attached to TI (E)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
ASME B16.5/16.47 flange attached to Liquid Out (F)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
ASME B16.5/16.47 flange attached to LSHH #1 (G1)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
ASME B16.5/16.47 flange attached to LSHH #2 (G2)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
ASME B16.5/16.47 flange attached to LG #1 (C1)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
ASME B16.5/16.47 flange attached to LG #2 (C2)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
UG-116(e) Required Marking: **RT3**							

Thickness Summary

Component Data								
Component Identifier	**Material**	**Diameter (in)**	**Length (in)**	**Nominal t (in)**	**Design t (in)**	**Total Corrosion (in)**	**Joint E**	**Load**
Ellipsoidal Head #1	SA-240 304	72 ID	18.33	0.33*	0.3217	0	0.85	Internal
Straight Flange on Ellipsoidal Head #1	SA-240 304	72 ID	2	0.375	0.3231	0	0.85	Internal
Cylinder #1	SA-240 304	72 ID	96	0.375	0.3231	0	0.85	Internal
Cylinder #2	SA-240 304	72 ID	96	0.375	0.3231	0	0.85	Internal
Cylinder #3	SA-240 304	72 ID	96	0.375	0.3231	0	0.85	Internal
Straight Flange on Ellipsoidal Head #2	SA-240 304	72 ID	2	0.375	0.3231	0	0.85	Internal
Ellipsoidal Head #2	SA-240 304	72 ID	18.33	0.33*	0.3217	0	0.85	Internal

*Head minimum thickness after forming

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

Weight Summary

Weight (lb) Contributed by Vessel Elements

Component	Metal New*	Metal Corroded	Insulation	Insulation Supports	Lining	Piping + Liquid	Operating Liquid		Test Liquid		Surface Area ft^2
							New	Corroded	New	Corroded	
Ellipsoidal Head #1	615.3	615.3	0	0	0	0	1,514.6	1,514.6	2,105.5	2,105.5	47
Cylinder #1	2,373.8	2,373.8	0	0	0	0	9,992.2	9,992.2	14,109.1	14,109.1	152
Cylinder #2	2,373.4	2,373.4	0	0	0	0	9,992.3	9,992.3	14,109.3	14,109.3	152
Cylinder #3	2,358.1	2,358.1	0	0	0	0	9,993.2	9,993.2	14,132.8	14,132.8	151
Ellipsoidal Head #2	626.9	626.9	0	0	0	0	1,514.8	1,514.8	2,057.9	2,057.9	48
Saddle #1	906	906	0	0	0	0	0	0	0	0	93
TOTAL:	**9,253.4**	**9,253.4**	**0**	**0**	**0**	**0**	**33,007.1**	**33,007.1**	**46,514.5**	**46,514.5**	**643**

*Shells with attached nozzles have weight reduced by material cut out for opening.

Weight (lb) Contributed by Attachments

Component	Body Flanges		Nozzles & Flanges		Packed Beds	Trays	Tray Supports	Rings & Clips	Vertical Loads	Surface Area ft^2
	New	Corroded	New	Corroded						
Ellipsoidal Head #1	0	0	164.5	164.5	0	0	0	0	0	6
Cylinder #1	0	0	0	0	0	0	0	0	0	0
Cylinder #2	0	0	7.7	7.7	0	0	0	0	0	0
Cylinder #3	0	0	154.8	154.8	0	0	0	0	0	6
Ellipsoidal Head #2	0	0	15.9	15.9	0	0	0	0	0	1
TOTAL:	**0**	**0**	**342.9**	**342.9**	**0**	**0**	**0**	**0**	**0**	**14**

Vessel Totals

	New	Corroded
Operating Weight (lb)	42,603	42,603
Empty Weight (lb)	9,596	9,596
Test Weight (lb)	56,111	56,111
Surface Area (ft^2)	657	-
Capacity** (US gal)	5,570	5,570

**The vessel capacity does not include volume of nozzle, piping or other attachments.

Vessel Lift Condition

Vessel Lift Weight, New (lb)	9,596
Center of Gravity from Datum (in)	138.6374

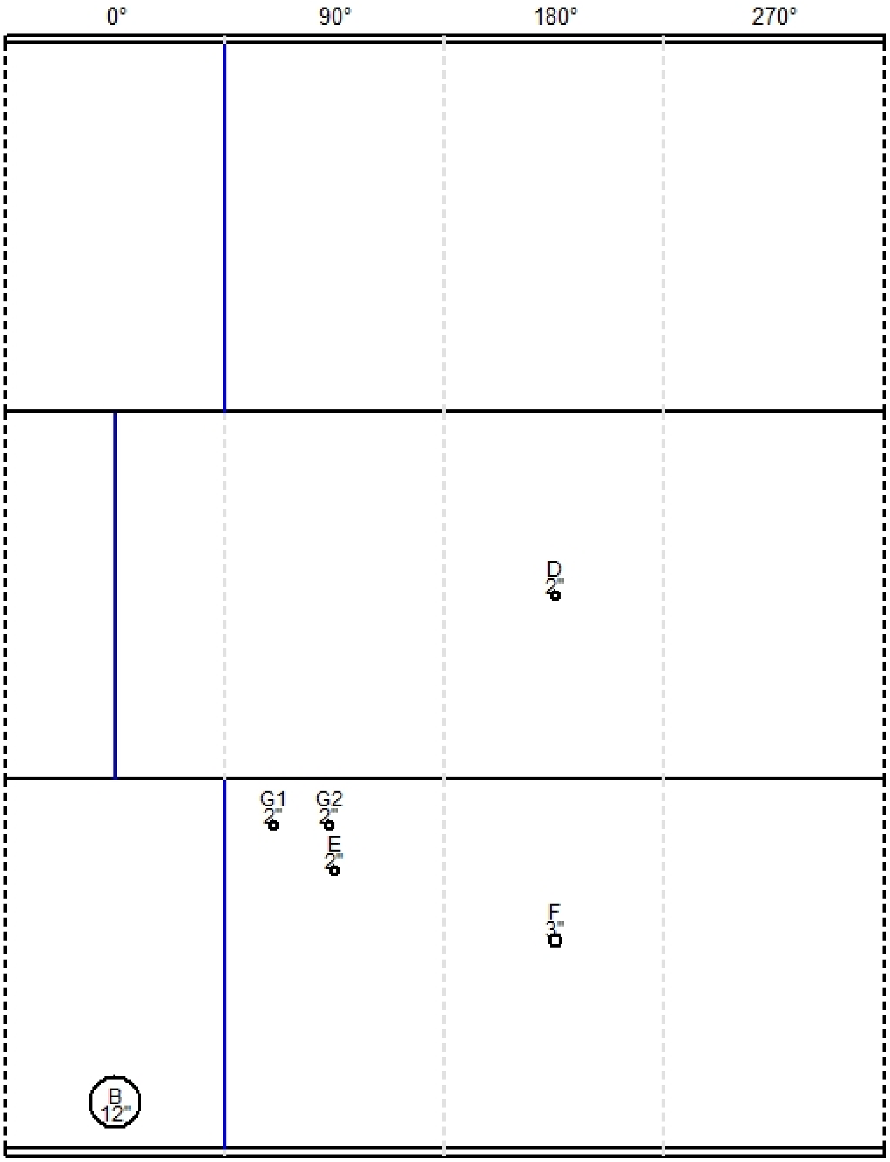
Long Seam Summary

Shell Long Seam Angles	
Component	**Seam 1**
Cylinder #1	45°
Cylinder #2	0°
Cylinder #3	45°

Shell Plate Lengths		
Component	**Starting Angle**	**Plate 1**
Cylinder #1	45°	227.3728"
Cylinder #2	0°	227.3728"
Cylinder #3	45°	227.3728"

Note

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



Shell Rollout

Hydrostatic Test

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

Gauge pressure at 70°F = 1.3*MAWP*LSR
= 1.3*153.96*1
= 200.15 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
Ellipsoidal Head #1 (1)	203.119	2.974	1	1.30
Straight Flange on Ellipsoidal Head #1	203.119	2.974	1	1.30
Cylinder #1	203.119	2.974	1	1.30
Cylinder #2	203.119	2.974	1	1.30
Cylinder #3	203.119	2.974	1	1.30
Straight Flange on Ellipsoidal Head #2	203.119	2.974	1	1.30
Ellipsoidal Head #2	203.119	2.974	1	1.30
Drain (D)	203.385	3.24	1	1.30
Inlet (A)	201.17	1.024	1	1.30
LG #1 (C1)	201.224	1.078	1	1.30
LG #2 (C2)	202.979	2.834	1	1.30
LSHH #1 (G1)	201.269	1.124	1	1.30
LSHH #2 (G2)	201.774	1.629	1	1.30
Liquid Out (F)	203.385	3.24	1	1.30
TI (E)	201.837	1.692	1	1.30
Vapor Out (B)	200.506	0.361	1	1.30

(1) Ellipsoidal Head #1 limits the UG-99(b) stress ratio.
(2) The zero degree angular position is assumed to be up, and the test liquid height is assumed to the top-most flange.

The field test condition has not been investigated.

Wind Code

Building Code: ASCE 7-10	
Elevation of base above grade	3.00 ft
Increase effective outer diameter by	0.00 ft
Wind Force Coefficient, Cf	0.7000
Risk Category (Table 1.5-1)	III
Basic Wind Speed, V	120.0000 mph
Exposure category	C
Wind Directionality Factor, Kd	0.9500
Topographic Factor, Kzt	1.0000
Enforce minimum design load of 16 psf per ASCE 29.8:	Yes

Wind Pressure (WP) Calculations

$Kz = 2.01 * (Z/z_g)^{2/\alpha}$
$= 2.01 * (15.00 / 900.00)^{0.2105}$
$= 0.8489$

$qz = 0.00256 * Kz * Kzt * Kd * V^2$
$= 0.00256 * 0.8489 * 1.0000 * 0.9500 * 120.0000^2$
$= 29.7286$ psf

$qz = 0.6 * \max (29.7286, 16.0000)$
$= 17.8372$ psf

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

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

Shear calculations are reported in the saddle report.

Seismic Code

Seismic calculations are reported in the saddle report.

HLL

ASME Section VIII Division 1, 2015 Edition	
Location from Center Line (in)	12
Operating Liquid Specific Gravity	1

Ellipsoidal Head #1

ASME Section VIII Division 1, 2015 Edition				
Component		Ellipsoidal Head		
Material		SA-240 304 (II-D p. 86, ln. 44)		
Attached To		Cylinder #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		150	150	-200
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		1.73	48	1
Test horizontal		2.97	82.375	1
Dimensions				
Inner Diameter		72"		
Head Ratio		2		
Minimum Thickness		0.33"		
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		615.28		246.76
Corroded		615.28		246.76
Radiography				
Category A joints		Seamless No RT		
Head to shell seam		Spot UW-11(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)	0.3217"
Maximum allowable working pressure (MAWP)	153.96 psi
Maximum allowable pressure (MAP)	155.69 psi
Straight Flange governs MDMT	-320°F

Design thickness for internal pressure, (Corroded at 150 °F) UG-32(c)(1)

t = P*D / (2*S*E - 0.2*P) + Corrosion
= 151.73*72 / (2*20,000*0.85 - 0.2*151.73) + 0
= 0.3216"

Maximum allowable working pressure, (Corroded at 150 °F) UG-32(c)(1)

P = 2*S*E*t / (D + 0.2*t) - P_s
= 2*20,000*0.85*0.33 / (72 +0.2*0.33) - 1.73
= 153.96 psi

Maximum allowable pressure, (New at 70 °F) UG-32(c)(1)

P = 2*S*E*t / (D + 0.2*t) - P_s
= 2*20,000*0.85*0.33 / (72 +0.2*0.33) - 0
= 155.69 psi

% Forming strain - UHA-44(a)(2)

EFE = $(75*t / R_f)*(1 - R_f / R_o)$
= $(75*0.375 / 12.4275)*(1 - 12.4275 / \infty)$
= 2.2631%

Straight Flange on Ellipsoidal Head #1

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-240 304 (II-D p. 86, ln. 44)		
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		150	150	-200
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		1.73	48	1
Test horizontal		2.97	82.375	1
Dimensions				
Inner Diameter		72"		
Length		2"		
Nominal Thickness		0.375"		
Corrosion	**Inner**	0"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		**Capacity (US gal)**
New		49.45		35.25
Corroded		49.45		35.25
Radiography				
Longitudinal seam		Seamless No RT		
Right Circumferential seam		Spot UW-11(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)	0.3231"
Maximum allowable working pressure (MAWP)	174.25 psi
Maximum allowable pressure (MAP)	175.98 psi
Rated MDMT	-320 °F

UHA-51 Material Toughness Requirements
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Design thickness, (at 150 °F) UG-27(c)(1)

t = P*R / (S*E - 0.60*P) + Corrosion
= 151.73*36 / (20,000*0.85 - 0.60*151.73) + 0
= 0.3231"

Maximum allowable working pressure, (at 150 °F) UG-27(c)(1)

P = S*E*t / (R + 0.60*t) - P_s
= 20,000*0.85*0.375 / (36 + 0.60*0.375) - 1.73
= 174.25 psi

Maximum allowable pressure, (at 70 °F) UG-27(c)(1)

P = S*E*t / (R + 0.60*t)
= 20,000*0.85*0.375 / (36 + 0.60*0.375)
= 175.98 psi

% Forming strain - UHA-44(a)(2)

EFE = $(50*t / R_f)*(1 - R_f / R_o)$
= (50*0.375 / 36.1875)*(1 - 36.1875 / ∞)
= 0.5181%

Allowable Compressive Stress, Hot and Corroded- S_{cHC}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289

B = 9,424 psi

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

S_{cHC} = min(B, S) = 9,424 psi

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

S_{cHN} = S_{cHC}
= 9,424 psi

Allowable Compressive Stress, Cold and New- S_{cCN}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289

B = 9,951 psi

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

S_{cCN} = min(B, S) = 9,951 psi

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

S_{cCC} = S_{cCN}
= 9,951 psi

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289

B = 9,424 psi

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

S_{cVC} = min(B, S) = 9,424 psi

Cylinder #1

<table>
<tr><th colspan="5">ASME Section VIII Division 1, 2015 Edition</th></tr>
<tr><td colspan="2">Component</td><td colspan="3">Cylinder</td></tr>
<tr><td colspan="2">Material</td><td colspan="3">SA-240 304 (II-D p. 86, ln. 44)</td></tr>
<tr><td>Impact Tested</td><td>Normalized</td><td>Fine Grain Practice</td><td>PWHT</td><td>Optimize MDMT/ Find MAWP</td></tr>
<tr><td>No</td><td>No</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td colspan="2"></td><td>Design Pressure (psi)</td><td>Design Temperature (°F)</td><td>Design MDMT (°F)</td></tr>
<tr><td colspan="2">Internal</td><td>150</td><td>150</td><td>-200</td></tr>
<tr><th colspan="5">Static Liquid Head</th></tr>
<tr><td colspan="2">Condition</td><td>P_s (psi)</td><td>H_s (in)</td><td>SG</td></tr>
<tr><td colspan="2">Operating</td><td>1.73</td><td>48</td><td>1</td></tr>
<tr><td colspan="2">Test horizontal</td><td>2.97</td><td>82.375</td><td>1</td></tr>
<tr><th colspan="5">Dimensions</th></tr>
<tr><td colspan="2">Inner Diameter</td><td colspan="3">72"</td></tr>
<tr><td colspan="2">Length</td><td colspan="3">96"</td></tr>
<tr><td colspan="2">Nominal Thickness</td><td colspan="3">0.375"</td></tr>
<tr><td rowspan="2">Corrosion</td><td>Inner</td><td colspan="3">0"</td></tr>
<tr><td>Outer</td><td colspan="3">0"</td></tr>
<tr><th colspan="5">Weight and Capacity</th></tr>
<tr><td colspan="2"></td><td colspan="2">Weight (lb)</td><td>Capacity (US gal)</td></tr>
<tr><td colspan="2">New</td><td colspan="2">2,373.77</td><td>1,692.05</td></tr>
<tr><td colspan="2">Corroded</td><td colspan="2">2,373.77</td><td>1,692.05</td></tr>
<tr><th colspan="5">Radiography</th></tr>
<tr><td colspan="2">Longitudinal seam</td><td colspan="3">Spot UW-11(b) Type 1</td></tr>
<tr><td colspan="2">Left Circumferential seam</td><td colspan="3">Spot UW-11(b) Type 1</td></tr>
<tr><td colspan="2">Right Circumferential seam</td><td colspan="3">Spot UW-11(b) Type 1</td></tr>
</table>

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	0.0625" + 0" = 0.0625"
Design thickness due to internal pressure (t)	0.3231"
Maximum allowable working pressure (MAWP)	174.25 psi
Maximum allowable pressure (MAP)	175.98 psi
Rated MDMT	-320 °F

UHA-51 Material Toughness Requirements
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Design thickness, (at 150 °F) UG-27(c)(1)

t = P*R / (S*E - 0.60*P) + Corrosion
= 151.73*36 / (20,000*0.85 - 0.60*151.73) + 0
= 0.3231"

Maximum allowable working pressure, (at 150 °F) UG-27(c)(1)

P = S*E*t / (R + 0.60*t) - P_s
= 20,000*0.85*0.375 / (36 + 0.60*0.375) - 1.73
= 174.25 psi

Maximum allowable pressure, (at 70 °F) UG-27(c)(1)

P = S*E*t / (R + 0.60*t)
= 20,000*0.85*0.375 / (36 + 0.60*0.375)
= 175.98 psi

% Forming strain - UHA-44(a)(2)

EFE = $(50*t / R_f)*(1 - R_f / R_o)$
= $(50*0.375 / 36.1875)*(1 - 36.1875 / \infty)$
= 0.5181%

Allowable Compressive Stress, Hot and Corroded- S_{cHC}, (table HA-1)

A = $0.125 / (R_o / t)$
= 0.125 / (36.375 / 0.375)
= 0.001289
B = 9,424 psi
S = 20,000 / 1.00 = 20,000 psi
S_{cHC} = min(B, S) = 9,424 psi

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

S_{cHN} = S_{cHC}
= 9,424 psi

Allowable Compressive Stress, Cold and New- S_{cCN}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289
B = 9,951 psi
S = 20,000 / 1.00 = 20,000 psi
S_{cCN} = min(B, S) = 9,951 psi

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

S_{cCC} = S_{cCN}
= 9,951 psi

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289
B = 9,424 psi
S = 20,000 / 1.00 = 20,000 psi
S_{cVC} = min(B, S) = 9,424 psi

