Department of Environmental Protection

2600 Blair Stone Road ♦ Tallahassee, Florida 32399-2400

DEP Form: 62-762.901(9)
Form Title: Storage Tank Equipment Registration Form
Effective Date: July 2019
Incorporated in Rule 62-762.851, F.A.C.

Storage Tank System Equipment Registration Form

Fill out completely

General Information

Company Name: Tate Metalworks
Contact Name: Nathaniel Beasley
Company Address: 255 Happy Lane
City, State: Roebuck, SC Zip: 29376
E-mail: nathan.beasley@tatemetalworks.com
Contact Number: 864-699-5102
Product Name: Paper Machine Bulk Oil Storage Tank
Model Number(s): 24-018-01
Product Type: 8'-0" ID x 23'-0.96" T-T, Horizontal Vessel, MOC
Rule(s) citation that registration is being requested within Chapter 62-761 (UST), and/or 62-762 (AST), F.A.C.: 62-762 (AST)

Write a brief description of equipment registration request including product limitations:

ASME Section VIII Div 1 non-stamp horizontal vessel. Third party radiography testing was performed as well as an in-house atmospheric hydro test.

Information Checklist (Choose Yes, No, or N/A - Not Applicable):

	Question	Yes	No	N/A
1.	Third-party Certification by a Nationally Recognized Testing Laboratory? (Required)	☐	☑	
2.	Documentation of third-party evaluation that the equipment meets DEP Rules?	☐	☐	☑
3.	Documents included about the qualifications of the Nationally Recognized Testing Laboratory?	☐	☑	☐
4.	Technical information and drawings included?	☑	☐	☐
5.	Installation instructions included?	☐	☑	☐
6.	Annual Operability Testing Requirements (Rules 62-761.500, 62-762.501, & 62-762.502 F.A.C.)?	☐	☑	☐
7.	Integrity Testing Requirements (Rules 62-761.700, 62-762.701, & 62-762.702, F.A.C.)?	☐	☑	☐
8.	Compatible with fuel blends containing >10% ethanol or >20% biodiesel?	☐	☐	☑
9.	Has the product been approved or registered in other countries or states? (If so provide list)	☐	☑	☐
10.	Any requirements for company-certified installers or trainers?	☐	☑	☐
11.	Was this product(s) previously approved or registered by the Department? If yes, EQ-______	☐	☑	☐
12.	Any changes or modifications to the equipment since the last submittal to DEP?	☐	☐	☑

Document Information: Provide supporting documents indicated as "Yes" above including this form via email to Tanknotify@floridadep.gov, or documents can be sent to FDEP, Division of Waste Management, 2600 Blair Stone Road, MS 4560, Tallahassee, FL 32399.

Write a brief description of equipment installation and performance in the U.S.:

To the best of our knowledge, the tank has been installed and has received an initial inspection pending FDEP registration

Equipment Registration Certification:

To the best of my knowledge and belief, all information submitted on this form is true, accurate and complete.

Nathaniel Beasley, Project Engineer
Printed Name and Title

Signature (right click to sign)

2/24/25
Date

For Department Use Only:

Date Application Received: 02/24/2025
Application complete: Yes: ☒ No: ☐

EQ- 1019 Date of complete or incomplete letter sent: 02/24/2025 Date Equipment Requires Renewal: 02/24/2030

Storage tank system equipment requires renewal every 5 years in accordance with subsection 62-762.851(2), F.A.C.

Tate

METALWORKS, INC.

24-018-01 Manufacturers Data Book

8'-0" ID x 23'-11.5" TL-TL Vessel

Paper Machine Bulk Oil Storage Tank

Equip. No. 303-150-00914

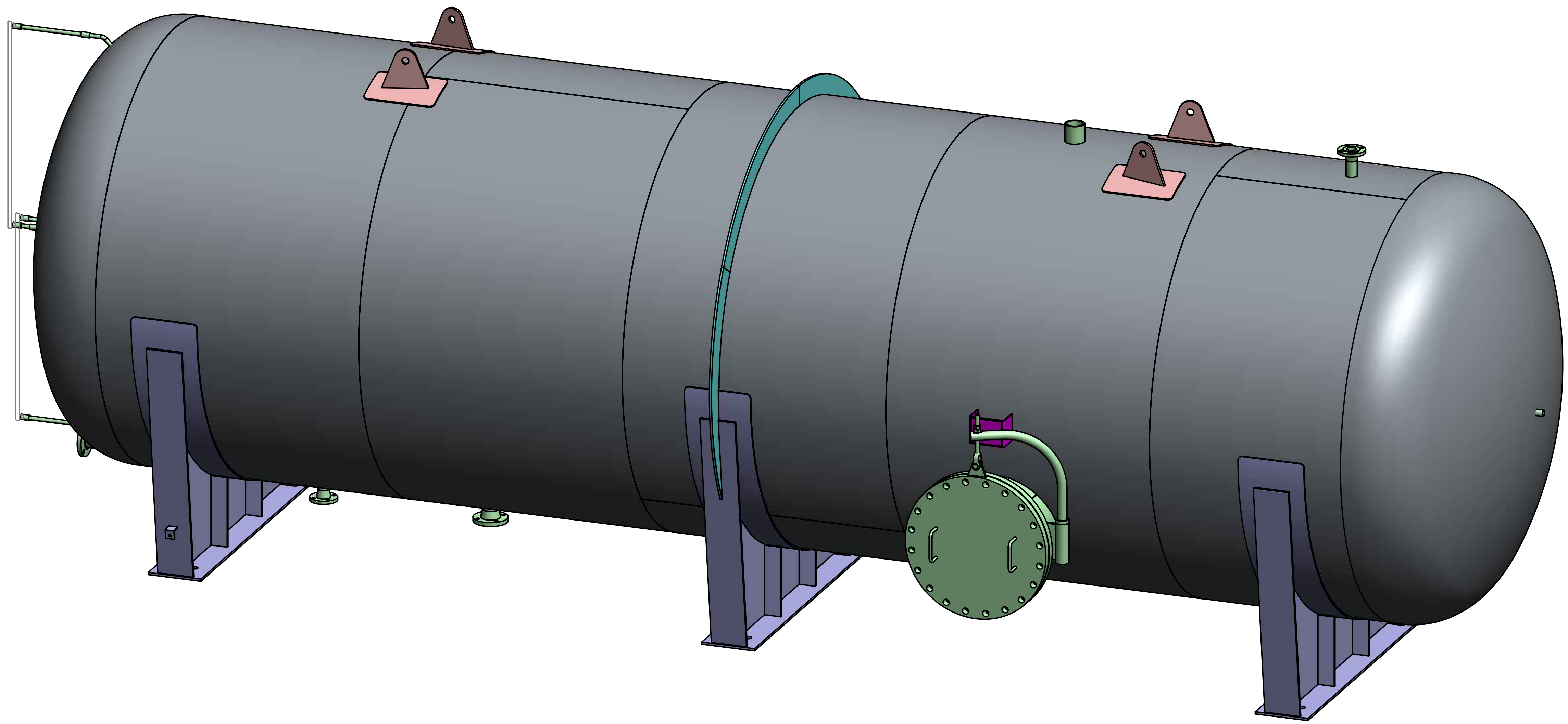
WestRock Seminole

Jacksonville, FL

SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 22687
CHARLES R. HOPE

INDEX

1.0 As-Built Drawings



PAPER MACHINE BULK OIL STORAGE TANK ~ 303-150-00914 3

ISOMETRIC

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3	12/16/24	CKS	ADDED STIFFENING RING ISSUED FOR CONSTRUCTION	NJB	DWC
2	08/26/24	DWC	REVISED NOZZLE N5 TO 3" COUPLING. ADDED NOZZLES N11 & N12. ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate

METALWORKS, INC.

