UOP RUSSELL LLC
Tulsa, Oklahoma

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

PRESSURE VESSELS

MECHANICAL DESIGN

Type (vertical, horizontal, tower)	Vertical
Diameter: (inch)	18" OD
S/S Length (ft-inch)	5' - 6"
Skirt Length(ft-inch)	1' - 0"
Design Pressure (psig)	1100
Design Temperature (°F)	150
MDMT (°F) @ Pressure (psig)	-20 @ 1100
Corrosion Allowance (inch)	0.125
Radiography	RT-2
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	Note 3
Fireproof	No
Code	ASME VIII, Div I
Code Stamp Req'd	Yes
Sandblast / Paint	SSPC-SP6 / TRCo Std ENG-36c (Note 4)
Ladder / Platform Clips Req'd?	No
Pipe Supports Req'd?	No

PROCESS DESIGN

Operating Pressure (psia)	981
Operating Temperature (°F)	120
Vapor Flow (Lb/Hr)	18,272
Vapor Density (Lb/cf)	3.333
Liquid Flow (Lb/Hr)	2,676
Liquid Density (Lb/cf)	61.89
Liquid Residence Time (Min)	5.0

MIST PAD

Req'd :	Yes	Diameter:	18
Overall Thk:	8	Pad Thk:	6"
Removable:	No	Grid Matl:	316SS
Wire Diameter:	0.011	Mesh Matl:	316SS

MATERIAL SPECIFICATIONS

Shell	SA-	106B
Head	SA-	516-70
Nozzle Necks	SA-	106B
Flanges	SA-	105
Couplings	SA-	105
Studs	SA-	193-B7
Nuts	SA-	194-2H
Skirt / Baseplate	SA-	106B / 516-70

NOZZLES

SERVICE	MK	QTY	SIZE	RATING	FACE & TYPE	NOZZLE APPURTENANCES
Inlet	A	1	4."	600	RF FLG	Diverter
Vapor Outlet / Inspection	B	1	4."	600	RF FLG	
Liquid Outlet	C	1	1."	600	RF FLG	Syphon
LC	D	2	1.5"	3000	CPLG	
LSHH	E	2	1."	6000	CPLG	
LG	F	2	.75"	6000	CPLG	
TI	G	1	.75"	6000	CPLG	
Inspection	H	1	2."	6000	CPLG	Plugged

INTERNALS AND APPURTENANCES

PACKING	Size (in.)	Type	Bed Height (ft.)	PLATFORMS	Quantity	Angle / Area		DOME	BOOT
Top				Access:		(deg)	Diameter (in):		
Middle				Stepoff:		(deg)	Length (in):		
Bottom				Other:		(Sq.Ft.)	with flanges		

TRAYS	Quantity	No. of Passes	Weldins by:	Platepack Length (inch):	Qty Break Flg Pairs:
				Total Ladder Length (ft):	Qty of Hat Trays:

NOTES:	1) See scope of supply for oversizing mist pads.	Weir Plate:	No
	2) 5 min residence time with NLL at 20"	Wave Baffle:	No
	3) Electric heat trace w/1" H to NLL	Nat'l Board Req'd:	Yes
	4) Use TRCo Painting System 3 with a Top Coat	Charcoal Bed Height (ft):	
		Qty Catalyst bed Supports:	

REVISION	A		0		1				
ENGINEER/DATE	JRG	11/29/10	JRG	7/14/2011	BH	11/21/11			
ISSUED FOR	RFQ		Purchase		Revised				

UOP RUSSELL, LLC
Tulsa, Oklahoma

FORM # MST-ELM

MIST ELIMINATOR SPECIFICATION

Job Number J-447

Vessel Tag V-447

Spec. No.: ME-

Spec. By: JRG

Checked By:

Date: 11/29/2010

Mistpad Installed Diameter:	18	inches
Mesh Thickness:	6	inches
Mesh Material:	316SS	
Density Required:	12	lbs/cf
Wire Diameter:	0.011	inches
Grid Material:	316SS	
Grid Diameter:	16.5	inches
Mistpad Overall Thickness:	8	inches
Oversize mesh (on all sides):	0.375	inch
Manway I.D.:	17	inches
Number of Segments:	4	
Removeable (Yes / No):	No	

Note 1: Oversized diameter of Mist Extractor shall allow the vessel to be shipped horizontally with the

No. of segments	**Oversize (all sides of each sections)**
1 or 2	**1/2"**
3 or 4	**3/8"**
More than 4	**1/4"**

Note 2: Grid diameter shall be 1-1/2" less than the installed diameter shown above.

Note 3: OD of each grid section shall be banded.

REVISION	0										
ENGINEER/DATE	JRG	7/14/2011									
ISSUED FOR	Purchase										

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
18" O.D. X 5'-6" SM/SM VERT. REGEN GAS SCRUBBER

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

Job No:
175017
Vessel Number:
TAG #V-447
Purchase Order No.:
4500754178

NAMEPLATE INFORMATION

MAWP: 1100 PSI at 150 Deg. F
MDMT -20 Deg. F at 1100 PSI
Serial Number(s): 175017
National Board Number(s): 2857

Radiography: RT-2
Postweld Heat Treated: NO
Construction Types: W

Signatures

Quality Control Mgr: George E Lewis Date: 1/12/17

Authorized Inspector: _____ Date: 2/7/17

LEWIS INDUSTRIES

V-447

TABLE OF CONTENTS

National Board Number: 2857

Mfr. Representative: [signature] Date: 2-7-17

Authorized Inspector: DMC Date: 2-7-17

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 Vertical Tank (Horizontal or vertical, tank) | 175017 (Manufacturer's serial number) | (CRN) | SC6-303 A & B (Drawing number) | 2857 (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-106-B (Material spec. number, grade) | .938 (Nominal thickness) | .125 (Corr. allow.) | 18" O. D. (Inner diameter) | 5'-6" [Length (overall)]

Body Flanges on Shells

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

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

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

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	Top	.813	.125	-	-	2:1	-	-	-	Concave
(b)	Bottom	.813	.125	-	-	2:1	-	-	-	Concave

Body Flanges on Heads

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

9. MAWP 1100 (Internal) - (External) at max. temp. 150 (Internal) - (External).

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

Proof test -.

10. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Type	Material: Nozzle	Material: Flange	Nozzle Thickness: Nom.	Nozzle Thickness: Corr.	Reinforcement Material	Attachment Details: Nozzle	Attachment Details: Flange	Location (Insp. Open.)
Inlet	1	4"	RFLWN	-	SA-105	CL600	.125	-	UW16.1(c)	-	Shell
Outlet	1	4"	RFLWN	-	SA-105	CL600	.125	-	UW16.1(c)	-	Head (a)
Connection	1	1"	RFLWN	-	SA-105	CL600	.125	-	UW16.1(c)	-	Shell
Connection	1	2"	CPLG	-	SA-105	CL6000	.125	-	UW16.1(y)	-	Shell
Connections	2	1 1/2"	CPLG	-	SA-105	CL3000	.125	-	UW16.1(y)	-	Shell
Connections	2	1"	CPLG	-	SA-105	CL6000	.125	-	UW16.1(y)	-	Shell
Connections	3	3/4"	CPLG	-	SA-105	CL6000	.125	-	UW16.1(y)	-	Shell

11. Supports: Skirt Yes (Yes or no) Lugs - (Number) Legs - (Number) Other - (Describe) Attached Bottom Head-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:
(Name of part, item number, Manufacturer's name and identifying stamp)

SAFETY VALVE(S) SUPPLIED BY OTHERS PER UG-125(a), IMPACT TESTING EXEMPT PER UCS-66(b)(3)

National Board Number: 2857

Mfr. Representative: GG Date: 2-7-17

Authorized Inspector: DMC Date: 2-7-17

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 2/7/17 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 2-7-17 , 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 2-7-17 Signed (Authorized Inspector) Commissions NB 15483A [National Board (incl. endorsements)]

(04/14)

TRAVELER

Job No.: 175017 Dimensions: 18"O.D. X 5'-6" S/S Hydro Press.: 1430

Serial No.: 175017 RT: 2 P.W.H.T.: N/A

National Board No.: 2857 M.A.W.P.: 1100 Other NDE: N/A

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

S-447

P.O. #

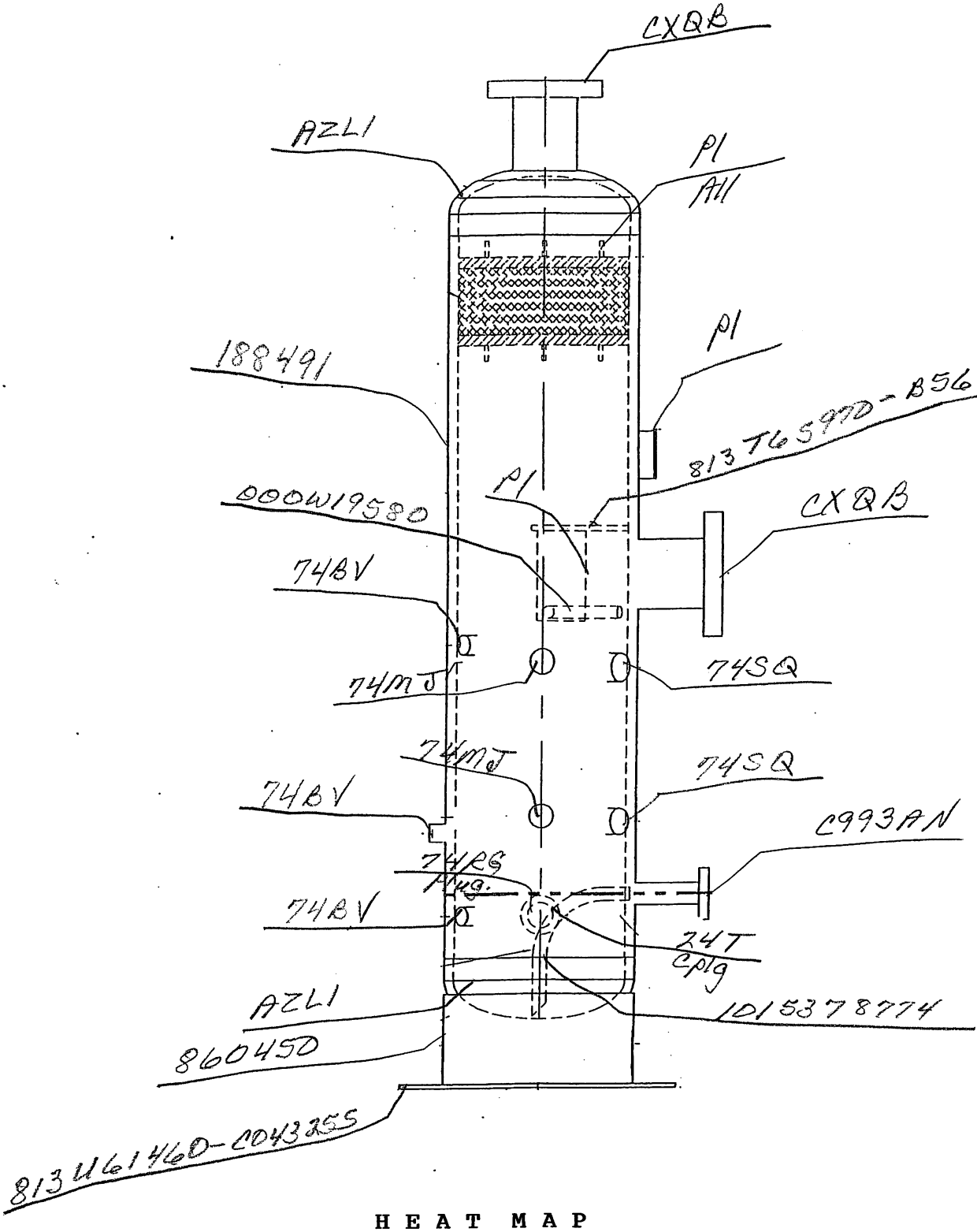
4500754178

LIC# 175017

Tag # V-447

ITEM #	QTY.	DESCRIPTION	COMMENTS	MATERIAL	WEIGHT	HEAT #
1	2	2:1 ELLIP. HEAD 18" O.D. (0.813" MIN. THK.) WITH 2" SF	HEAD 1&2	SA-516-70	200	AZLI
2	1	PIPE, 18" S/80 (0.938" NOM.) x 5'-6" LG. BExBE	SHELL	SA-106-B	940	188491
3	1	PIPE, 18 " STD. SMLS. (0.375" NOM.) x 8 5/16" LG. PBE	SKIRT	SA-106-B	50	860450
4	1	PLATE, 3/8" THK. x 26" O.D. x 15" I.D. W/(4) 7/8" DIA. HOLES x 22 1/2" DIA B.C. 913461460 -	BASE RING	SA-516-70	38	C04325
		EQUALLY SPACED & STRADDLE NORMAL CENTERLINES				
6	1	FLANGE, 1" RFLWN 600#, x 9" LG.	C	SA-105	9	C993AN
7	2	FLANGE, 4" RFLWN 600#, x 10" LG.	A, B	SA-105	136	CX8B
8	1	CPLG, 2" 6000# TOE x 3" LG.	H	SA-105	3	24T
9	2	CPLG, 1 1/2" 3000# TOE x 3" LG.	D1 D2	SA-105	4	74SQ
10	3	CPLG, 3/4" 6000# TOE x 3 3/8" LG.	F1,F2,G	SA-105	3	74BV
11	1	PLUG, SOLID STEEL, ROUND HEAD THREADED 2"	H	SA-105	1	74RG
12	2	CPLG, 1" 6000# TOE x 3" LG.	E1, E2	SA-105	3	74MJ
14	4	FLAT BAR, 3/8" THK. X 1 1/2" WD x 11 5/8" LG.	MIST PAD	SA-36	8	PI
15	2	FLAT BAR, 3/8" THK. X 1 1/2" WD x 1'-4 1/8" LG.	MIST PAD	SA-36	5	PI
16	1	WIRE MESH PAD, 12 PCF, .011" WIRE, 6" THK. X 16 1/8" O.D., W/1" GRID TOP & BOTTOM (316SS)	MIST PAD	316SS	16	
18	1	PLATE, 1/2" THK. X 8 1/2" WD x 9 3/16" LG. (CUT PER DETAIL "A") 913765970 -	INLET DIVERTER	SA-516-70	11	B562448
19	1	ANGLE, 6" x 6" x 1/2" x 7 1/2" LG.	INLET DIVERTER	SA-36	13	PI
20	2	PIPE, 3/4" XH x 7 1/8" LG. (CUT PER DETAIL A)	INLET DIVERTER	SA-106B	2	0000419580
22	1	PIPE, 1" S/160 x 1'-1 1/4" LG. POE (BEND AND CUT PER DETAIL "D")	SYPHON	SA-106-B	2	10153787??
27	1	W6x15 x 4 1/2" LG. (CUT PER DETAIL)	NAMEPLATE	SA-36	3	PI

PCE 2/1/17

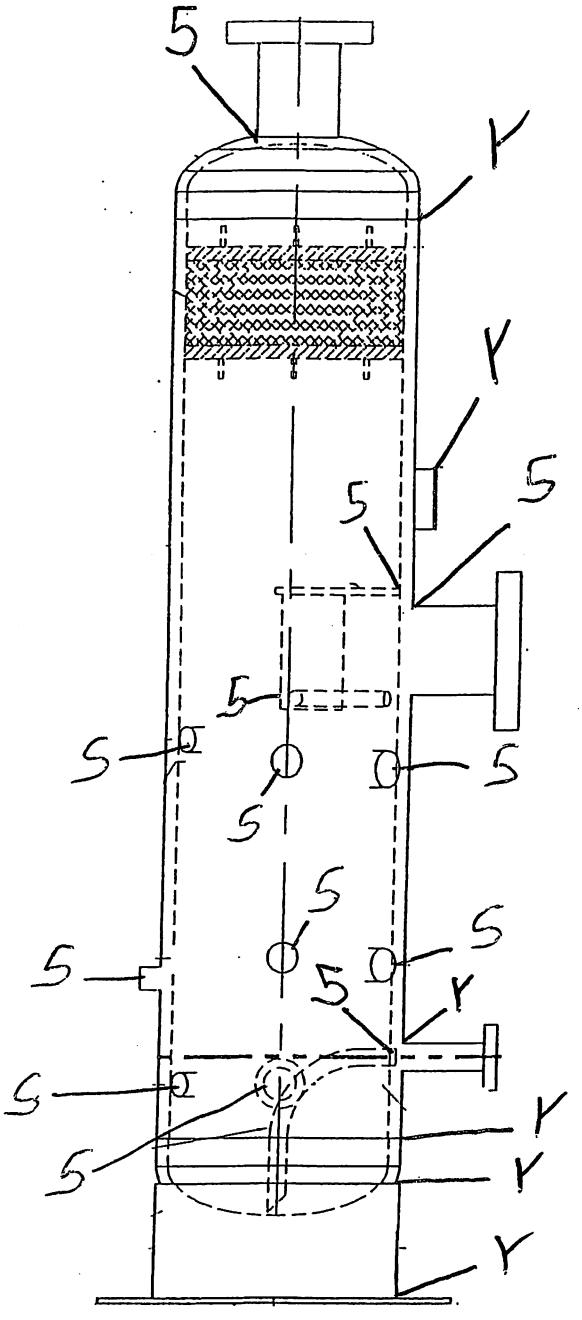


H E A T M A P

LIC #175017

UOP TAG #V-447

PKE 3/1/17

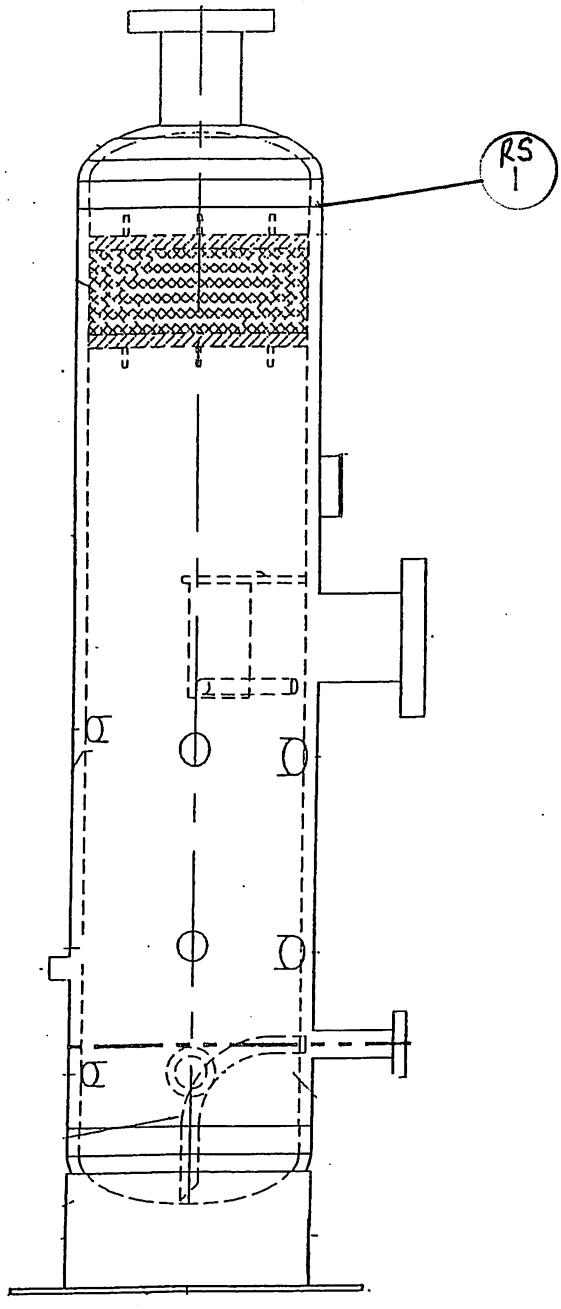


W E L D M A P

LIC #175017

UOP TAG #V-447

PKR 2/1/11



X - R A Y M A P

LIC #175017

UOP TAG #V-447

ACR 2/1/17

J-447 V-447

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

TECHNIQUE / INSPECTION REPORT

DATE 1-31-17 DAY Tues

CUSTOMER DATA

NAME Lewis
ADDRESS
PHONE ATTN:
W.O. # 175017 P.O. #
JOB LOCATION Collinsville 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 REP = REPAIR RET = RETAKE
WT = WELD THICKNESS RES = RESHOOT
WR = WELD REINFORCEMENT BM = BASE MATERIAL

	WELD/FILM NUMBER	JOB NUMBER	OD	BM	WR	WT	WITHIN STD'S YES	WITHIN STD'S NO	# FILM	FILM SIZE / MFG / TYPE	SOD	OFD	IQI S-F	# EXP	DEFECT LOCATION
1	RS1	175017 1-2	18"	.938	.125	1.063	✓		1	4½x10 F80	9"	1.063	B	1	
2															
3															
4															
5															
6															
7															
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1-31-17

METHOD RT	SOURCE SIZE DIAG. 1146	ISOTOPE Ir192	NO. CURIES 90	DEV. TIME 5min	DEV. TEMP 68°	DENSITY 2.4	
NO. OF WELDS 1	FT. LONG SEAMS	STANDARDS ASME Sec V	PERDIEM	NO. OF FILM 1	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 Marcic O'Neal				ASNT LEVEL II	
COMPANY REPRESENTATIVE		NDT TECHNICIAN Jesse Graham				ASNT LEVEL II	

SIGNATURE CERTIFIES TIME & MATERIALS CORRECT SIGNATURE

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

201762

Rev. 5/08

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: 175017

ITEM NUMBER: 18" O.D. X 5'-6" SM/SM VERT. REGEN GAS SCRUBBER TAG #V-447
J-447

CUSTOMER: UOP RUSSELL LLC / HONEYWELL

PURCHASE ORDER NUMBER: 4500754178

MAX. ALLOW. WORKING PRESS.:

SHELL SIDE: 1100 P.S.I.