Cylinder #2

<table>
<tr><th colspan="5">ASME Section VIII Division 1, 2015 Edition</th></tr>
<tr><td colspan="2">Component</td><td colspan="3">Cylinder</td></tr>
<tr><td colspan="2">Material</td><td colspan="3">SA-240 304 (II-D p. 86, ln. 44)</td></tr>
<tr><td>Impact Tested</td><td>Normalized</td><td>Fine Grain Practice</td><td>PWHT</td><td>Optimize MDMT/ Find MAWP</td></tr>
<tr><td>No</td><td>No</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td colspan="2"></td><td>Design Pressure (psi)</td><td>Design Temperature (°F)</td><td>Design MDMT (°F)</td></tr>
<tr><td colspan="2">Internal</td><td>150</td><td>150</td><td>-200</td></tr>
<tr><th colspan="5">Static Liquid Head</th></tr>
<tr><td colspan="2">Condition</td><td>P_s (psi)</td><td>H_s (in)</td><td>SG</td></tr>
<tr><td colspan="2">Operating</td><td>1.73</td><td>48</td><td>1</td></tr>
<tr><td colspan="2">Test horizontal</td><td>2.97</td><td>82.375</td><td>1</td></tr>
<tr><th colspan="5">Dimensions</th></tr>
<tr><td colspan="2">Inner Diameter</td><td colspan="3">72"</td></tr>
<tr><td colspan="2">Length</td><td colspan="3">96"</td></tr>
<tr><td colspan="2">Nominal Thickness</td><td colspan="3">0.375"</td></tr>
<tr><td rowspan="2">Corrosion</td><td>Inner</td><td colspan="3">0"</td></tr>
<tr><td>Outer</td><td colspan="3">0"</td></tr>
<tr><th colspan="5">Weight and Capacity</th></tr>
<tr><td colspan="2"></td><td colspan="2">Weight (lb)</td><td>Capacity (US gal)</td></tr>
<tr><td colspan="2">New</td><td colspan="2">2,373.43</td><td>1,692.05</td></tr>
<tr><td colspan="2">Corroded</td><td colspan="2">2,373.43</td><td>1,692.05</td></tr>
<tr><th colspan="5">Radiography</th></tr>
<tr><td colspan="2">Longitudinal seam</td><td colspan="3">Spot UW-11(b) Type 1</td></tr>
<tr><td colspan="2">Left Circumferential seam</td><td colspan="3">Spot UW-11(b) Type 1</td></tr>
<tr><td colspan="2">Right Circumferential seam</td><td colspan="3">Spot UW-11(b) Type 1</td></tr>
</table>

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	0.0625" + 0" = 0.0625"
Design thickness due to internal pressure (t)	0.3231"
Maximum allowable working pressure (MAWP)	174.25 psi
Maximum allowable pressure (MAP)	175.98 psi
Rated MDMT	-320 °F

UHA-51 Material Toughness Requirements
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Design thickness, (at 150 °F) UG-27(c)(1)

t = P*R / (S*E - 0.60*P) + Corrosion
= 151.73*36 / (20,000*0.85 - 0.60*151.73) + 0
= 0.3231"

Maximum allowable working pressure, (at 150 °F) UG-27(c)(1)

P = S*E*t / (R + 0.60*t) - P_s
= 20,000*0.85*0.375 / (36 + 0.60*0.375) - 1.73
= 174.25 psi

Maximum allowable pressure, (at 70 °F) UG-27(c)(1)

P = S*E*t / (R + 0.60*t)
= 20,000*0.85*0.375 / (36 + 0.60*0.375)
= 175.98 psi

% Forming strain - UHA-44(a)(2)

EFE = $(50 \cdot t / R_f) \cdot (1 - R_f / R_o)$
= $(50 \cdot 0.375 / 36.1875) \cdot (1 - 36.1875 / \infty)$
= 0.5181%

Allowable Compressive Stress, Hot and Corroded- S_{cHC}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289

B = 9,424 psi

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

S_{cHC} = min(B, S) = 9,424 psi

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

S_{cHN} = S_{cHC}
= 9,424 psi

Allowable Compressive Stress, Cold and New- S_{cCN}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289
B = 9,951 psi
S = 20,000 / 1.00 = 20,000 psi
S_{cCN} = min(B, S) = 9,951 psi

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

S_{cCC} = S_{cCN}
= 9,951 psi

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289
B = 9,424 psi
S = 20,000 / 1.00 = 20,000 psi
S_{cVC} = min(B, S) = 9,424 psi

Cylinder #3

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-240 304 (II-D p. 86, ln. 44)		
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		150	150	-200
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		1.73	48	1
Test horizontal		2.97	82.375	1
Dimensions				
Inner Diameter		72"		
Length		96"		
Nominal Thickness		0.375"		
Corrosion	**Inner**	0"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		**Capacity (US gal)**
New		2,358.06		1,692.05
Corroded		2,358.06		1,692.05
Radiography				
Longitudinal seam		Spot UW-11(b) Type 1		
Left Circumferential seam		Spot UW-11(b) Type 1		
Right Circumferential seam		Spot UW-11(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)	0.3231"
Maximum allowable working pressure (MAWP)	174.25 psi
Maximum allowable pressure (MAP)	175.98 psi
Rated MDMT	-320 °F

UHA-51 Material Toughness Requirements
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Design thickness, (at 150 °F) UG-27(c)(1)

t = P*R / (S*E - 0.60*P) + Corrosion
= 151.73*36 / (20,000*0.85 - 0.60*151.73) + 0
= 0.3231"

Maximum allowable working pressure, (at 150 °F) UG-27(c)(1)

$P = S*E*t / (R + 0.60*t) - P_s$
= 20,000*0.85*0.375 / (36 + 0.60*0.375) - 1.73
= 174.25 psi

Maximum allowable pressure, (at 70 °F) UG-27(c)(1)

P = S*E*t / (R + 0.60*t)
= 20,000*0.85*0.375 / (36 + 0.60*0.375)
= 175.98 psi

% Forming strain - UHA-44(a)(2)

$EFE = (50*t / R_f)*(1 - R_f / R_o)$
$= (50*0.375 / 36.1875)*(1 - 36.1875 / \infty)$
= 0.5181%

Allowable Compressive Stress, Hot and Corroded- S_{cHC}, (table HA-1)

$A = 0.125 / (R_o / t)$
= 0.125 / (36.375 / 0.375)
= 0.001289

B = 9,424 psi

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

S_{cHC} = min(B, S) = 9,424 psi

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

S_{cHN} = S_{cHC}
= 9,424 psi

Allowable Compressive Stress, Cold and New- S_{cCN}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289
B = 9,951 psi
S = 20,000 / 1.00 = 20,000 psi
S_{cCN} = min(B, S) = 9,951 psi

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

S_{cCC} = S_{cCN}
= 9,951 psi

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289
B = 9,424 psi
S = 20,000 / 1.00 = 20,000 psi
S_{cVC} = min(B, S) = 9,424 psi

Straight Flange on Ellipsoidal Head #2

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-240 304 (II-D p. 86, ln. 44)		
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		150	150	-200
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		1.73	48	1
Test horizontal		2.97	82.375	1
Dimensions				
Inner Diameter		72"		
Length		2"		
Nominal Thickness		0.375"		
Corrosion	**Inner**	0"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		**Capacity (US gal)**
New		49.45		35.25
Corroded		49.45		35.25
Radiography				
Longitudinal seam		Seamless No RT		
Left Circumferential seam		Spot UW-11(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)	0.3231"
Maximum allowable working pressure (MAWP)	174.25 psi
Maximum allowable pressure (MAP)	175.98 psi
Rated MDMT	-320 °F

UHA-51 Material Toughness Requirements
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Design thickness, (at 150 °F) UG-27(c)(1)

t = P*R / (S*E - 0.60*P) + Corrosion
= 151.73*36 / (20,000*0.85 - 0.60*151.73) + 0
= 0.3231"

Maximum allowable working pressure, (at 150 °F) UG-27(c)(1)

P = S*E*t / (R + 0.60*t) - P_s
= 20,000*0.85*0.375 / (36 + 0.60*0.375) - 1.73
= 174.25 psi

Maximum allowable pressure, (at 70 °F) UG-27(c)(1)

P = S*E*t / (R + 0.60*t)
= 20,000*0.85*0.375 / (36 + 0.60*0.375)
= 175.98 psi

% Forming strain - UHA-44(a)(2)

EFE = $(50*t / R_f)*(1 - R_f / R_o)$
= $(50*0.375 / 36.1875)*(1 - 36.1875 / \infty)$
= 0.5181%

Allowable Compressive Stress, Hot and Corroded- S_{cHC}, (table HA-1)

A = $0.125 / (R_o / t)$
= 0.125 / (36.375 / 0.375)
= 0.001289
B = 9,424 psi
S = 20,000 / 1.00 = 20,000 psi
S_{cHC} = min(B, S) = 9,424 psi

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

S_{cHN} = S_{cHC}
= 9,424 psi

Allowable Compressive Stress, Cold and New- S_{cCN}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289
B = 9,951 psi
S = 20,000 / 1.00 = 20,000 psi
S_{cCN} = min(B, S) = 9,951 psi

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

S_{cCC} = S_{cCN}
= 9,951 psi

Allowable Compressive Stress, Vacuum and Corroded- S_{cVC}, (table HA-1)

A = 0.125 / (R_o / t)
= 0.125 / (36.375 / 0.375)
= 0.001289
B = 9,424 psi
S = 20,000 / 1.00 = 20,000 psi
S_{cVC} = min(B, S) = 9,424 psi

Ellipsoidal Head #2

ASME Section VIII Division 1, 2015 Edition				
Component		Ellipsoidal Head		
Material		SA-240 304 (II-D p. 86, ln. 44)		
Attached To		Cylinder #3		
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		150	150	-200
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		1.73	48	1
Test horizontal		2.97	82.375	1
Dimensions				
Inner Diameter		72"		
Head Ratio		2		
Minimum Thickness		0.33"		
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		626.9		246.76
Corroded		626.9		246.76
Radiography				
Category A joints		Seamless No RT		
Head to shell seam		Spot UW-11(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)	0.3217"
Maximum allowable working pressure (MAWP)	153.96 psi
Maximum allowable pressure (MAP)	155.69 psi
Straight Flange governs MDMT	-320°F

Design thickness for internal pressure, (Corroded at 150 °F) UG-32(c)(1)

t = P*D / (2*S*E - 0.2*P) + Corrosion
= 151.73*72 / (2*20,000*0.85 - 0.2*151.73) + 0
= 0.3216"

Maximum allowable working pressure, (Corroded at 150 °F) UG-32(c)(1)

P = 2*S*E*t / (D + 0.2*t) - P_s
= 2*20,000*0.85*0.33 / (72 +0.2*0.33) - 1.73
= 153.96 psi

Maximum allowable pressure, (New at 70 °F) UG-32(c)(1)

P = 2*S*E*t / (D + 0.2*t) - P_s
= 2*20,000*0.85*0.33 / (72 +0.2*0.33) - 0
= 155.69 psi

% Forming strain - UHA-44(a)(2)

EFE = $(75*t / R_f)*(1 - R_f / R_o)$
= (75*0.375 / 12.4275)*(1 - 12.4275 / ∞)
= 2.2631%

Saddle #1

ASME Section VIII Division 1, 2015 Edition		
Saddle Material		
Saddle Construction	Web at edge of rib	
Welded to Vessel	Yes	
Saddle Allowable Stress, S_s	20,000 psi	
Saddle Yield Stress, S_y	38,000 psi	
Foundation Allowable Stress	1,658 psi	
Design Pressure	**Left Saddle**	**Right Saddle**
Operating	155.69 psi	
Test	203.12 psi	
Dimensions		
Right saddle distance to datum	18"	
Tangent To Tangent Length, L	292"	
Saddle separation, L_s	240"	
Vessel Radius, R	36.375"	
Tangent Distance Left, A_l	26"	
Tangent Distance Right, A_r	26"	
Saddle Height, H_s	60"	
Saddle Contact Angle, θ	124°	
Web Plate Thickness, t_s	0.5"	
Base Plate Length, E	66"	
Base Plate Width, F	7"	
Base Plate Thickness, t_b	0.625"	
Number of Stiffening Ribs, n	4	
Largest Stiffening Rib Spacing, d_i	21.5417"	
Stiffening Rib Thickness, t_w	0.5"	
Saddle Width, b	6"	
Bolting		
Material	Grade 36	
Bolt Allowable Shear	15,000 psi	
Description	2.25" series 8 threaded	
Corrosion on root	0"	
Anchor Bolts per Saddle	2	

Base coefficient of friction, μ	0.45	
Weight		
	Operating, Corroded	**Hydrotest**
Weight on Left Saddle	20,875 lb	27,649 lb
Weight on Right Saddle	20,823 lb	27,555 lb
Weight of Saddle Pair	906 lb	

Notes

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

Stress Summary

Load	Condition	Saddle	Bending + pressure between saddles (psi)				Bending + pressure at the saddle (psi)			
			S_1 (+)	allow (+)	S_1 (-)	allow (-)	S_2 (+)	allow (+)	S_2 (-)	allow (-)
Seismic	Operating	Right Saddle	8,322	20,400	849	11,308	7,814	24,000	341	11,308
		Left Saddle					7,814	24,000	341	11,308
Wind	Operating	Right Saddle	8,100	20,400	627	11,308	7,782	24,000	309	11,308
		Left Saddle					7,782	24,000	309	11,308
	Test	Right Saddle	10,534	22,950	785	11,941	10,159	27,000	409	11,941
		Left Saddle					10,159	27,000	409	11,941
Weight	Operating	Right Saddle	8,054	17,000	581	9,424	7,782	20,000	309	9,424
		Left Saddle					7,782	20,000	309	9,424

Stress Summary

Load	Condition	Saddle	Tangential shear (psi)		Circumferential stress (psi)		Stress over saddle (psi)		Splitting (psi)	
			S_3	allow	S_4 (horns)	allow (+/-)	S_5	allow	S_6	allow
Seismic	Operating	Right Saddle	2,032	16,000	-10,950	30,000	9,670	13,350	1,059	13,333
		Left Saddle	2,038	16,000	-10,977	30,000	9,694	13,350	1,061	13,333
Wind	Operating	Right Saddle	1,424	16,000	-8,086	30,000	7,140	13,350	782	13,333
		Left Saddle	1,428	16,000	-8,104	30,000	7,157	13,350	784	13,333
	Test	Right Saddle	1,750	21,600	-10,106	27,000	8,925	27,000	977	34,200
		Left Saddle	1,757	21,600	-10,140	27,000	8,955	27,000	980	34,200
Weight	Operating	Right Saddle	1,289	16,000	-7,488	30,000	6,613	13,350	724	13,333
		Left Saddle	1,293	16,000	-7,507	30,000	6,629	13,350	726	13,333

Seismic base shear on vessel

Vessel is assumed to be a rigid structure.

Method of seismic analysis	ASCE 7-10 ground supported
Vertical seismic accelerations considered	Yes
Importance factor, I_e	1.25
Site Class	D
Short period spectral response acceleration as percent of g, S_s	100
From Table 11.4-1, F_a	1.1
Risk Category (Table 1.5-1)	III

Equations

$S_{MS} = F_a{*}S_s$

$S_{DS} = (2 / 3){*}S_{MS}$

$F_p = 0.3{*}S_{DS}{*}W{*}I_e{*}0.7$

Results

$S_{MS} = 1.1{*}1$	1.1
$S_{DS} = (2 / 3){*}1.1$	0.7333
Seismic Design Category (Section 11.6)	D
$F_p = 0.3{*}0.7333{*}41{,}698{*}1.25{*}0.7$	8,026.87 lb_f

Saddle reactions due to weight + seismic

V_v = vertical seismic force acting on the saddle

V = horizontal seismic shear acting on the saddle (worst case if not slotted)

Seismic longitudinal reaction, Q_l

Seismic transverse reaction, Q_t

Equations

$Q_l = V*H_s / L_s + V_v$

$Q_t = V*H_s / (R_o*\text{Sin}(\theta / 2)) + V_v$

$Q = W + \max[Q_t , Q_l]$

Results

Operating	Right Saddle	$Q_l = 8{,}026.87*60 / 240 + 0.14*0.7333*20{,}823$	4,144.54 lb_f
		$Q_t = 4{,}008.43*60 / (36.375*\text{Sin}(124 / 2)) + 0.14*0.7333*20{,}823$	9,626.2 lb_f
		$Q = 20{,}823 + \max[9{,}626.2 , 4{,}144.54]$	30,449.2 lb_f
	Left Saddle	$Q_l = 8{,}026.87*60 / 240 + 0.14*0.7333*20{,}875$	4,149.88 lb_f
		$Q_t = 4{,}018.44*60 / (36.375*\text{Sin}(124 / 2)) + 0.14*0.7333*20{,}875$	9,650.24 lb_f
		$Q = 20{,}875 + \max[9{,}650.24 , 4{,}149.88]$	30,525.24 lb_f