P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE

8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK

WESTROCK SEMINOLE ~ JACKSONVILLE, FL

TANK MODEL

SCALE: SCALE 1:28

DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-MOD-3

FILE NAME 24-018-01-MOD

BY CKS

DRAWING SCHEDULE

TATE DWG. NO.	DESCRIPTION
24-018-01-000	SPECIFICATIONS, NOTES, & DRAWINGS
24-018-01-001	GENERAL ARRANGEMENT
24-018-01-002	ORIENTATION
24-018-01-003	NOZZLE SCHEDULE
24-018-01-004	NOZZLE STANDARD DETAILS
24-018-01-005	CROSS SECTION & JOINT DETAILS
24-018-01-007	SHELL WELD MAP
24-018-01-008	SHELL PLATE DETAILS
24-018-01-020	HEAD DETAILS
24-018-01-030	HEAD DETAILS
24-018-01-040	SHELL MANWAY DETAILS
24-018-01-041	SHELL MANWAY DETAILS
24-018-01-045	NOZZLE DETAILS
24-018-01-060	MISCELLANEOUS DETAILS
24-018-01-061	MISCELLANEOUS DETAILS
24-018-01-062	MISCELLANEOUS DETAILS
24-018-01-065	SADDLE DETAILS
24-018-01-066	SADDLE DETAILS
24-018-01-067	SADDLE DETAILS
24-018-01-070	FOUNDATION LOAD DETAILS
24-018-01-080	HYDROSTATIC TEST DETAILS
24-018-01-081	HYDROSTATIC TEST DETAILS
24-018-01-082	HYDROSTATIC TEST DETAILS
24-018-01-083	HYDROSTATIC TEST DETAILS
24-018-01-090	SHIPPING ENVELOPE

2

DESIGN NOTES:

CONSTRUCTION SHALL BE IN ACCORDANCE WITH: ASME SECTION VIII, DIV. 1 ~ NON-STAMPED

EQUIPMENT NO. 303-150-00914 MANUFACTURER SERIAL NO. 24-018-01

DESIGN CONDITIONS: 0 INTERNAL/ 0 EXTERNAL P.S.I.G. @ 150° F

MINIMUM DESIGN METAL TEMPERATURE (MDMT): 0 ° F @ 0 INTERNAL/ 0 EXTERNAL P.S.I.G.

CORROSION ALLOWANCE: 1/8" SHELL & HEADS SPECIFIC GRAVITY: 0.9

HYDRO-TEST CONDITIONS: SEE SHEET 080

INSPECTION BY: TATE & CUSTOMER SYMBOL APPLIED: NONE

EST. WEIGHT EMPTY: 13,906 LBS

TANK/VESSEL TO BE THOROUGHLY CLEANED OF ALL FOREIGN MATTER, INCLUDING DIRT, WELD FLUX/SPATTER, MILL SCALE, TRASH ETC, AFTER FABRICATION.

MATERIAL NOTES:

SHELL: SA240-304/304L HEADS/ROOF/BOTTOM: SA240-304/304L

SKIRT: N/A BASE RING: N/A

ANCHOR CHAIRS: N/A SUPPORT LEGS: N/A

INSULATION RINGS: N/A STIFFENING RINGS: N/A

TOP ANGLE: N/A REPADS: SA240-304/304L

FORGINGS/COUPLINGS: SA182-F304/304L BACKING FLANGES: N/A

STUB ENDS: N/A PLATE FLANGES: N/A

NOZZLE NECK (PIPE): SA312-TP304/304L SMLS NOZZLE NECK (PLATE): SA240-304/304L

FLANGE BOLTS: SA193-B8/ SA194-GR8 STRUCTURAL BOLTS: N/A

GASKETS: 1/8" THK GARLOCK 3000

GASKETS (HYDROSTATIC TEST): RED RUBBER

PLATFORM: N/A

LADDER/STAIRWAY: N/A HANDRAIL: N/A

OTHER: SADDLE: SA240-304/304L

1. TATE METALWORKS STANDARD WELD PROCEDURES:
   WPS 21: STAINLESS STEEL, SAW
   WPS 22: STAINLESS STEEL, FCAW
   WPS 50: STAINLESS STEEL, GTAW

2. TESTING PROCEDURES:
   A. VISUAL: VISUALLY INSPECT ALL WELDS.
   B. AIR TEST SHELL REPADS: TATE PROCEDURE: APT-001
   C. RADIOGRAPHY: X-RAY PER ASME, SECTION VIII, DIVISION 1
   D. HYDROSTATIC: HYDROSTATIC PRESSURE TEST PER TEST PROCEDURES

3. CLEANING:
   A. ALL WELDS WILL BE MECHANICALLY CLEANED. THE REMOVAL OF HEAT TINT IS INCLUDED
   B. AT THE COMPLETION OF FABRICATION, BUT PRIOR TO THE HYDROTEST, THE INTERIOR AND EXTERIOR OF THE TANK WILL BE PICKLED AND PASSIVATED PER TATE METALWORKS STANDARD STAINLESS STEEL CLEANING METHODS

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2	12/16/24	CKS	REVISED DRAWING SCHEDULE ISSUED FOR CONSTRUCTION	NJB	DWC
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

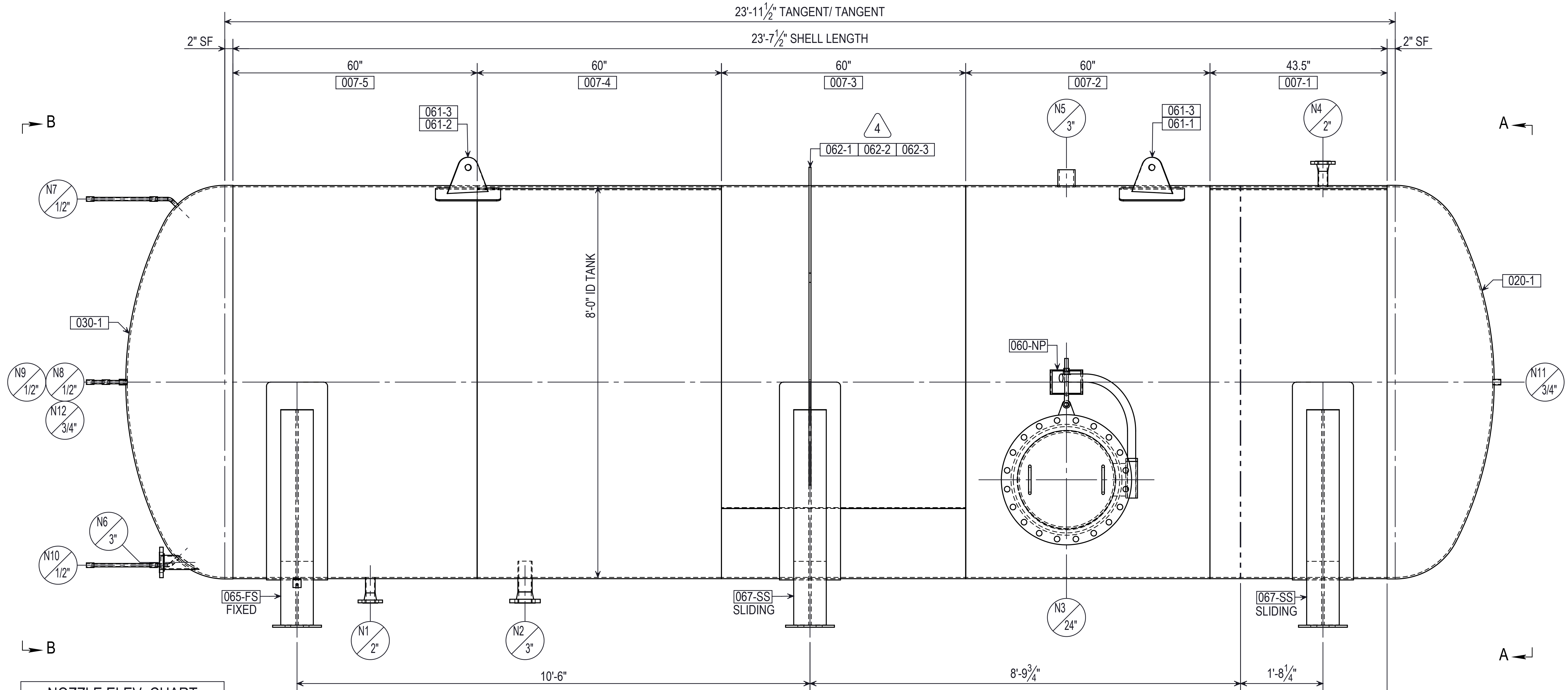
Tate METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SPECIFICATIONS, NOTES, & DRAWINGS