TUBE SIDE: P.S.I.

TEST PRESSURE:

SHELL SIDE: 1430 P.S.I.

TUBE SIDE: P.S.I.

HOLDING TIME ONE (1) HR(S)

TEST GAUGE SERIAL NUMBER L3000-1 3000#

SPECIAL INSTRUCTIONS: WITH CHART

Quality Control Manager: George E Lewis **Date** 2-7-17

Authorized Inspector: **Date** 2-7-17

Customer Inspector: **Date** 2/7/17

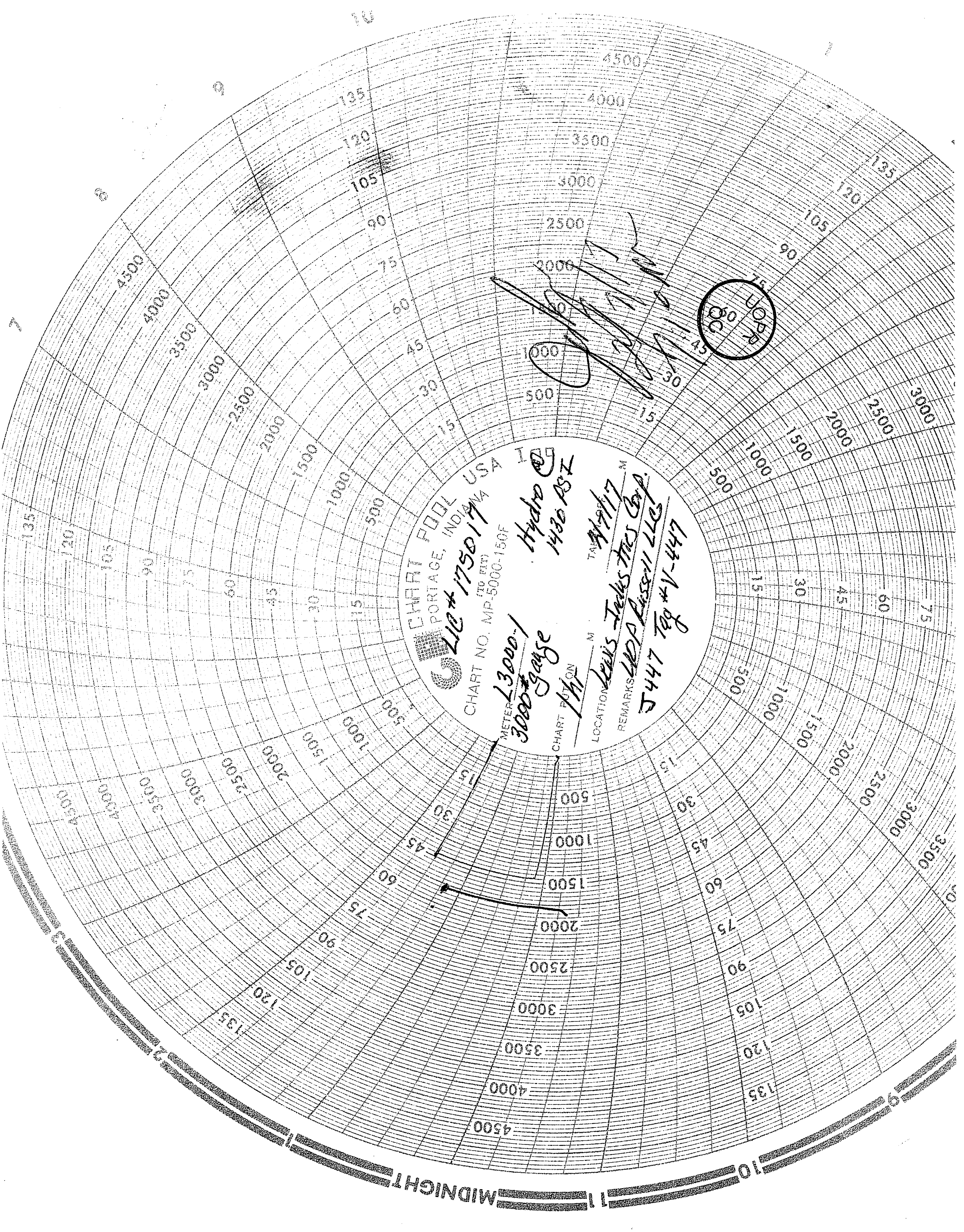


CHART POOL USA INC
PORTAGE, INDIANA
CHART NO. MP-5000-150F
LIC# 175017
Hydro @ 1430 PSI
METER L3000-1 3000# gauge
CHART PUT ON 1hr
TAKEN OFF 4/7/17
LOCATION Lewis Industries Corp.
REMARKS UDOP Russell LLC
J447 Tag #V-447
UDOP QC
MIDNIGHT

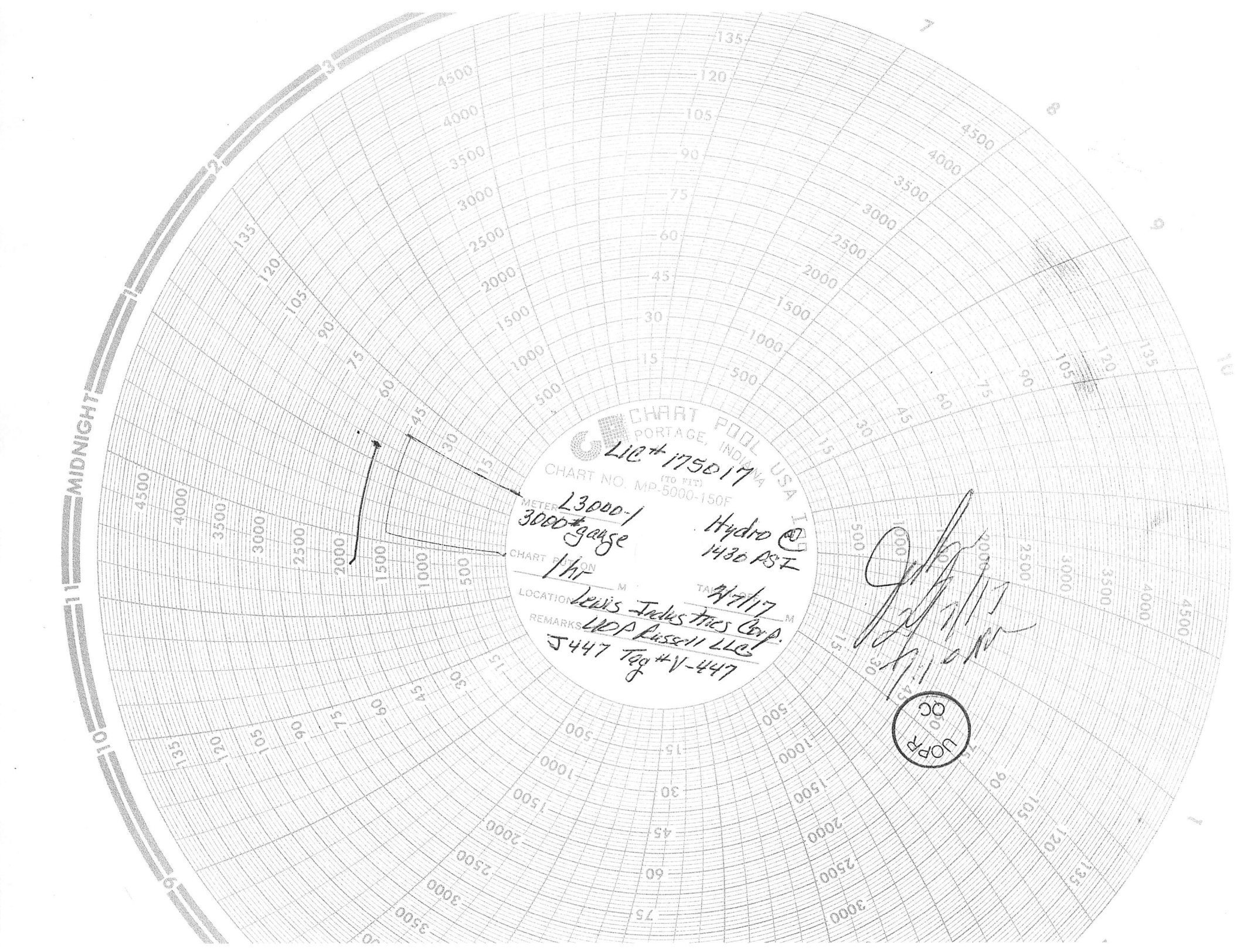
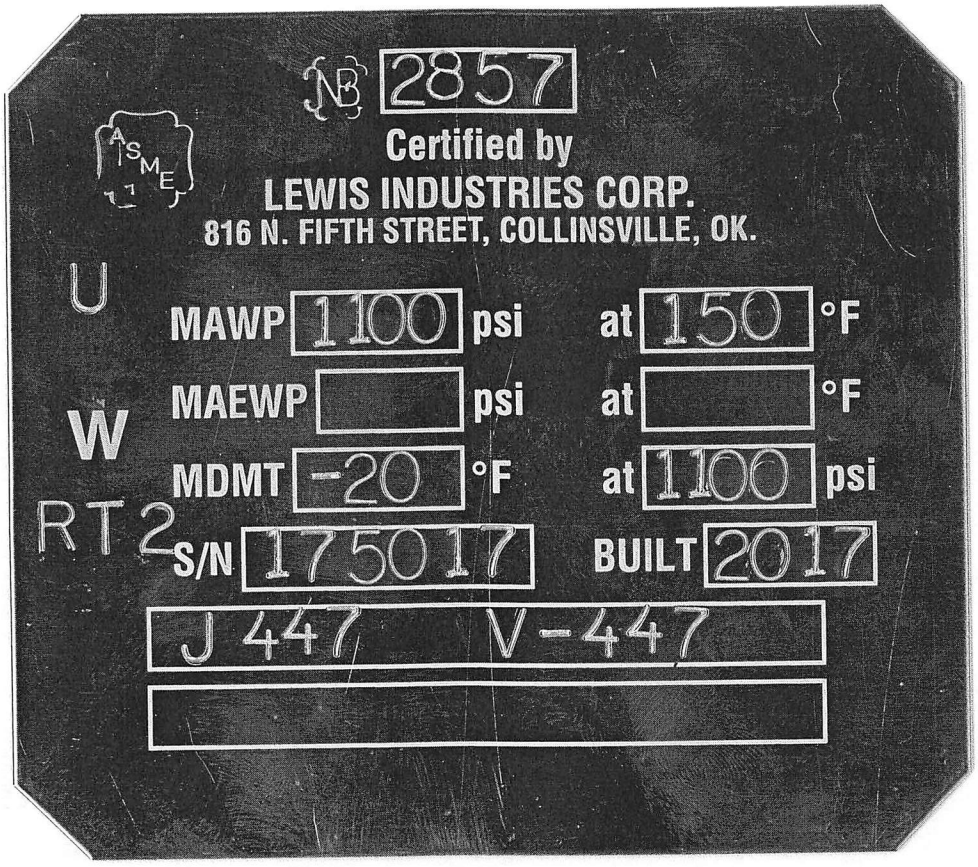
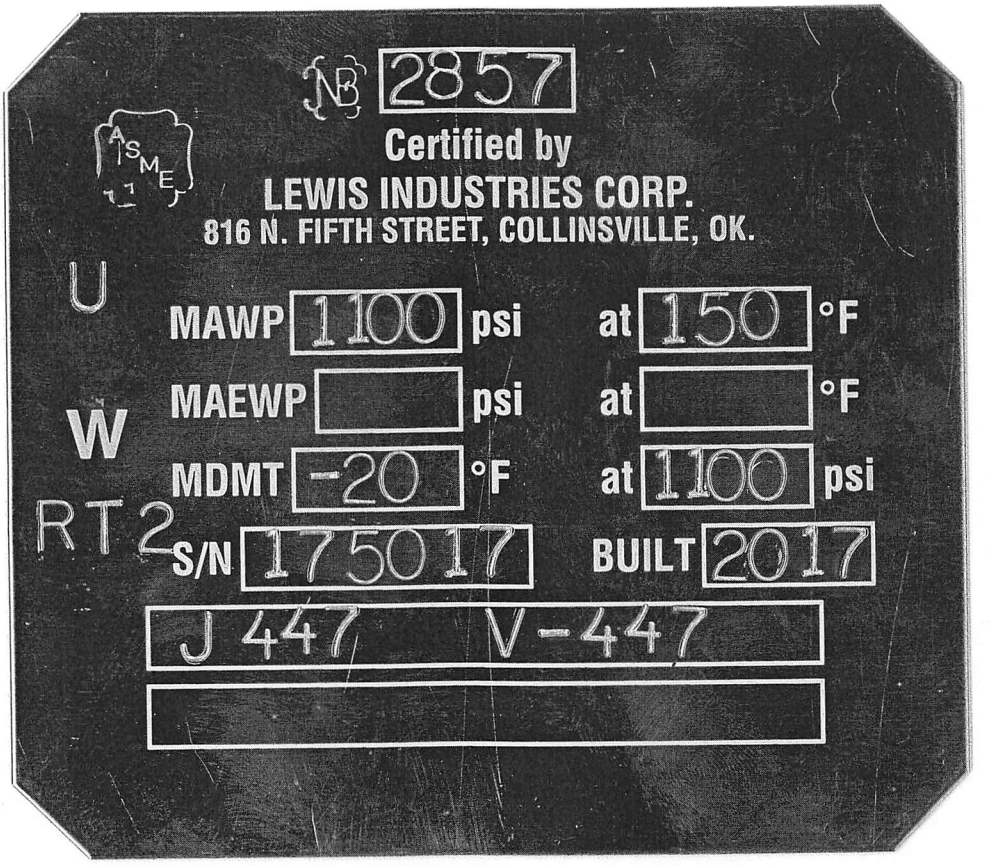


CHART POOL USA LTD
PORTAGE, INDIANA
CHART NO. MP-5000-150F
(TO FIT)
LIC# 175017
METER 3000-1
3000# gauge
CHART PUT ON 1/17
Hydro @ 1430 PST
TAKEN 1/17
LOCATION Lewis Industries Corp.
REMARKS WDP Russell LLC
J447 Tag #V-447
MIDNIGHT
UOPR
QC


NB 2857
ASME
Certified by
LEWIS INDUSTRIES CORP.
816 N. FIFTH STREET, COLLINSVILLE, OK.
U
MAWP 1100 psi at 150 °F
MAEWP psi at °F
W
MDMT -20 °F at 1100 psi
RT 2
S/N 175017 BUILT 2017
J 447 V-447


NB 2857
ASME
Certified by
LEWIS INDUSTRIES CORP.
816 N. FIFTH STREET, COLLINSVILLE, OK.
U
MAWP 1100 psi at 150 °F
MAEWP psi at °F
W
MDMT -20 °F at 1100 psi
RT 2
S/N 175017 BUILT 2017
J 447 V-447

UOP
A Honeywell Company

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

Quality Management System

Job Number : 175017 **Equipment Number :** J447/V-447 **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.

			Activity Information	Code
No	**Acceptance Criteria**	**UOP Notes to Fabricator**	**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

UOP
A Honeywell Company

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

Quality Management System

Job Number : 175017 **Equipment Number : J447/V-447** **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: J--447
Technical Document(s):	Applicable codes/Drawings/Customer requirements	
Equipment Description:	VERT. REGEN GAS SCRUBBER	
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 IND. CORP., 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**	

Issued by:		**Date:**	
Reviewed by:		**Date:** 4/3/17	
Acknowledged by:		**Date:**	

SSAB

Test Certificate

12400 Highway 43 North, Axis, Alabama 36505, US

Form TC1: Revision 2: Date 23 Apr 2014

Customer:
PRESCOR INC.
P.O. BOX 9856

TULSA
OK 74157 0856

Customer P.O.No.: MM15077 | **Mill Order No.** 41-422436-03 | **Shipping Manifest:** AR202205

Product Description: ASTM A516-70(10)/ASME SA516-70(13)
AS-ROLLED, TENSILE COUPON NORMALIZED
1650F+/-25F/1HR/*

Ship Date: 20 Mar 15
Cert Date: 20 Mar 15

Cert No: 081500263
(Page 1 of 1)

Size: 1.000 X 120.0 X 240.0 (IN)

Tested Pieces:				Tensiles:						Charpy Impact Tests							
Heat Id	Piece Id	Tested Thickness	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir	Hardness	Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
W5B779	E10	0.997 (DISCRT)	L	50	73		26	T							
W5B779	E10*	0.997 (DISCRT)	L	51	74		29	T	AZ LI						

Chemical Analysis

Heat Id	C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	ORGN
W5B779	.19	1.10	.008	.001	.25	.028	.027	.27	.13	.15	.04	.000	.004	.008	.0002	USA

KILLED STEEL
MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT.
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
RESULTS OF TESTS PERFORMED ON NORMALIZED TEST COUPONS ARE LABELED ABOVE WITH *
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA.
PRODUCTS SHIPPED:
W5B779 E10 PCES: 3, LBS: 24504

(P) Cust Part #:

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

Justin Ward +1 251 662 4400
SENIOR METALLURGIST - PRODUCT

PCR 2/1/17

LLC# 175017

FSPET 1880

Manufacturer: ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/1 ROMAN. NEAMT.COUNTY, ROMANIA	**MILL TEST CERTIFICATE** according to EN 10204/3.1/2004	Page 1/4 D 1882/1 30.11.2014	ArcelorMittal

Buyer: ARCELOR INTERNATIONAL AMERICA LLC. 1 South Dearborn Street. 13th Floor Chicago, IL 60603-9888 USA	SEAMLESS STEEL PIPES	Total weight: 85.123 tons 187 664 lbs	Total Length: 334.38 meters 1 097.02 feets	Pieces 31	Bundles -

Buyer's reference	AMI ORDER: 10088643 / PO NUMBER: HR053756
Contract	50001782

Standard: API 5L-ed.45-2012- PSL 1, ASTM A106/A 106M-2014;ASTM A 53/A53M- 2012; ASME SA 106/SA 106M-2013; ASME SA 53/SA 53M-2013;NACE MR 0103-2012; NACE MR 0175/ISO 15156-1&2/2009

Dimensions: 457.00 x 23.83 mm 18.000 x 0.938 inch | Schedule: 80 | Length: 9.50 - 12.50 m | 31.17 - 41.01 feet

Item	Item Client
11	-

Hydro Test:	Bar	PSI	MPa	Time(sec)
	205	2970	20.5	5

Steel Grade: B / X42 / C -

Chemical Analysis(%)