Saddle reactions due to weight + wind			
Wind longitudinal reaction, Q_l			
Wind transverse reaction, Q_t			
Wind pressure, P_w			17.8372 psf
Equations			
$V_{wt} = P_w*G*(C_{f(shell)}*(\text{Projected shell area}) + C_{f(saddle)}*(\text{Projected saddle area}))$			
$V_{we} = P_w*G*(C_{f(shell)}*\pi*R_o^2 / 144 + C_{f(saddle)}*(\text{Projected saddle area}))$			
$Q_t = V_{wt}*H_s / (R_o*\text{Sin}(\theta / 2))$			
$Q_l = V_{we}*H_s / L_s$			
$Q = W + \max[Q_t , Q_l]$			
Results			
Operating	Right Saddle	$V_{wt} = 17.84*0.85*(0.7*80.9592 + 2*0.9844)$	889.08 lb_f
		$V_{we} = 17.84*0.85*(0.5*\pi*36.375^2 / 144 + 2*13.5623)$	630.08 lb_f
		$Q_t = 889.08*60 / (36.375*\text{Sin}(124 / 2))$	1,660.94 lb_f
		$Q_l = 630.08*60 / 240$	157.52 lb_f
		Q = 20,823 + max[1,660.94 , 157.52]	22,483.94 lb_f
	Left Saddle	$V_{wt} = 17.84*0.85*(0.7*80.9592 + 2*0.9844)$	889.08 lb_f
		$V_{we} = 17.84*0.85*(0.5*\pi*36.375^2 / 144 + 2*13.5623)$	630.08 lb_f
		$Q_t = 889.08*60 / (36.375*\text{Sin}(124 / 2))$	1,660.94 lb_f
		$Q_l = 630.08*60 / 240$	157.52 lb_f
		Q = 20,875 + max[1,660.94 , 157.52]	22,535.94 lb_f
Test	Right Saddle	$V_{wt} = 5.89*0.85*(0.7*80.9592 + 2*0.9844)$	293.4 lb_f
		$V_{we} = 5.89*0.85*(0.5*\pi*36.375^2 / 144 + 2*13.5623)$	207.93 lb_f
		$Q_t = 293.4*60 / (36.375*\text{Sin}(124 / 2))$	548.11 lb_f
		$Q_l = 207.93*60 / 240$	51.98 lb_f
		Q = 27,555 + max[548.11 , 51.98]	28,103.11 lb_f
	Left Saddle	$V_{wt} = 5.89*0.85*(0.7*80.9592 + 2*0.9844)$	293.4 lb_f
		$V_{we} = 5.89*0.85*(0.5*\pi*36.375^2 / 144 + 2*13.5623)$	207.93 lb_f
		$Q_t = 293.4*60 / (36.375*\text{Sin}(124 / 2))$	548.11 lb_f
		$Q_l = 207.93*60 / 240$	51.98 lb_f
		Q = 27,649 + max[548.11 , 51.98]	28,197.11 lb_f

Load Case 1: Seismic, Operating

Longitudinal stress between saddles (Seismic, Operating, left saddle loading and geometry govern)

$S_1 = \pm 3*K_1*Q*(L / 12) / (\pi*R^2*t)$
$= 3*0.588*30{,}525.24*(292 / 12) / (\pi*36.1875^2*0.375)$
= 849 psi

$S_p = P*R / (2*t)$
= 155.69*36 / (2*0.375)
= 7,473 psi

Maximum tensile stress $S_{1t} = S_1 + S_p$ = 8,322 psi
Maximum compressive stress (shut down) $S_{1c} = S_1$ = 849 psi

Tensile stress is acceptable (<=1.2*S*E = 20,400 psi)
Compressive stress is acceptable (<=1.2*S_c = 11,308 psi)

Longitudinal stress at the right saddle (Seismic, Operating)

L_e = 2*(Left head depth) / 3 + L + 2*(Right head depth) / 3
= 2*18.33 / 3 + 292 + 2*18.33 / 3
= 316.44 in

Seismic vertical acceleration coefficient m = 0.5333*0.1925 = 0.1027

$w = W_t*(1 + m) / L_e$ = 41,698*(1 + 0.1027) / 316.44 = 145.3 lb_f/in

Bending moment at the right saddle:

$M_q = w*(2*H*A_r / 3 + A_r^2 / 2 - (R^2 - H^2) / 4)$
$= 145.3*(2*18.33*26 / 3 + 26^2 / 2 - (36.375^2 - 18.33^2) / 4)$
= 59,418.2 lb_f-in

$S_2 = \pm M_q*K_1' / (\pi*R^2*t)$
$= 59{,}418.2*8.8457 / (\pi*36.1875^2*0.375)$
= 341 psi

$S_p = P*R / (2*t)$
= 155.69*36 / (2*0.375)
= 7,473 psi

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 7,814 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 341 psi

Tensile stress is acceptable (<=1.2*S = 24,000 psi)
Compressive stress is acceptable (<=1.2*S_c = 11,308 psi)

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

$Q_{shear} = Q - w*(a + 2*H / 3)$
= 30,449.2 - 145.3*(26 + 2*18.33 / 3)
= 24,895.8 lb_f

$S_3 = K_{2.2}*Q_{shear} / (R*t)$
= 1.1076*24,895.8 / (36.1875*0.375)
= 2,032 psi

Tangential shear stress is acceptable (<= 0.8*S = 16,000 psi)

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

S_4 = -Q / (4*t*(b+1.56*Sqr(R_o*t))) - 3*K_3*Q / (2*t^2)
= -30,449.2 / (4*0.375*(6+1.56*Sqr(36.375*0.375))) - 3*0.0284*30,449.2 / (2*0.375^2)
= -10,950 psi

Circumferential stress at saddle horns is acceptable (<=1.5*S_a = 30,000 psi)

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

S_5 = K_5*Q / (t*(t_s + 1.56*Sqr(R_o*t_c)))
= 0.7457*30,449.2 / (0.375*(0.5 + 1.56*Sqr(36.375*0.375)))
= 9,670 psi

Ring compression in shell is acceptable (<= 0.5*S_y = 13,350 psi)

Saddle splitting load (right, Seismic, Operating)

Area resisting splitting force = Web area + wear plate area

A_e = H_{eff}*t_s + t_p*W_p
= 12.125*0.5 + 0*0
= 6.0625 in^2

S_6 = K_8*Q / A_e
= 0.2108*30,449.2 / 6.0625
= 1,059 psi

Stress in saddle is acceptable (<= (2 / 3)*S_s = 13,333 psi)

Longitudinal stress at the left saddle (Seismic, Operating)

L_e = 2*(Left head depth) / 3 + L + 2*(Right head depth) / 3
= 2*18.33 / 3 + 292 + 2*18.33 / 3
= 316.44 in

Seismic vertical acceleration coefficient m = 0.5333*0.1925 = 0.1027

w = W_t*(1 + m) / L_e = 41,698*(1 + 0.1027) / 316.44 = 145.3 lb_f/in

Bending moment at the left saddle:

M_q = w*(2*H*A_l / 3 + A_l^2 / 2 - (R^2 - H^2) / 4)
= 145.3*(2*18.33*26 / 3 + 26^2 / 2 - (36.375^2 - 18.33^2) / 4)
= 59,418.2 lb_f-in

S_2 = ± M_q*K_1' / (π*R^2*t)
= 59,418.2*8.8457 / (π*36.1875^2*0.375)
= 341 psi

S_p = P*R / (2*t)
= 155.69*36 / (2*0.375)
= 7,473 psi

Maximum tensile stress S_{2t} = S_2 + S_p = 7,814 psi
Maximum compressive stress (shut down) S_{2c} = S_2 = 341 psi

Tensile stress is acceptable (<=1.2*S = 24,000 psi)

Compressive stress is acceptable ($<=1.2*S_c = 11{,}308$ psi)

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

Q_{shear} = Q - w*(a + 2*H / 3)
= 30,525.24 - 145.3*(26 + 2*18.33 / 3)
= 24,971.84 lb_f

$S_3 = K_{2.2}*Q_{shear}$ / (R*t)
= 1.1076*24,971.84 / (36.1875*0.375)
= 2,038 psi

Tangential shear stress is acceptable (<= 0.8*S = 16,000 psi)

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

$S_4 = -Q / (4*t*(b+1.56*Sqr(R_o*t))) - 3*K_3*Q / (2*t^2)$
= -30,525.24 / (4*0.375*(6+1.56*Sqr(36.375*0.375))) - 3*0.0284*30,525.24 / (2*0.375^2)
= -10,977 psi

Circumferential stress at saddle horns is acceptable ($<=1.5*S_a$ = 30,000 psi)

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

$S_5 = K_5*Q / (t*(t_s + 1.56*Sqr(R_o*t_c)))$
= 0.7457*30,525.24 / (0.375*(0.5 + 1.56*Sqr(36.375*0.375)))
= 9,694 psi

Ring compression in shell is acceptable ($<= 0.5*S_y$ = 13,350 psi)

Saddle splitting load (left, Seismic, Operating)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff}*t_s + t_p*W_p$
= 12.125*0.5 + 0*0
= 6.0625 in^2

$S_6 = K_8*Q / A_e$
= 0.2108*30,525.24 / 6.0625
= 1,061 psi

Stress in saddle is acceptable ($<= (2 / 3)*S_s$ = 13,333 psi)

Load Case 2: Wind, Operating

Longitudinal stress between saddles (Wind, Operating, left saddle loading and geometry govern)

$S_1 = \pm 3*K_1*Q*(L / 12) / (\pi*R^2*t)$
= 3*0.588*22,535.94*(292 / 12) / (π*36.1875^2*0.375)
= 627 psi

S_p = P*R / (2*t)
= 155.69*36 / (2*0.375)
= 7,473 psi

Maximum tensile stress $S_{1t} = S_1 + S_p$ = 8,100 psi

Maximum compressive stress (shut down) $S_{1c} = S_1$ = 627 psi

Tensile stress is acceptable (<=1.2*S*E = 20,400 psi)
Compressive stress is acceptable (<=1.2*S_c = 11,308 psi)

Longitudinal stress at the right saddle (Wind, Operating)

L_e = 2*(Left head depth) / 3 + L + 2*(Right head depth) / 3
= 2*18.33 / 3 + 292 + 2*18.33 / 3
= 316.44 in

w = W_t / L_e = 41,698 / 316.44 = 131.77 lb_f/in

Bending moment at the right saddle:

M_q = w*(2*H*A_r / 3 + A_r^2 / 2 - (R^2 - H^2) / 4)
= 131.77*(2*18.33*26 / 3 + 26^2 / 2 - (36.375^2 - 18.33^2) / 4)
= 53,885.9 lb_f-in

S_2 = ± M_q*K_1' / (π*R^2*t)
= 53,885.9*8.8457 / (π*36.1875^2*0.375)
= 309 psi

S_p = P*R / (2*t)
= 155.69*36 / (2*0.375)
= 7,473 psi

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 7,782 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 309 psi

Tensile stress is acceptable (<=1.2*S = 24,000 psi)
Compressive stress is acceptable (<=1.2*S_c = 11,308 psi)

Tangential shear stress in the shell (right saddle, Wind, Operating)

Q_{shear} = Q - w*(a + 2*H / 3)
= 22,483.94 - 131.77*(26 + 2*18.33 / 3)
= 17,447.6 lb_f

S_3 = $K_{2.2}$*Q_{shear} / (R*t)
= 1.1076*17,447.6 / (36.1875*0.375)
= 1,424 psi

Tangential shear stress is acceptable (<= 0.8*S = 16,000 psi)

Circumferential stress at the right saddle horns (Wind, Operating)

S_4 = -Q / (4*t*(b+1.56*Sqr(R_o*t))) - 3*K_3*Q / (2*t^2)
= -22,483.94 / (4*0.375*(6+1.56*Sqr(36.375*0.375))) - 3*0.0284*22,483.94 / (2*0.375^2)
= -8,086 psi

Circumferential stress at saddle horns is acceptable (<=1.5*S_a = 30,000 psi)

Ring compression in shell over right saddle (Wind, Operating)

S_5 = K_5*Q / (t*(t_s + 1.56*Sqr(R_o*t_c)))
= 0.7457*22,483.94 / (0.375*(0.5 + 1.56*Sqr(36.375*0.375)))

= 7,140 psi

Ring compression in shell is acceptable (<= 0.5*S_y = 13,350 psi)

Saddle splitting load (right, Wind, Operating)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff}*t_s + t_p*W_p$
= 12.125*0.5 + 0*0
= 6.0625 in^2

$S_6 = K_8*Q / A_e$
= 0.2108*22,483.94 / 6.0625
= 782 psi

Stress in saddle is acceptable (<= (2 / 3)*S_s = 13,333 psi)

Longitudinal stress at the left saddle (Wind, Operating)

L_e = 2*(Left head depth) / 3 + L + 2*(Right head depth) / 3
= 2*18.33 / 3 + 292 + 2*18.33 / 3
= 316.44 in

w = W_t / L_e = 41,698 / 316.44 = 131.77 lb_f/in

Bending moment at the left saddle:

$M_q = w*(2*H*A_l / 3 + A_l^2 / 2 - (R^2 - H^2) / 4)$
= 131.77*(2*18.33*26 / 3 + 26^2 / 2 - (36.375^2 - 18.33^2) / 4)
= 53,885.9 lb_f-in

$S_2 = \pm M_q*K_1' / (\pi*R^2*t)$
= 53,885.9*8.8457 / (π*36.1875^2*0.375)
= 309 psi

$S_p = P*R / (2*t)$
= 155.69*36 / (2*0.375)
= 7,473 psi

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 7,782 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 309 psi

Tensile stress is acceptable (<=1.2*S = 24,000 psi)
Compressive stress is acceptable (<=1.2*S_c = 11,308 psi)

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

$Q_{shear} = Q - w*(a + 2*H / 3)$
= 22,535.94 - 131.77*(26 + 2*18.33 / 3)
= 17,499.6 lb_f

$S_3 = K_{2.2}*Q_{shear} / (R*t)$
= 1.1076*17,499.6 / (36.1875*0.375)
= 1,428 psi

Tangential shear stress is acceptable (<= 0.8*S = 16,000 psi)

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

S_4 = -Q / (4*t*(b+1.56*Sqr(R_o*t))) - 3*K_3*Q / (2*t^2)
= -22,535.94 / (4*0.375*(6+1.56*Sqr(36.375*0.375))) - 3*0.0284*22,535.94 / (2*0.375^2)
= -8,104 psi

Circumferential stress at saddle horns is acceptable (<=1.5*S_a = 30,000 psi)

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

S_5 = K_5*Q / (t*(t_s + 1.56*Sqr(R_o*t_c)))
= 0.7457*22,535.94 / (0.375*(0.5 + 1.56*Sqr(36.375*0.375)))
= 7,157 psi

Ring compression in shell is acceptable (<= 0.5*S_y = 13,350 psi)

Saddle splitting load (left, Wind, Operating)

Area resisting splitting force = Web area + wear plate area

A_e = H_{eff}*t_s + t_p*W_p
= 12.125*0.5 + 0*0
= 6.0625 in^2

S_6 = K_8*Q / A_e
= 0.2108*22,535.94 / 6.0625
= 784 psi

Stress in saddle is acceptable (<= (2 / 3)*S_s = 13,333 psi)

Load Case 3: Wind, Test

Longitudinal stress between saddles (Wind, Test, left saddle loading and geometry govern)

S_1 = ± 3*K_1*Q*(L / 12) / (π*R^2*t)
= 3*0.588*28,197.11*(292 / 12) / (π*36.1875^2*0.375)
= 785 psi

S_p = P*R / (2*t)
= 203.12*36 / (2*0.375)
= 9,750 psi

Maximum tensile stress S_{1t} = S_1 + S_p = 10,534 psi
Maximum compressive stress (shut down) S_{1c} = S_1 = 785 psi

Tensile stress is acceptable (<= 0.9*S_y*E = 22,950 psi)
Compressive stress is acceptable (<=1.2*S_c = 11,941 psi)

Longitudinal stress at the right saddle (Wind, Test)

L_e = 2*(Left head depth) / 3 + L + 2*(Right head depth) / 3
= 2*18.33 / 3 + 292 + 2*18.33 / 3
= 316.44 in

w = W_t / L_e = 55,204 / 316.44 = 174.45 lb_f/in

Bending moment at the right saddle:

$M_q = w*(2*H*A_r / 3 + A_r^2 / 2 - (R^2 - H^2) / 4)$
$= 174.45*(2*18.33*26 / 3 + 26^2 / 2 - (36.375^2 - 18.33^2) / 4)$
$= 71{,}339.5\ lb_f\text{-}in$

$S_2 = \pm M_q*K_1' / (\pi*R^2*t)$
$= 71{,}339.5*8.8457 / (\pi*36.1875^2*0.375)$
$= 409$ psi

$S_p = P*R / (2*t)$
$= 203.12*36 / (2*0.375)$
$= 9{,}750$ psi

Maximum tensile stress $S_{2t} = S_2 + S_p =$ 10,159 psi
Maximum compressive stress (shut down) $S_{2c} = S_2 =$ 409 psi

Tensile stress is acceptable (<= $0.9*S_y$ = 27,000 psi)
Compressive stress is acceptable (<=$1.2*S_c$ = 11,941 psi)

Tangential shear stress in the shell (right saddle, Wind, Test)

$Q_{shear} = Q - w*(a + 2*H / 3)$
$= 28{,}103.11 - 174.45*(26 + 2*18.33 / 3)$
$= 21{,}435.5\ lb_f$

$S_3 = K_{2.2}*Q_{shear} / (R*t)$
$= 1.1076*21{,}435.5 / (36.1875*0.375)$
= 1,750 psi

Tangential shear stress is acceptable (<= $0.8*(0.9*S_y)$ = 21,600 psi)

Circumferential stress at the right saddle horns (Wind, Test)

$S_4 = -Q / (4*t*(b+1.56*Sqr(R_o*t))) - 3*K_3*Q / (2*t^2)$
$= -28{,}103.11 / (4*0.375*(6+1.56*Sqr(36.375*0.375))) - 3*0.0284*28{,}103.11 / (2*0.375^2)$
= -10,106 psi

Circumferential stress at saddle horns is acceptable (<= $0.9*S_y$ = 27,000 psi)

Ring compression in shell over right saddle (Wind, Test)

$S_5 = K_5*Q / (t*(t_s + 1.56*Sqr(R_o*t_c)))$
$= 0.7457*28{,}103.11 / (0.375*(0.5 + 1.56*Sqr(36.375*0.375)))$
= 8,925 psi

Ring compression in shell is acceptable (<= $0.9*S_y$ = 27,000 psi)

Saddle splitting load (right, Wind, Test)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff}*t_s + t_p*W_p$
$= 12.125*0.5 + 0*0$
$= 6.0625\ in^2$

$S_6 = K_8*Q / A_e$

= 0.2108*28,103.11 / 6.0625
= 977 psi

Stress in saddle is acceptable (<= 0.9*S_y = 34,200 psi)

Longitudinal stress at the left saddle (Wind, Test)

L_e = 2*(Left head depth) / 3 + L + 2*(Right head depth) / 3
= 2*18.33 / 3 + 292 + 2*18.33 / 3
= 316.44 in

w = W_t / L_e = 55,204 / 316.44 = 174.45 lb_f/in

Bending moment at the left saddle:

M_q = w*(2*H*A_l / 3 + A_l^2 / 2 - (R^2 - H^2) / 4)
= 174.45*(2*18.33*26 / 3 + 26^2 / 2 - (36.375^2 - 18.33^2) / 4)
= 71,339.5 lb_f-in

S_2 = ± M_q*K_1' / (π*R^2*t)
= 71,339.5*8.8457 / (π*36.1875^2*0.375)
= 409 psi

S_p = P*R / (2*t)
= 203.12*36 / (2*0.375)
= 9,750 psi

Maximum tensile stress S_{2t} = S_2 + S_p = 10,159 psi
Maximum compressive stress (shut down) S_{2c} = S_2 = 409 psi