SCALE: SCALE 1:5

DRAWING NUMBER: Job Ph Sht Rev
24-018-01-005-2

FILE NAME 24-018-01-005
BY CKS



ELEVATION

(REF DWG -002 FOR TRUE ORIENTATION)

WORKLINE

CENTER PUNCH OUTSIDE ONLY
FOR PERMANENT REFERENCE
ALL DIMENSIONS ARE TO THIS POINT

NOZZLE ELEV. CHART

(HORIZONTALLY FROM WORKLINE)

MARK No.	SIZE	DIMENSION
N1	2"	17'-9 3/4"
N2	3"	14'-7 3/4"
N3	24"	3'-6 3/4"
N4	2"	- 1'-8 1/4"
N5	3"	3'-6 3/4"
N6	3"	HEAD
N7	1/2"	HEAD
N8	1/2"	HEAD
N9	1/2"	HEAD
N10	1/2"	HEAD
N11	3/4"	HEAD
N12	3/4"	HEAD

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4	12/16/24	CKS	ADDED STIFFENING RING ISSUED FOR CONSTRUCTION	NJB	DWC
3	09/06/24	DWC	REVISED NOZZLE N2 INTERNAL PROJECTION. ISSUED FOR CONSTRUCTION.	NJB	CKS
2	08/26/24	DWC	REVISE NOZZLE N5 TO 3" COUPLING. ADDED NOZZLES N11 & N12. ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

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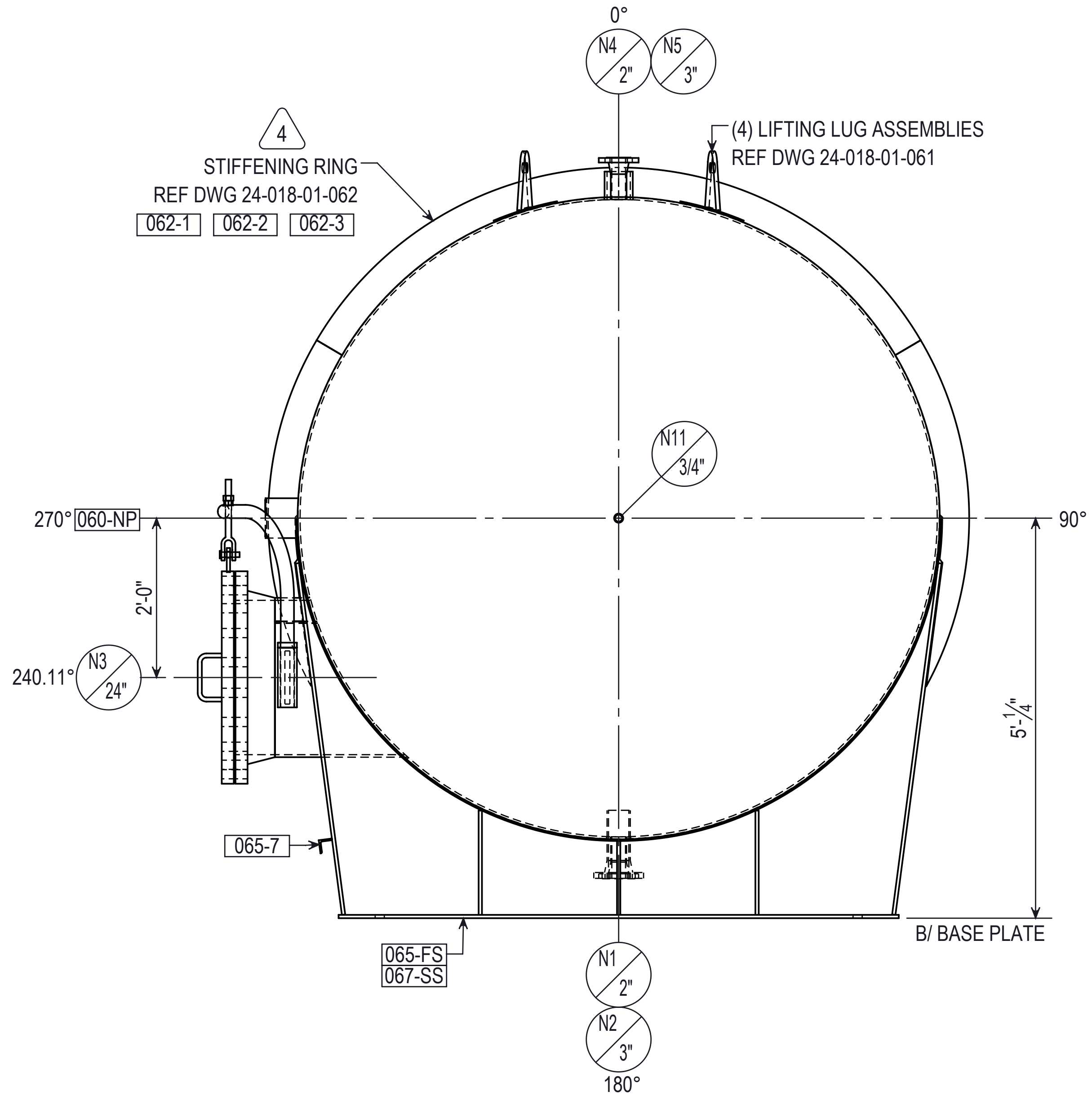
TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
GENERAL ARRANGEMENT