Heat	Bulletin No.	Product Req.		C	Mn	Si	S	P	Cr	Ni	Cu	Mo	V	Nb	Ti	B
			Max	0.23	1.06	-	0.030	0.030	0.40	0.40	0.40	0.15	-	-	-	0.0010
			Min	-	0.29	0.10	-	-	-	-	-	-	-	-	-	-
182910		Heat analysis		0.20	0.90	0.25	0.008	0.012	0.07	0.08	0.18	0.02	0.002	0.002	0.001	0.0005
188491		Heat analysis		0.21	0.93	0.25	0.008	0.011	0.08	0.07	0.20	0.02	0.002	0.002	0.003	0.0003
191849		Heat analysis		0.21	0.94	0.28	0.004	0.010	0.08	0.07	0.19	0.02	0.002	0.002	0.002	0.0003
192076		Heat analysis		0.21	0.94	0.26	0.005	0.008	0.08	0.07	0.19	0.02	0.002	0.002	0.002	0.0005
182910	13-1353	Product analysis		0.20	0.92	0.21	0.005	0.012	0.06	0.07	0.18	0.00	0.000	0.002	0.000	0.0000
182910	13-1353	Product analysis		0.20	0.92	0.20	0.005	0.012	0.06	0.07	0.17	0.00	0.000	0.002	0.000	0.0000
188491	14-787	Product analysis		0.20	0.94	0.24	0.008	0.012	0.08	0.07	0.19	0.02	0.002	0.002	0.000	0.0000
188491	14-787	Product analysis		0.21	0.93	0.25	0.008	0.011	0.08	0.08	0.20	0.02	0.002	0.002	0.000	0.0000
191849	14-2940	Product analysis		0.20	0.90	0.28	0.007	0.012	0.08	0.08	0.18	0.03	0.000	0.002	0.000	0.0000
191849	14-2940	Product analysis		0.20	0.90	0.27	0.007	0.012	0.08	0.08	0.18	0.03	0.000	0.002	0.000	0.0000
192076	14-2940	Product analysis		0.20	0.91	0.27	0.006	0.011	0.08	0.08	0.20	0.02	0.000	0.002	0.000	0.0000
192076	14-2940	Product analysis		0.20	0.91	0.26	0.006	0.011	0.08	0.08	0.20	0.02	0.000	0.002	0.000	0.0000

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative
Eng. Iesanu Cristian

ArcelorMittal Tubular Products Roman S.A. ArcelorMittal J27/88/91 Romania

Formular 12A, rev.9

PKC 21/17
LIC# 175017

| 4500751484 | S447 | 188491] | [IN: 22] | T0379851-1 | FSPET1880 |

Manufacturer: ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST. 15A/1 ROMAN. NEAMT,COUNTY, ROMANIA	**MILL TEST CERTIFICATE** according to EN 10204/3.1/2004	Page 2/4 D 1882/1 30.11.2014	ArcelorMittal

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Buyer's reference	AMI ORDER: 10088643 / PO NUMBER: HR053756
Contract	50001782

Standard: API 5L-ed.45-2012- PSL 1; ASTM A106/A 106M-2014,ASTM A 53/A53M-2012; ASME SA 106/SA 106M-2013; ASME SA 53/SA 53M-2013:NACE MR 0103-2012; NACE MR 0175/ISO 15156-1&2/2009

Dimensions: 457.00 x 23.83 mm 18.000 x 0.938 inch	Schedule: 80	Length. 9.50 - 12.50 m	31.17 - 41.01 feet

Item	Item Client
11	-

Hydro Test:	Bar	PSI	MPa	Time(sec)
	205	2970	20.5	5

Steel Grade: B / X42 / C -

Chemical Analysis(%)

Heat	Bulletin No.	Product Req.		Nb + V	Nb + Ti + V	Cr + Mo + Ni + Cu + V	CE_IIW
			Max	0.060	0.150	1.000	0.41
			Min	-	-	-	-
182910		Heat analysis		0.004	0.005	0.352	0.39
188491		Heat analysis		0.004	0.007	0.372	0.40
191849		Heat analysis		0.004	0.006	0.362	0.40
192076		Heat analysis		0.004	0.006	0.362	0.40
182910	13-1353	Product analysis		0.002	0.002	0.310	0.38
182910	13-1353	Product analysis		0.002	0.002	0.300	0.38
188491	14-787	Product analysis		0.004	0.004	0.362	0.39
188491	14-787	Product analysis		0.004	0.004	0.382	0.40
191849	14-2940	Product analysis		0.002	0.002	0.370	0.39
191849	14-2940	Product analysis		0.002	0.002	0.370	0.39
192076	14-2940	Product analysis		0.002	0.002	0.380	0.39
192076	14-2940	Product analysis		0.002	0.002	0.380	0.39

$CEpcm = C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo/15+V/10+5B$ $CE\_S = C+Mn/6$ $CE_{IIW} = C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15$

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative
Eng. Iesanu Cristian

ArcelorMittal Tubular Products Roman S.A. ArcelorMittal J27/80/91 Romania

Formular 12A, rev.9

PKE 2/1/17
HC#175017

| 4500751484 | S447 | 188491] | [IN: 22] | T0379851-1 | FSPET1880 |

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Dimensions: 457.00 x 23.83 mm / 18.000 x 0.938 inch | Schedule: 80 | Length: 9.50 - 12.50 m | 31.17 - 41.01 feet

Item	Item Client
11	-

Hydro Test:	Bar	PSI	MPa	Time(sec)
	205	2970	20.5	5

Steel Grade: B / X42 / C -

Tensile Test

Heat	Orientation	Length		Width/Diameter		Thickness		Section		Mechanical test Bulletin No.	YS MPa	YS (PSI:1000)	UTS MPa	UTS (PSI:1000)	E %	YS/UTS max: -
		mm	inch	mm	inch	mm	inch	mm²	inch²							
182910	Longitudinal Round	50.8	2	12.50	0.492	0.00	0.000	122.7	4.831	14-4427	359.00	52.1	541.00	78.5	31.00	0.66
188491	Longitudinal Round	50.8	2	12.50	0.492	0.00	0.000	122.7	4.831	14-4426	355.00	51.5	540.00	78.3	30.90	0.66
191849	Longitudinal Round	50.8	2	12.55	0.494	0.00	0.000	123.6	4.866	14-4581	360.00	52.2	546.00	79.2	32.10	0.66
192076	Longitudinal Round	50.8	2	12.55	0.494	0.00	0.000	123.6	4.866	14-4581	379.00	55.0	546.00	79.2	31.50	0.69

Hardness Test

Heat	Hardness Test Bulletin No.	HB max.-	HV 10 max.-	HV 10 max.-					HRC max.22
				OD	Midwall	ID	End A	End B	
182910	13-2895	-	-	-	-	-	-	-	<22
188491	14-926	-	-	-	-	-	-	-	<22
191849	14-3060	-	-	-	-	-	-	-	<22
192076	14-3060	-	-	-	-	-	-	-	<22

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative .
Eng. Iesanu Cristian

ArcelorMittal Tubular Products Roman S.A. ArcelorMittal J27/85/91 * * * * România *

Formular 12A, rev.9

PCE 31/1/17
LIC* 175017

[| 4500751484 | S447 | 188491] | [IN: 22] | T0379851-1 | FSPET1880 |

Manufacturer: ArcelorMittal Tubular Products Roman S.A. STEFAN CEL MARE ST, 15A/1 ROMAN. NEAMT,COUNTY, ROMANIA	**MILL TEST CERTIFICATE** according to EN 10204/3.1/2004	Page 4/4 D 1882/1 30.11.2014	ArcelorMittal

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Buyer's reference AMI ORDER: 10088643 / PO NUMBER: HR053756 Contract 50001782	Standard: API 5L-ed.45-2012- PSL 1; ASTM A106/A 106M-2014;ASTM A 53/A53M- 2012; ASME SA 106/SA 106M-2013, ASME SA 53/SA 53M-2013;NACE MR 0103-2012; NACE MR 0175/ISO 15156-1&2/2009

Dimensions: 457.00 x 23.83 mm 18.000 x 0.938 inch	Schedule: 80	Length 9.50 - 12.50 m	31.17 - 41.01 feet

Item	Item Client
11	-

Hydro Test:	Bar	PSI	MPa	Time(sec)
	205	2970	20.5	5

Steel Grade: B / X42 / C
-

Technological/Microstructure Test

Heat	Flattening Test Bulletin No.	Flattening Test
182910	13-2828	OK
188491	14-1007	OK
191849	14-3672	OK
192076	14-3672	OK

Heat

Heat	Pieces	Length (m)	Weight (kg)
182910	1	-	-
188491	3	-	-
191849	8	-	-
192076	19	-	-

Remarks Manufacturing process – hot rolling. Fine Grain Steel.
Steel is fully killed and produced by electric furnace.ArcelorMittal Warszawa Sp.z.o.o.-ul.Kasprowicza 132.01-949 WARSZAWA .
Hydrostatic test hold for 5 sec. no leakage noticed.

We state on our sole responsibility that the delivered products are in conformity with the order requirements.

Quality Control Representative
Eng. Iesanu Cristian

ArcelorMittal Tubular Products Roman S.A. ArcelorMittal J27/88/91 Romania

Formular 12A, rev.9

PKR 31/1/17
WO# 175017

| 4500751484 | S447 | 188491] | [IN: 22] | T0379851-1 | FSPET1880 |

[| 4500751484 | S447 | | 860450] | [LN: 24] | T0379851-1 | FSHB18STD |

HUTA BATORY
Sp. z o.o.
UL. Dyrekcyjna 6
41-506 Chorzów
POLAND

ŚWIADECTWO ODBIORU No 3803/EXP/R/12

CERTYFICAT DE RECEPTION INSPECTION CERTIFICATE
ABNAHMEPRÜFZEUGNIS СЕРТИФИКАТ
Acc. to EN 10204:2006 type 3.1
/nr normy/

Zamawiający ALCHEMIA S.A. 00 - 842 WARSZAWA UL.ŁUCKA 7/9
Le client-Ordered by-Besteller-Заказчик

Adres wysyłkowy COUTINHO & FERROSTAAL HOUSTON, TX 77060
Adresse-Address-Versandadreesse-Адрес получателя

Nr i data zamówienia klienta No et date la commande Order No and date No und Datum der Bestellung No и число заказа	Nr zlecenia Ordre No Manuf. Order No Auftrag No No наряда	Nr awiza Avis No Advice No Versandanzeige No No извещения	Nr wagonu Wagen No Car No Wagon No No вагона
PL/ABR/12/00701 1040325300	4249046/12		

Wyszczególnienie zamówienia:
Specyfication de la commande-Order Specification-Spizifikation der Bestellung-Спецификация заказа

Przedmiot i wykonanie (stan obr. Termicz.,mech. Itp.) L'objet et l'execution (traitement thermique et l'usinage) Item and specification (Heat and mechanical treatment etc.) Gagenstand und Ausführung (therm und mechan. Bearbeitung usw.) Предмет и исполнение (состояние терм. и механобраб. и пр.)	Wymiar lub rysunek Dimensions ou dessin Dimesions or drawing Abmessung order Zeichnung Размер чертеж	Marka Marque Steel type Marke Марка	Wytop Coulée Heat Abstich Плавка	Sztuk Pièces Pieces Stück Штук	mb. ft (c. mtr.) c. mtr. l. M. пог. м	Kg lb (kg) кг
Seamless steel pipes acc. to ASTM A106/A106M/10/A53/A53M/10/ ASME SA106/SA53/ SEC.II.P.A/10. Outside diameter tolerances +/- 1 %. Tolerances wall of thicknes +22,5/-12,5%. Outside surface double lacquered. Bevelled ends. Pipes hot finished > 850 degree C and cooled in still air. Melting proces: Electric furnace-Fully killed. No Mercury, Mercury compounds or Mercury bearing instruments and or equipment have been used in any manner which might cause contamination in manufacture, assembly or test of material. No weld repair. Fine grain practice.Country of melt and manufacture: Poland.	18" x 0,375" (457 x 9,53 mm) 37 - 44 ft (11,28 - 13,41 m)	B/C	860450	11	440,8 (134,31)	32461 (14724)

Kontrolę techniczną powyższego zamówienia przeprowadził Oddział Technicznej Kontroli. Wyniki badań podano niżej.
Le controle technique de la été exécute par le Service de Controle. Les resultats des essais sont indiqués ci-aprés.
The technical investigation of this order has been executed by the Works Control. Results of tests are as follows.
Die technische Prüfung obiger Bestellung wurde von der Fabrikationskontrolle durchgeführt. Die Ergebnisse der Proben sind nachstehend angeführt.
Технический контроль вышеупомянутого заказа произвел Отдел Технического Контроля. Результат испытания представлен ниже.

1. SKŁAD CHEMICZNY - ANALYSE CHIMIQUE – CHEMICAL COMPOSITION – CHEMISCHE ZUSAMMENSETZUNG
ХИМИЧЕСКИЙ СОСТАВ

Wytop Coulée Heat Abstich Плавка	C	Mn	Si	P	S	Cr	Ni	Cu
860450	0,18	0,94	0,23	0,009	0,008	0,05	0,08	0,16
control anal.	0,19	0,91	0,23	0,008	0,006	0,05	0,07	0,16
	0,20	0,94	0,24	0,009	0,008	0,05	0,08	0,16
	Mo	V	Ceq					
	0,02	0,00	0,37					
	0,02	0,00	0,37					
	0,02	0,00	0,39					

PKR 2/1/17
LK nr 175017

[| 4500751484 | S447 | | 860450] | [LN: 24] | T0379851-1 | FSHB18STD |

2. BADANIA MECHANICZNE – ESSAIS MECANIQUES – MECHANICAL TESTS – MECHANISCHE UNTERSUCHUNGEN
МЕХАНИЧЕСКИЕ ИСПЫТАНИЯ

Nr wytopu lub próby No de la coulée ou De l'eprouvette Heat No Or. Tests No Abstich Oder Probe No No плавки или пробы	Stan obróbki Termicznej Traitement thermique Heat treatement Therm. Bearbeitung Термич. обработка	Yield Re PSI MPa min	Tensile Rm PSI MPa min	A 2" % min	Z %	U	Twardość Dureté Hardness Härte Твердость
		275	485	30,0			
Test size: $1^1/_2$" longitudinal 860450/21333		51488 (355)	78610 (542)	34,8			Hardness guarantee - max 22 HRC. Pipes in accordance with NACE MR 0175/ ISO - 15156-2/03 AN.A.p.A 2.1.2 and NACE MR 0103/2005 P.2.1

3.BADANIA TECHNOLOGICZNE – ESSAIS TECHNOLOGIQUES – TECHNOLOGICAL TESTS – TECHNOLOGISCHE PRÜFUNGEN

Flattening test - positive results

4. INNE BADANIA – AUTRES ESSAIS – OTHER TESTS – ANDERE UNTERSUCHUNGEN – ДРУГИЕ ИСПЫТАНИЯ

Each pipes has been hydrostatically tested by pressure 1015 PSI - positive results time 5 s

5. UWAGI DODATKOWE – ADDITIONAL REMARKS – AUTRESOBSERVATIONS – ANDERE BEMERUNGEN

Huta Batory Sp.z o.o. has Quality Management System accordance with Directive 97/23/EC (PED) – Annex I – par. 4.3 –cert.TÜV no 07-202-3537 WP/WZ 0888/10.

Powierzchnię i wymiary zbadano w 100% - Surface et dimensions ont été controlés et 100% - Surface and dimensions tested at 100%
Oberfläche und Abmessungen geprüft zu 100% - Наружный осмотр и проверка измерений произведены в 100% - positive results

Niniejszym potwierdzam, że wyżej wymieniony materiał został zbadany i spełnia warunki potwierdzenia zamówienia - Par la presente je confirme que le materiel susmentionne a ete examine et il remplit les conditions de la confirmation de commande.- We hereby certify, that the material described above has been tested and complies with the terms of the order.- Es wird bestaetigt, dass das oben genannte Material geprueft wurde und den Bedingungen der Bestellung entspricht.- Подтверждаем, что вышеуказанный материал был протестирован и соответствует условиям подтверждения договора.

Material oznaczono – La material est marqué – Material marked – Das Material wurde bezeichnet – Материал обозначен

Acc.to A106/A53/SA106/SA53/B/C.

Na podstawie wyżej przeprowadzonych prób material zwolniono – Sur la base des essais si-dessus le material est dliv-According to the carried out tests the material released – Untersuchungen wurde das Material freigegeben – На основании вушенменованных Испытаний признан годным.

Kontrola Jakości Contróle de Fabrication Control of Manufacture Fabrikationskontrolle Технический контроль	Dyrekcja Huty Direction de l'Usine Works Management Hütten - Direktion Дирекция Завода	
SPECJALISTA Z ZAKRESU KONTROLI JAKOŚCI Halina Rehmet	Kierownik Działu Kontroli Jakości i Technologii inż. Jerzy Nowaczyk	dn. 18.09. 2012 r.

PER 3/1/17
LIC# 175017

[| 4500751484 | S447 | | 000W19580] | [LN: 25] | T0379851-1 | DS.75XH |

MST SEAMLESS TUBE & PIPE

TEST REPORT

4558 MICHIGAN SEAMLESS TUBE SOUTH LYON, MICHIGAN 48178 SHIPMENT 001

ORDER NUMBER	CUSTOMER ORDER NUMBER	DATE	OFC	COM	DI WI	NET SLS	GR SLS	ACCOUNT NUMBER	US		PAGE
070883	HP231359	12/30/15	21	00	16	08	01	06701000000	A1	2PT	1

SOLD TO: INDUSTRIAL PIPING SPECIALISTS
P O BOX 581270
TULSA OK USA 74158

SHIP TO: INDUSTRIAL PIPING SPECIALISTS
7755 HARMS ROAD
HOUSTON TX 77041

SN
TR
INV

ROUTING: OPEN TOP/FULLY TARPED/FOB SOUTH LYON MI — PPD TRUCK

ANALYSIS	SHAPE	PRODUCT	FC	ANNEAL	REQUESTED
1026	ROUND	COLD DRAWN		PER SPEC	01/15/16

SPECIFICATION	CMST	DESCRIPTION	PROMISE
SEAMLESS ASTM/ASME A/SA 106 BC 14		CD CARBON PIPE	01/15/16

SPECIAL INSTRUCTIONS: BLUE UV & CAP_ HYDRO & EDDY CURRENT TEST. MTR TO CERT TO A106B/ A106C, A53B, EN10204 3.1, DIN 50 049 3.1, NACE MR 0175 & MR 0103 MELT & MFG IN USA, HEAT TREAT TIME & TEMP & TRACE ELEMENTS. QTY TOLS +0/-10X. EMAIL SHIPPING DOCUMENTS. PRICE PER FOOT INCLUDES FREIGHT.