Tensile stress is acceptable (<= 0.9*S_y = 27,000 psi)
Compressive stress is acceptable (<=1.2*S_c = 11,941 psi)

Tangential shear stress in the shell (left saddle, Wind, Test)

Q_{shear} = Q - w*(a + 2*H / 3)
= 28,197.11 - 174.45*(26 + 2*18.33 / 3)
= 21,529.5 lb_f

S_3 = $K_{2.2}$*Q_{shear} / (R*t)
= 1.1076*21,529.5 / (36.1875*0.375)
= 1,757 psi

Tangential shear stress is acceptable (<= 0.8*(0.9*S_y) = 21,600 psi)

Circumferential stress at the left saddle horns (Wind, Test)

S_4 = -Q / (4*t*(b+1.56*Sqr(R_o*t))) - 3*K_3*Q / (2*t^2)
= -28,197.11 / (4*0.375*(6+1.56*Sqr(36.375*0.375))) - 3*0.0284*28,197.11 / (2*0.375^2)
= -10,140 psi

Circumferential stress at saddle horns is acceptable (<= 0.9*S_y = 27,000 psi)

Ring compression in shell over left saddle (Wind, Test)

S_5 = K_5*Q / (t*(t_s + 1.56*Sqr(R_o*t_c)))
= 0.7457*28,197.11 / (0.375*(0.5 + 1.56*Sqr(36.375*0.375)))

= 8,955 psi

Ring compression in shell is acceptable (<= 0.9*S_y = 27,000 psi)

Saddle splitting load (left, Wind, Test)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff}*t_s + t_p*W_p$
= 12.125*0.5 + 0*0
= 6.0625 in^2

$S_6 = K_8*Q / A_e$
= 0.2108*28,197.11 / 6.0625
= 980 psi

Stress in saddle is acceptable (<= 0.9*S_y = 34,200 psi)

Load Case 4: Weight, Operating

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

$S_1 = \pm 3*K_1*Q*(L / 12) / (\pi*R^2*t)$
= 3*0.588*20,875*(292 / 12) / (π*36.1875^2*0.375)
= 581 psi

$S_p = P*R / (2*t)$
= 155.69*36 / (2*0.375)
= 7,473 psi

Maximum tensile stress $S_{1t} = S_1 + S_p$ = 8,054 psi
Maximum compressive stress (shut down) $S_{1c} = S_1$ = 581 psi

Tensile stress is acceptable (<=1*S*E = 17,000 psi)
Compressive stress is acceptable (<=1*S_c = 9,424 psi)

Longitudinal stress at the right saddle (Weight, Operating)

L_e = 2*(Left head depth) / 3 + L + 2*(Right head depth) / 3
= 2*18.33 / 3 + 292 + 2*18.33 / 3
= 316.44 in

$w = W_t / L_e$ = 41,698 / 316.44 = 131.77 lb_f/in

Bending moment at the right saddle:

$M_q = w*(2*H*A_r / 3 + A_r^2 / 2 - (R^2 - H^2) / 4)$
= 131.77*(2*18.33*26 / 3 + 26^2 / 2 - (36.375^2 - 18.33^2) / 4)
= 53,885.9 lb_f-in

$S_2 = \pm M_q*K_1' / (\pi*R^2*t)$
= 53,885.9*8.8457 / (π*36.1875^2*0.375)
= 309 psi

$S_p = P*R / (2*t)$
= 155.69*36 / (2*0.375)
= 7,473 psi

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 7,782 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 309 psi

Tensile stress is acceptable (<=1*S = 20,000 psi)
Compressive stress is acceptable (<=1*S_c = 9,424 psi)

Tangential shear stress in the shell (right saddle, Weight, Operating)

Q_{shear} = Q - w*(a + 2*H / 3)
= 20,823 - 131.77*(26 + 2*18.33 / 3)
= 15,786.67 lb_f

$S_3 = K_{2.2}$*Q_{shear} / (R*t)
= 1.1076*15,786.67 / (36.1875*0.375)
= 1,289 psi

Tangential shear stress is acceptable (<= 0.8*S = 16,000 psi)

Circumferential stress at the right saddle horns (Weight, Operating)

S_4 = -Q / (4*t*(b+1.56*Sqr(R_o*t))) - 3*K_3*Q / (2*t^2)
= -20,823 / (4*0.375*(6+1.56*Sqr(36.375*0.375))) - 3*0.0284*20,823 / (2*0.375^2)
= -7,488 psi

Circumferential stress at saddle horns is acceptable (<=1.5*S_a = 30,000 psi)

Ring compression in shell over right saddle (Weight, Operating)

$S_5 = K_5$*Q / (t*(t_s + 1.56*Sqr(R_o*t_c)))
= 0.7457*20,823 / (0.375*(0.5 + 1.56*Sqr(36.375*0.375)))
= 6,613 psi

Ring compression in shell is acceptable (<= 0.5*S_y = 13,350 psi)

Saddle splitting load (right, Weight, Operating)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff}$*t_s + t_p*W_p
= 12.125*0.5 + 0*0
= 6.0625 in^2

$S_6 = K_8$*Q / A_e
= 0.2108*20,823 / 6.0625
= 724 psi

Stress in saddle is acceptable (<= (2 / 3)*S_s = 13,333 psi)

Longitudinal stress at the left saddle (Weight, Operating)

L_e = 2*(Left head depth) / 3 + L + 2*(Right head depth) / 3
= 2*18.33 / 3 + 292 + 2*18.33 / 3
= 316.44 in

w = W_t / L_e = 41,698 / 316.44 = 131.77 lb_f/in

Bending moment at the left saddle:

$M_q = w*(2*H*A_l / 3 + A_l^2 / 2 - (R^2 - H^2) / 4)$
$= 131.77*(2*18.33*26 / 3 + 26^2 / 2 - (36.375^2 - 18.33^2) / 4)$
$= 53,885.9$ lb_f-in

$S_2 = \pm M_q*K_1' / (\pi*R^2*t)$
$= 53,885.9*8.8457 / (\pi*36.1875^2*0.375)$
= 309 psi

$S_p = P*R / (2*t)$
= 155.69*36 / (2*0.375)
= 7,473 psi

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 7,782 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 309 psi

Tensile stress is acceptable (<=1*S = 20,000 psi)
Compressive stress is acceptable (<=1*S_c = 9,424 psi)

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

$Q_{shear} = Q - w*(a + 2*H / 3)$
= 20,875 - 131.77*(26 + 2*18.33 / 3)
= 15,838.67 lb_f

$S_3 = K_{2.2}*Q_{shear} / (R*t)$
= 1.1076*15,838.67 / (36.1875*0.375)
= 1,293 psi

Tangential shear stress is acceptable (<= 0.8*S = 16,000 psi)

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

$S_4 = -Q / (4*t*(b+1.56*Sqr(R_o*t))) - 3*K_3*Q / (2*t^2)$
$= -20,875 / (4*0.375*(6+1.56*Sqr(36.375*0.375))) - 3*0.0284*20,875 / (2*0.375^2)$
= -7,507 psi

Circumferential stress at saddle horns is acceptable (<=1.5*S_a = 30,000 psi)

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

$S_5 = K_5*Q / (t*(t_s + 1.56*Sqr(R_o*t_c)))$
= 0.7457*20,875 / (0.375*(0.5 + 1.56*Sqr(36.375*0.375)))
= 6,629 psi

Ring compression in shell is acceptable (<= 0.5*S_y = 13,350 psi)

Saddle splitting load (left, Weight, Operating)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff}*t_s + t_p*W_p$
= 12.125*0.5 + 0*0
= 6.0625 in^2

$S_6 = K_8*Q / A_e$

= 0.2108*20,875 / 6.0625
= 726 psi

Stress in saddle is acceptable (<= (2 / 3)*S_s = 13,333 psi)

Shear stress in anchor bolting, one end slotted

Maximum seismic or wind base shear = 8,026.87 lb_f

Thermal expansion base shear = W*μ = 21,328*0.45 = 9,597.6 lb_f
Corroded root area for a 2.25" series 8 threaded bolt = 3.423 in^2 (2 per saddle)

Bolt shear stress = 9,597.6 / (3.423*1*2) = 1,402 psi

Anchor bolt stress is acceptable (<= 15,000 psi)

Shear stress in anchor bolting, transverse

Maximum seismic or wind base shear = 8,026.87 lb_f
Corroded root area for a 2.25" series 8 threaded bolt = 3.423 in^2 (2 per saddle)

Bolt shear stress = 8,026.87 / (3.423*2*2) = 586 psi

Anchor bolt stress is acceptable (<= 15,000 psi)

Web plate buckling check (Escoe pg 251)

Allowable compressive stress S_c is the lesser of 20,000 or 18,075 psi: (18,075)

$S_c = K_i*\pi^2*E / (12*(1 - 0.3^2)*(d_i / t_s)^2)$
$= 1.28*\pi^2*29E+06 / (12*(1 - 0.3^2)*(21.5417 / 0.5)^2)$
= 18,075 psi

Allowable compressive load on the saddle

$b_e = d_i*t_s / (d_i*t_s + 2*t_w*(b - 1))$
= 21.5417*0.5 / (21.5417*0.5 + 2*0.5*(6 - 1))
= 0.683

$F_b = n*(A_s + 2*b_e*t_s)*S_c$
= 4*(2.75 + 2*0.683*0.5)*18,075
= 248,196.18 lb_f

Saddle loading of 30,978.24 lb_f is <= F_b; satisfactory.

Primary bending + axial stress in the saddle due to end loads (assumes one saddle slotted)
$\sigma_b = V*(H_s - x_o)*y / I + Q / A$
= 8,026.87*(60 - 29.6803)*4.25 / 77.46 + 30,525.24 / 43.1172
= 14,061 psi

The primary bending + axial stress in the saddle <= 20,000 psi; satisfactory.

Secondary bending + axial stress in the saddle due to end loads (includes thermal expansion, assumes one saddle slotted)
$\sigma_b = V*(H_s - x_o)*y / I + Q / A$
= 17,624.47*(60 - 29.6803)*4.25 / 77.46 + 30,525.24 / 43.1172
= 30,028 psi

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

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

where a = 21.5417, b = 6.5 in

$t_b = (\beta_1 * q * b^2 / (1.5 * S_a))^{0.5}$
$= (3*67*6.5^2 / (1.5*20{,}000))^{0.5}$
= 0.5323 in

The base plate thickness of 0.625 in is adequate.

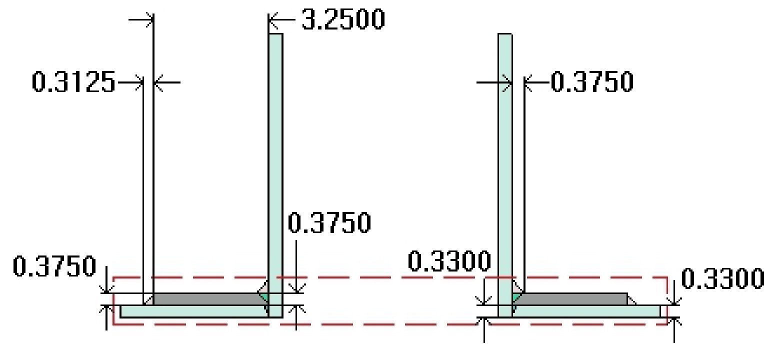
Foundation bearing check

$S_f = Q_{max} / (F*E)$
= 30,978.24 / (7*66)
= 67 psi

Concrete bearing stress ≤ 1,658 psi ; satisfactory.

Inlet (A)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation	
Located on	Ellipsoidal Head #1
Orientation	0°
End of nozzle to datum line	314"
Calculated as hillside	Yes
Distance to head center, R	24"
Passes through a Category A joint	No
Nozzle	
Description	NPS 12 Sch 40S (Std)
Access opening	No
Material specification	SA-312 TP304 Wld & smls pipe (II-D p. 90, ln. 9)
Inside diameter, new	12"
Pipe nominal wall thickness	0.375"
Pipe minimum wall thickness[1]	0.3281"
Corrosion allowance	0"
Opening chord length	13.249"
Projection available outside vessel, Lpr	9.4715"
Projection available outside vessel to flange face, Lf	13.9715"
Local vessel minimum thickness	0.33"
Liquid static head included	0 psi
Longitudinal joint efficiency	0.85
Reinforcing Pad	

Material specification	SA-240 304 (II-D p. 86, ln. 44)
Diameter, D_p	20.5569"
Thickness, t_e	0.375"
Is split	No
Welds	
Inner fillet, Leg_{41}	0.375"
Outer fillet, Leg_{42}	0.3125"
Nozzle to vessel groove weld	0.33"
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 12 Class 150 WN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 352, ln. 20)
Blind included	No
Rated MDMT	-320°F
Liquid static head	0 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(b) Type 1
Notes	
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F	

UHA-51 Material Toughness Requirements Nozzle	
t_r = 153.96*6 / (20,000*0.85 - 0.6*153.96) =	0.0546"
Stress ratio = t_r*E^* / (t_n - c) = 0.0546*0.85 / (0.3281 - 0) =	0.1415
Impact test exempt per UHA-51(g) (coincident ratio = 0.1415)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of -200°F.	

UHA-51 Material Toughness Requirements Pad
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 150 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}
3.5799	4.0123	0.7923	0.5442	--	2.4375	0.2383	0.2702	0.3281

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
56,648.6	64,400	200,942.95	18,646	282,570.16	69,350	196,705.34

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})	0.165	0.2188	weld size is adequate

Calculations for internal pressure 150 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(13.249, 6.6245 + (0.375 - 0) + (0.33 - 0))
= 13.249 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*(0.33 - 0), 2.5*(0.375 - 0) + 0.375)
= 0.825 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 150*6 / (20,000*1 - 0.6*150)
= 0.0452 in

Required thickness t_r from UG-37(a)

t_r = P*D / (2*S*E - 0.2*P)
= 150*72 / (2*20,000*1 - 0.2*150)
= 0.2702"

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*D / (2*S*E - 0.2*P)
= 150*72 / (2*20,000*0.85 - 0.2*150)
= 0.3179"

Area required per UG-37(c)

Allowable stresses: S_n = 20,000, S_v = 20,000, S_p = 20,000 psi

f_{r1} = lesser of 1 or S_n / S_v = 1

f_{r2} = lesser of 1 or S_n / S_v = 1

f_{r3} = lesser of f_{r2} or S_p / S_v = 1

f_{r4} = lesser of 1 or S_p / S_v = 1

A = $d*t_r*F + 2*t_n*t_r*F*(1 - f_{r1})$
= 13.249*0.2702*1 + 2*0.375*0.2702*1*(1 - 1)
= 3.5799 in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= 0.7923 in^2

= $d*(E_1*t - F*t_r) - 2*t_n*(E_1*t - F*t_r)*(1 - f_{r1})$
= 13.249*(1*0.33 - 1*0.2702) - 2*0.375*(1*0.33 - 1*0.2702)*(1 - 1)
= 0.7923 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*(0.33 + 0.375)*(1*0.33 - 1*0.2702) - 2*0.375*(1*0.33 - 1*0.2702)*(1 - 1)
= 0.0843 in^2

A_2 = smaller of the following= 0.5442 in^2

= $5*(t_n - t_{rn})*f_{r2}*t$
= 5*(0.375 - 0.0452)*1*0.33
= 0.5442 in^2

= $2*(t_n - t_{rn})*(2.5*t_n + t_e)*f_{r2}$
= 2*(0.375 - 0.0452)*(2.5*0.375 + 0.375)*1
= 0.8657 in^2

A_{41} = Leg^2*f_{r3}
= 0.375^2*1
= 0.1406 in^2

A_{42} = Leg^2*f_{r4}

= 0.3125^2*1

= 0.0977 in^2

A_5 = $(D_p - d - 2*t_n)*t_e*f_{r4}$

= (20.5569 - 14.0569)*0.375*1

= 2.4375 in^2

Area = $A_1 + A_2 + A_{41} + A_{42} + A_5$

= 0.7923 + 0.5442 + 0.1406 + 0.0977 + 2.4375

= 4.0123 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 $0.7*t_{min}$ = 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 = 0.33 in

$t_{w(min)}$ = $0.5*t_{min}$ = 0.165 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.

$t_{a\ UG\text{-}27}$ = $P*R_n / (S_n*E - 0.6*P)$ + Corrosion

= 150*6 / (20,000*0.85 - 0.6*150) + 0

= 0.0532 in

t_a = max[$t_{a\ UG\text{-}27}$, $t_{a\ UG\text{-}22}$]

= max[0.0532 , 0]

= 0.0532 in

t_{b1} = 0.2702 in

t_{b1} = max[t_{b1} , $t_{b\ UG16}$]

= max[0.2702 , 0.0625]

= 0.2702 in

t_b = min[t_{b3} , t_{b1}]

= min[0.3281 , 0.2702]

= 0.2702 in

$t_{UG\text{-}45}$ = max[t_a , t_b]
= max[0.0532 , 0.2702]
= 0.2702 in

Available nozzle wall thickness new, t_n = 0.875*0.375 = 0.3281 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*20,000 =	14,000 psi
Inner fillet weld in shear:	0.49*20,000 =	9,800 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
(π / 2)*Nozzle OD*Leg*S_i = (π / 2)*12.75*0.375*9,800 = 73,601.63 lb_f

(2) Outer fillet weld in shear
(π / 2)*Pad OD*Leg*S_o = (π / 2)*20.5569*0.3125*9,800 = 98,890.28 lb_f

(3) Nozzle wall in shear
(π / 2)*Mean nozzle dia*t_n*S_n = (π / 2)*12.375*0.375*14,000 = 102,052.67 lb_f

(4) Groove weld in tension
(π / 2)*Nozzle OD*t_w*S_g = (π / 2)*12.75*0.33*14,800 = 97,815.06 lb_f

(6) Upper groove weld in tension
(π / 2)*Nozzle OD*t_w*S_g = (π / 2)*12.75*0.375*14,800 = 111,153.47 lb_f

Loading on welds per UG-41(b)(1)

W = $(A - A_1 + 2*t_n*f_{r1}*(E_1*t - F*t_r))*S_v$
= (3.5799 - 0.7923 + 2*0.375*1*(1*0.33 - 1*0.2702))*20,000
= 56,648.6 lb_f

$W_{1\text{-}1}$ = $(A_2 + A_5 + A_{41} + A_{42})*S_v$
= (0.5442 + 2.4375 + 0.1406 + 0.0977)*20,000
= 64,400 lb_f

$W_{2\text{-}2}$ = $(A_2 + A_3 + A_{41} + A_{43} + 2*t_n*t*f_{r1})*S_v$
= (0.5442 + 0 + 0.1406 + 0 + 2*0.375*0.33*1)*20,000
= 18,646 lb_f

$W_{3\text{-}3}$ = $(A_2 + A_3 + A_5 + A_{41} + A_{42} + A_{43} + 2*t_n*t*f_{r1})*S_v$
= (0.5442 + 0 + 2.4375 + 0.1406 + 0.0977 + 0 + 2*0.375*0.33*1)*20,000

= 69,350 lb_f

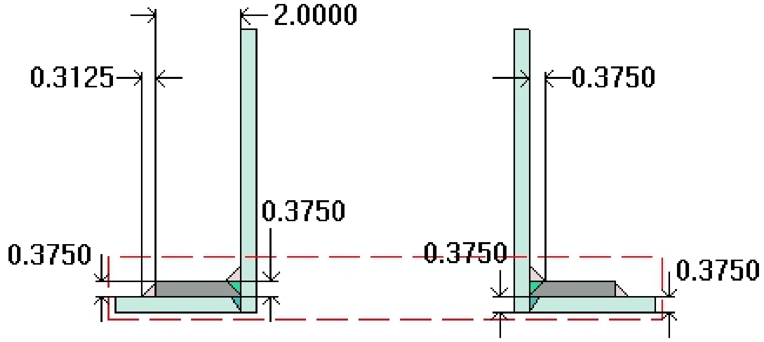
Load for path 1-1 lesser of W or W_{1-1} = 56,648.6 lb_f
Path 1-1 through (2) & (3) = 98,890.28 + 102,052.67 = 200,942.95 lb_f
Path 1-1 is stronger than W so it is acceptable per UG-41(b)(2).