SCALE
SCALE 1:25

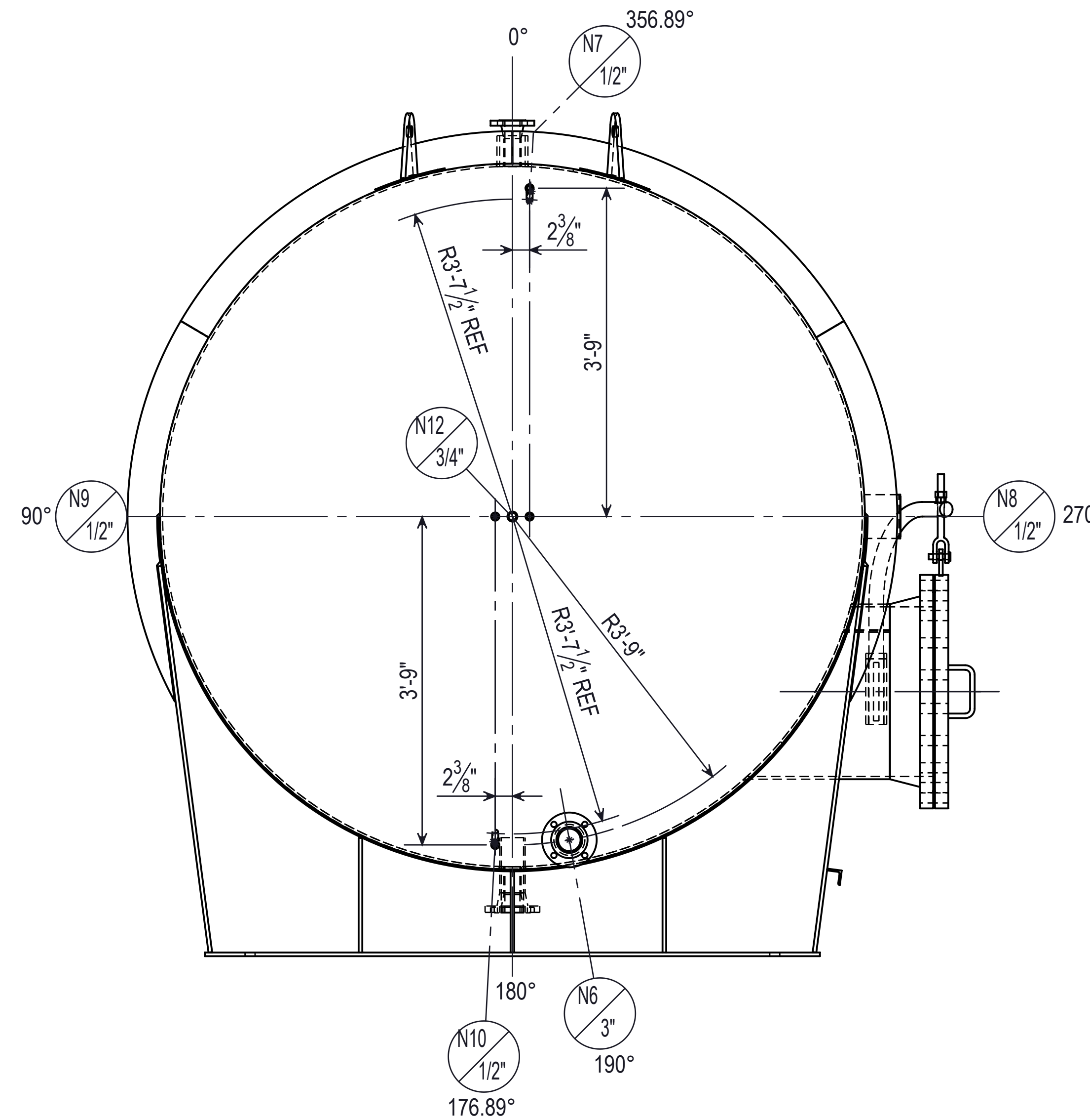
DRAWING NUMBER
Job Ph Sht Rev
24-018-01-001-4

FILE NAME 24-018-01-001
BY CKS

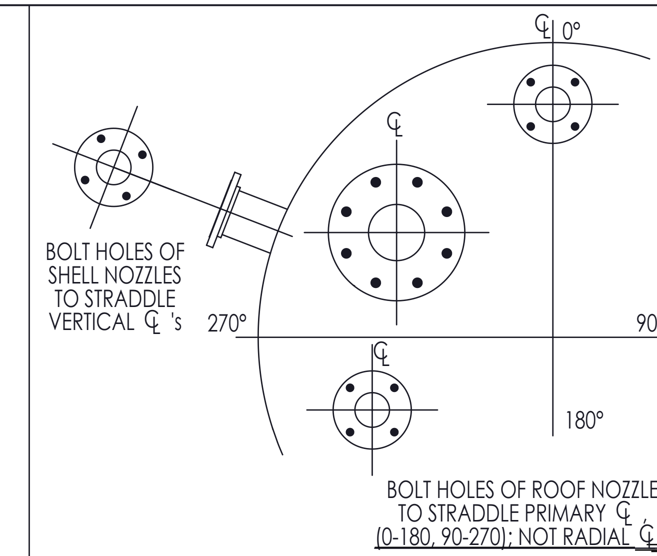


SECTION A-A

HEAD NOZZLES NOT SHOWN FOR CLARITY



SECTION B-B



DETAIL FOR 2-HOLEING

4

MARK	DESCRIPTION	QTY	SHEET
067-SS	SLIDING SADDLE	2	067
065-7	GROUNDING LUG	1	065
065-FS	FIXED SADDLE	1	065
062-1,2,3	STIFFENING RING	1	062
061-3	LIFTING LUG REPAD	4	061
061-2	LIFTING LUG	2	061
061-1	LIFTING LUG	2	061
060-NP	NAMEPLATE ASSEMBLY	1	060

ACCESSORY SCHEDULE

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
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REVISIONS

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METALWORKS, INC.

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TITLE

8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK

WESTROCK SEMINOLE ~ JACKSONVILLE, FL

ORIENTATION

SCALE: SCALE 1:26

DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-002-4

FILE NAME 24-018-01-002
BY CKS

NOZZLE AND MANWAY SCHEDULE

MARK	SIZE	NOZ-SE SCH/THICK	NOZ NECK CUT LGTH	FLANGE RATING	FLANGE TYPE	SE TYPE	FLANGE BOLTING	SERVICE	PROJECTION				MATERIAL			WELD DETAIL	WELD DIM & WPS						REPAD			REMARKS
									OS	IS	LG SIDE	SH SIDE	NOZZLE NECK	FLANGE	REPAD		a/WPS	b/WPS	c/WPS	d/WPS	e/WPS	f/WPS	THICK	O.D.	I.D.	
N1	2"	SCH 40S	4 13/16"	150#	RFWN	--	--	DRAIN	6"	FLUSH	--	--	SA312-TP304/304L SMLS	SA182-F304/304L	--	9	3/16:50	--	--	--	--	--	--	--	--	--
N2	3"	SCH 40S	7 9/16"	150#	RFWN	--	--	OUTLET	6"	4"	--	--	SA312-TP304/304L SMLS	SA182-F304/304L	--	7	3/16:22	3/16:22	--	--	--	--	--	--	--	--
N3	24"							MANWAY																		REF DWG 24-018-01-040
N4	2"	SCH 40S	4 13/16"	150#	RFWN	--	--	FILL	6"	FLUSH	--	--	SA312-TP304/304L SMLS	SA182-F304/304L	--	9	3/16:50	--	--	--	--	--	--	--	--	--
N5	3"	FULL CPLG	--	3000#	THREADED	--	--	VENT	3 7/8"	FLUSH	--	--	--	SA182-F304/304L	--	10	3/16:22	--	--	1/4:22	--	--	--	--	--	--
N6	3"	SCH 40S	12 7/16"	150#	RFSO	--	--	LEVEL TRANSMITTER	--	FLUSH	8 7/8"	4"	SA312-TP304/304L SMLS	SA182-F304/304L	--	9	1/4:22	--	--	--	1/4:22	5/16:22	--	--	--	--
N7	1/2"							VISUAL LEVEL GAUGE																		REF DWG 24-018-01-045
N8	1/2"							VISUAL LEVEL GAUGE																		REF DWG 24-018-01-045
N9	1/2"							VISUAL LEVEL GAUGE																		REF DWG 24-018-01-045
N10	1/2"							VISUAL LEVEL GAUGE																		REF DWG 24-018-01-045
N11	3/4"	FULL CPLG	--	3000#	THREADED	--	--	SPIN HOLE PLUG	1 5/8"	FLUSH	--	--	--	SA182-F304/304L	--	10	3/16:50	--	--	1/4:50	--	--	--	--	--	w/ PLUG
N12	3/4"	FULL CPLG	--	3000#	THREADED	--	--	SPIN HOLE PLUG	1 5/8"	FLUSH	--	--	--	SA182-F304/304L	--	10	3/16:50	--	--	1/4:50	--	--	--	--	--	w/ PLUG