ITEM	QUANTITY	O.D.	I.D.	WALL	LENGTH	WT/FT	WEIGHT	
		1.050		.154 AVG		1.474		13:14:59 01/14/16

ITM NUM	BALE NUM	--BALE-- PCS	FTG	HEAT NO.	LENGTH			ITM STATUS	PART NUMBER
1	1 W	95	1995	000W19580	CUT	21'	.000"	COM	

HEAT NO.	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	Al	REMARKS
000W19580	.240	.740	.010	.017	.230	.080	.080	.030	.150	.020	EF KES
CHECK	.258	.709	.013	.022	.230	.075	.074	.027	.147	.024	V.003
CHECK	.276	.731	.013	.021	.237	.075	.075	.027	.151	.023	NB.002 TI.00

HEAT NO.	ULT. STR. PSI	YIELD, PSI	% ELONG 2"	HARDNESS	HYDRO TEST PSI	ULTRA SONIC %	EDDY CURRENT	EXPANSION
000W19580	72,305	46,950	43.7	HRB 76-80	2500		OK	

BEND	FLATTEN	FLARE	REV. FLATTEN	FLANGE
OK				

MELTED & MANUFACTURED IN USA
NORMALIZED @ 1650F FOR 24 MINUTES
TENSILE: FULL SIZE LONGITUDINAL

Manager • Quality Assurance

We hereby certify that the reported data are correct according to Michigan Seamless Tube tests and those of its suppliers. 8.2.P8.F9 Rev 2

PKR 9/1/17
LIC# 175017

[| 4500751484 | S447 | | 1015378774] | [LN: 26] | T0379851-1 | FSVAT1160 |

voestalpine Tubulars GmbH & Co KG

Alpinestrasse 17
8652 Kindberg-Aumuehl
T. +43/3865/22 15-0
F. +43/3865/2215-532
www.vatubulars.com

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

General Partner: voestalpine Tubulars GmbH
Legal Structure: Limited Liability Company
Location: Linz, Company Registry Number 106933f
Commercial Court of Linz

FSVAT 1160

INSPECTION - CERTIFICATE 3.1

(according to EN 10204)

ABNAHMEPRUEFZEUGNIS 3.1

(gem. EN 10204)

No. 119903

CERTIFICAT DE CONTROLE DES PRODUITS PAR L'USINE 3.1

(selon EN 10204)

Hersteller: Manufacturer: Producteur:	voestalpine Tubulars GmbH & Co KG, Austria
Besteller: Purchaser: Archeteur:	VOEST-ALPINE TUBULAR CORPORATION USA-77077 HOUSTON, TEXAS INDUSTRIAL PIPING SPECIALISTS. INC. TULSA OK 74158-1270, US
Pruefgegenstand: Object of tests: Eprouvette:	**Line Pipe** **LP-USA-01** **LINEPIPE-01.0** **non upset ends (API 5 D + 5 L) - non upset** **UV coating**
Werkstoff: Material: Matières:	GRADE B
Anforderungen: Requirements: Exigence:	Grade B acc. to ASTM A 53 / A 53M-2012 ASME SA 53-2015 Grade B acc. to ASTM A 106 / A 106M-2015, ASME SA 106-2015 Grade B acc. to API 5 L, 45.edt.-2012 (PSL1) NACE MR 0175 / ISO 15156-2009 NACE MR 0103-2012 LINEPIPE-01.0; LP-USA-01
Ausführung: Condition: Cond. de livraison:	NU, PLAIN END, PE,
Wärmebehandlung: Heat treatment: Traitment de chaleur:	AS ROLLED
Coupl.die stamped:	
Coupl.paint stencilling:	
Colour coding:	Fully painted: Bands:
Tube die stamped:	
Tube paint stencilling:	va SPEC 5L-0033 "API" 04.2016 1.315" 0.250" B PSL1 SMLS TESTED 2500 PSI Length ft Heat No. A/SA 53 GRADE B S A/SA 106 GRADE B SCHED.160 PO No.: HR066557 Made in Austria
Colour coding:	Fully painted: Bands: purple
Label:	PO No.: HR066557, DAT Port of Houston
Remarks:	*) SI units have been converted to US customary units

Auftrags-Nr.: Our works order No.: No usine:	20850 / 3
Bestellnr.: Your order No.: No de la commande:	HR066557/VATC PO# 602604
Zeichen des Lieferwerks: Marking of producer: Marque du fabricant:	va
Erschmelzungsart: Melting process: Procédé d'élaboration:	**BOF** fully killed, produced to fine grain practice

Kindberg, 18.04.2016

voestalpine Tubulars GmbH & Co KG
Qualitätsstelle / Quality Department
WEITZER
Abnahmebeauftragter
authorized inspection representative
représentant autorisé du controle

No. 119903

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

voestalpine
ONE STEP AHEAD.

PKR 2/1/17
LIC # 175017

[| 4500751484 | S447 | | 1015378774] | [LN: 26] | T0379851-1 | FSVAT1160 |

voestalpine Tubulars GmbH & Co KG

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

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

Volume of delivery

Heat	Lot	Remark
1015378774	206455 AD 01	

Test results

1 Biegeversuch/Bend test: bestanden/passed

2 Dimensionskontrolle/ Dimensional Inspection: bestanden/passed

3 Streuflusspruefung gem. ASTM E 570 / Flux leakage testing acc. ASTM E 570 (N 12,5 longitudinal, type and size of reference indicator used): bestanden/passed

4 Visuelle Inspektion/ Visual Inspection: bestanden/passed

5 Wasserinnendruckversuch/Hydrostatic test: 2500 PSI (duration min. 5 sec.) bestanden/passed

Test remarks

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

Kindberg, 18.04.2016

No. 119903

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voestalpine Tubulars GmbH & Co KG
Qualitätsstelle / Quality Department
WEITZER
Abnahmebeauftragter
authorized inspection representative
représentant autorisé du controle

voestalpine
ONE STEP AHEAD.

PKR 04/1/17
LIC 4175017

[| 4500751484 | S447 | | 1015378774] | [LN: 26] | T0379851-1 | FSVAT1160 |

voestalpine Tubulars GmbH & Co KG

ensile testing

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

yield strength:
Gr B: 35500 PSI

tensile strength:
Gr. B: 60200 PSI

Hardness testing

Lot No		Test Type	Heat treatment	Specimen No.	Location	Test Method	Hardness Number from	to	Mean Hardness Number from	to	Variation
						Requ.:				**99.50**	
206455	AD01	Standard	as rolled	1	Body	HRB	74.70	75.80	74.97	75.50	0.53

Kindberg, 18.04.2016

No. 119903

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PKR 21/1/17
LIC# 175017

voestalpine Tubulars GmbH & Co KG

ıemical test results

...at analysis

C	Si	Mn	P	S	Cr	Ni	Cu	Al	Ti	Mo	V	Sn	B	N2	Nb	Ca	CEQ
max. Requ.																	
0.2300		1.0600	0.0300	0.0300	0.4000	0.4000	0.4000			0.1500	0.0800						0.4000
min. Requ.																	
0.0000	0.1000	0.2900															
1015378774																	
0.1557	0.1953	0.7289	0.0146	0.0073	0.0260	0.0212	0.0230	0.0288	0.0009	0.0036	0.0018	0.0013	0.0002	0.0059	0.0000	0.0022	0.2864

Chemical test results

Product analysis

C	Si	Mn	P	S	Cr	Ni	Cu	Al	Ti	Mo	V	Sn	B	N2	Nb	Ca	CEQ
Lot No. 206455 AD 01 1 Standard Heat No. 1015378774																	
0.1545	0.1737	0.6971	0.0137	0.0072	0.0233	0.0215	0.0242	0.0233	0.0012	0.0041	0.0033	0.0019	0.0002	0.0067	0.0007	0.0000	0.2799
Lot No. 206455 AD 01 2 Standard Heat No. 1015378774																	
0.1539	0.1665	0.6953	0.0107	0.0067	0.0237	0.0232	0.0291	0.0236	0.0013	0.0042	0.0032	0.0022	0.0002	0.0063	0.0007	0.0000	0.2795
Lot No. 206455 AD 01 3 Standard Heat No. 1015378774																	
0.1522	0.1790	0.7090	0.0114	0.0075	0.0244	0.0227	0.0297	0.0263	0.0016	0.0044	0.0041	0.0025	0.0002	0.0061	0.0013	0.0000	0.2804
Lot No. 206455 AD 01 4 Standard Heat No. 1015378774																	
0.1590	0.1867	0.7181	0.0146	0.0071	0.0241	0.0211	0.0252	0.0254	0.0015	0.0042	0.0041	0.0022	0.0002	0.0066	0.0013	0.0000	0.2883
Lot No. 206455 AD 01 5 Standard Heat No. 1015378774																	
0.1524	0.1837	0.7065	0.0146	0.0069	0.0269	0.0215	0.0247	0.0248	0.0014	0.0040	0.0039	0.0023	0.0002	0.0060	0.0011	0.0000	0.2802
Lot No. 206455 AD 01 6 Standard Heat No. 1015378774																	
0.1535	0.1828	0.7042	0.0145	0.0071	0.0267	0.0213	0.0248	0.0246	0.0014	0.0039	0.0038	0.0022	0.0002	0.0055	0.0010	0.0000	0.2808

Kindberg, 18.04.2016

No. 119903

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authorized inspection representative
représentant autorisé du controle

voestalpine
ONE STEP AHEAD.

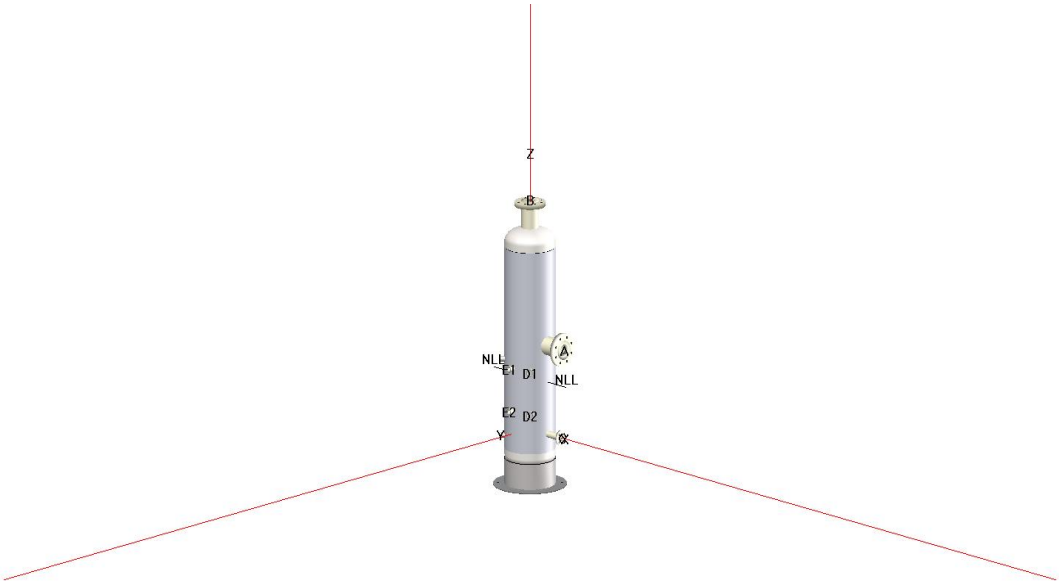
PKR 4/1/17
LIC # 175017

UOP Russell

7050 South Yale

Suite 210

Tulsa OK 74136



COMPRESS Pressure Vessel Design Calculations

Item: Regen Gas Scrubber

Vessel No: V-447

Revision: A

Designer & Date: GAT 11/9/2016

Designed in accordance with UG-22

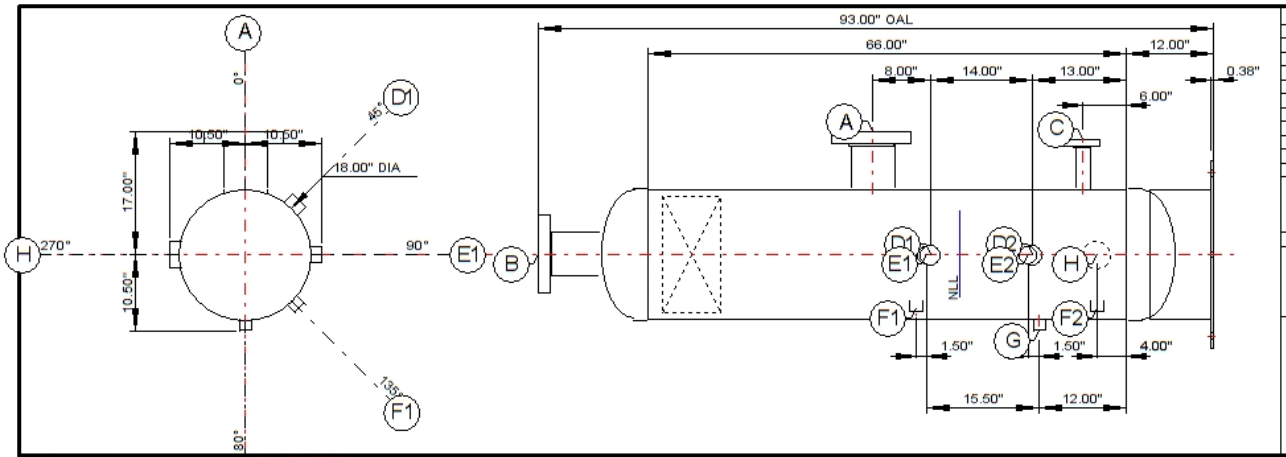
Reviewed: ASH 11/9/2016

Table of Contents

Table of Contents

Revision History

Revisions			
No.	**Date**	**Operator**	**Notes**
0	12/27/2010	Bill	New vessel created ASME Section VIII Division 1 [COMPRESS Build 7110]
1	5/21/2012	Bill	Converted from ASME Section VIII Division 1, 2010 Edition to ASME Section VIII Division 1, 2010 Edition, A11 Addenda. Default Forging Material Changed to A 105. During the conversion, changes may have been made to your vessel (some may be listed above). Please check your vessel carefully.
2	8/14/2013	SHP	- Split shell into two courses to apply insulation to the NLL. - Applied insulation per SC6 datasheet. - Adjusted skirt height to match SC6 sketch.
3	2/11/2015	SHP	Revised - Code year - Removed pseudo split shell, applied insulation over entire shell conservatively. - Revised NLL to HLL - Add mist pad
4	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	1,100 psi
Vacuum Pressure	0 psi
Test Pressure (Shop)	1,430 psi
Test Pressure (Field)	1,430 psi
Design Temperature	150 °F
MDMT	-20 °F
Corrosion Allowance	0.125 "
Radiography	RT2
PWHT	None

Estimated Weights

Dry: 1,459 lb Wet: 1,665 lb

Materials

Cylinder(s):	SA-106 B Smls pipe
Head(s):	SA-516 70
Transition(s):	
Support:	SA-106 B Smls pipe

NOZZLE SCHEDULE

MARK	NOZZLE	SIZE & SCH	FLANGE	MARK	NOZZLE	SIZE & SCH	FLANGE
F2	LG	NPS 0.75 Class 600					
C	Liquid Out	2.37 OD x 0.56	NPS 1 LWN Class				
E2	LSHH	NPS 1 Class 6000 -					
D2	LC	NPS 1.5 Class 3000					
D1	LC	NPS 1.5 Class 3000					
E1	LSHH	NPS 1 Class 6000 -					
F1	LG	NPS 0.75 Class 600					
A	Inlet	6 OD x 1	NPS 4 LWN Class	H	Inspection	NPS 2 Class 6000 -	
B	Vapor Out/Inspecti	6 OD x 1	NPS 4 LWN Class	G	IT	NPS 0.75 Class 600	

REVISIONS

REV	DATE	DESCRIPTION
0	12/27/2010	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-447

Deficiencies Summary

Warnings Summary

Warnings for BTM HEAD
UCS-79: The extreme fiber elongation exceeds 5 percent and the thickness exceeds 5/8 inch;. Heat treatment per UCS-56 is required if fabricated by cold forming. (warning)

Warnings for Inlet (A)
The attached ASME B16.5 flange limits the nozzle MAP. (warning)

Warnings for Liquid Out (C)
The attached ASME B16.5 flange limits the nozzle MAP. (warning)

Warnings for Straight Flange on BTM HEAD
UCS-79: The extreme fiber elongation exceeds 5 percent and the thickness exceeds 5/8 inch;. Heat treatment per UCS-56 is required if fabricated by cold forming. (warning)

Warnings for Straight Flange on TOP HEAD
UCS-79: The extreme fiber elongation exceeds 5 percent and the thickness exceeds 5/8 inch;. Heat treatment per UCS-56 is required if fabricated by cold forming. (warning)

Warnings for TOP HEAD
UCS-79: The extreme fiber elongation exceeds 5 percent and the thickness exceeds 5/8 inch;. Heat treatment per UCS-56 is required if fabricated by cold forming. (warning)

Warnings for Vapor Out/Inspection (B)
The attached ASME B16.5 flange limits the nozzle MAWP. (warning)
The attached ASME B16.5 flange limits the nozzle MAP. (warning)

Nozzle Schedule

Specifications									
Nozzle mark	Identifier	Size	Materials		Impact Tested	Normalized	Fine Grain	Flange	Blind
A	Inlet	6 OD x 1	Nozzle	SA-105	No	No	No	NPS 4 Class 600 LWN A105	No
B	Vapor Out/Inspection	6 OD x 1	Nozzle	SA-105	No	No	No	NPS 4 Class 600 LWN A105	No
C	Liquid Out	2.12 OD x 0.56	Nozzle	SA-105	No	No	No	NPS 1 Class 600 LWN A105	No
D1	LC	NPS 1.5 Class 3000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
D2	LC	NPS 1.5 Class 3000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
E1	LSHH	NPS 1 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
E2	LSHH	NPS 1 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
F1	LG	NPS 0.75 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
F2	LG	NPS 0.75 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
G	TI	NPS 0.75 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No
H	Inspection	NPS 2 Class 6000 - threaded	Nozzle	SA-105	No	No	No	N/A	No

Nozzle Summary

Dimensions												
Nozzle mark	OD (in)	t_n (in)	Req t_n (in)	A_1?	A_2?	Shell			Reinforcement Pad		Corr (in)	A_a/A_r (%)
						Nom t (in)	Design t (in)	User t (in)	Width (in)	t_{pad} (in)		
A	6	1	0.37	Yes	Yes	0.938	0.6894		N/A	N/A	0.125	138.5
B	6	1	0.37	Yes	Yes	0.813*	0.5544		N/A	N/A	0.125	210.1
C	2.12	0.56	0.2598	Yes	Yes	0.938	N/A		N/A	N/A	0.125	Exempt
D1	2.5	0.3	0.1923	Yes	Yes	0.938	N/A		N/A	N/A	0.125	Exempt
D2	2.5	0.3	0.1923	Yes	Yes	0.938	N/A		N/A	N/A	0.125	Exempt
E1	2.25	0.4675	0.1875	Yes	Yes	0.938	N/A		N/A	N/A	0.125	Exempt
E2	2.25	0.4675	0.1875	Yes	Yes	0.938	N/A		N/A	N/A	0.125	Exempt
F1	1.75	0.35	0.1875	Yes	Yes	0.938	N/A		N/A	N/A	0.125	Exempt
F2	1.75	0.35	0.1875	Yes	Yes	0.938	N/A		N/A	N/A	0.125	Exempt
G	1.75	0.35	0.1875	Yes	Yes	0.938	N/A		N/A	N/A	0.125	Exempt
H	3.625	0.625	0.2226	Yes	Yes	0.938	0.6898		N/A	N/A	0.125	104.4
*Head minimum thickness after forming												

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

Pressure Summary

Component Summary							
Identifier	P Design (psi)	T Design (°F)	MAWP (psi)	MAP (psi)	MDMT (°F)	MDMT Exemption	Impact Tested
TOP HEAD	1,100	150	1,674.41	1,966.55	-20	Note 1	No
Straight Flange on TOP HEAD	1,100	150	1,724.14	2,023.12	-20	Note 2	No
SHELL	1,100	150	1,363.28	1,618.46	-20	Note 2	No
Straight Flange on BTM HEAD	1,100	150	1,723.24	2,023.12	-20	Note 2	No
BTM HEAD	1,100	150	1,673.36	1,966.55	-20	Note 3	No
Inlet (A)	1,100	150	1,299.49	1,480	-45.7	Note 4	No
Vapor Out/Inspection (B)	1,100	150	1,420	1,480	-45.7	Note 4	No
Liquid Out (C)	1,100	150	1,363.59	1,480	-45.6	Note 5	No
LC (D1)	1,100	150	1,364.21	1,618.57	-155	Note 6	No
LC (D2)	1,100	150	1,363.81	1,618.57	-155	Note 7	No
LSHH (E1)	1,100	150	1,364.21	1,618.57	-155	Note 8	No
LSHH (E2)	1,100	150	1,363.85	1,618.57	-155	Note 8	No
LG (F1)	1,100	150	1,364.21	1,618.57	-155	Note 9	No
LG (F2)	1,100	150	1,363.51	1,618.57	-155	Note 10	No
TI (G)	1,100	150	1,363.8	1,618.57	-155	Note 10	No
Inspection (H)	1,100	150	1,123.27	1,618.57	-155	Note 11	No

Chamber Summary	
Design MDMT	-20 °F
Rated MDMT	-20 °F @ 1,123.27 psi
MAWP hot & corroded	1,100 psi @ 150 °F
MAP cold & new	1,480 psi @ 70 °F
(1) The MAWP is limited due to the MAWP limit set in the Calculations tab of the Set Mode dialog. (2) This pressure chamber is not designed for external pressure.	

Notes for MDMT Rating		
Note #	**Exemption**	**Details**
1.	Straight Flange governs MDMT	
2.	Material is impact test exempt per UG-20(f)	UCS-66 governing thickness = 0.8208 in
3.	Straight Flange governs MDMT	
4.	LWN rated MDMT per UCS-66(c)(4) Flange rated MDMT per UCS-66(b)(1)(b) = -45.7°F (Coincident ratio = 0.7432) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	
5.	LWN rated MDMT per UCS-66(c)(4) Flange rated MDMT per UCS-66(b)(1)(b) = -45.6°F (Coincident ratio = 0.7437) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	
6.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.3494).	
7.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.3495).	
8.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.13).	
9.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1643).	
10.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1644).	
11.	Nozzle is impact test exempt to -155°F per UCS-66(b)(3) (coincident ratio = 0.1494).	