Load for path 2-2 lesser of W or W_{2-2} = 18,646 lb_f
Path 2-2 through (1), (4), (6) = 73,601.63 + 97,815.06 + 111,153.47 = 282,570.16 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} = 56,648.6 lb_f
Path 3-3 through (2), (4) = 98,890.28 + 97,815.06 = 196,705.34 lb_f
Path 3-3 is stronger than W so it is acceptable per UG-41(b)(2).

Vapor Out (B)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation

Located on	Cylinder #3
Orientation	0°
Nozzle center line offset to datum line	6"
End of nozzle to shell center	46.375"
Passes through a Category A joint	No

Nozzle

Description	NPS 12 Sch 40S (Std)
Access opening	No
Material specification	SA-312 TP304 Wld & smls pipe (II-D p. 90, ln. 9)
Inside diameter, new	12"
Pipe nominal wall thickness	0.375"
Pipe minimum wall thickness[1]	0.3281"
Corrosion allowance	0"
Projection available outside vessel, Lpr	5.5"
Projection available outside vessel to flange face, Lf	10"
Local vessel minimum thickness	0.375"
Liquid static head included	0 psi
Longitudinal joint efficiency	0.85

Reinforcing Pad

Material specification	SA-240 304 (II-D p. 86, ln. 44)
Diameter, D_p	16.75"

Thickness, t_e	0.375"
Is split	No
Welds	
Inner fillet, Leg_{41}	0.375"
Outer fillet, Leg_{42}	0.3125"
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 12 Class 150 WN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 352, ln. 20)
Blind included	No
Rated MDMT	-320°F
Liquid static head	0 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(b) Type 1
Notes	
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F	

UHA-51 Material Toughness Requirements Nozzle	
t_r = 153.96*6 / (20,000*0.85 - 0.6*153.96) =	0.0546"
Stress ratio = t_r*E^* / (t_n - c) = 0.0546*0.85 / (0.3281 - 0) =	0.1415
Impact test exempt per UHA-51(g) (coincident ratio = 0.1415)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of -200°F.	

UHA-51 Material Toughness Requirements Pad
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 150 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}
3.2546	3.6021	1.2454	0.6184	--	1.5	0.2383	0.2712	0.3281

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
41,741.5	47,134	182,629.62	20,805	295,908.57	52,759	191,730.42

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})	0.1875	0.2188	weld size is adequate

Calculations for internal pressure 150 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(12, 6 + (0.375 - 0) + (0.375 - 0))
= 12 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) + 0.375)
= 0.9375 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 150*6 / (20,000*1 - 0.6*150)
= 0.0452 in

Required thickness t_r from UG-37(a)

t_r = P*R / (S*E - 0.6*P)
= 150*36 / (20,000*1 - 0.6*150)
= 0.2712 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*R / (S*E - 0.6*P)
= 150*36 / (20,000*0.85 - 0.6*150)
= 0.3193 in

Area required per UG-37(c)

Allowable stresses: S_n = 20,000, S_v = 20,000, S_p = 20,000 psi

f_{r1} = lesser of 1 or S_n / S_v = 1

f_{r2} = lesser of 1 or S_n / S_v = 1

f_{r3} = lesser of f_{r2} or S_p / S_v = 1

f_{r4} = lesser of 1 or S_p / S_v = 1

A = $d*t_r*F + 2*t_n*t_r*F*(1 - f_{r1})$
= 12*0.2712*1 + 2*0.375*0.2712*1*(1 - 1)
= 3.2546 in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= 1.2454 in^2

= $d*(E_1*t - F*t_r) - 2*t_n*(E_1*t - F*t_r)*(1 - f_{r1})$
= 12*(1*0.375 - 1*0.2712) - 2*0.375*(1*0.375 - 1*0.2712)*(1 - 1)
= 1.2454 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 + 0.375)*(1*0.375 - 1*0.2712) - 2*0.375*(1*0.375 - 1*0.2712)*(1 - 1)
= 0.1557 in^2

A_2 = smaller of the following= 0.6184 in^2

= $5*(t_n - t_{rn})*f_{r2}*t$
= 5*(0.375 - 0.0452)*1*0.375
= 0.6184 in^2

= $2*(t_n - t_{rn})*(2.5*t_n + t_e)*f_{r2}$
= 2*(0.375 - 0.0452)*(2.5*0.375 + 0.375)*1
= 0.8657 in^2

A_{41} = Leg^2*f_{r3}
= 0.375^2*1
= 0.1406 in^2

A_{42} = Leg^2*f_{r4}
= 0.3125^2*1
= 0.0977 in^2

A_5 = $(D_p - d - 2*t_n)*t_e*f_{r4}$
= (16.75 - 12 - 2*0.375)*0.375*1
= 1.5 in^2

Area = $A_1 + A_2 + A_{41} + A_{42} + A_5$
= 1.2454 + 0.6184 + 0.1406 + 0.0977 + 1.5
= 3.6021 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 $0.7*t_{min}$ = 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
$t_{w(min)}$ = $0.5*t_{min}$ = 0.1875 in
$t_{w(actual)}$ = 0.7*Leg = 0.7*0.3125 = 0.2188 in

UG-45 Nozzle Neck Thickness Check

$t_{a\ UG\text{-}27}$ = $P*R_n / (S_n*E - 0.6*P)$ + Corrosion
= 150*6 / (20,000*0.85 - 0.6*150) + 0
= 0.0532 in

t_a = max[$t_{a\ UG\text{-}27}$, $t_{a\ UG\text{-}22}$]
= max[0.0532 , 0]
= 0.0532 in

t_{b1} = P*R / (S*E - 0.6*P) + Corrosion
= 150*36 / (20,000*1 - 0.6*150) + 0
= 0.2712 in

t_{b1} = max[t_{b1} , $t_{b\ UG16}$]
= max[0.2712 , 0.0625]
= 0.2712 in

t_b = min[t_{b3} , t_{b1}]
= min[0.3281 , 0.2712]
= 0.2712 in

$t_{UG\text{-}45}$ = max[t_a , t_b]
= max[0.0532 , 0.2712]
= 0.2712 in

Available nozzle wall thickness new, t_n = 0.875*0.375 = 0.3281 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*20,000 =	14,000 psi
Inner fillet weld in shear:	0.49*20,000 =	9,800 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
(π / 2)*Nozzle OD*Leg*S_i = (π / 2)*12.75*0.375*9,800 = 73,601.63 lb_f

(2) Outer fillet weld in shear
(π / 2)*Pad OD*Leg*S_o = (π / 2)*16.75*0.3125*9,800 = 80,576.94 lb_f

(3) Nozzle wall in shear
(π / 2)*Mean nozzle dia*t_n*S_n = (π / 2)*12.375*0.375*14,000 = 102,052.67 lb_f

(4) Groove weld in tension
(π / 2)*Nozzle OD*t_w*S_g = (π / 2)*12.75*0.375*14,800 = 111,153.47 lb_f

(6) Upper groove weld in tension
(π / 2)*Nozzle OD*t_w*S_g = (π / 2)*12.75*0.375*14,800 = 111,153.47 lb_f

Loading on welds per UG-41(b)(1)

W = $(A - A_1 + 2*t_n*f_{r1}*(E_1*t - F*t_r))*S_v$
= (3.2546 - 1.2454 + 2*0.375*1*(1*0.375 - 1*0.2712))*20,000
= 41,741.5 lb_f

W_{1-1} = $(A_2 + A_5 + A_{41} + A_{42})*S_v$
= (0.6184 + 1.5 + 0.1406 + 0.0977)*20,000
= 47,134 lb_f

W_{2-2} = $(A_2 + A_3 + A_{41} + A_{43} + 2*t_n*t*f_{r1})*S_v$
= (0.6184 + 0 + 0.1406 + 0 + 2*0.375*0.375*1)*20,000
= 20,805 lb_f

W_{3-3} = $(A_2 + A_3 + A_5 + A_{41} + A_{42} + A_{43} + 2*t_n*t*f_{r1})*S_v$
= (0.6184 + 0 + 1.5 + 0.1406 + 0.0977 + 0 + 2*0.375*0.375*1)*20,000
= 52,759 lb_f

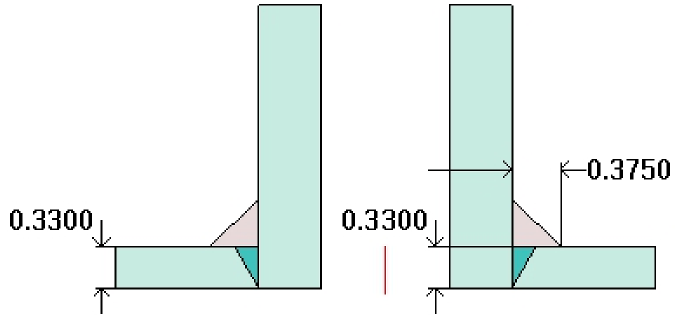
Load for path 1-1 lesser of W or W_{1-1} = 41,741.5 lb_f
Path 1-1 through (2) & (3) = 80,576.94 + 102,052.67 = 182,629.62 lb_f
Path 1-1 is stronger than W so it is acceptable per UG-41(b)(2).

Load for path 2-2 lesser of W or W_{2-2} = 20,805 lb_f
Path 2-2 through (1), (4), (6) = 73,601.63 + 111,153.47 + 111,153.47 = 295,908.57 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} = 41,741.5 lb_f
Path 3-3 through (2), (4) = 80,576.94 + 111,153.47 = 191,730.42 lb_f
Path 3-3 is stronger than W so it is acceptable per UG-41(b)(2).

LG #1 (C1)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation	
Located on	Ellipsoidal Head #2
Orientation	0°
End of nozzle to datum line	-31"
Calculated as hillside	Yes
Distance to head center, R	17"
Passes through a Category A joint	No

Nozzle	
Access opening	No
Material specification	SA-182 F304 <= 5 (II-D p. 86, ln. 34)
Inside diameter, new	1"
Nominal wall thickness	0.5"
Corrosion allowance	0"
Opening chord length	1.0352"
Projection available outside vessel, Lpr	5.9834"
Projection available outside vessel to flange face, Lf	6.5434"
Local vessel minimum thickness	0.33"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.33"

ASME B16.5-2013 Flange	
Description	NPS 1 Class 150 LWN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 352, ln. 20)
Blind included	No
Rated MDMT	-320°F
Liquid static head	0 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Impact Tested	No

Notes
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F

UHA-51 Material Toughness Requirements Nozzle
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Reinforcement Calculations for Internal Pressure

<table>
<tr><th colspan="7">UG-37 Area Calculation Summary (in^2)</th><th colspan="2">UG-45 Summary (in)</th></tr>
<tr><td colspan="7">For P = 150 psi @ 150 °F</td><td colspan="2">The nozzle passes UG-45</td></tr>
<tr><td>A required</td><td>A available</td><td>A_1</td><td>A_2</td><td>A_3</td><td>A_5</td><td>A welds</td><td>t_{req}</td><td>t_{min}</td></tr>
<tr><td colspan="7">This nozzle is exempt from area calculations per UG-36(c)(3)(a)</td><td>0.1348</td><td>0.5</td></tr>
</table>

<table>
<tr><th>UG-41 Weld Failure Path Analysis Summary</th></tr>
<tr><td>The nozzle is exempt from weld strength calculations per UW-15(b)(2)</td></tr>
</table>

<table>
<tr><th colspan="4">UW-16 Weld Sizing Summary</th></tr>
<tr><td>Weld description</td><td>Required weld throat size (in)</td><td>Actual weld throat size (in)</td><td>Status</td></tr>
<tr><td>Nozzle to shell fillet (Leg_{41})</td><td>0.231</td><td>0.2625</td><td>weld size is adequate</td></tr>
</table>

Calculations for internal pressure 150 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = $MAX(d, R_n + (t_n - C_n) + (t - C))$

= MAX(1.0352, 0.5176 + (0.5 - 0) + (0.33 - 0))

= 1.3476 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*(0.33 - 0), 2.5*(0.5 - 0) + 0)

= 0.825 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = $P*R_n / (S_n*E - 0.6*P)$

= 150*0.5 / (20,000*1 - 0.6*150)

= 0.0038 in

Required thickness t_r from UG-37(a)(c)

t_r = $P*K_1*D / (2*S*E - 0.2*P)$

= 150*0.9*72 / (2*20,000*1 - 0.2*150)

= 0.2432 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*D / (2*S*E - 0.2*P)
= 150*72 / (2*20,000*0.85 - 0.2*150)
= 0.3179"

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-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
= 150*0.5 / (20,000*1 - 0.6*150) + 0
= 0.0038 in

t_a = max[$t_{a\ UG\text{-}27}$, $t_{a\ UG\text{-}22}$]
= max[0.0038 , 0]
= 0.0038 in

t_{b1} = 0.2702 in

t_{b1} = max[t_{b1} , $t_{b\ UG16}$]
= max[0.2702 , 0.0625]
= 0.2702 in

t_b = min[t_{b3} , t_{b1}]
= min[0.1348 , 0.2702]
= 0.1348 in

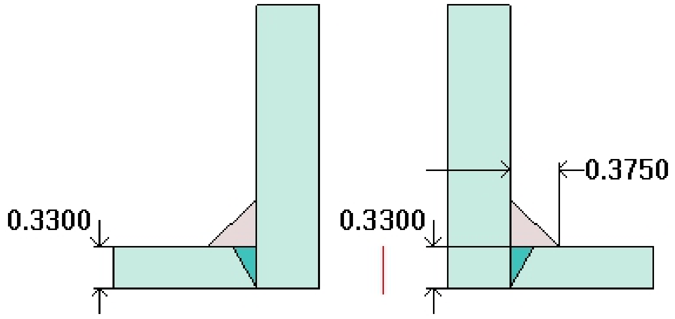
$t_{UG\text{-}45}$ = max[t_a , t_b]
= max[0.0038 , 0.1348]
= 0.1348 in

Available nozzle wall thickness new, t_n = 0.5 in

The nozzle neck thickness is adequate.

LG #2 (C2)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation

Located on	Ellipsoidal Head #2
Orientation	180°
End of nozzle to datum line	-24"
Calculated as hillside	Yes
Distance to head center, R	31.625"
Passes through a Category A joint	No

Nozzle

Access opening	No
Material specification	SA-182 F304 <= 5 (II-D p. 86, ln. 34)
Inside diameter, new	1"
Nominal wall thickness	0.5"
Corrosion allowance	0"
Opening chord length	1.3517"
Projection available outside vessel, Lpr	5.5791"
Projection available outside vessel to flange face, Lf	6.1391"
Local vessel minimum thickness	0.33"
Liquid static head included	1.57 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.33"

ASME B16.5-2013 Flange	
Description	NPS 1 Class 150 LWN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 352, ln. 20)
Blind included	No
Rated MDMT	-320°F
Liquid static head	1.57 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Impact Tested	No
Notes	
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F	

UHA-51 Material Toughness Requirements Nozzle
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 151.57 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	0.5

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 151.57 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(1.3517, 0.6759 + (0.5 - 0) + (0.33 - 0))
= 1.5059 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*(0.33 - 0), 2.5*(0.5 - 0) + 0)
= 0.825 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 151.5747*0.5 / (20,000*1 - 0.6*151.5747)
= 0.0038 in

Required thickness t_r from UG-37(a)

t_r = P*D / (2*S*E - 0.2*P)
= 151.57*72 / (2*20,000*1 - 0.2*151.57)
= 0.273"

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*D / (2*S*E - 0.2*P)
= 151.57*72 / (2*20,000*0.85 - 0.2*151.57)
= 0.3213"

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-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
= 151.5747*0.5 / (20,000*1 - 0.6*151.5747) + 0
= 0.0038 in

t_a = max[$t_{a\ UG\text{-}27}$, $t_{a\ UG\text{-}22}$]
= max[0.0038 , 0]
= 0.0038 in

t_{b1} = 0.273 in

t_{b1} = max[t_{b1} , $t_{b\ UG16}$]
= max[0.273 , 0.0625]
= 0.273 in

t_b = min[t_{b3} , t_{b1}]
= min[0.1348 , 0.273]
= 0.1348 in

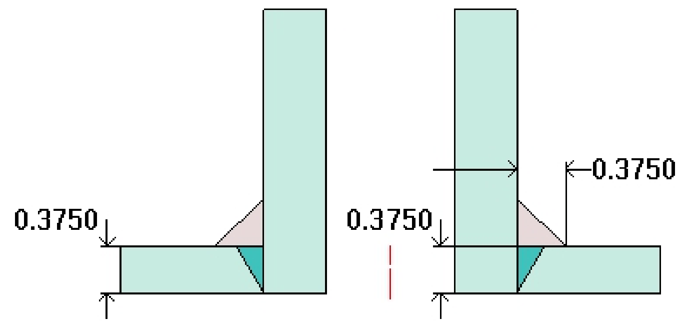
$t_{UG\text{-}45}$ = max[t_a , t_b]
= max[0.0038 , 0.1348]
= 0.1348 in

Available nozzle wall thickness new, t_n = 0.5 in

The nozzle neck thickness is adequate.