GENERAL NOTES:
1. ALL NOZZLES TO BE FLUSH WITH THE INSIDE OF THE TANK UNLESS NOTED OTHERWISE.

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3	09/06/24	DWC	REVISED NOZZLE N2 INTERNAL PROJECTION. ISSUED FOR CONSTRUCTION.	NJB	CKS
2	08/26/24	DWC	REVISED NOZZLE N5 TO 3" COUPLING. ADDED NOZZLES N11 & N12. ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

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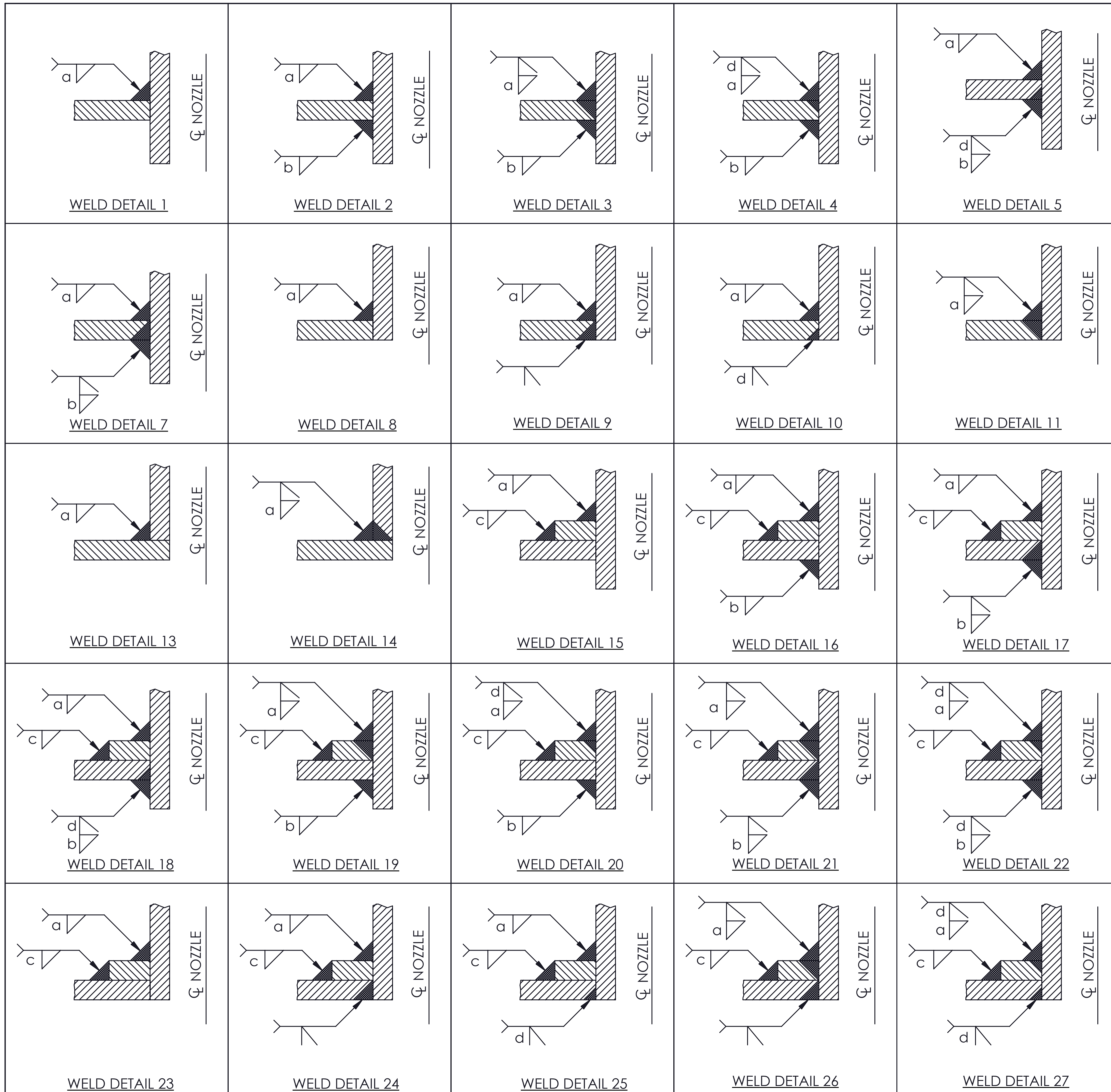
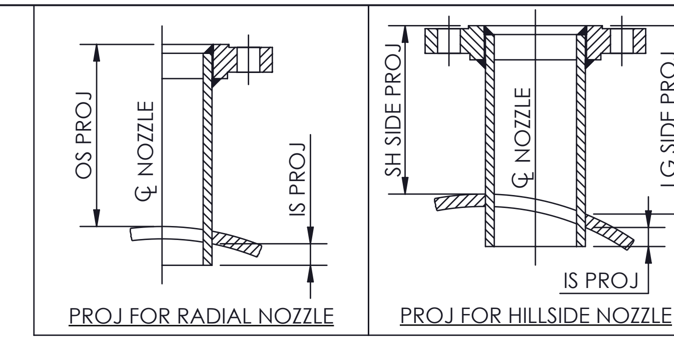
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
NOZZLE SCHEDULE