Settings Summary

COMPRESS 2016 Build 7600	
ASME Section VIII Division 1, 2015 Edition	
Units	U.S. Customary
Datum Line Location	6.00" from bottom seam
Vessel Design Mode	Get Thickness from Pressure
Minimum thickness	0.0625" per UG-16(b)
Design for cold shut down only	No
Design for lethal service (full radiography required)	No
User has limited MAWP to	1,100 psi
Design nozzles for	Design P only
Corrosion weight loss	100% of theoretical loss
UG-23 Stress Increase	1.20
Skirt/legs stress increase	1.0
Minimum nozzle projection	1"
Juncture calculations for $\alpha > 30$ only	Yes
Preheat P-No 1 Materials > 1.25" and <= 1.50" thick	No
UG-37(a) shell tr calculation considers longitudinal stress	No
Cylindrical shells made from pipe are entered as minimum thickness	No
Nozzles made from pipe are entered as minimum thickness	No
ASME B16.9 fittings are entered as minimum thickness	No
Butt welds	Tapered per Figure UCS-66.3(a)
Disallow Appendix 1-5, 1-8 calculations under 15 psi	No
Hydro/Pneumatic Test	
Shop Hydrotest Pressure	1.3 times vessel MAWP
Test liquid specific gravity	1.00
Field Hydrotest Pressure	1.3 times vessel MAWP
Wind load present @ field	33% of design
Maximum stress during test	90% of yield
Required Marking - UG-116	
UG-116(e) Radiography	RT2
UG-116(f) Postweld heat treatment	None
Code Cases\Interpretations	
Use Code Case 2547	No

Use Code Case 2695	No
Apply interpretation VIII-1-83-66	Yes
Apply interpretation VIII-1-86-175	Yes
Apply interpretation VIII-1-01-37	Yes
Apply interpretation VIII-1-01-150	No
Apply interpretation VIII-1-07-50	No
No UCS-66.1 MDMT reduction	No
No UCS-68(c) MDMT reduction	No
Disallow UG-20(f) exemptions	No
UG-22 Loadings	
UG-22(a) Internal or External Design Pressure	Yes
UG-22(b) Weight of the vessel and normal contents under operating or test conditions	Yes
UG-22(c) Superimposed static reactions from weight of attached equipment (external loads)	No
UG-22(d)(2) Vessel supports such as lugs, rings, skirts, saddles and legs	Yes
UG-22(f) Wind reactions	Yes
UG-22(f) Seismic reactions	Yes
UG-22(j) Test pressure and coincident static head acting during the test:	Yes
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		Top Circumferential Seam		Bottom Circumferential Seam		Mark
	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	
TOP HEAD	N/A	Seamless No RT	N/A	N/A	B	Spot UW-11(a)(5)(b) / Type 1	RT2
SHELL	N/A	Seamless No RT	B	Spot UW-11(a)(5)(b) / Type 1	B	Spot UW-11(a)(5)(b) / Type 1	RT2
BTM HEAD	N/A	Seamless No RT	B	Spot UW-11(a)(5)(b) / Type 1	N/A	N/A	RT2
Nozzle	**Longitudinal Seam**		**Nozzle to Vessel Circumferential Seam**		**Nozzle free end Circumferential Seam**		
Vapor Out/Inspection (B)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
Inlet (A)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
LG (F1)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
LSHH (E1)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
LC (D1)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
LC (D2)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
LSHH (E2)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
Liquid Out (C)	N/A	Seamless No RT	D	N/A / Type 7	C	N/A	N/A
LG (F2)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
TI (G)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
Inspection (H)	N/A	Seamless No RT	D	N/A / Type 7	N/A	N/A	N/A
Nozzle Flange	**Longitudinal Seam**		**Flange Face**		**Nozzle to Flange Circumferential Seam**		
ASME B16.5/16.47 flange attached to Vapor Out/Inspection (B)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
ASME B16.5/16.47 flange attached to Inlet (A)	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 (C)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A	N/A
UG-116(e) Required Marking: **RT2**							

Thickness Summary

Component Data								
Component Identifier	Material	Diameter (in)	Length (in)	Nominal t (in)	Design t (in)	Total Corrosion (in)	Joint E	Load
TOP HEAD	SA-516 70	18 OD	4.9065	0.813*	0.5879	0.125	1.00	Internal
Straight Flange on TOP HEAD	SA-516 70	18 OD	2	0.875	0.6094	0.125	1.00	Internal
SHELL	SA-106 B Smls pipe	18 OD	66	0.938	0.6899	0.125	1.00	Internal
Straight Flange on BTM HEAD	SA-516 70	18 OD	2	0.875	0.6098	0.125	1.00	Internal
BTM HEAD	SA-516 70	18 OD	4.9065	0.813*	0.5884	0.125	1.00	Internal
SKIRT	SA-106 B Smls pipe	18 OD	8.7	0.375	0.0066	0	0.55	Seismic
*Head minimum thickness after forming								

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

Weight Summary

Weight (lb) Contributed by Vessel Elements											
Component	Metal New*	Metal Corroded	Insulation	Insulation Supports	Lining	Piping + Liquid	Operating Liquid		Test Liquid		Surface Area ft²
							New	Corroded	New	Corroded	
TOP HEAD	100.4	86.6	0	0	0	0	0	0	38.6	40.7	3
SHELL	921.3	804.5	51.3	0	0	0	170.5	176.1	490.3	506.2	25
BTM HEAD	106.9	92.1	6.8	0	0	0	35.7	37.5	35.7	37.5	4
SKIRT	48.9	48.9	0	0	0	0	0	0	0	0	7
BASE RING	37	37	0	0	0	0	0	0	0	0	5
TOTAL:	**1,214.4**	**1,069.1**	**58.1**	**0**	**0**	**0**	**206.2**	**213.5**	**564.6**	**584.4**	**44**
*Shells with attached nozzles have weight reduced by material cut out for opening.											

Weight (lb) Contributed by Attachments											
Component	Body Flanges		Nozzles & Flanges		Packed Beds	Ladders & Platforms	Trays	Tray Supports	Rings & Clips	Vertical Loads	Surface Area ft²
	New	Corroded	New	Corroded							
TOP HEAD	0	0	75.1	71.2	0	0	0	0	0	0	1
SHELL	0	0	100	90.9	11.3	0	0	0	0	0	2
BTM HEAD	0	0	0	0	0	0	0	0	0	0	0
SKIRT	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	**0**	**0**	**175.1**	**162**	**11.3**	**0**	**0**	**0**	**0**	**0**	**4**

Vessel Totals		
	New	Corroded
Operating Weight (lb)	1,665	1,514
Empty Weight (lb)	1,459	1,301
Test Weight (lb)	2,024	1,885
Surface Area (ft²)	48	-
Capacity** (US gal)	67	69
**The vessel capacity does not include volume of nozzle, piping or other attachments.		

Vessel Lift Condition	
Vessel Lift Weight, New (lb)	1,401
Center of Gravity from Datum (in)	26.5174
Note: Vessel lift weight includes weight of insulation supports as they are assumed to be shop installed.	

Hydrostatic Test

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

Gauge pressure at 70°F =
1.3*MAWP*LSR
= 1.3*1,100*1
= 1,430 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**	**Stress during test (psi)**	**Allowable test stress (psi)**	**Stress excessive?**
TOP HEAD (1)	1,430.909	0.909	1	1.30	12,968	34,200	No
Straight Flange on TOP HEAD	1,430.907	0.907	1	1.30	13,990	34,200	No
SHELL	1,430.905	0.905	1	1.30	14,759	31,500	No
Straight Flange on BTM HEAD	1,430.907	0.907	1	1.30	13,990	34,200	No
BTM HEAD	1,430.909	0.909	1	1.30	12,968	34,200	No
Inlet (A)	1,430.289	0.289	1	1.30	16,433	47,250	No
Inspection (H)	1,430.657	0.657	1	1.30	16,530	47,250	No
LC (D1)	1,430.408	0.408	1	1.30	17,542	47,250	No
LC (D2)	1,430.408	0.408	1	1.30	17,542	47,250	No
LG (F1)	1,430.895	0.895	1	1.30	15,269	47,250	No
LG (F2)	1,430.895	0.895	1	1.30	15,269	47,250	No
LSHH (E1)	1,430.637	0.637	1	1.30	15,303	47,250	No
LSHH (E2)	1,430.637	0.637	1	1.30	15,303	47,250	No
Liquid Out (C)	1,430.289	0.289	1	1.30	14,239	47,250	No
TI (G)	1,430.993	0.993	1	1.30	15,270	47,250	No
Vapor Out/Inspection (B)	1,430.686	0.686	1	1.30	15,477	51,300	No

(1) TOP HEAD limits the UG-99(b) stress ratio.
(2) P_L stresses at nozzle openings have been estimated using the method described in PVP-Vol. 399, pages 77-82.
(3) $1.5*0.9*S_y$ used as the basis for the maximum local primary membrane stress at the nozzle intersection P_L.
(4) The zero degree angular position is assumed to be up, and the test liquid height is assumed to the top-most flange.

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

Vertical field hydrostatic test based on MAWP per UG-99(b)

Gauge pressure at 70°F = 1.3*MAWP*LSR
= 1.3*1,100*1
= 1,430 psi

Vertical field hydrostatic test							
Identifier	**Local test pressure (psi)**	**Test liquid static head (psi)**	**UG-99(b) stress ratio**	**UG-99(b) pressure factor**	**Stress during test (psi)**	**Allowable test stress (psi)**	**Stress excessive?**
TOP HEAD (1)	1,430.542	0.542	1	1.30	12,965	34,200	No
Straight Flange on TOP HEAD	1,430.542	0.542	1	1.30	13,987	34,200	No
SHELL	1,432.924	2.924	1	1.30	14,780	31,500	No
Straight Flange on BTM HEAD	1,432.996	2.996	1	1.30	14,011	34,200	No
BTM HEAD	1,433.144	3.144	1	1.30	12,989	34,200	No
Inlet (A)	1,431.733	1.733	1	1.30	16,449	47,250	No
Inspection (H)	1,432.822	2.822	1	1.30	16,555	47,250	No
LC (D1)	1,431.984	1.984	1	1.30	17,561	47,250	No
LC (D2)	1,432.489	2.489	1	1.30	17,567	47,250	No
LG (F1)	1,431.896	1.896	1	1.30	15,280	47,250	No
LG (F2)	1,432.798	2.798	1	1.30	15,290	47,250	No
LSHH (E1)	1,431.955	1.955	1	1.30	15,317	47,250	No
LSHH (E2)	1,432.46	2.46	1	1.30	15,322	47,250	No
Liquid Out (C)	1,432.725	2.725	1	1.30	14,263	47,250	No
TI (G)	1,432.51	2.51	1	1.30	15,286	47,250	No
Vapor Out/Inspection (B)	1,430.292	0.292	1	1.30	15,473	51,300	No

(1) TOP HEAD limits the UG-99(b) stress ratio.
(2) P_L stresses at nozzle openings have been estimated using the method described in PVP-Vol. 399, pages 77-82.
(3) 1.5*0.9*S_y used as the basis for the maximum local primary membrane stress at the nozzle intersection P_L.

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

Vertical field hydrostatic test based on design P per UG-99(b)

Gauge pressure at 70°F = 1.3*Design P*LSR
= 1.3*1,100*1
= 1,430 psi

Vertical field hydrostatic test				
Identifier	**Local test pressure (psi)**	**Test liquid static head (psi)**	**UG-99(b) stress ratio**	**UG-99(b) pressure factor**
TOP HEAD (1)	1,430.542	0.542	1	1.30
Straight Flange on TOP HEAD	1,430.542	0.542	1	1.30
SHELL	1,432.924	2.924	1	1.30
Straight Flange on BTM HEAD	1,432.996	2.996	1	1.30
BTM HEAD	1,433.148	3.148	1	1.30
Inlet (A)	1,431.737	1.737	1	1.30
Inspection (H)	1,432.827	2.827	1	1.30
LC (D1)	1,431.988	1.988	1	1.30
LC (D2)	1,432.493	2.493	1	1.30
LG (F1)	1,431.901	1.901	1	1.30
LG (F2)	1,432.803	2.803	1	1.30
LSHH (E1)	1,431.959	1.959	1	1.30
LSHH (E2)	1,432.465	2.465	1	1.30
Liquid Out (C)	1,432.73	2.73	1	1.30
TI (G)	1,432.514	2.514	1	1.30
Vapor Out/Inspection (B)	1,430.292	0.292	1	1.30
(1) TOP HEAD limits the UG-99(b) stress ratio.				

Seismic Code

Building Code: ASCE 7-10 ground supported		
Site Class		D
Importance Factor, I_e		1.2500
Spectral Response Acceleration at short period (% g), S_s		100.00%
Spectral Response Acceleration at period of 1 sec (% g), S_1		40.00%
Response Modification Coeficient from Table 15.4-2, R		3.0000
Acceleration-based Site Coefficient, F_a		1.1000
Velocity-based Site Coefficient, F_v		1.6000
Long-period Transition Period, T_L		12.0000
Redundancy factor, ρ		1.0000
Risk Category (Table 1.5-1)		III
User Defined Vertical Accelerations Considered		No
Vessel Characteristics		
Height		7.0752 ft
Weight	Operating, Corroded	1,514 lb
	Empty, Corroded	1,301 lb
Period of Vibration Calculation		
Fundamental Period, T	Operating, Corroded	0.015 sec (f = 68.4 Hz)
	Empty, Corroded	0.014 sec (f = 69.2 Hz)

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

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

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

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

Seismic Shear Reports:

Operating, Corroded
Empty, Corroded
Base Shear Calculations

Seismic Shear Report: Operating, Corroded					
Component	**Elevation of Bottom above Base (in)**	**Elastic Modulus E (10^6 psi)**	**Inertia I (ft^4)**	**Seismic Shear at Bottom (lb_f)**	**Bending Moment at Bottom (lb_f-ft)**
TOP HEAD	77.9954	29.0	*	61	25
SHELL	11.9954	29.0	0.0783	284	1,189
BTM HEAD (top)	8.7	29.0	*	287	1,267
SKIRT	0	29.0	0.0389	291	1,478
*Moment of Inertia I varies over the length of the component					

Seismic Shear Report: Empty, Corroded					
Component	**Elevation of Bottom above Base (in)**	**Elastic Modulus E (10^6 psi)**	**Inertia I (ft^4)**	**Seismic Shear at Bottom (lb_f)**	**Bending Moment at Bottom (lb_f-ft)**
TOP HEAD	77.9954	29.4	*	57	23
SHELL	11.9954	29.4	0.0783	245	1,089
BTM HEAD (top)	8.7	29.4	*	247	1,157
SKIRT	0	29.4	0.0389	250	1,338
*Moment of Inertia I varies over the length of the component					

11.4.3: Maximum considered earthquake spectral response acceleration

The maximum considered earthquake spectral response acceleration at short period, S_{MS}
S_{MS} = F_a * S_s = 1.1000 * 100.00 / 100 = 1.1000
The maximum considered earthquake spectral response acceleration at 1 s period, S_{M1}
S_{M1} = F_v * S_1 = 1.6000 * 40.00 / 100 = 0.6400

11.4.4: Design spectral response acceleration parameters

Design earthquake spectral response acceleration at short period, S_{DS}
S_{DS} = 2 / 3 * S_{MS} = 2 / 3 * 1.1000 = 0.7333
Design earthquake spectral response acceleration at 1 s period, S_{D1}

S_{D1} = 2 / 3 * S_{M1} = 2 / 3 * 0.6400 = 0.4267

11.6 Seismic Design Category

The Risk Category is III.
From Table 11.6-1, the Seismic Design Category based on S_{Ds} = 0.7333 is D.
From Table 11.6-2, the Seismic Design Category based on S_{D1} = 0.4267 is D.
This vessel is assigned to Seismic Design Category D.

12.4.2.3: Seismic Load Combinations: Vertical Term

Factor is applied to dead load.

Compressive Side: = 1.0 + 0.14 * S_{DS}
= 1.0 + 0.14 * 0.7333
= 1.1027
Tensile Side: = 0.6 - 0.14 * S_{DS}
= 0.6 - 0.14 * 0.7333
= 0.4973

Base Shear Calculations

Operating, Corroded
Empty, Corroded

Base Shear Calculations: Operating, Corroded

Paragraph 15.4.2: T < 0.06, so:
V = 0.30 * S_{Ds} * W * I_e
= 0.30 * 0.7333 * 1,514.0936 * 1.2500
= 416.38 lb

12.4.2.1 Seismic Load Combinations: Horizontal Seismic Load Effect, E_h
Q_E = V
E_h = 0.7 * ρ * Q_E (Only 70% of seismic load considered as per Section 2.4.1)
= 0.70 * 1.0000 * 416.38
= 291.46 lb

Base Shear Calculations: Empty, Corroded

Paragraph 15.4.2: T < 0.06, so:
V = 0.30 * S_{Ds} * W * I_e
= 0.30 * 0.7333 * 1,300.5667 * 1.2500
= 357.66 lb

12.4.2.1 Seismic Load Combinations: Horizontal Seismic Load Effect, E_h
Q_E = V
E_h = 0.7 * ρ * Q_E (Only 70% of seismic load considered as per Section 2.4.1)
= 0.70 * 1.0000 * 357.66

= 250.36 lb

Building Code: ASCE 7-10		
Elevation of base above grade		1.00 ft
Increase effective outer diameter by		1.50 ft
Wind Force Coefficient, Cf		0.7000
Risk Category (Table 1.5-1)		III
Basic Wind Speed, V		120.00 mph
Exposure category		C
Wind Directionality Factor, Kd		0.9500
Topographic Factor, Kzt		1.0000
Enforce min. loading of 16 psf		Yes
Vessel Characteristics		
Height, h		7.0752 ft
Minimum Diameter, b	Operating, Corroded	1.6667 ft
	Empty, Corroded	1.6667 ft
	Hydrotest, New, Field	1.6667 ft
	Hydrotest, Corroded, Field	1.6667 ft
Fundamental Frequency, n_1	Operating, Corroded	68.3974 Hz
	Empty, Corroded	69.1796 Hz
	Hydrotest, New, Field	57.6348 Hz
	Hydrotest, Corroded, Field	58.0310 Hz
Damping coefficient, β	Operating, Corroded	0.0259
	Empty, Corroded	0.0209
	Hydrotest, New, Field	0.0259
	Hydrotest, Corroded, Field	0.0259

Table Lookup Values

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

Wind Deflection Reports:

Operating, Corroded
Empty, Corroded
Hydrotest, New, field
Hydrotest, Corroded, field
Wind Pressure Calculations

Wind Deflection Report: Operating, Corroded								
Component	**Elevation of Bottom above Base (in)**	**Effective OD (ft)**	**Elastic Modulus E (10^6 psi)**	**Inertia I (ft^4)**	**Platform Wind Shear at Bottom (lb_f)**	**Total Wind Shear at Bottom (lb_f)**	**Bending Moment at Bottom (lb_f-ft)**	**Deflection at Top (in)**
TOP HEAD	77.9954	3.00	29.0	*	0	18	5	0.0007
SHELL	11.9954	3.17	29.0	0.07834	0	216	763	0.0006
BTM HEAD (top)	8.7	3.17	29.0	*	0	226	824	0
SKIRT	0	3.00	29.0	0.0389	0	251	997	0
*Moment of Inertia I varies over the length of the component								

Wind Deflection Report: Empty, Corroded								
Component	Elevation of Bottom above Base (in)	Effective OD (ft)	Elastic Modulus E (10^6 psi)	Inertia I (ft^4)	Platform Wind Shear at Bottom (lb_f)	Total Wind Shear at Bottom (lb_f)	Bending Moment at Bottom (lb_f-ft)	Deflection at Top (in)
TOP HEAD	77.9954	3.00	29.4	*	0	18	5	0.0006
SHELL	11.9954	3.17	29.4	0.07834	0	216	763	0.0006
BTM HEAD (top)	8.7	3.17	29.4	*	0	226	824	0
SKIRT	0	3.00	29.4	0.0389	0	251	997	0
*Moment of Inertia I varies over the length of the component								

Wind Deflection Report: Field Hydrotest, New								
Component	Elevation of Bottom above Base (in)	Effective OD (ft)	Elastic Modulus E (10^6 psi)	Inertia I (ft^4)	Platform Wind Shear at Bottom (lb_f)	Total Wind Shear at Bottom (lb_f)	Bending Moment at Bottom (lb_f-ft)	Deflection at Top (in)
TOP HEAD	77.9954	3.00	29.4	*	0	15	4	0.0005
SHELL	11.9954	3.17	29.4	0.0885	0	183	668	0.0005
BTM HEAD (top)	8.7	3.17	29.4	*	0	191	720	0
SKIRT	0	3.00	29.4	0.0389	0	212	866	0
*Moment of Inertia I varies over the length of the component								

Wind Deflection Report: Field Hydrotest, Corroded								
Component	Elevation of Bottom above Base (in)	Effective OD (ft)	Elastic Modulus E (10^6 psi)	Inertia I (ft^4)	Platform Wind Shear at Bottom (lb_f)	Total Wind Shear at Bottom (lb_f)	Bending Moment at Bottom (lb_f-ft)	Deflection at Top (in)
TOP HEAD	77.9954	3.00	29.4	*	0	15	4	0.0006
SHELL	11.9954	3.17	29.4	0.07834	0	183	661	0.0005
BTM HEAD (top)	8.7	3.17	29.4	*	0	191	713	0
SKIRT	0	3.00	29.4	0.0389	0	212	859	0
*Moment of Inertia I varies over the length of the component								

Wind Pressure (WP) Calculations

Gust Factor (G^-) Calculations

$Kz = 2.01 * (Z/Zg)^{2/\alpha}$

$= 2.01 * (Z/900.00)^{0.2105}$

$qz = 0.00256 * Kz * Kzt * Kd * V^2$

$= 0.00256 * Kz * 1.0000 * 0.9500 * 120.0000^2$

$= 35.0208 * Kz$

$WP = 0.6 * qz * G * Cf$ (Minimum 16 lb/ft^2)

$= 0.6 * qz * G * 0.7000$ (Minimum 16 lb/ft^2)

Design Wind Pressures							
Height Z (')	Kz	qz (psf)	WP (psf)				
			Operating	Empty	Hydrotest New	Hydrotest Corroded	Vacuum
15.0	0.8489	29.73	11.38	11.38	9.60	9.60	N.A.
Design Wind Force determined from: F = Pressure * Af , where Af is the projected area.							