Drain (D)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation

Located on	Cylinder #2
Orientation	180°
Nozzle center line offset to datum line	138"
End of nozzle to shell center	43.375"
Passes through a Category A joint	No

Nozzle

Access opening	No
Material specification	SA-182 F304 <= 5 (II-D p. 86, ln. 34)
Inside diameter, new	1"
Nominal wall thickness	0.5"
Corrosion allowance	0"
Projection available outside vessel, Lpr	6.44"
Projection available outside vessel to flange face, Lf	7"
Local vessel minimum thickness	0.375"
Liquid static head included	1.75 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.375"

ASME B16.5-2013 Flange	
Description	NPS 1 Class 150 LWN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 352, ln. 20)
Blind included	No
Rated MDMT	-320°F
Liquid static head	2 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Impact Tested	No
Notes	
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F	

UHA-51 Material Toughness Requirements Nozzle
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 151.75 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	0.5

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 151.75 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(1, 0.5 + (0.5 - 0) + (0.375 - 0))
= 1.375 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*(0.5 - 0) + 0)
= 0.9375 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 151.7462*0.5 / (20,000*1 - 0.6*151.7462)
= 0.0038 in

Required thickness t_r from UG-37(a)

t_r = P*R / (S*E - 0.6*P)
= 151.7462*36 / (20,000*1 - 0.6*151.7462)
= 0.2744 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*R / (S*E - 0.6*P)
= 151.7462*36 / (20,000*0.85 - 0.6*151.7462)
= 0.3231 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-45 Nozzle Neck Thickness Check

$t_{a\ UG\text{-}27}$ = P*R_n / (S_n*E - 0.6*P) + Corrosion
= 151.9989*0.5 / (20,000*1 - 0.6*151.9989) + 0
= 0.0038 in

t_a = max[$t_{a\ UG\text{-}27}$, $t_{a\ UG\text{-}22}$]
= max[0.0038 , 0]
= 0.0038 in

t_{b1} = P*R / (S*E - 0.6*P) + Corrosion
= 151.7462*36 / (20,000*1 - 0.6*151.7462) + 0
= 0.2744 in

t_{b1} = max[t_{b1} , $t_{b\ UG16}$]
= max[0.2744 , 0.0625]
= 0.2744 in

t_b = min[t_{b3} , t_{b1}]
= min[0.1348 , 0.2744]
= 0.1348 in

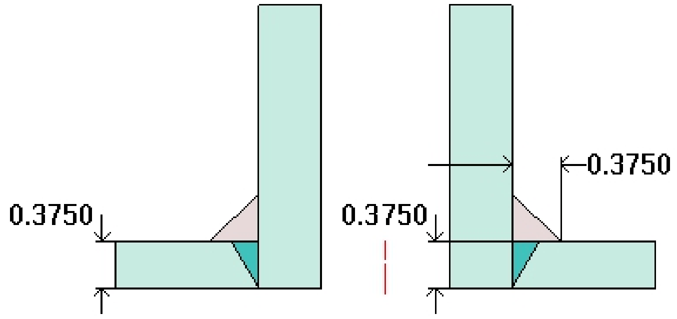
$t_{UG\text{-}45}$ = max[t_a , t_b]
= max[0.0038 , 0.1348]
= 0.1348 in

Available nozzle wall thickness new, t_n = 0.5 in

The nozzle neck thickness is adequate.

TI (E)

ASME Section VIII Division 1, 2015 Edition	



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

Location and Orientation	
Located on	Cylinder #3
Orientation	90°
Nozzle center line offset to datum line	66"
End of nozzle to shell center	43.375"
Passes through a Category A joint	No

Nozzle	
Access opening	No
Material specification	SA-182 F304 <= 5 (II-D p. 86, ln. 34)
Inside diameter, new	1"
Nominal wall thickness	0.5"
Corrosion allowance	0"
Projection available outside vessel, Lpr	6.44"
Projection available outside vessel to flange face, Lf	7"
Local vessel minimum thickness	0.375"
Liquid static head included	0.43 psi
Longitudinal joint efficiency	1

Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.375"

ASME B16.5-2013 Flange	
Description	NPS 1 Class 150 LWN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 352, ln. 20)
Blind included	No
Rated MDMT	-320°F
Liquid static head	0.43 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Impact Tested	No
Notes	
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F	

UHA-51 Material Toughness Requirements Nozzle
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 150.43 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.1348	0.5

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 150.43 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned} L_R &= \text{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\ &= \text{MAX}(1, 0.5 + (0.5 - 0) + (0.375 - 0)) \\ &= 1.375 \text{ in} \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned} L_H &= \text{MIN}(2.5{*}(t - C), 2.5{*}(t_n - C_n) + t_e) \\ &= \text{MIN}(2.5{*}(0.375 - 0), 2.5{*}(0.5 - 0) + 0) \\ &= 0.9375 \text{ in} \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned} t_{rn} &= P{*}R_n / (S_n{*}E - 0.6{*}P) \\ &= 150.4332{*}0.5 / (20{,}000{*}1 - 0.6{*}150.4332) \\ &= 0.0038 \text{ in} \end{aligned}$$

Required thickness t_r from UG-37(a)

$$\begin{aligned} t_r &= P{*}R / (S{*}E - 0.6{*}P) \\ &= 150.4332{*}36 / (20{,}000{*}1 - 0.6{*}150.4332) \\ &= 0.272 \text{ in} \end{aligned}$$

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*R / (S*E - 0.6*P)
= 150.4332*36 / (20,000*0.85 - 0.6*150.4332)
= 0.3203 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-45 Nozzle Neck Thickness Check

$t_{a\ UG\text{-}27}$ = P*R_n / (S_n*E - 0.6*P) + Corrosion
= 150.4332*0.5 / (20,000*1 - 0.6*150.4332) + 0
= 0.0038 in

t_a = max[$t_{a\ UG\text{-}27}$, $t_{a\ UG\text{-}22}$]
= max[0.0038 , 0]
= 0.0038 in

t_{b1} = P*R / (S*E - 0.6*P) + Corrosion
= 150.4332*36 / (20,000*1 - 0.6*150.4332) + 0
= 0.272 in

t_{b1} = max[t_{b1} , $t_{b\ UG16}$]
= max[0.272 , 0.0625]
= 0.272 in

t_b = min[t_{b3} , t_{b1}]
= min[0.1348 , 0.272]
= 0.1348 in

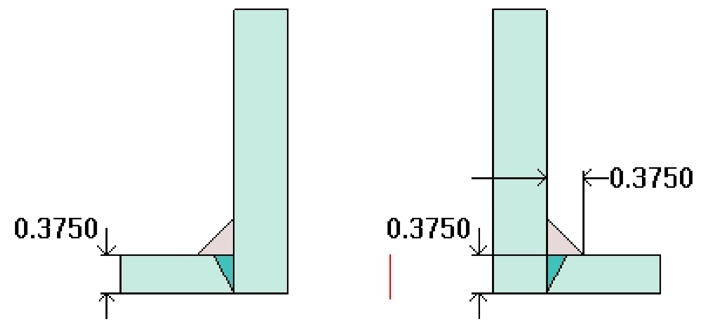
$t_{UG\text{-}45}$ = max[t_a , t_b]
= max[0.0038 , 0.1348]
= 0.1348 in

Available nozzle wall thickness new, t_n = 0.5 in

The nozzle neck thickness is adequate.

Liquid Out (F)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation

Located on	Cylinder #3
Orientation	180°
Nozzle center line offset to datum line	48"
End of nozzle to shell center	43.375"
Passes through a Category A joint	No

Nozzle

Access opening	No
Material specification	SA-182 F304 <= 5 (II-D p. 86, ln. 34)
Inside diameter, new	2"
Nominal wall thickness	0.53"
Corrosion allowance	0"
Projection available outside vessel, Lpr	6.25"
Projection available outside vessel to flange face, Lf	7"
Local vessel minimum thickness	0.375"
Liquid static head included	1.75 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg$_{41}$	0.375"
Nozzle to vessel groove weld	0.375"

ASME B16.5-2013 Flange	
Description	NPS 2 Class 150 LWN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 352, ln. 20)
Blind included	No
Rated MDMT	-320°F
Liquid static head	2 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Impact Tested	No
Notes	
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F	

UHA-51 Material Toughness Requirements Nozzle
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 151.75 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)							0.189	0.53

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 151.75 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(2, 1 + (0.53 - 0) + (0.375 - 0))
= 2 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*(0.53 - 0) + 0)
= 0.9375 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 151.7462*1 / (20,000*1 - 0.6*151.7462)
= 0.0076 in

Required thickness t_r from UG-37(a)

t_r = P*R / (S*E - 0.6*P)
= 151.7462*36 / (20,000*1 - 0.6*151.7462)
= 0.2744 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*R / (S*E - 0.6*P)
= 151.7462*36 / (20,000*0.85 - 0.6*151.7462)
= 0.3231 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-45 Nozzle Neck Thickness Check

$t_{a\ UG-27}$ = P*R_n / (S_n*E - 0.6*P) + Corrosion
= 151.9989*1 / (20,000*1 - 0.6*151.9989) + 0
= 0.0076 in

t_a = max[$t_{a\ UG-27}$, $t_{a\ UG-22}$]
= max[0.0076 , 0]
= 0.0076 in

t_{b1} = P*R / (S*E - 0.6*P) + Corrosion
= 151.7462*36 / (20,000*1 - 0.6*151.7462) + 0
= 0.2744 in

t_{b1} = max[t_{b1} , $t_{b\ UG16}$]
= max[0.2744 , 0.0625]
= 0.2744 in

t_b = min[t_{b3} , t_{b1}]
= min[0.189 , 0.2744]
= 0.189 in

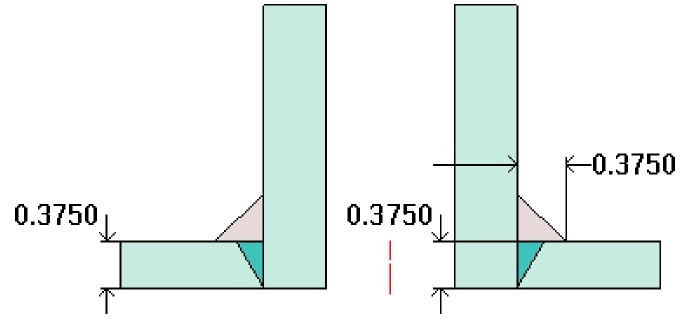
t_{UG-45} = max[t_a , t_b]
= max[0.0076 , 0.189]
= 0.189 in

Available nozzle wall thickness new, t_n = 0.53 in

The nozzle neck thickness is adequate.

LSHH #1 (G1)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation	
Located on	Cylinder #3
Orientation	90°
Nozzle center line offset to datum line	78"
End of nozzle to shell center	39.75"
Offset from center, Lo	-15.75"
Passes through a Category A joint	No

Nozzle	
Access opening	No
Material specification	SA-182 F304 <= 5 (II-D p. 86, ln. 34)
Inside diameter, new	1"
Nominal wall thickness	0.5"
Corrosion allowance	0"
Opening chord length	1.1111"
Projection available outside vessel, Lpr	5.9398"
Projection available outside vessel to flange face, Lf	6.4998"
Local vessel minimum thickness	0.375"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.375"

ASME B16.5-2013 Flange	
Description	NPS 1 Class 150 LWN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 352, ln. 20)
Blind included	No
Rated MDMT	-320°F
Liquid static head	0 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Impact Tested	No
Notes	
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F	

UHA-51 Material Toughness Requirements Nozzle
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 150 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	0.5

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 150 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$\begin{aligned} L_R &= \mathrm{MAX}(d, R_n + (t_n - C_n) + (t - C)) \\ &= \mathrm{MAX}(1.1111, 0.5556 + (0.5 - 0) + (0.375 - 0)) \\ &= 1.4306 \text{ in} \end{aligned}$$

Outer Normal Limit of reinforcement per UG-40

$$\begin{aligned} L_H &= \mathrm{MIN}(2.5*(t - C), 2.5*(t_n - C_n) + t_e) \\ &= \mathrm{MIN}(2.5*(0.375 - 0), 2.5*(0.5 - 0) + 0) \\ &= 0.9375 \text{ in} \end{aligned}$$

Nozzle required thickness per UG-27(c)(1)

$$\begin{aligned} t_{rn} &= P*R_n / (S_n*E - 0.6*P) \\ &= 150*0.5 / (20,000*1 - 0.6*150) \\ &= 0.0038 \text{ in} \end{aligned}$$

Required thickness t_r from UG-37(a)

$$\begin{aligned} t_r &= P*R / (S*E - 0.6*P) \\ &= 150*36 / (20,000*1 - 0.6*150) \\ &= 0.2712 \text{ in} \end{aligned}$$

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*R / (S*E - 0.6*P)
= 150*36 / (20,000*0.85 - 0.6*150)
= 0.3193 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-45 Nozzle Neck Thickness Check

$t_{a\ UG\text{-}27}$ = P*R_n / (S_n*E - 0.6*P) + Corrosion
= 150*0.5 / (20,000*1 - 0.6*150) + 0
= 0.0038 in

t_a = max[$t_{a\ UG\text{-}27}$, $t_{a\ UG\text{-}22}$]
= max[0.0038 , 0]
= 0.0038 in

t_{b1} = P*R / (S*E - 0.6*P) + Corrosion
= 150*36 / (20,000*1 - 0.6*150) + 0
= 0.2712 in

t_{b1} = max[t_{b1} , $t_{b\ UG16}$]
= max[0.2712 , 0.0625]
= 0.2712 in

t_b = min[t_{b3} , t_{b1}]
= min[0.1348 , 0.2712]
= 0.1348 in

$t_{UG\text{-}45}$ = max[t_a , t_b]
= max[0.0038 , 0.1348]
= 0.1348 in

Available nozzle wall thickness new, t_n = 0.5 in

The nozzle neck thickness is adequate.

Reinforcement check in the plane parallel to the longitudinal axis

Reinforcement Calculations for Internal Pressure

<table>
<tr><th colspan="7">UG-37 Area Calculation Summary (in^2)</th><th colspan="2">UG-45 Summary (in)</th></tr>
<tr><th colspan="7">For P = 150 psi @ 150 °F</th><th colspan="2">The nozzle passes UG-45</th></tr>
<tr><th>A required</th><th>A available</th><th>A_1</th><th>A_2</th><th>A_3</th><th>A_5</th><th>A welds</th><th>t_{req}</th><th>t_{min}</th></tr>
<tr><td colspan="7">This nozzle is exempt from area calculations per UG-36(c)(3)(a)</td><td>0.1348</td><td>0.5</td></tr>
</table>

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

Parallel Limit of reinforcement per UG-40

L_R = $MAX(d, R_n + (t_n - C_n) + (t - C))$

= $MAX(1, 0.5 + (0.5 - 0) + (0.375 - 0))$

= 1.375 in

Outer Normal Limit of reinforcement per UG-40

L_H = $MIN(2.5*(t - C), 2.5*(t_n - C_n) + t_e)$

= $MIN(2.5*(0.375 - 0), 2.5*(0.5 - 0) + 0)$

= 0.9375 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = $P*R_n / (S_n*E - 0.6*P)$

= $150*0.5 / (20{,}000*1 - 0.6*150)$

= 0.0038 in

Required thickness t_r from UG-37(a)

t_r = $P*R / (S*E - 0.6*P)$

= $150*36 / (20{,}000*1 - 0.6*150)$

= 0.2712 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*R / (S*E - 0.6*P)
= 150*36 / (20,000*0.85 - 0.6*150)
= 0.3193 in

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

UG-45 Nozzle Neck Thickness Check

$t_{a\ UG\text{-}27}$ = $P*R_n$ / (S_n*E - 0.6*P) + Corrosion
= 150*0.5 / (20,000*1 - 0.6*150) + 0
= 0.0038 in

t_a = max[$t_{a\ UG\text{-}27}$, $t_{a\ UG\text{-}22}$]
= max[0.0038 , 0]
= 0.0038 in

t_{b1} = P*R / (S*E - 0.6*P) + Corrosion
= 150*36 / (20,000*1 - 0.6*150) + 0
= 0.2712 in

t_{b1} = max[t_{b1} , $t_{b\ UG16}$]
= max[0.2712 , 0.0625]
= 0.2712 in

t_b = min[t_{b3} , t_{b1}]
= min[0.1348 , 0.2712]
= 0.1348 in

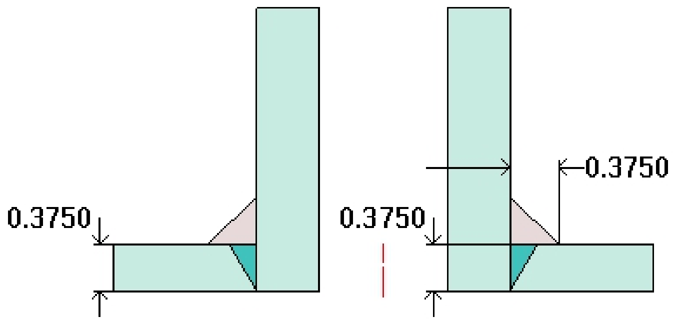
$t_{UG\text{-}45}$ = max[t_a , t_b]
= max[0.0038 , 0.1348]
= 0.1348 in

Available nozzle wall thickness new, t_n = 0.5 in

The nozzle neck thickness is adequate.

LSHH #2 (G2)

ASME Section VIII Division 1, 2015 Edition



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

Location and Orientation

Located on	Cylinder #3
Orientation	90°
Nozzle center line offset to datum line	78"
End of nozzle to shell center	43.375"
Offset from center, Lo	-1.75"
Passes through a Category A joint	No

Nozzle

Access opening	No
Material specification	SA-182 F304 <= 5 (II-D p. 86, ln. 34)
Inside diameter, new	1"
Nominal wall thickness	0.5"
Corrosion allowance	0"
Opening chord length	1.0012"
Projection available outside vessel, Lpr	6.4477"
Projection available outside vessel to flange face, Lf	7.0077"
Local vessel minimum thickness	0.375"
Liquid static head included	0.37 psi
Longitudinal joint efficiency	1

Welds

Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.375"

ASME B16.5-2013 Flange	
Description	NPS 1 Class 150 LWN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 352, ln. 20)
Blind included	No
Rated MDMT	-320°F
Liquid static head	0.37 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Impact Tested	No
Notes	
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F	

UHA-51 Material Toughness Requirements Nozzle
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F
Material is exempt from impact testing at the Design MDMT of -200°F.