SCALE: SCALE 1:1
DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-003-3

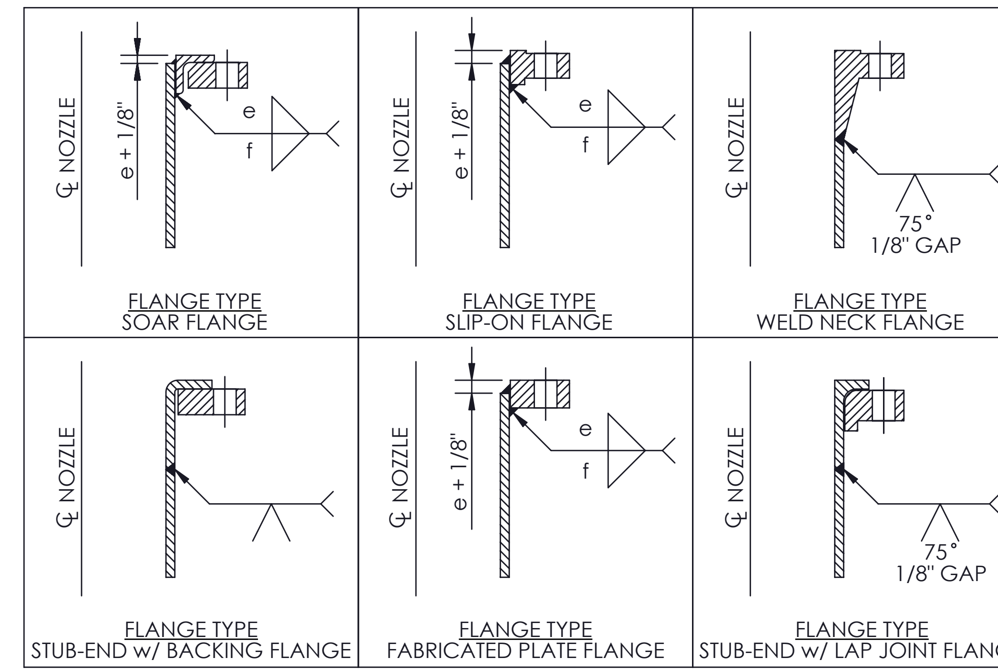
FILE NAME: 24-018-01-003
BY: CKS



WELD DETAIL



NOZZLE PROJECTION



FLANGE TYPE

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
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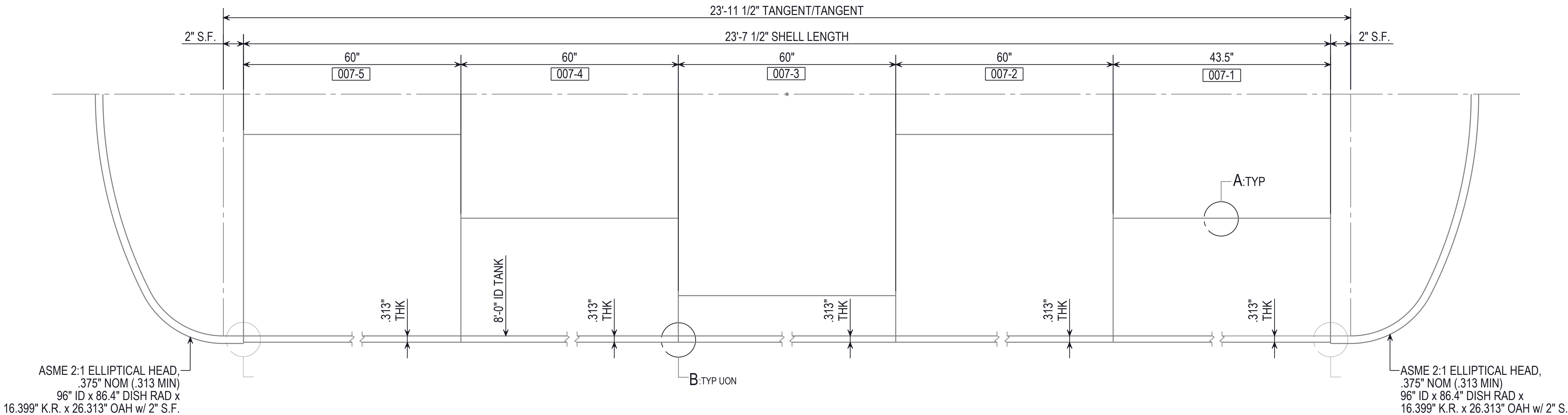
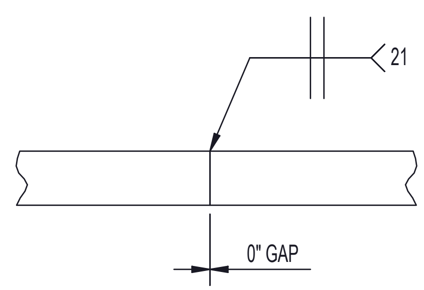
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
NOZZLE STANDARD DETAILS

SCALE: SCALE 1:1
DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-004-1

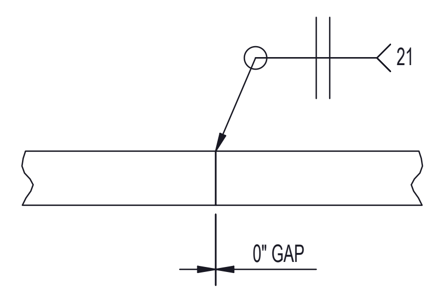
FILE NAME 24-018-01-004
BY CKS



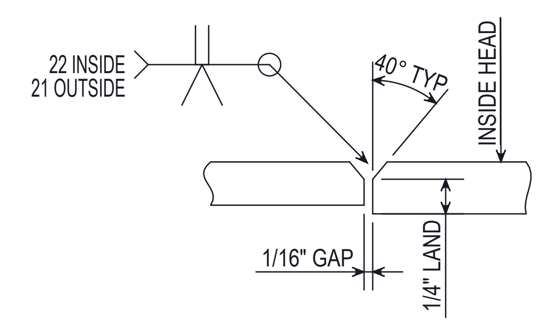
CROSS SECTION



DETAIL A



DETAIL B



DETAIL C

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
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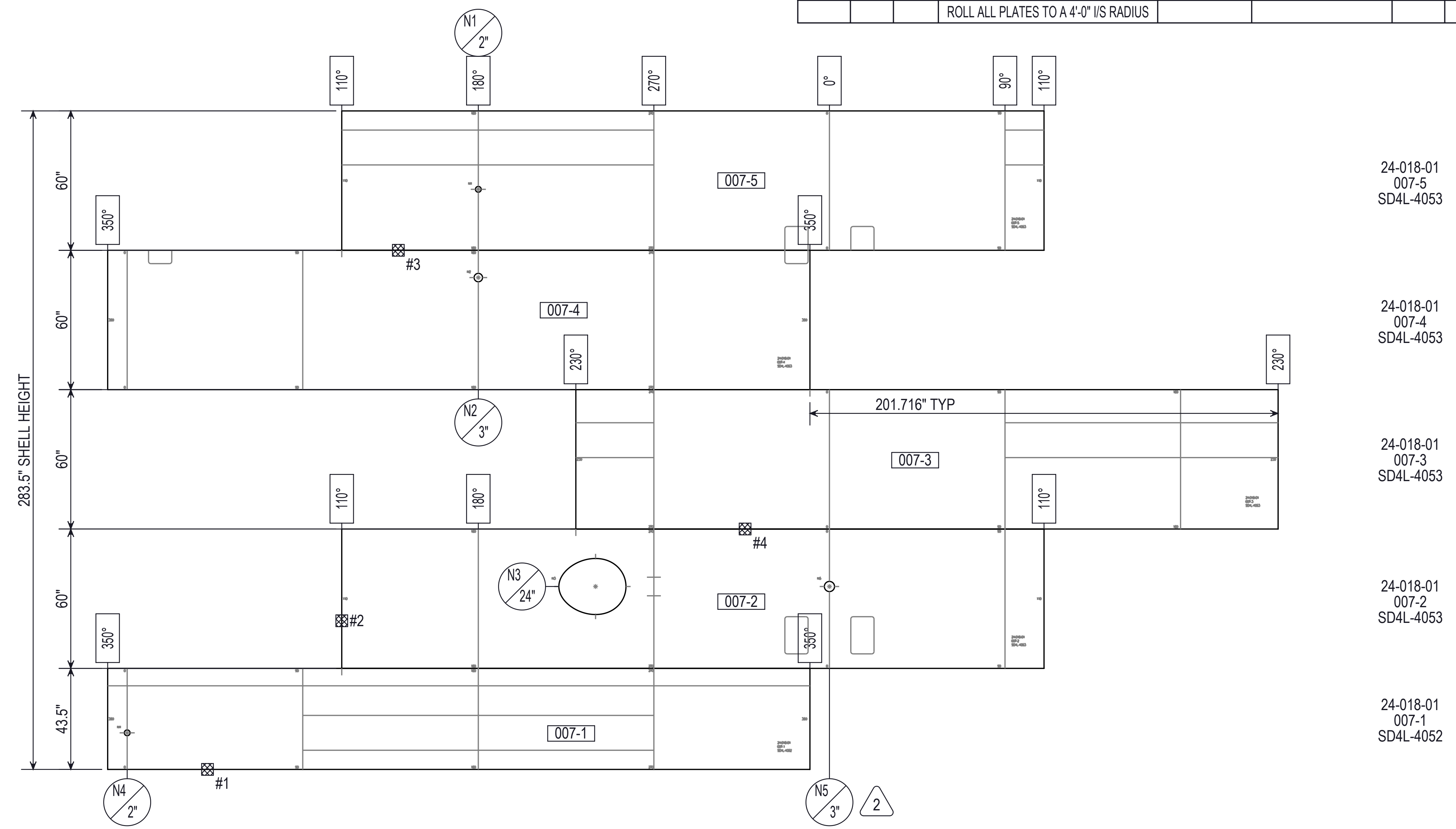
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
CROSS SECTION & JOINT DETAILS