Gust Factor Calculations

Operating, Corroded
Empty, Corroded
Hydrotest, New, field
Hydrotest, Corroded, field

Gust Factor Calculations: Operating, Corroded

Vessel is considered a rigid structure as n_1 = 68.3974 Hz ≥ 1 Hz.

z^- = max (0.60 * h , z_{min})
= max (0.60 * 7.0752 , 15.0000)
= 15.0000
I_{z^-} = c * $(33 / z^-)^{1/6}$
= 0.2000 * $(33 / 15.0000)^{1/6}$
= 0.2281
L_{z^-} = l * $(z^- / 33)^{ep}$
= 500.0000 * $(15.0000 / 33)^{0.2000}$
= 427.0566
Q = Sqr(1 / (1 + 0.63 * ((b + h) / L_{z^-})$^{0.63}$))
= Sqr(1 / (1 + 0.63 * ((1.6667 + 7.0752) / 427.0566)$^{0.63}$))
= 0.9739
G = 0.925 * (1 + 1.7 * g_Q * I_{z^-} * Q) / (1 + 1.7 * g_v * I_{z^-})
= 0.925 * (1 + 1.7 * 3.40* 0.2281 * 0.9739) / (1 + 1.7 * 3.40 * 0.2281)
= 0.9113

Gust Factor Calculations: Empty, Corroded

Vessel is considered a rigid structure as n_1 = 69.1796 Hz ≥ 1 Hz.

z^- = max (0.60 * h , z_{min})
= max (0.60 * 7.0752 , 15.0000)
= 15.0000
I_{z^-} = c * $(33 / z^-)^{1/6}$
= 0.2000 * $(33 / 15.0000)^{1/6}$
= 0.2281
L_{z^-} = l * $(z^- / 33)^{ep}$
= 500.0000 * $(15.0000 / 33)^{0.2000}$
= 427.0566

$Q = \mathrm{Sqr}(1 / (1 + 0.63 * ((b + h) / L_{z^-})^{0.63}))$
$= \mathrm{Sqr}(1 / (1 + 0.63 * ((1.6667 + 7.0752) / 427.0566)^{0.63}))$
$= 0.9739$
$G = 0.925 * (1 + 1.7 * g_Q * I_{z^-} * Q) / (1 + 1.7 * g_v * I_{z^-})$
$= 0.925 * (1 + 1.7 * 3.40 * 0.2281 * 0.9739) / (1 + 1.7 * 3.40 * 0.2281)$
$= 0.9113$

Gust Factor Calculations: Hydrotest, New, field

Vessel is considered a rigid structure as $n_1 = 57.6348$ Hz ≥ 1 Hz.

$z^- = \max (0.60 * h , z_{min})$
$= \max (0.60 * 7.0752 , 15.0000)$
$= 15.0000$
$I_{z^-} = c * (33 / z^-)^{1/6}$
$= 0.2000 * (33 / 15.0000)^{1/6}$
$= 0.2281$
$L_{z^-} = l * (z^- / 33)^{ep}$
$= 500.0000 * (15.0000 / 33)^{0.2000}$
$= 427.0566$
$Q = \mathrm{Sqr}(1 / (1 + 0.63 * ((b + h) / L_{z^-})^{0.63}))$
$= \mathrm{Sqr}(1 / (1 + 0.63 * ((1.6667 + 7.0752) / 427.0566)^{0.63}))$
$= 0.9739$
$G = 0.925 * (1 + 1.7 * g_Q * I_{z^-} * Q) / (1 + 1.7 * g_v * I_{z^-})$
$= 0.925 * (1 + 1.7 * 3.40 * 0.2281 * 0.9739) / (1 + 1.7 * 3.40 * 0.2281)$
$= 0.9113$

Gust Factor Calculations: Hydrotest, Corroded, field

Vessel is considered a rigid structure as $n_1 = 58.0310$ Hz ≥ 1 Hz.

$z^- = \max (0.60 * h , z_{min})$
$= \max (0.60 * 7.0752 , 15.0000)$
$= 15.0000$
$I_{z^-} = c * (33 / z^-)^{1/6}$
$= 0.2000 * (33 / 15.0000)^{1/6}$
$= 0.2281$
$L_{z^-} = l * (z^- / 33)^{ep}$
$= 500.0000 * (15.0000 / 33)^{0.2000}$
$= 427.0566$
$Q = \mathrm{Sqr}(1 / (1 + 0.63 * ((b + h) / L_{z^-})^{0.63}))$
$= \mathrm{Sqr}(1 / (1 + 0.63 * ((1.6667 + 7.0752) / 427.0566)^{0.63}))$
$= 0.9739$
$G = 0.925 * (1 + 1.7 * g_Q * I_{z^-} * Q) / (1 + 1.7 * g_v * I_{z^-})$
$= 0.925 * (1 + 1.7 * 3.40 * 0.2281 * 0.9739) / (1 + 1.7 * 3.40 * 0.2281)$
$= 0.9113$

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

ASME Section VIII Division 1, 2015 Edition	
Location from Datum (in)	17
Operating Liquid Specific Gravity	1

TOP HEAD

ASME Section VIII Division 1, 2015 Edition				
Component		Ellipsoidal Head		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Attached To		SHELL		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		1,100	150	-20
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Test horizontal		0.91	25.187	1
Test vertical		0.47	13	1
Dimensions				
Outer Diameter		18"		
Head Ratio		2		
Minimum Thickness		0.813"		
Corrosion	**Inner**	0.125"		
	Outer	0"		
Length L_{sf}		2"		
Nominal Thickness t_{sf}		0.875"		
Weight and Capacity				
		Weight (lb)[1]	**Capacity (US gal)[1]**	
New		100.37	4.28	
Corroded		86.59	4.49	
Radiography				
Category A joints		Seamless No RT		
Head to shell seam		Spot UW-11(a)(5)(b) Type 1		

[1] includes straight flange

Results Summary	
Governing condition	internal pressure
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.5879"
Maximum allowable working pressure (MAWP)	1,674.41 psi
Maximum allowable pressure (MAP)	1,966.55 psi
Straight Flange governs MDMT	-20°F

Factor K		
$K = (1/6)*[2 + (D / (2*h))^2]$		
Corroded	$K = (1/6)*[2 + (16.624 / (2*4.2185))^2]$	0.9804
New	$K = (1/6)*[2 + (16.374 / (2*4.0935))^2]$	1

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

$t = P*D_o*K / (2*S*E + 2*P*(K - 0.1)) + Corrosion$
$= 1,100*18*0.980392 / (2*20,000*1 + 2*1,100*(0.980392 - 0.1)) + 0.125$
$= 0.5879$"

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

$P = 2*S*E*t / (K*D_o - 2*t*(K - 0.1)) - P_s$
$= 2*20,000*1*0.688 / (0.980392*18 - 2*0.688*(0.980392 - 0.1)) - 0$
$= 1,674.41$ psi

Maximum allowable pressure, (New at 70 °F) Appendix 1-4(c)

$P = 2*S*E*t / (K*D_o - 2*t*(K - 0.1)) - P_s$
$= 2*20,000*1*0.813 / (1*18 - 2*0.813*(1 - 0.1)) - 0$
$= 1,966.55$ psi

% Extreme fiber elongation - UCS-79(d)

$EFE = (75*t / R_f)*(1 - R_f / R_o)$
$= (75*0.875 / 3.2211)*(1 - 3.2211 / \infty)$
$= 20.3736\%$

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

Straight Flange on TOP HEAD

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		1,100	150	-20
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Test horizontal		0.91	25.125	1
Test vertical		0.54	15	1
Dimensions				
Outer Diameter		18"		
Length		2"		
Nominal Thickness		0.875"		
Corrosion	**Inner**	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		**Capacity (US gal)**
New		26.64		1.8
Corroded		23		1.85
Radiography				
Longitudinal seam		Seamless No RT		
Bottom Circumferential seam		Spot UW-11(a)(5)(b) Type 1		

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.6094"
Design thickness due to combined loadings + corrosion	0.345"
Maximum allowable working pressure (MAWP)	1,724.14 psi
Maximum allowable pressure (MAP)	2,023.12 psi
Rated MDMT	-20 °F

UCS-66 Material Toughness Requirements	
Governing thickness, t_g =	0.8208"
MDMT =	-20°F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20°F.	

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

t = $P*R_o$ / (S*E + 0.40*P) + Corrosion
= 1,100*9 / (20,000*1.00 + 0.40*1,100) + 0.125
= 0.6094"

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

P = $S*E*t / (R_o - 0.40*t) - P_s$
= 20,000*1.00*0.75 / (9 - 0.40*0.75) - 0
= 1,724.14 psi

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

P = $S*E*t / (R_o - 0.40*t)$
= 20,000*1.00*0.875 / (9 - 0.40*0.875)
= 2,023.12 psi

% Extreme fiber elongation - UCS-79(d)

EFE = $(50*t / R_f)*(1 - R_f / R_o)$
= $(50*0.875 / 8.5625)*(1 - 8.5625 / \infty)$
= 5.1095%

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

Thickness Required Due to Pressure + External Loads								
Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S_t	S_c					
Operating, Hot & Corroded	1,100	20,000	17,381	150	0.125	Wind	0.22	0.2199
						Seismic	0.22	0.2198
Operating, Hot & New	1,100	20,000	17,420	150	0	Wind	0.2166	0.2165
						Seismic	0.2167	0.2165
Hot Shut Down, Corroded	0	20,000	17,381	150	0.125	Wind	0.0001	0.0002
						Seismic	0	0.0002
Hot Shut Down, New	0	20,000	17,420	150	0	Wind	0.0001	0.0002
						Seismic	0	0.0002
Empty, Corroded	0	20,000	17,381	70	0.125	Wind	0.0001	0.0002
						Seismic	0	0.0002
Empty, New	0	20,000	17,420	70	0	Wind	0.0001	0.0002
						Seismic	0	0.0002
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	20,000	17,381	150	0.125	Weight	0.0002	0.0002

SHELL

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-106 B Smls pipe (II-D p. 14, ln. 15)		
Pipe NPS and Schedule		NPS 18 Sch 80		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		1,100	150	-20
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		0.83	23	1
Test horizontal		0.9	25.062	1
Test vertical		2.92	81	1
Dimensions				
Outer Diameter		18"		
Length		66"		
Pipe Nominal Thickness		0.938"		
Pipe Minimum Thickness[1]		0.8208"		
Corrosion	**Inner**	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		**Capacity (US gal)**
New		921.29		58.34
Corroded		804.48		60.16
Insulation				
		Thickness (in)	**Density (lb/ft^3)**	**Weight (lb)**
Insulation		1	22.5	51.3
		Spacing(in)	**Individual Weight (lb)**	**Total Weight (lb)**
Insulation Supports		0	0	0
Radiography				

Longitudinal seam	Seamless No RT
Top Circumferential seam	Spot UW-11(a)(5)(b) Type 1
Bottom Circumferential seam	Spot UW-11(a)(5)(b) Type 1

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

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.6899"
Design thickness due to combined loadings + corrosion	0.3829"
Maximum allowable working pressure (MAWP)	1,363.28 psi
Maximum allowable pressure (MAP)	1,618.46 psi
Rated MDMT	-20 °F

UCS-66 Material Toughness Requirements	
Governing thickness, t_g =	0.8208"
MDMT =	-20°F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20°F.	

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

t = $P*R_o$ / (S*E + 0.40*P) + Corrosion
= 1,100.83*9 / (17,100*1.00 + 0.40*1,100.83) + 0.125
= 0.6899"

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

P = S*E*t / (R_o - 0.40*t) - P_s
= 17,100*1.00*(0.938*0.875 - 0.125) / (9 - 0.40*(0.938*0.875 - 0.125)) - 0.83
= 1,363.28 psi

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

P = S*E*t / (R_o - 0.40*t)
= 17,100*1.00*(0.938*0.875) / (9 - 0.40*(0.938*0.875))
= 1,618.46 psi

Thickness Required Due to Pressure + External Loads								
Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S_t	S_c					
Operating, Hot & Corroded	1,100	17,100	17,100	150	0.125	Wind	0.2565	0.2515
						Seismic	0.2579	0.2501
Operating, Hot & New	1,100	17,100	17,100	150	0	Wind	0.2526	0.2474
						Seismic	0.2543	0.2456
Hot Shut Down, Corroded	0	17,100	17,100	150	0.125	Wind	0.0016	0.0029
						Seismic	0.0029	0.0041
Hot Shut Down, New	0	17,100	17,100	150	0	Wind	0.0015	0.0031
						Seismic	0.0033	0.0046
Empty, Corroded	0	17,100	17,100	70	0.125	Wind	0.0016	0.0029
						Seismic	0.0026	0.0039
Empty, New	0	17,100	17,100	70	0	Wind	0.0015	0.0031
						Seismic	0.003	0.0044
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	17,100	17,100	150	0.125	Weight	0.0009	0.0016

Straight Flange on BTM HEAD

ASME Section VIII Division 1, 2015 Edition				
Component		Cylinder		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		1,100	150	-20
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		0.9	25	1
Test horizontal		0.91	25.125	1
Test vertical		3	83	1
Dimensions				
Outer Diameter		18"		
Length		2"		
Nominal Thickness		0.875"		
Corrosion	**Inner**	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		**Capacity (US gal)**
New		26.64		1.8
Corroded		23		1.85
Insulation				
		Thickness (in)	**Density (lb/ft^3)**	**Weight (lb)**
Insulation		1	22.5	0
		Spacing(in)	**Individual Weight (lb)**	**Total Weight (lb)**
Insulation Supports		0	0	0
Radiography				
Longitudinal seam		Seamless No RT		
Top Circumferential seam		Spot UW-11(a)(5)(b) Type 1		

Results Summary	
Governing condition	Internal pressure
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.6098"
Design thickness due to combined loadings + corrosion	0.3477"
Maximum allowable working pressure (MAWP)	1,723.24 psi
Maximum allowable pressure (MAP)	2,023.12 psi
Rated MDMT	-20 °F

UCS-66 Material Toughness Requirements	
Governing thickness, t_g =	0.8208"
MDMT =	-20°F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20°F.	

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

t = $P*R_o$ / (S*E + 0.40*P) + Corrosion
= 1,100.9*9 / (20,000*1.00 + 0.40*1,100.9) + 0.125
= 0.6098"

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

P = $S*E*t$ / (R_o - 0.40*t) - P_s
= 20,000*1.00*0.75 / (9 - 0.40*0.75) - 0.9
= 1,723.24 psi

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

P = $S*E*t$ / (R_o - 0.40*t)
= 20,000*1.00*0.875 / (9 - 0.40*0.875)
= 2,023.12 psi

% Extreme fiber elongation - UCS-79(d)

EFE = (50*t / R_f)*(1 - R_f / R_o)
= (50*0.875 / 8.5625)*(1 - 8.5625 / ∞)
= 5.1095%

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

Thickness Required Due to Pressure + External Loads								
Condition	Pressure P (psi)	Allowable Stress Before UG-23 Stress Increase (psi)		Temperature (°F)	Corrosion C (in)	Load	Req'd Thk Due to Tension (in)	Req'd Thk Due to Compression (in)
		S_t	S_c					
Operating, Hot & Corroded	1,100	20,000	17,381	150	0.125	Wind	0.2214	0.217
						Seismic	0.2227	0.2158
Operating, Hot & New	1,100	20,000	17,420	150	0	Wind	0.2181	0.2135
						Seismic	0.2196	0.212
Hot Shut Down, Corroded	0	20,000	17,381	150	0.125	Wind	0.0014	0.003
						Seismic	0.0026	0.0042
Hot Shut Down, New	0	20,000	17,420	150	0	Wind	0.0014	0.0032
						Seismic	0.0029	0.0047
Empty, Corroded	0	20,000	17,381	70	0.125	Wind	0.0014	0.003
						Seismic	0.0023	0.0039
Empty, New	0	20,000	17,420	70	0	Wind	0.0014	0.0032
						Seismic	0.0026	0.0044
Hot Shut Down, Corroded, Weight & Eccentric Moments Only	0	20,000	17,381	150	0.125	Weight	0.0009	0.0015

BTM HEAD

ASME Section VIII Division 1, 2015 Edition				
Component		Ellipsoidal Head		
Material		SA-516 70 (II-D p. 18, ln. 37)		
Attached To		SHELL		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Optimize MDMT/ Find MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		1,100	150	-20
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		1.05	29.2185	1
Test horizontal		0.91	25.187	1
Test vertical		3.14	87.0935	1
Dimensions				
Outer Diameter		18"		
Head Ratio		2		
Minimum Thickness		0.813"		
Corrosion	**Inner**	0.125"		
	Outer	0"		
Length L_{sf}		2"		
Nominal Thickness t_{sf}		0.875"		
Weight and Capacity				
		Weight (lb)[1]		**Capacity (US gal)[1]**
New		106.87		4.28
Corroded		92.1		4.49
Insulation				
		Thickness (in)	**Density (lb/ft^3)**	**Weight (lb)**
Insulation		1	22.5	6.82
		Spacing(in)	**Individual Weight (lb)**	**Total Weight (lb)**
Insulation Supports		0	0	0
Radiography				
Category A joints		Seamless No RT		

Head to shell seam	Spot UW-11(a)(5)(b) Type 1

[1] includes straight flange

Results Summary	
Governing condition	internal pressure
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.5884"
Maximum allowable working pressure (MAWP)	1,673.36 psi
Maximum allowable pressure (MAP)	1,966.55 psi
Straight Flange governs MDMT	-20°F

Factor K		
$K = (1/6)*[2 + (D / (2*h))^2]$		
Corroded	$K = (1/6)*[2 + (16.624 / (2*4.2185))^2]$	0.9804
New	$K = (1/6)*[2 + (16.374 / (2*4.0935))^2]$	1

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

$t = P*D_o*K / (2*S*E + 2*P*(K - 0.1)) + Corrosion$
$= 1,101.05*18*0.980392 / (2*20,000*1 + 2*1,101.05*(0.980392 - 0.1)) + 0.125$
$= 0.5883"$

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

$P = 2*S*E*t / (K*D_o - 2*t*(K - 0.1)) - P_s$
$= 2*20,000*1*0.688 / (0.980392*18 - 2*0.688*(0.980392 - 0.1)) - 1.05$
$= 1,673.36$ psi

Maximum allowable pressure, (New at 70 °F) Appendix 1-4(c)

$P = 2*S*E*t / (K*D_o - 2*t*(K - 0.1)) - P_s$
$= 2*20,000*1*0.813 / (1*18 - 2*0.813*(1 - 0.1)) - 0$
$= 1,966.55$ psi

% Extreme fiber elongation - UCS-79(d)

$EFE = (75*t / R_f)*(1 - R_f / R_o)$
$= (75*0.875 / 3.2211)*(1 - 3.2211 / \infty)$
$= 20.3736\%$

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

SKIRT

ASME Section VIII Division 1, 2015 Edition		
Component		Support Skirt
Material		SA-106 B Smls pipe (II-D p. 14, ln. 15)
Skirt is Attached To		BTM HEAD
Skirt Attachment Offset		3.2954" down from the top seam
Design Temperature		
Internal		150°F
Dimensions		
Inner Diameter	**Top**	17.25"
	Botttom	17.25"
Length (includes base ring thickness)		8.7"
Nominal Thickness		0.375"
Corrosion	**Inner**	0"
	Outer	0"
Weight		
New		48.92 lb
Corroded		48.92 lb
Joint Efficiency		
Top		0.55
Bottom		0.8

Skirt design thickness, largest of the following + corrosion = 0.0066 in

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

The skirt thickness of 0.3281 in is adequate.