Reinforcement Calculations for Internal Pressure

<table>
<tr><th colspan="7">UG-37 Area Calculation Summary (in^2)</th><th colspan="2">UG-45 Summary (in)</th></tr>
<tr><td colspan="7">For P = 150.37 psi @ 150 °F</td><td colspan="2">The nozzle passes UG-45</td></tr>
<tr><td>A required</td><td>A available</td><td>A_1</td><td>A_2</td><td>A_3</td><td>A_5</td><td>A welds</td><td>t_{req}</td><td>t_{min}</td></tr>
<tr><td colspan="7">This nozzle is exempt from area calculations per UG-36(c)(3)(a)</td><td>0.1348</td><td>0.5</td></tr>
</table>

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

<table>
<tr><th colspan="4">UW-16 Weld Sizing Summary</th></tr>
<tr><td>Weld description</td><td>Required weld throat size (in)</td><td>Actual weld throat size (in)</td><td>Status</td></tr>
<tr><td>Nozzle to shell fillet (Leg_{41})</td><td>0.25</td><td>0.2625</td><td>weld size is adequate</td></tr>
</table>

Calculations for internal pressure 150.37 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(1.0012, 0.5006 + (0.5 - 0) + (0.375 - 0))
= 1.3756 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*(0.5 - 0) + 0)
= 0.9375 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 150.37*0.5 / (20,000*1 - 0.6*150.37)
= 0.0038 in

Required thickness t_r from UG-37(a)

t_r = P*R / (S*E - 0.6*P)
= 150.37*36 / (20,000*1 - 0.6*150.37)
= 0.2719 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*R / (S*E - 0.6*P)
= 150.37*36 / (20,000*0.85 - 0.6*150.37)
= 0.3201 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-45 Nozzle Neck Thickness Check

$t_{a\ UG\text{-}27}$ = P*R_n / (S_n*E - 0.6*P) + Corrosion
= 150.37*0.5 / (20,000*1 - 0.6*150.37) + 0
= 0.0038 in

t_a = max[$t_{a\ UG\text{-}27}$, $t_{a\ UG\text{-}22}$]
= max[0.0038 , 0]
= 0.0038 in

t_{b1} = P*R / (S*E - 0.6*P) + Corrosion
= 150.37*36 / (20,000*1 - 0.6*150.37) + 0
= 0.2719 in

t_{b1} = max[t_{b1} , $t_{b\ UG16}$]
= max[0.2719 , 0.0625]
= 0.2719 in

t_b = min[t_{b3} , t_{b1}]
= min[0.1348 , 0.2719]
= 0.1348 in

$t_{UG\text{-}45}$ = max[t_a , t_b]
= max[0.0038 , 0.1348]
= 0.1348 in

Available nozzle wall thickness new, t_n = 0.5 in

The nozzle neck thickness is adequate.

Reinforcement check in the plane parallel to the longitudinal axis

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 150.37 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	0.5

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

Parallel Limit of reinforcement per UG-40

L_R = MAX(d, R_n + (t_n - C_n) + (t - C))
= MAX(1, 0.5 + (0.5 - 0) + (0.375 - 0))
= 1.375 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*(0.5 - 0) + 0)
= 0.9375 in

Nozzle required thickness per UG-27(c)(1)

t_{rn} = P*R_n / (S_n*E - 0.6*P)
= 150.37*0.5 / (20,000*1 - 0.6*150.37)
= 0.0038 in

Required thickness t_r from UG-37(a)

t_r = P*R / (S*E - 0.6*P)
= 150.37*36 / (20,000*1 - 0.6*150.37)
= 0.2719 in

Required thickness t_r per Interpretation VIII-1-07-50

t_r = P*R / (S*E - 0.6*P)
= 150.37*36 / (20,000*0.85 - 0.6*150.37)
= 0.3201 in

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

UG-45 Nozzle Neck Thickness Check

$t_{a\ UG\text{-}27}$ = $P*R_n$ / (S_n*E - 0.6*P) + Corrosion
= 150.37*0.5 / (20,000*1 - 0.6*150.37) + 0
= 0.0038 in

t_a = max[$t_{a\ UG\text{-}27}$, $t_{a\ UG\text{-}22}$]
= max[0.0038 , 0]
= 0.0038 in

t_{b1} = P*R / (S*E - 0.6*P) + Corrosion
= 150.37*36 / (20,000*1 - 0.6*150.37) + 0
= 0.2719 in

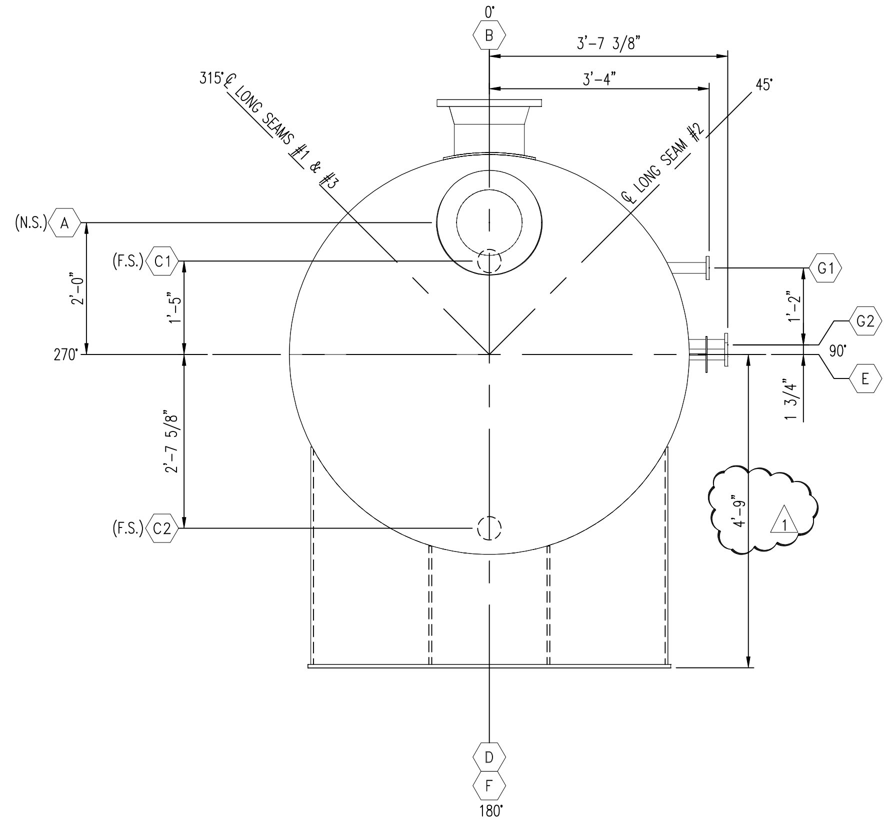
t_{b1} = max[t_{b1} , $t_{b\ UG16}$]
= max[0.2719 , 0.0625]
= 0.2719 in

t_b = min[t_{b3} , t_{b1}]
= min[0.1348 , 0.2719]
= 0.1348 in

$t_{UG\text{-}45}$ = max[t_a , t_b]
= max[0.0038 , 0.1348]
= 0.1348 in

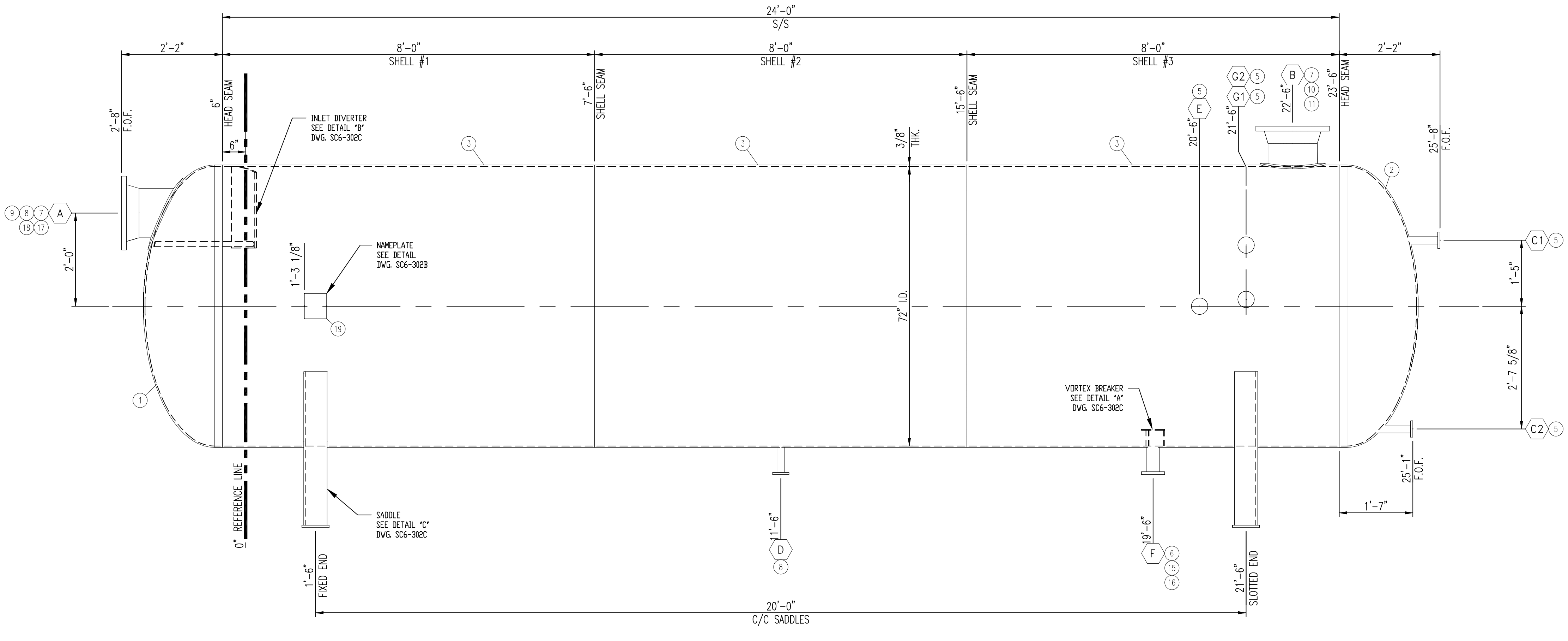
Available nozzle wall thickness new, t_n = 0.5 in

The nozzle neck thickness is adequate.



ORIENTATION

SCALE 3/4"=1'-0"



ELEVATION

SCALE 3/4"=1'-0"

J-447
11/15/16
IFC

UOP RUSSELL STANDARD
60 MM CRYO PLANT
FABRICATION DETAILS
V-492 – COLD DRAIN TANK 72" I.D. x 24'-0" S/S

REV.	DRAWING NO.	SCALE	DRAWN BY AR	APPVD. BY AM	CHCK'D BY WC
1	SC6–302A	NOTED	DATE 5/14/15	DATE 5/14/15	DATE 5/14/15

OK P.E.# 6852
WV COA# C04812–00
TX P.E.# F–7531

UOP Russell

7050 S. Yale, Suite 210
Tulsa, Oklahoma 74136
Phone: 918–481–5682
Fax.: 918–481–7427

1	REVISED SADDLE HEIGHT	AR	6/29/16	LH	6/29/16
0	ISSUE FOR CONSTRUCTION	AR	5/14/15	BL	5/14/15
REV.	DESCRIPTION	BY	DATE	APP'D	DATE

REVISIONS

CONFIDENTIALITY STATEMENT

THIS DRAWING CONTAINS CERTAIN PROPRIETARY INFORMATION THAT IS THE PROPERTY OF UOP RUSSELL, LLC. THIS DRAWING IS PROVIDED FOR THE SOLE PURPOSE OF MAINTAINING AND/OR OPERATING THE PLANT AND/OR RELATED EQUIPMENT DESCRIBED HEREIN. THIS INFORMATION SHALL NOT BE USED FOR ANY OTHER PURPOSE. RECIPIENTS SHALL TAKE ALL REASONABLE MEASURES TO MAINTAIN THE CONFIDENTIALITY OF THIS DRAWING. NO PART OF THIS DRAWING MAY BE REPRODUCED OR USED FOR THE PURPOSES OTHER THAN OPERATING AND/OR MAINTAINING THE PLANT AND/OR RELATED EQUIPMENT MANUFACTURED BY UOP RUSSELL, LLC WITHOUT THE EXPRESS WRITTEN CONSENT OF UOP RUSSELL, LLC. ANY DUPLICATION OF THIS DRAWING IN WHOLE OR IN PART IS A VIOLATION COPYRIGHT AND IS SUBJECT TO CIVIL AND CRIMINAL PENALTIES.

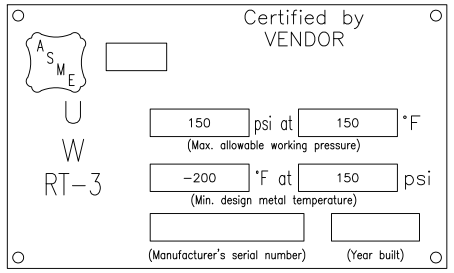
ITEM #	QTY.	DESCRIPTION	COMMENTS	MATERIAL	WEIGHT	HEAT #
1	1	HEAD 2:1 ELLIP. 72" I.D. (0.33" MIN THK) W/2" SF	HEAD #1	SA-240-304	754	
2	1	HEAD 2:1 ELLIP. 72" I.D. (0.33" MIN THK) W/2" SF	HEAD #2	SA-240-304	754	
3	3	R&W CYLINDER 72" I.D. x 8'-0" LG. (0.375" THK) BBE	SHELL #1,#2,#3	SA-240-304	6960	
5	6	FLANGE, 1" 150# RFLWN x 9" LG.	C1,C2,D,E,G1,G2	SA-182-F-304	44	
6	1	FLANGE, 2" 150# RFLWN x 9" LG.	F	SA-182-F-304	16	
7	2	FLANGE, 12" 150# RFWN S/40S	A,B	SA-182-F-304	240	
8	1	PLATE, 3/8" THK. x 12 7/8" ID x 20 3/4" OD (FORM TO MATCH HEAD, HILLSIDE)	A	SA-240-304	23	
9	1	PIPE, 12" S/40S x 10 7/8" LG. BBE	A	SA-312-TP304(W)	49	
10	1	PLATE, 3/8" THK. x 12 7/8" ID x 16 3/4" OD (ROLL TO 36 3/8" ISR)	B	SA-240-304	10	
11	1	PIPE, 12" S/40S x 6 1/2" LG PExBE	B	SA-312-TP304(W)	29	
12	2	PLATE, 5/8" THK x 66" LG x 7" WD W/(2) HOLES (SEE DETAIL "C")	SADDLE	SA-240-304	163	
13	2	PLATE, 1/2" THK x 77" W x 3'-3 1/16" LG (BEND & CUT PER DETAIL "C")	SADDLE	SA-240-304	853	
14	4	PLATE, 1/2" THK x 5 1/2" W x 1'-9 9/16" LG. (CUT PER DETAIL "C")	SADDLE	SA-240-304	67	
15	1	PLATE, 1/4" THK x 6"OD	VORTEX BREAKER	SA-240-304	2	
16	3	PLATE, 1/4" THK x 3/4" W x 4" LG	VORTEX BREAKER	SA-240-304	1	
2 17	2	PLATE, 1/2" THK x 12" W. x 1'-9" LG. (TRIM PER DETAIL "B")	INLET DIVERTER	SA-240-304	71	
2 18	2	PIPE, 1" XH x 2'-1 7/8" LG. BBE (CUT PER DETAIL "B")	INLET DIVERTER	SA-312-TP304(W)	9	
19	1	PLATE, 1/4" x 6" x 6"	NAMEPLATE	SA-240-304	3	
20	1	PLATE, 1/4" THK x 2 3/4" x 6"	NAMEPLATE	SA-240-304	2	

CONFIDENTIALITY STATEMENT

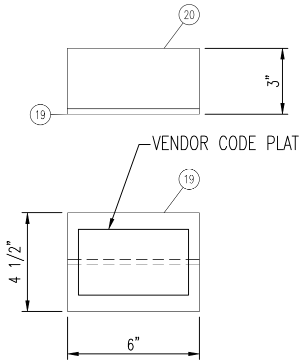
THIS DRAWING CONTAINS CERTAIN PROPRIETARY INFORMATION THAT IS THE PROPERTY OF UOP RUSSELL, LLC. THIS DRAWING IS PROVIDED FOR THE SOLE PURPOSE OF MAINTAINING AND/OR OPERATING THE PLANT AND/OR RELATED EQUIPMENT DESCRIBED HEREIN. THIS INFORMATION SHALL NOT BE USED FOR ANY OTHER PURPOSE. RECIPIENTS SHALL TAKE ALL REASONABLE MEASURES TO MAINTAIN THE CONFIDENTIALITY OF THIS DRAWING. NO PART OF THIS DRAWING MAY BE REPRODUCED OR USED FOR THE PURPOSES OTHER THAN OPERATING AND/OR MAINTAINING THE PLANT AND/OR RELATED EQUIPMENT MANUFACTURED BY UOP RUSSELL, LLC WITHOUT THE EXPRESS WRITTEN CONSENT OF UOP RUSSELL, LLC. ANY DUPLICATION OF THIS DRAWING IN WHOLE OR IN PART IS A VIOLATION COPYRIGHT AND IS SUBJECT TO CIVIL AND CRIMINAL PENALTIES.