SCALE: SCALE 1:5
DRAWING NUMBER (Job Pc Sht Rev): 24-018-01-005-1

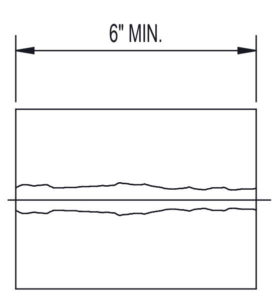
FILE NAME 24-018-01-005
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
			SHELL ASSEMBLY PIECES					
007-1		1	PL, 0.313" x 43.5" x 302.575"		SA240-304/304L	2	1188	REF DWG 24-018-01-008
007-2		1	PL, 0.313" x 60" x 302.575"		SA240-304/304L	3	1589	REF DWG 24-018-01-008
007-3		1	PL, 0.313" x 60" x 302.575"		SA240-304/304L	3	1640	
007-4		1	PL, 0.313" x 60" x 302.575"		SA240-304/304L	3	1639	REF DWG 24-018-01-008
007-5		1	PL, 0.313" x 60" x 302.575"		SA240-304/304L	3	1639	REF DWG 24-018-01-008
			ROLL ALL PLATES TO A 4'-0" I/S RADIUS					



SHELL WELD MAP

VIEW FROM OUTSIDE



FILM DETAIL "A"

(4) REQUIRED

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2	08/26/24	DWC	REVISED NOZZLE N5 TO 3" COUPLING. ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate

METALWORKS, INC.