Results Summary							
Loading	**Condition**	**Tensile or Compressive Side**	**Governing Skirt Location**	**Temperature (°F)**	**Allowable Stress (psi)**	**Calculated Stress/E (psi)**	**Required thickness (in)**
Wind	operating, corroded	Tensile	top	150	17,100	121.39	0.0027
		Compressive	bottom		17,032.67	201.85	0.0044
	operating, new	Tensile	top	150	17,100	115.12	0.0025
		Compressive	bottom		17,032.67	210.05	0.0046
	empty, corroded	Tensile	top	70	17,100	132.61	0.0029
		Compressive	bottom		17,032.67	191.57	0.0042
	empty, new	Tensile	top	70	17,100	125.96	0.0028
		Compressive	bottom		17,032.67	200.12	0.0044
	test, corroded	Tensile	top	70	17,100	75.43	0.0017
		Compressive	bottom		17,032.67	201.61	0.0044
	test, new	Tensile	bottom	70	17,100	70.16	0.0015
		Compressive			17,032.67	209.21	0.0046
Seismic	operating, corroded	Tensile	top	150	17,100	239.92	0.0053
		Compressive	bottom		17,032.67	272.27	0.006
	operating, new	Tensile	top	150	17,100	263.79	0.0058
		Compressive	bottom		17,032.67	299.81	0.0066
	empty, corroded	Tensile	top	70	17,100	222.93	0.0049
		Compressive	bottom		17,032.67	242.57	0.0053
	empty, new	Tensile	top	70	17,100	247.27	0.0054
		Compressive	bottom		17,032.67	271.06	0.006

Loading due to seismic, operating & new

Tensile side

Required thickness, tensile stress at base:

$t = -(0.6 - 0.14*S_{DS})*W / (\pi*D*S_t*E) + 48*M / (\pi*D^2*S_t*E)$
$= -(0.6 - 0.14*0.7333)*1{,}628.19 / (\pi*17.625*17{,}100*0.8) + 48*1{,}626.6 / (\pi*17.625^2*17{,}100*0.8)$
$= 0.0048$ in

Required thickness, tensile stress at the top:

$t = -(0.6 - 0.14*S_{DS})*W_t / (\pi*D_t*S_t*E) + 48*M_t / (\pi*D_t^2*S_t*E)$
$= -(0.6 - 0.14*0.7333)*1{,}579.27 / (\pi*17.625*17{,}100*0.55) + 48*1{,}394.5 / (\pi*17.625^2*17{,}100*0.55)$
$= 0.0058$ in

Compressive side

Required thickness, compressive stress at base:

$t = (1 + 0.14*S_{DS})*W / (\pi*D*S_c*E_c) + 48*M / (\pi*D^2*S_c*E_c)$
$= (1 + 0.14*0.7333)*1{,}628.19 / (\pi*17.625*17{,}033*1) + 48*1{,}626.6 / (\pi*17.625^2*17{,}033*1)$
$= 0.0066$ in

Required thickness, compressive stress at the top:

$t = (1 + 0.14*S_{DS})*W_t / (\pi*D_t*S_c*E_c) + 48*M_t / (\pi*D_t^2*S_c*E_c)$

$= (1 + 0.14*0.7333)*1,579.27 / (\pi*17.625*17,033*1) + 48*1,394.5 / (\pi*17.625^2*17,033*1)$

$= 0.0059$ in

BASE RING

Inputs	
Base configuration	single base plate without gussets
Base plate material	SA-516-70
Base plate allowable stress, S_p	20,000 psi
Foundation compressive strength	20,000 psi
Bolt circle, BC	22.5"
Base plate inner diameter, D_i	15"
Base plate outer diameter, D_o	26"
Base plate thickness, t_b	0.375"
Anchor Bolts	
Material	CS
Allowable stress, S_b	20,000 psi
Bolt size and type	0.75" series 8 threaded
Number of bolts, N	4
Corrosion allowance (applied to root radius)	0"
Anchor bolt clearance	0.125"
Bolt root area (corroded), A_b	0.3 in^2
Diameter of anchor bolt holes, d_b	0.875"
Initial bolt preload	0% (0 psi)
Bolt at 0°	No

Results Summary							
Load	Vessel condition	Base V (lb_f)	Base M (lb_f-ft)	W (lb)	Required bolt area (in^2)	t_r Base (in)	Foundation bearing stress (psi)
Wind	operating, corroded	250.9	996.6	1,514.1	0.0152	0.1704	12.1
Wind	operating, new	250.9	1,003.6	1,665.2	0.0143	0.1738	12.58
Wind	empty, corroded	250.9	996.6	1,300.6	0.0168	0.1661	11.49
Wind	empty, new	250.9	1,003.6	1,459	0.0158	0.1697	12
Wind	test, corroded	211.7	858.6	1,885	0.0088	0.1702	12.07
Wind	test, new	211.7	865.6	2,023.6	0.0079	0.1734	12.52
Seismic	operating, corroded	291.5	1,477.8	1,514.1	0.03	0.1978	16.3
Seismic	operating, new	320.5	1,626.6	1,665.2	0.033	0.2075	17.94
Seismic	empty, corroded	250.4	1,337.8	1,300.6	0.0276	0.1868	14.54
Seismic	empty, new	280.9	1,490.9	1,459	0.0307	0.1974	16.23

Anchor bolt load (governing)

$P = -(0.6 - 0.14*S_{DS})*W / N + 48 * M / (N*BC)$
$= -(0.6 - 0.14*0.7333)*1,665.19 / 4 + 48 * 1,626.6 / (4*22.5)$
$= 660.47\ lb_f$

Required area per bolt = P / S_b = 0.033 in^2

The area provided (0.302 in^2) by the specified anchor bolt is adequate.

Foundation bearing stress (governing)

$A_c = \pi*(D_o^2 - D_i^2) / 4 - N*\pi*d_b^2 / 4$
$= \pi*(26^2 - 15^2) / 4 - 4*\pi*0.875^2 / 4$
$= 351.8093\ in^2$

$I_c = \pi*(D_o^4 - D_i^4) / 64$
$= \pi*(26^4 - 15^4) / 64$
$= 19,946.71\ in^4$

$f_c = N*A_b*Preload / A_c + (1 + 0.14*S_{DS})*W / A_c + 6*M*D_o / I_c$
$= 4*0.302*0 / 351.8093 + (1 + 0.14*0.7333)*1,665.19 / 351.8093 + 6*1,626.6*26 / 19,946.71$
$=$ 18 psi

As f_c <= 20,000 psi the base plate width is satisfactory.

Base plate required thickness (governing)

$t_r = (3*f_c*L^2 / S_p)^{0.5}$
$= (3*18*4^2 / 20,000)^{0.5}$
$=$ 0.2075 in

The base plate thickness is satisfactory.

Mist pad

ASME Section VIII Division 1, 2015 Edition	
Inputs	
Distance from Bottom of Bed to Datum	50"
Bed Depth	8"
Bed Diameter	16.124"
Bed Density	12.00 lb/ft^3
Liquid Holdup	2.00% of dry weight
Weight	
Estimated Bed Weight, Empty	11.3 lb
Estimated Bed Weight, Operating	11.6 lb
Loading Conditions	
Included in Vessel Lift Weight	Yes
Present When Vessel is Empty	Yes
Present During Test	Yes

Inlet (A)

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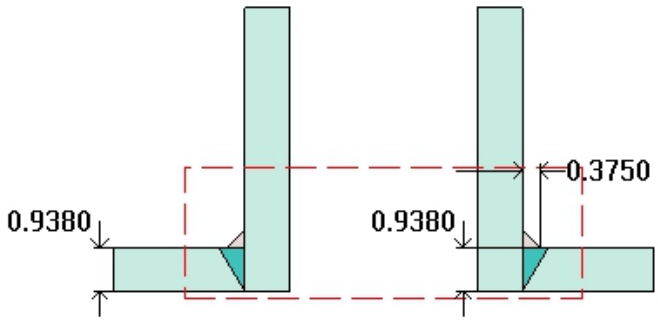
Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL
Orientation	0°
Nozzle center line offset to datum line	29"
End of nozzle to shell center	17"
Passes through a Category A joint	No
Nozzle	
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	4"
Nominal wall thickness	1"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	6.25"
Projection available outside vessel to flange face, Lf	8"
Local vessel minimum thickness	0.8208"
Liquid static head included	0 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.938"

ASME B16.5-2013 Flange	
Description	NPS 4 Class 600 LWN A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-45.7°F
Liquid static head	0 psi
MAWP rating	1,420 psi @ 150°F
MAP rating	1,480 psi @ 70°F
Hydrotest rating	2,225 psi @ 70°F
PWHT performed	No
Impact Tested	No
Gasket	
Description	Flexitallic Spiral Wound CG 304 S.S.
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -45.7°F (Coincident ratio = 0.7432) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements	
LWN rated MDMT per UCS-66(c)(4) =	-45.7°F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

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

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,299.49 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}
2.821	2.821	0.1362	2.5442	--	--	0.1406	0.37	1

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

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

Reinforcement Calculations for MAP

The attached ASME B16.5 flange limits the nozzle MAP.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,480 psi @ 70 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
3.0115	3.8806	0.2717	3.4683	--	--	0.1406	0.245	1

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

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

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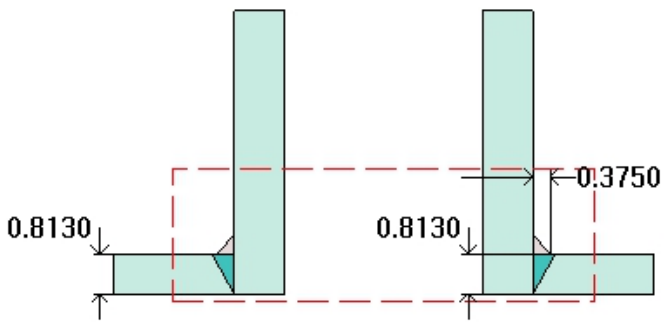
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	TOP HEAD
Orientation	0°
End of nozzle to datum line	75"
Calculated as hillside	No
Distance to head center, R	0"
Passes through a Category A joint	No
Nozzle	
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	4"
Nominal wall thickness	1"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	6.6241"
Projection available outside vessel to flange face, Lf	8.3741"
Local vessel minimum thickness	0.813"
Liquid static head included	0 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.813"

ASME B16.5-2013 Flange	
Description	NPS 4 Class 600 LWN A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-45.7°F
Liquid static head	0 psi
MAWP rating	1,420 psi @ 150°F
MAP rating	1,480 psi @ 70°F
Hydrotest rating	2,225 psi @ 70°F
PWHT performed	No
Impact Tested	No
Gasket	
Description	Flexitallic Spiral Wound CG 304 S.S.
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -45.7°F (Coincident ratio = 0.7432) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements	
LWN rated MDMT per UCS-66(c)(4) =	-45.7°F
Material is exempt from impact testing per UG-20(f) at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

The attached ASME B16.5 flange limits the nozzle MAWP.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,420 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}
2.3413	3.1912	0.5827	2.4679	--	--	0.1406	0.37	1

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

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

Reinforcement Calculations for MAP

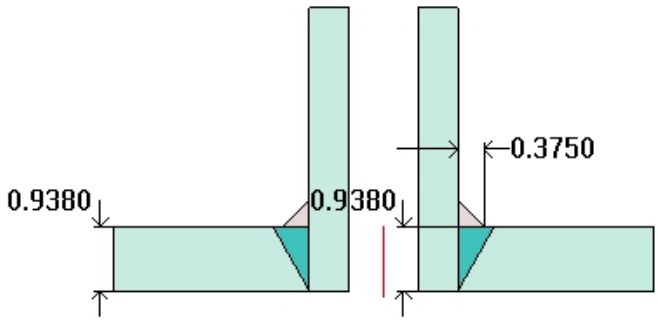
The attached ASME B16.5 flange limits the nozzle MAP.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,480 psi @ 70 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
2.3287	4.4992	0.9233	3.4353	--	--	0.1406	0.245	1

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

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

Liquid Out (C)

ASME Section VIII Division 1, 2015 Edition	
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	SHELL
Orientation	0°
Nozzle center line offset to datum line	0"
End of nozzle to shell center	16"
Passes through a Category A joint	No
Nozzle	
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1"
Nominal wall thickness	0.56"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	6.06"
Projection available outside vessel to flange face, Lf	7"
Local vessel minimum thickness	0.8208"
Liquid static head included	0.63 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.938"

ASME B16.5-2013 Flange	
Description	NPS 1 Class 600 LWN A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 344, ln. 31)
Blind included	No
Rated MDMT	-45.6°F
Liquid static head	0.61 psi
MAWP rating	1,420 psi @ 150°F
MAP rating	1,480 psi @ 70°F
Hydrotest rating	2,225 psi @ 70°F
PWHT performed	No
Impact Tested	No
Gasket	
Description	Flexitallic Spiral Wound CG 304 S.S.
Notes	
Flange rated MDMT per UCS-66(b)(1)(b) = -45.6°F (Coincident ratio = 0.7437) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UCS-66 Material Toughness Requirements	
LWN rated MDMT per UCS-66(c)(4) =	-45.6°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,364.22 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)							0.2598	0.56

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

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

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

Reinforcement Calculations for MAP

The attached ASME B16.5 flange limits the nozzle MAP.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,480 psi @ 70 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.1348	0.56

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

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

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

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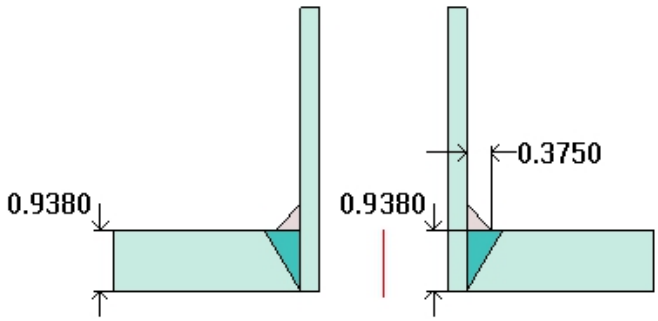
Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL
Orientation	45°
Nozzle center line offset to datum line	21"
End of nozzle to shell center	10.5"
Passes through a Category A joint	No

Nozzle	
Description	NPS 1.5 Class 3000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.9"
Nominal wall thickness	0.3"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	1.5"
Local vessel minimum thickness	0.8208"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.938"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 1,100*1.075 / (20,000*1 - 0.6*1,100) =	0.0611"
Stress ratio = t_r*E^* / (t_n - c) = 0.0611*1 / (0.3 - 0.125) =	0.3494
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,364.21 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)							0.208	0.3

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})	0.1225	0.2625	weld size is adequate

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

Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,618.57 psi @ 70 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.098	0.3

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})	0.21	0.2625	weld size is adequate

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

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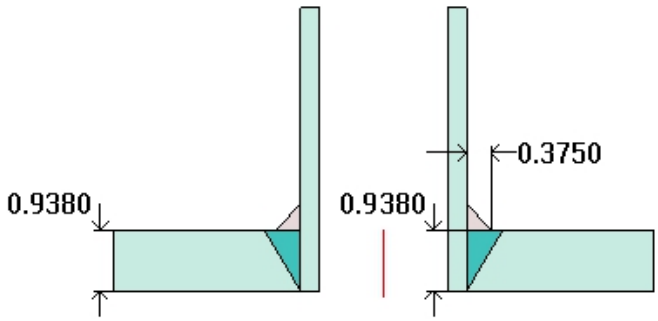
Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL
Orientation	45°
Nozzle center line offset to datum line	7"
End of nozzle to shell center	10.5"
Passes through a Category A joint	No

Nozzle	
Description	NPS 1.5 Class 3000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.9"
Nominal wall thickness	0.3"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	1.5"
Local vessel minimum thickness	0.8208"
Liquid static head included	0.4 psi
Longitudinal joint efficiency	1

Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.938"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 1,100.4*1.075 / (20,000*1 - 0.6*1,100.4) =	0.0612"
Stress ratio = t_r*E^* / (t_n - c) = 0.0612*1 / (0.3 - 0.125) =	0.3495
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,364.21 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)							0.208	0.3

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})	0.1225	0.2625	weld size is adequate

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

Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,618.57 psi @ 70 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.098	0.3

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})	0.21	0.2625	weld size is adequate

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

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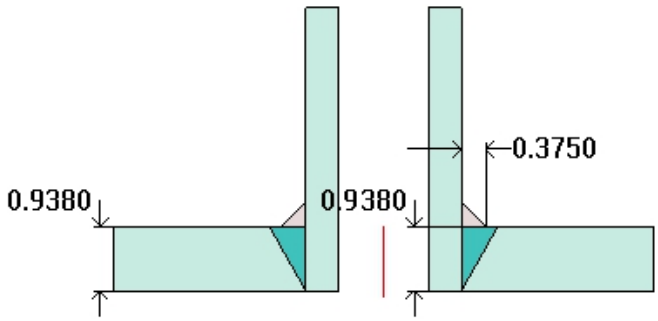
Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL
Orientation	90°
Nozzle center line offset to datum line	21.5"
End of nozzle to shell center	10.5"
Passes through a Category A joint	No

Nozzle	
Description	NPS 1 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.315"
Nominal wall thickness	0.4675"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	1.5"
Local vessel minimum thickness	0.8208"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.938"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 1,100*0.7825 / (20,000*1 - 0.6*1,100) =	0.0445"
Stress ratio = t_r*E^* / (t_n - c) = 0.0445*1 / (0.4675 - 0.125) =	0.13
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,364.21 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)							0.1997	0.4675

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.2398	0.2625	weld size is adequate

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

Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,618.57 psi @ 70 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.0882	0.4675

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

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

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

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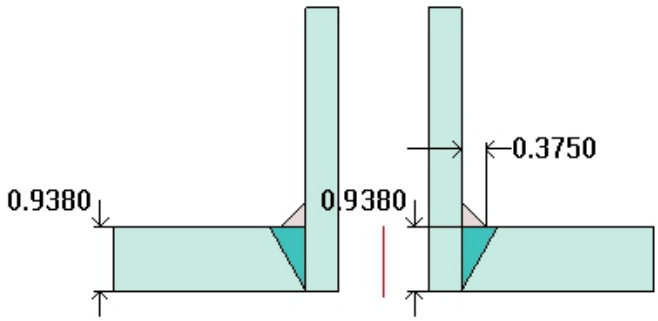
Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL
Orientation	90°
Nozzle center line offset to datum line	7.5"
End of nozzle to shell center	10.5"
Passes through a Category A joint	No

Nozzle	
Description	NPS 1 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.315"
Nominal wall thickness	0.4675"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	1.5"
Local vessel minimum thickness	0.8208"
Liquid static head included	0.37 psi
Longitudinal joint efficiency	1

Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.938"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 1,100.37*0.7825 / (20,000*1 - 0.6*1,100.37) =	0.0445"
Stress ratio = t_r*E^* / (t_n - c) = 0.0445*1 / (0.4675 - 0.125) =	0.13
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,364.22 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)							0.1997	0.4675

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.2398	0.2625	weld size is adequate