REVISIONS

REV.	DESCRIPTION	BY	DATE	APP'D	DATE
2	REVISED HYDROSTATIC TEST & B.O.M. ITEMS #17 & #18	AR	8/24/16	GG	8/24/16
1	REVISED ITEMS #13 & #14	AR	6/29/16	LH	6/29/16
0	ISSUE FOR CONSTRUCTION	AR	5/14/15	BL	5/14/15



VENDOR CODE PLATE



NAMEPLATE BRACKET

SCALE 3" = 1'-0"

NOZZLE SCHEDULE

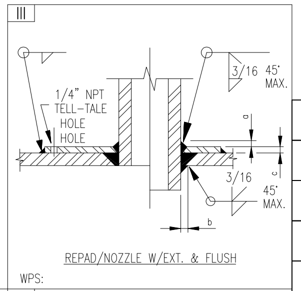
ANSI B16.5 FLANGES / B2.1 NPT

MARK	SERVICE	SIZE	RATING	TYPE	REPAD		PROJECTION		WELD DETAIL	WELD SIZE			COMMENTS
					THK.	O.D.	OUTSIDE	INSIDE		"a"	"b"	"c"	
G1,G2	LSHH	1"	150#	RFLWN			SEE DWG	D	II	3/8			
F	LIQUID OUT	2"	150#	RFLWN			7"	B	II	3/8			VORTEX BREAKER
E	TI	1"	150#	RFLWN			7"	D	II	3/8			
D	DRAIN	1"	150#	RFLWN			7"	B	II	3/8			
C1,C2	LG	1"	150#	RFLWN			SEE DWG	D	II	3/8			
B	VAPOR OUT	12"	150#	RFWN	3/8"	16 3/4"	10"	B	III,VI	3/8		5/16	
A	INLET	12"	150#	RFWN	3/8"	20 3/4"	SEE DWG	SEE DWG	III,VI	3/8		5/16	DIVERTER

WELD NOTES:
1) ALL BEVEL ANGLES TO BE 5°± ROOT PASS GAP TO BE ± 3/16"
2) INTERNAL PROJECTION FOR NOZZLES (IF REQ'D.) TO BE SPECIFIED ON THE VESSEL OUT-LINE DRAWING. WHERE INTERNAL PROJECTION IS NOT REQUIRED, THE NOZZLE SHALL BE SQUARE AND SMOOTH.
3) TAPER DIFFERENCES IN THICKNESS TO A 3 : 1 TAPER.
4) ALL FILLET WELDS 3/8" UNLESS OTHERWISE NOTED ON VESSEL OUT-LINE DRAWING OR SCHEDULE OF OPENINGS.
5) FABRICATION TOLERANCES PER UOPR. ENGINEERING STANDARD: ENG-13ac.

SHOP NOTES:
1) ALL NOZZLE REINFORCING PADS TO HAVE 1/4" NPT TELL-TALE HOLE. ALL OTHER PADS TO HAVE A GAP IN THE WELD TO PERMIT VENTING.
2) FLG. BOLT HLS. TO STRADDLE PRINCIPAL CL'S. OF VESSEL.
3) ALL CONNECTIONS TO BE COVERED FOR SHIPPING. FLANGES TO BE CLEANED AND COATED WITH RUST PREVENTATIVE.
4) IF SHOWN, LIFTING LUGS ARE DESIGNED FOR EMPTY VESSEL LIFT ONLY.

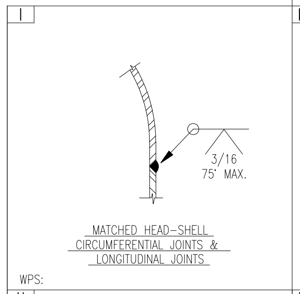
III



REPAD/NOZZLE W/EXT. & FLUSH

WPS:

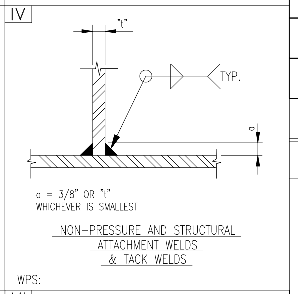
I



MATCHED HEAD-SHELL CIRCUMFERENTIAL JOINTS & LONGITUDINAL JOINTS

WPS:

IV

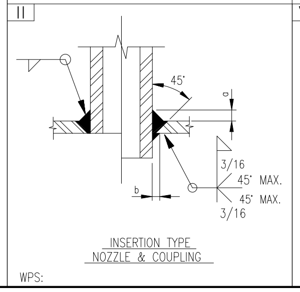


a = 3/8" OR "t" WHICHEVER IS SMALLEST

NON-PRESSURE AND STRUCTURAL ATTACHMENT WELDS & TACK WELDS

WPS:

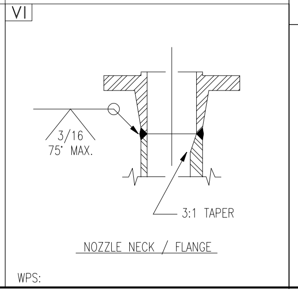
II



INSERTION TYPE NOZZLE & COUPLING

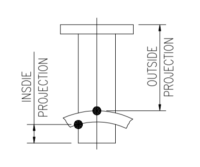
WPS:

VI



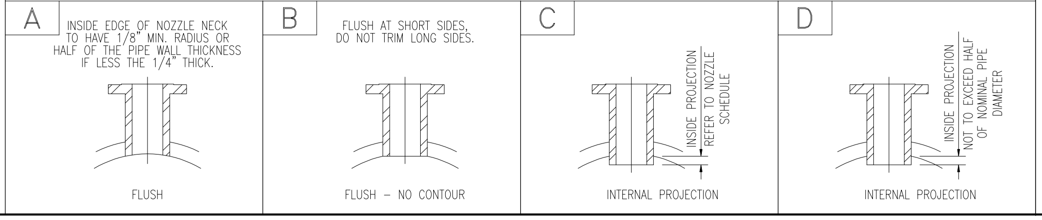
NOZZLE NECK / FLANGE

WPS:



NOZZLE PROJECTION

INSIDE PROJECTIONS



A INSIDE EDGE OF NOZZLE NECK TO HAVE 1/8" MIN. RADIUS OR HALF OF THE PIPE WALL THICKNESS IF LESS THE 1/4" THICK.

FLUSH

B FLUSH AT SHORT SIDES, DO NOT TRIM LONG SIDES.

FLUSH - NO CONTOUR

C INTERNAL PROJECTION

D INTERNAL PROJECTION

DESIGN DATA:

VESSEL TO BE CONSTRUCTED IN STRICT ACCORDANCE WITH THE 2015 EDITION AND NO ADDENDA OF THE ASME PRESSURE VESSEL CODE: SECTION VIII DIVISION 1, AND IS TO BE SO STAMPED.

NATIONAL BOARD NUMBER REQUIRED ■ YES ☐ NO

MAWP : 150 PSI @ 150 DEG. F. LIMITED BY: DESIGN OF VESSEL
MDMT: -200 DEG. F. @ 150 PSIG
FINAL HYDROSTATIC TEST: 200 2 PSI CHART REQ'D: ■ YES ☐ NO
HEAT TREAT: 0 HRS. 0 MIN. @ 1150 +/- 50 DEG. F. (CARBON STEEL)
CORROSION ALLOWANCE: 0"
CLIENT INSPECTION REQUIRED: ■ YES ☐ NO
SPECIAL WELD PROCEDURES REQ'D.: ☐ YES ■ NO
INSULATION REQUIRED: ☐ YES ■ NO - TYPE
MILL TEST REPORTS: ■ STD. PER CODE ☐ PER SPECS-
IMPACT REQUIREMENTS: IMPACT TEST EXEMPT PER UHA-51(d)(1)(a) & UHA-51(g)
EARTHQUAKE: ASCE 7-10 SITE=D, I=1.25 WIND VELOCITY: ASCE 7-10 120 MPH CAT |||, Exp C,
WEIGHT EMPTY: 9596 # FULL OF WATER: 56111 # OPERATING: 42603 #
SPECIFICATIONS: UOPR. ENGINERING STANDARDS
SURFACE PREPARATION: NONE
PAINT: NONE

NDE REQUIREMENTS:

	100%	RT1	RT2	RT3	RT4	NONE
RADIOGRAPHY:						
CATEGORY A WELDS	☐	☐	☐	■	☐	☐
LONG SEAM (SHELL)	FULL LTH.	FULL LTH.	FULL LTH.	SPOT		
CATEGORY B WELDS						
HEAD TO SHELL	FULL LTH.	FULL LTH.	SPOT	SPOT		
INTERMEDIATE GIRTH	FULL LTH.	FULL LTH.	SPOT	SPOT		
NOZZLE > 10" OR > 1.125	FULL	FULL	SPOT	SPOT		
NOZZLE ≤ 10" AND ≤ 1.125	FULL	N/A	N/A	N/A		
JOINT EFFICIENCIES (%)						
LONG SEAM	100	100	100	85		70
SEAMLESS	100	100	100	100		85
HEAD-SHELL	100	100	100	85		70

ULTRASONIC TEST: ☐ YES ■ NO

MAGNETIC PARTICLE TEST: ☐ YES ■ NO

DYE PENETRANT TEST: ☐ YES ■ NO

ADDITIONAL NDE NOTES:
NONE

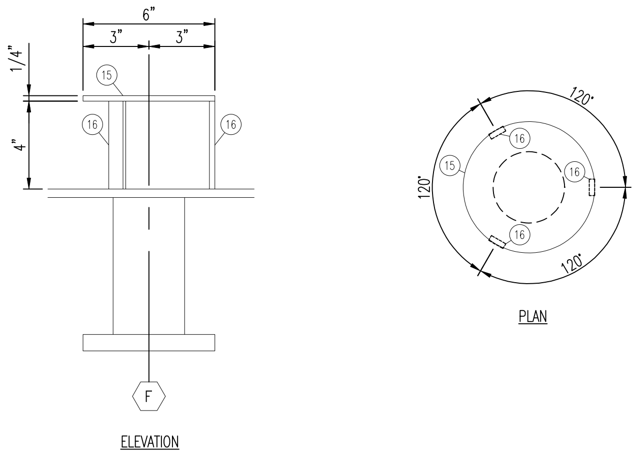
J-447
11/15/16
IFC

WV COA# C04812-00
TX P.E.# F-7531
OK P.E.# 6852

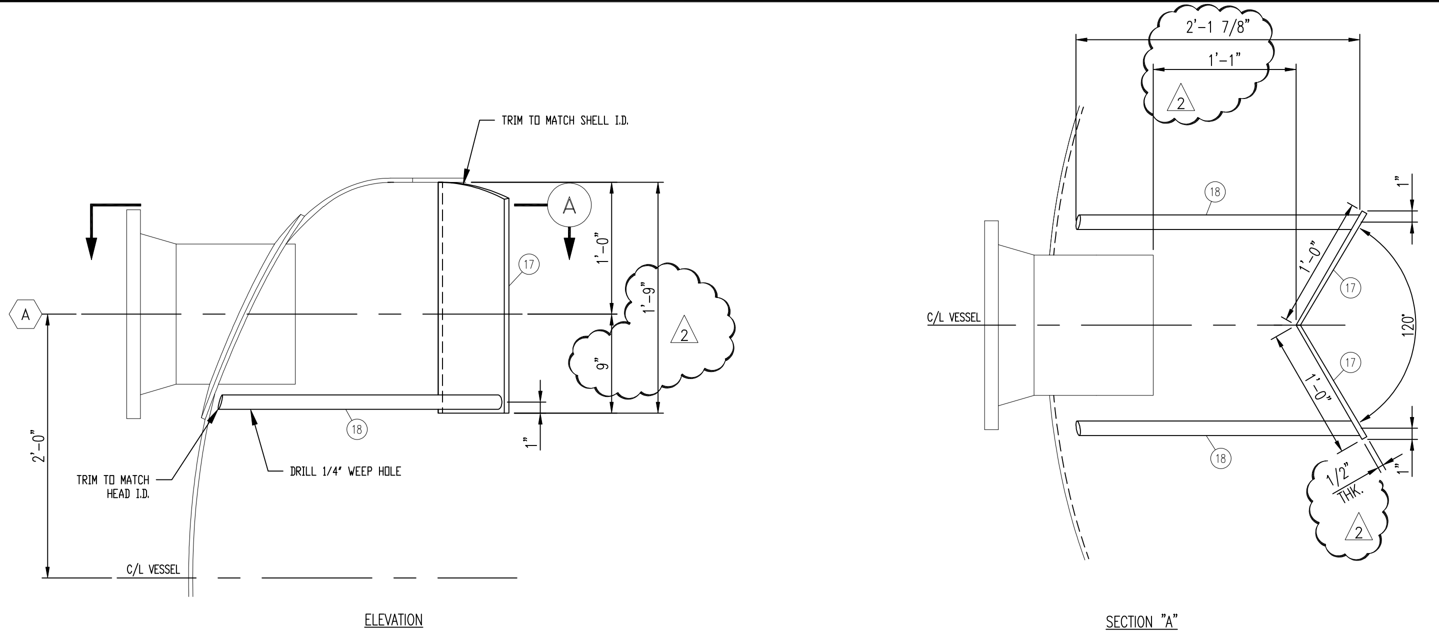
UOP Russell
7050 S. Yale, Suite 210
Tulsa, Oklahoma 74136
Phone: 918-481-5682
Fax.: 918-481-7427

UOP RUSSELL STANDARD
60 MM CRYO PLANT
FABRICATION DETAILS
V-492 - COLD DRAIN TANK 72" I.D. x 24'-0" S/S

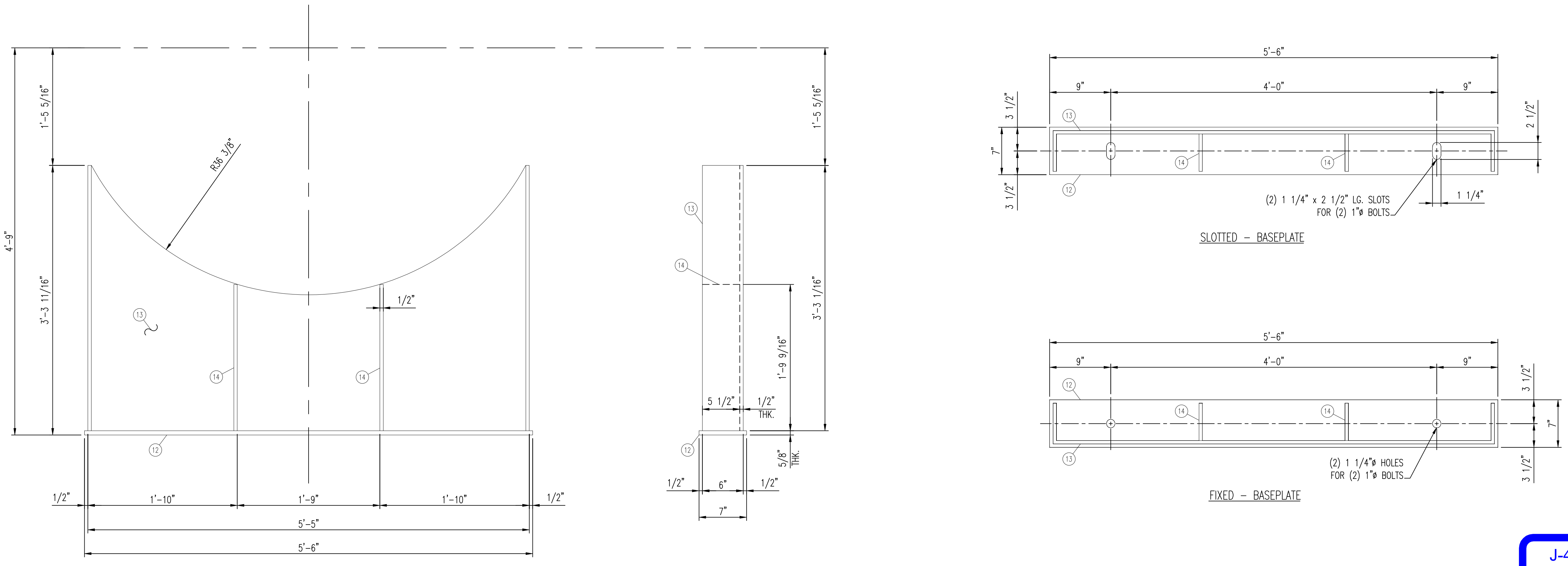
REV.	DRAWING NO.	SCALE	DRAWN BY	APPVD. BY	CHCK'D BY
2	SC6-302B	NOTED	AR	AM	WC
			DATE 5/14/15	DATE 5/14/15	DATE 5/14/15



DETAIL (A)
SCALE 3"=1'-0"



DETAIL (B)
SCALE 1 1/2"=1'-0"



DETAIL (C)
SCALE 1 1/2"=1'-0"

J-447
11/15/16
IFC

CONFIDENTIALITY STATEMENT

THIS DRAWING CONTAINS CERTAIN PROPRIETARY INFORMATION THAT IS THE PROPERTY OF UOP RUSSELL, LLC. THIS DRAWING IS PROVIDED FOR THE SOLE PURPOSE OF MAINTAINING AND/OR OPERATING THE PLANT AND/OR RELATED EQUIPMENT DESCRIBED HEREIN. THIS INFORMATION SHALL NOT BE USED FOR ANY OTHER PURPOSE. RECIPIENTS SHALL TAKE ALL REASONABLE MEASURES TO MAINTAIN THE CONFIDENTIALITY OF THIS DRAWING. NO PART OF THIS DRAWING MAY BE REPRODUCED OR USED FOR THE PURPOSES OTHER THAN OPERATING AND/OR MAINTAINING THE PLANT AND/OR RELATED EQUIPMENT MANUFACTURED BY UOP RUSSELL, LLC WITHOUT THE EXPRESS WRITTEN CONSENT OF UOP RUSSELL, LLC. ANY DUPLICATION OF THIS DRAWING IN WHOLE OR IN PART IS A VIOLATION COPYRIGHT AND IS SUBJECT TO CIVIL AND CRIMINAL PENALTIES.

REV.	DESCRIPTION	BY	DATE	APP'D	DATE
2	REVISED DETAIL "B"	AR	8/24/16	GG	8/24/16
1	REVISED DETAIL "C"	AR	6/29/16	LH	6/29/16
0	ISSUE FOR CONSTRUCTION	AR	5/14/15	BL	5/14/15

REVISIONS

OK P.E.# 6852
WW COA# C04812-00
TX P.E.# F-7531

UOP Russell

7050 S. Yale, Suite 210
Tulsa, Oklahoma 74136
Phone: 918-481-5682
Fax.: 918-481-7427

UOP RUSSELL STANDARD
60 MM CRYO PLANT
FABRICATION DETAILS
V-492 - COLD DRAIN TANK 72" I.D. x 24'-0" S/S

REV.	DRAWING NO.	SCALE	DRAWN BY	APPVD. BY	CHCK'D BY
2	SC6-302C	NOTED	AR	AM	WC
			DATE 5/14/15	DATE 5/14/15	DATE 5/14/15