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

Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,618.57 psi @ 70 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.0882	0.4675

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

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

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

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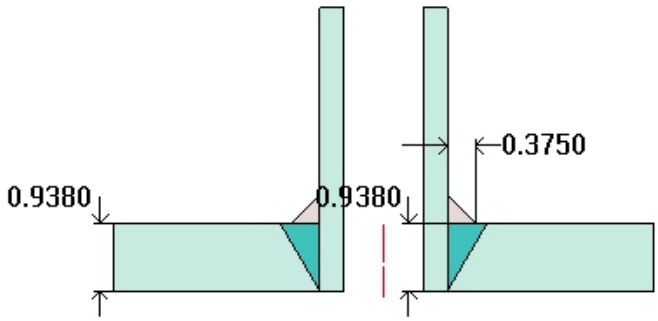
Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL
Orientation	135°
Nozzle center line offset to datum line	23"
End of nozzle to shell center	10.5"
Passes through a Category A joint	No

Nozzle	
Description	NPS 0.75 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.05"
Nominal wall thickness	0.35"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	1.5"
Local vessel minimum thickness	0.8208"
Liquid static head included	0 psi
Longitudinal joint efficiency	1

Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.938"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 1,100*0.65 / (20,000*1 - 0.6*1,100) =	0.037"
Stress ratio = t_r*E^* / (t_n - c) = 0.037*1 / (0.35 - 0.125) =	0.1643
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,364.21 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)							0.1875	0.35

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.1575	0.2625	weld size is adequate

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

Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,618.57 psi @ 70 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.0686	0.35

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

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

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

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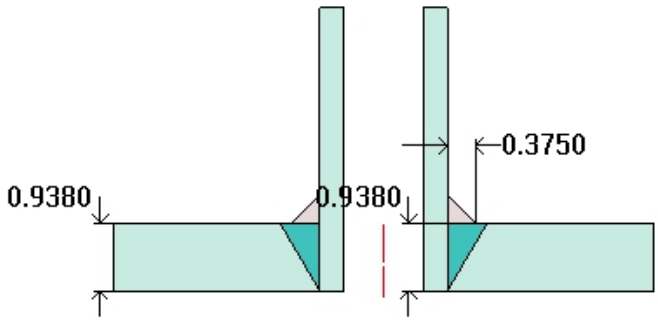
Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL
Orientation	135°
Nozzle center line offset to datum line	-2"
End of nozzle to shell center	10.5"
Passes through a Category A joint	No

Nozzle	
Description	NPS 0.75 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.05"
Nominal wall thickness	0.35"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	1.5"
Local vessel minimum thickness	0.8208"
Liquid static head included	0.7 psi
Longitudinal joint efficiency	1

Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.938"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 1,100.7*0.65 / (20,000*1 - 0.6*1,100.7) =	0.037"
Stress ratio = t_r*E^* / (t_n - c) = 0.037*1 / (0.35 - 0.125) =	0.1644
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,364.21 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)							0.1875	0.35

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.1575	0.2625	weld size is adequate

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

Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,618.57 psi @ 70 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.0686	0.35

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

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

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

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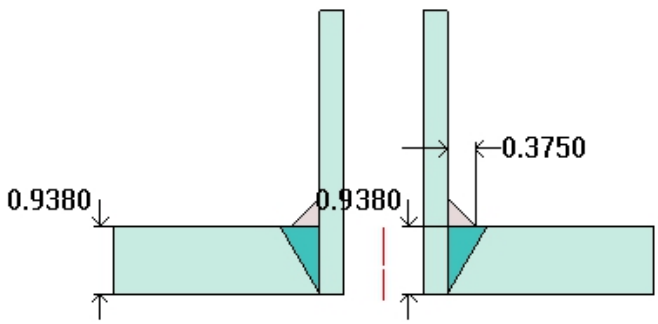
Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL
Orientation	180°
Nozzle center line offset to datum line	6"
End of nozzle to shell center	10.5"
Passes through a Category A joint	No
Nozzle	
Description	NPS 0.75 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	1.05"
Nominal wall thickness	0.35"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	1.5"
Local vessel minimum thickness	0.8208"
Liquid static head included	0.42 psi
Longitudinal joint efficiency	1
Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.938"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 1,100.42*0.65 / (20,000*1 - 0.6*1,100.42) =	0.037"
Stress ratio = t_r*E^* / (t_n - c) = 0.037*1 / (0.35 - 0.125) =	0.1644
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,364.21 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)							0.1875	0.35

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.1575	0.2625	weld size is adequate

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

Reinforcement Calculations for MAP

The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,618.57 psi @ 70 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.0686	0.35

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

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

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

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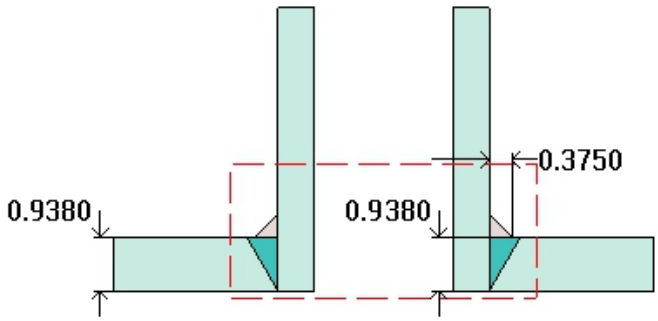

Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	SHELL
Orientation	270°
Nozzle center line offset to datum line	-2"
End of nozzle to shell center	10.5"
Passes through a Category A joint	No

Nozzle	
Description	NPS 2 Class 6000 - threaded
Access opening	No
Material specification	SA-105 (II-D p. 18, ln. 23)
Inside diameter, new	2.375"
Nominal wall thickness	0.625"
Corrosion allowance	0.125"
Projection available outside vessel, Lpr	1.5"
Local vessel minimum thickness	0.8208"
Liquid static head included	0.73 psi
Longitudinal joint efficiency	1

Welds	
Inner fillet, Leg_{41}	0.375"
Nozzle to vessel groove weld	0.938"

UCS-66 Material Toughness Requirements Nozzle	
t_r = 1,100.73*1.3125 / (20,000*1 - 0.6*1,100.73) =	0.0747"
Stress ratio = t_r*E^* / (t_n - c) = 0.0747*1 / (0.625 - 0.125) =	0.1494
Stress ratio ≤ 0.35, MDMT per UCS-66(b)(3) =	-155°F
Material is exempt from impact testing at the Design MDMT of -20°F.	

Reinforcement Calculations for MAWP

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

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,124 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
1.5131	1.5132	0.3134	1.0592	--	--	0.1406	0.2246	0.625

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

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

Reinforcement Calculations for MAP

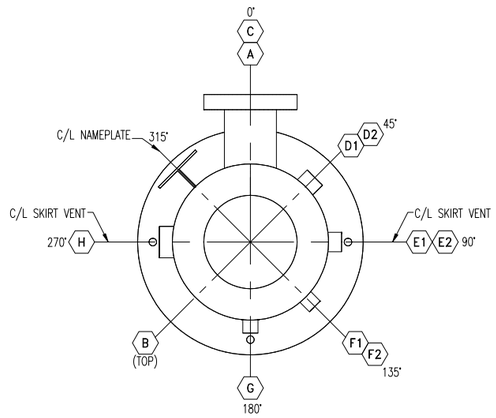
The vessel wall thickness governs the MAP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1,618.57 psi @ 70 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.1421	0.625

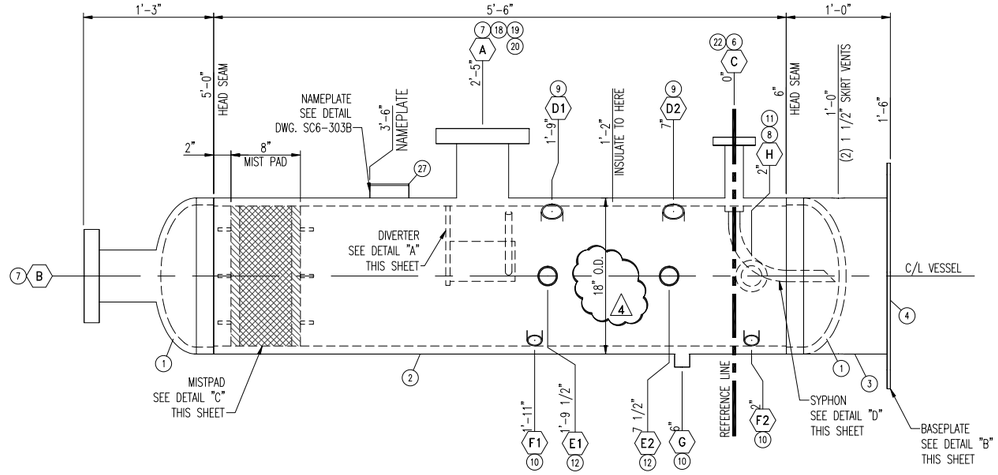
UG-41 Weld Failure Path Analysis Summary
The nozzle is exempt from weld strength calculations per UW-15(b)(2)

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

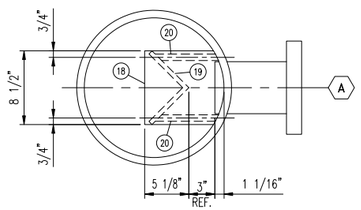
This opening does not require reinforcement per UG-36(c)(3)(a)

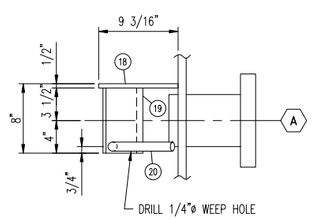


ORIENTATION
SCALE 1 1/2"=1'-0"



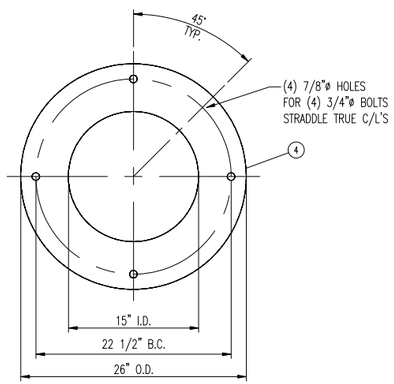
ELEVATION
SCALE 1 1/2"=1'-0"



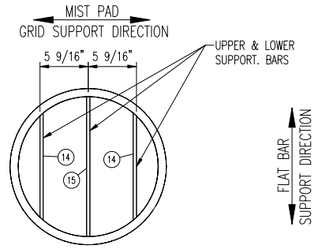


ELEVATION

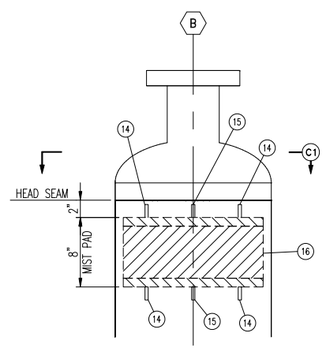
DETAIL
SCALE 1 1/2" = 1'-0" A



DETAIL
SCALE 1 1/2" = 1'-0" B

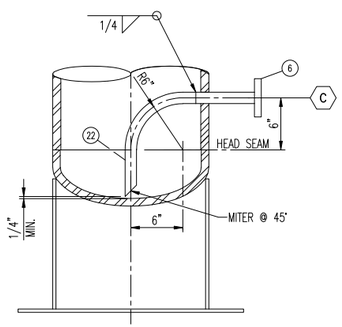


PLAN
SECTION "C1"



ELEVATION

DETAIL
SCALE 1 1/2" = 1'-0" C



DETAIL
SCALE 1 1/2" = 1'-0" D

J-447
11/15/16
IFC

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REV.	DESCRIPTION	DATE	APP'D
4	ADDED O.D. DIMENSION TO ELEVATION	8/24/16	GG
3	RELOCATED SKIRT VENTS	3/23/15	WC
2	REVISED TITLE BLOCK	08/16/13	AR
1	MOVED CPL. "G" TO MATCH DIMENSION	10/30/12	BH

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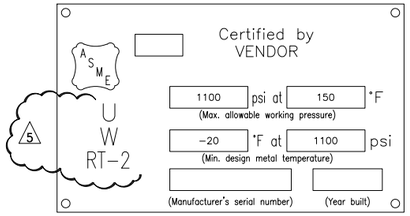
UOP RUSSELL STANDARD
60 MM CRYO PLANT
FABRICATION DETAILS
V-447 – REGEN GAS SCRUBBER 18" O.D. x 5'-6" S/S

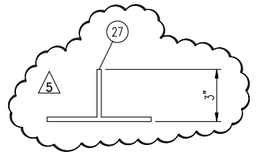
DRAWN BY	DATE	APPR. BY	DATE	CHK'D BY	DATE
AR	1/13/11	NR	2/17/11	BH	1/17/11

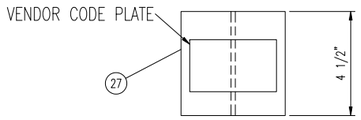
SCALE: NOTED
DRAWING NO.: SC6-303A
REV.: 4

ITEM #	QTY.	DESCRIPTION	COMMENTS	MATERIAL	WEIGHT	HEAT #
1	2	2:1 ELLIP. HEAD 18" O.D. (0.813" MIN. THK.) WITH 2" SF	HEAD 1&2	SA-516-70	200	
2	1	PIPE, 18" S/80 (0.938" NOM.) x 5'-6" LG. BExBE	SHELL	SA-106-B	940	
3	1	PIPE, 18 " STD. SMLS. (0.375" NOM.) x 8 5/16" LG. PBE	SKIRT	SA-106-B	50	
4	1	PLATE, 3/8" THK. x 26" O.D. x 15" I.D. W/(4) 7/8" DIA. HOLES x 22 1/2" DIA B.C.	BASE RING	SA-516-70	38	
		EQUALLY SPACED & STRADDLE NORMAL CENTERLINES				
6	1	FLANGE, 1" RFLWN 600#, x 9" LG.	C	SA-105	9	
7	2	FLANGE, 4" RFLWN 600#, x 10" LG.	A, B	SA-105	136	
8	1	CPLG, 2" 6000# TOE x 3" LG.	H	SA-105	3	
9	2	CPLG, 1 1/2" 3000# TOE x 3" LG.	D1 D2	SA-105	4	
10	3	CPLG, 3/4" 6000# TOE x 3 3/8" LG.	F1,F2,G	SA-105	3	
11	1	PLUG, SOLID STEEL, ROUND HEAD THREADED 2"	H	SA-105	1	
12	2	CPLG, 1" 6000# TOE x 3" LG.	E1, E2	SA-105	3	
14	4	FLAT BAR, 3/8" THK. X 1 1/2" WD x 11 5/8" LG.	MIST PAD	SA-36	8	
15	2	FLAT BAR, 3/8" THK. X 1 1/2" WD x 1'-4 1/8" LG.	MIST PAD	SA-36	5	
16	1	WIRE MESH PAD, 12 PCF, .011" WIRE, 6" THK. X 16 1/8" O.D., W/1" GRID TOP & BOTTOM (316SS)	MIST PAD	316SS	16	
18	1	PLATE, 1/2" THK. X 8 1/2" WD x 9 3/16" LG. (CUT PER DETAIL "A")	INLET DIVERTER	SA-516-70	11	
19	1	ANGLE, 6" x 6" x 1/2" x 7 1/2" LG.	INLET DIVERTER	SA-36	13	
20	2	PIPE, 3/4" XH x 7 1/8" LG. (CUT PER DETAIL A)	INLET DIVERTER	SA-106B	2	
22	1	PIPE, 1" S/160 x 1'-1 1/4" LG. POE (BEND AND CUT PER DETAIL "D")	SYPHON	SA-106-B	2	
27	1	W6x15 x 4 1/2" LG. (CUT PER DETAIL)	NAMEPLATE	SA-36	3	



VENDOR CODE PLATE





NAMEPLATE BRACKET
SCALE 3" = 1'-0"

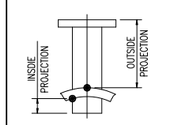
MARK	SERVICE	SIZE	RATING	TYPE	THK. REPAD	O.D. REPAD	OUTSIDE PROJECTION	INSIDE PROJECTION	WELD DETAIL	"a" WELD SIZE	"b" WELD SIZE	"c" WELD SIZE	COMMENTS
H	INSPECTION	2"	6000#	CPLG			1 1/2"	D	II	3/8			PLUGGED
G	TI	3/4"	6000#	CPLG			1 1/2"	D	II	3/8			
F1,F2	LG	3/4"	6000#	CPLG			1 1/2"	D	II	3/8			
E1,E2	LSHH	1"	6000#	CPLG			1 1/2"	D	II	3/8			
D1,D2	LC	1 1/2"	3000#	CPLG			1 1/2"	D	II	3/8			
C	LIQUID OUTLET	1"	600#	RFLWN			7"	D	II	3/8			SYPHON
B	VAPOR OUT/INSPECTION	4"	600#	RFLWN			SEE DWG.	B	II	3/8			
A	INLET	4"	600#	RFLWN			8"	SEE DWG.	II	3/8			INLET DIVERTER

NOZZLE SCHEDULE

ANSI B16.5 FLANGES / B2.1 NPT

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.

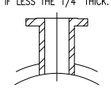
SHOP NOTES:
1) ALL NOZZLE REINFORCING PADS TO HAVE 1/4" NPT TELL-TALE HOLE. ALL OTHER PADS TO HAVE A GAP IN THE WELD TO PERMIT VENTING.
2) FLG. BOLT HLS. TO STRADDLE PRINCIPAL CL'S. OF VESSEL.
3) ALL CONNECTIONS TO BE COVERED FOR SHIPPING. FLANGES TO BE CLEANED AND COATED WITH RUST PREVENTATIVE.
4) IF SHOWN, LIFTING LUGS ARE DESIGNED FOR EMPTY VESSEL LIFT ONLY.



NOZZLE PROJECTION

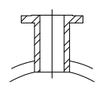
INSIDE PROJECTIONS

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.

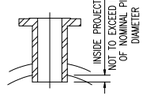


FLUSH - NO CONTOUR

C

INTERNAL PROJECTION

D



INTERNAL PROJECTION

DESIGN DATA:

5

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 : 1100 PSI @ 150 DEG. F. LIMITED BY: DESIGN OF VESSEL
MDMT: -20 DEG. F. @ 1100 PSIG
FINAL HYDROSTATIC TEST: 1430 PSI CHART REQ'D: ■YES □NO
HEAT TREAT: 0 HRS. 0 MIN. @ 1150 +/- 50 DEG. F. (CARBON STEEL)
CORROSION ALLOWANCE: .125"
CLIENT INSPECTION REQUIRED: ■YES □NO
SPECIAL WELD PROCEDURES REQ'D.: □YES ■NO
INSULATION REQUIRED: ■YES □NO - TYPE 1" H TO NLL W/ EHT
MILL TEST REPORTS: ■STD. PER CODE □PER SPECS-
IMPACT REQUIREMENTS: IMPACT TEST EXEMPT PER UG-20(f) , UCS-66 CURVE B & UCS-66(b)(3)
EARTHQUAKE: ASCE 7-10 SITE=D I=1.25 WIND VELOCITY: ASCE 7-10 120 MPH EXP C, CAT III
WEIGHT EMPTY: 1550 # FULL OF WATER: 2115 # OPERATING: 1750 #
SPECIFICATIONS: UOPR ENGINERING STANDARDS
SURFACE PREPARATION: PER JOB SPECIFICATIONS
PAINT: PER JOB SPECIFICATIONS

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:

J-447
11/15/16
IFC

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REV.	DESCRIPTION	BY	DATE	APP'D	DATE
5	REVISED EDITION & ADDENDA, & NAMEPLATE	AR	3/23/15	WC	3/23/15
4	REVISED TITLE BLOCK & STAMP	MSD	08/16/13	AR	08/16/13
3	REVISED PAINT & ADDENDA	AR	5/21/12	BH	5/21/12
2	REVISED WIND & SEISMIC	AR	11/22/11	BH	11/22/11

REVISIONS

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TX P.E.# F-7531
OK P.E.# 6852

UOP RUSSELL STANDARD
60 MM CRYO PLANT
FABRICATION DETAILS
V-447 - REGEN GAS SCRUBBER 18" O.D. x 5'-6" S/S

DRAWN BY	DATE	APP'D BY	DATE	CHK'D BY	DATE
AR	1/13/11	AR	2/17/11	NR	2/17/11
				BH	1/17/11

SCALE: NOTED
DRAWING NO.: SC6-303B
REV.: 5