P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE

8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK

WESTROCK SEMINOLE ~ JACKSONVILLE, FL

SHELL WELD MAP

SCALE

SCALE 1:54

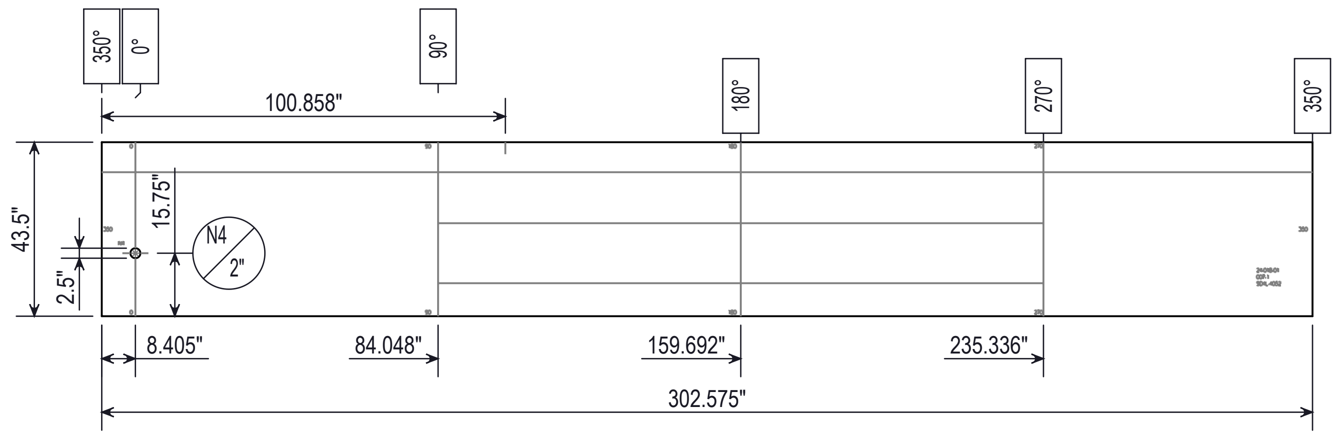
DRAWING NUMBER

Job Ph Sht Rev

24-018-01-007-2

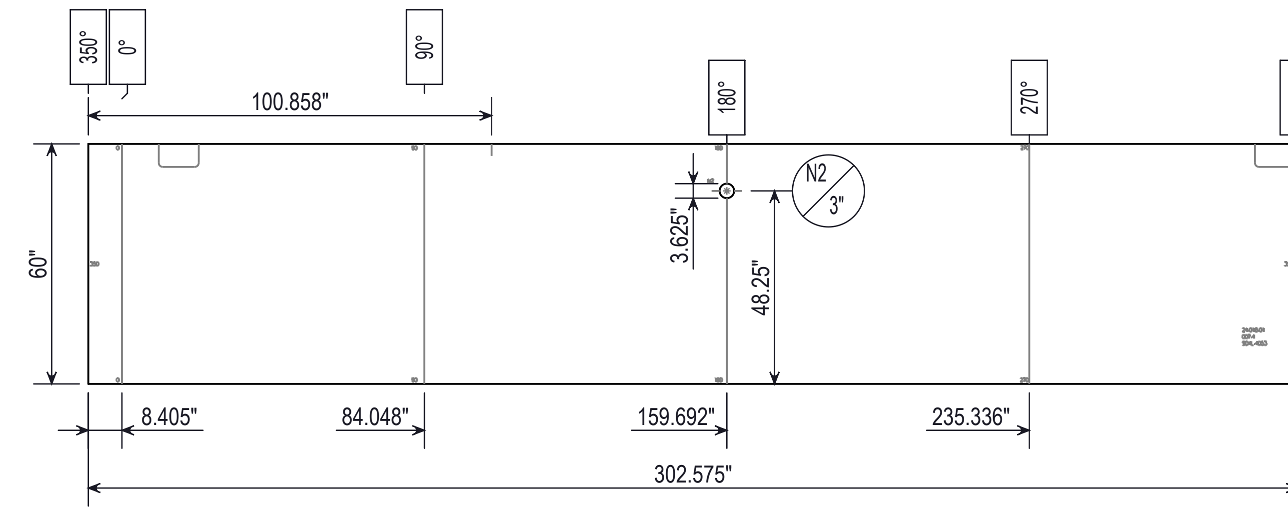
FILE NAME 24-018-01-007

BY CKS



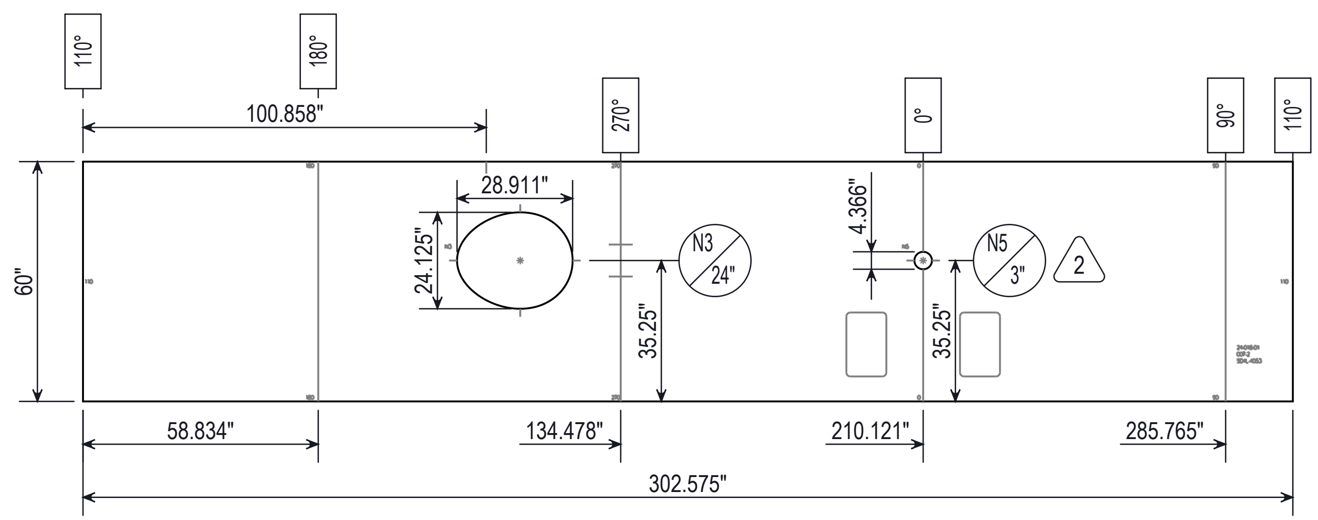
MK 007-1 PLATE LAYOUT

VIEW FROM OUTSIDE



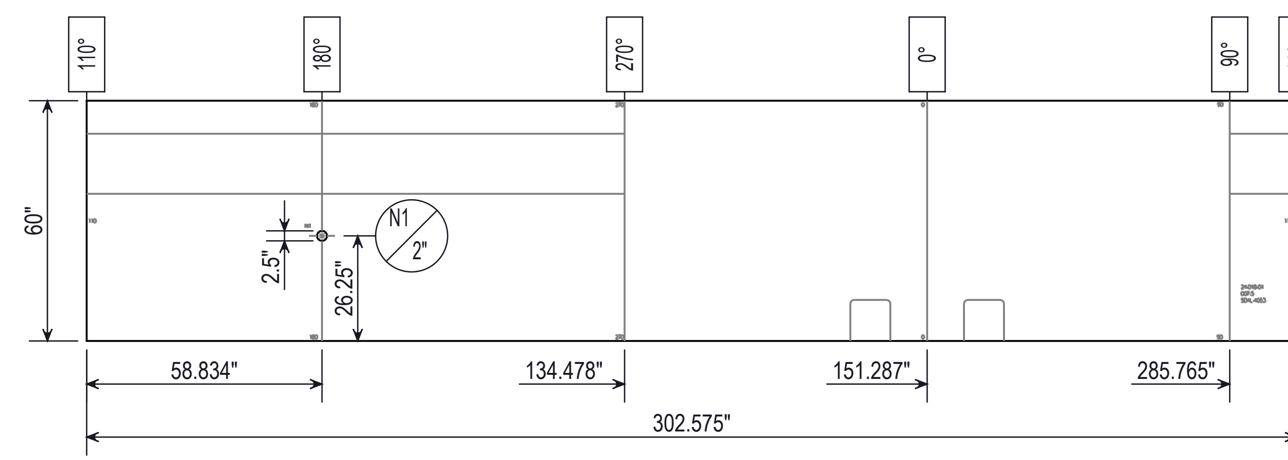
MK 007-4 PLATE LAYOUT

VIEW FROM OUTSIDE



MK 007-2 PLATE LAYOUT

VIEW FROM OUTSIDE



MK 007-5 PLATE LAYOUT

VIEW FROM OUTSIDE

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2	08/26/24	DWC	REVISED NOZZLE N5 TO 3" COUPLING. ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

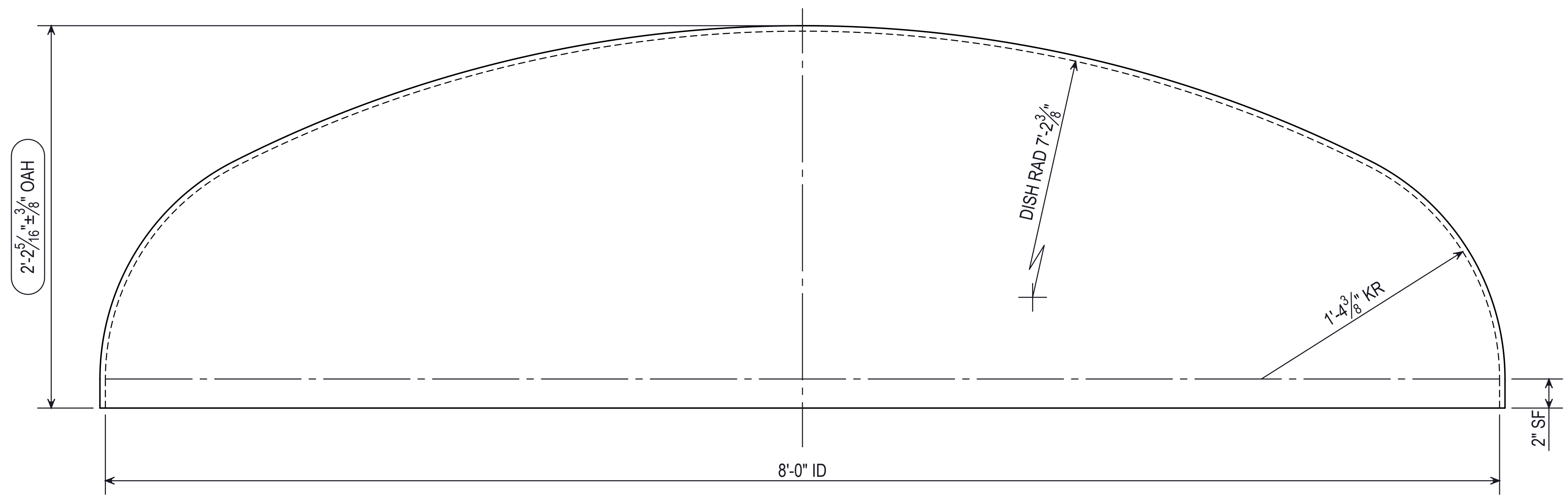
TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SHELL PLATE DETAILS

SCALE: SCALE 1:48

DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-008-2

FILE NAME 24-018-01-008
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
			ELLIPSOILDAL HEAD					
020-1		1	HD, .375" NOM THK (.313" MIN), 96" ID x 86.4" DISH RAD x 16.399" KR x 26.313" OAH w/ 2"SF		SA240-304/304L	1	1176	



HEAD ~ 020-1

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

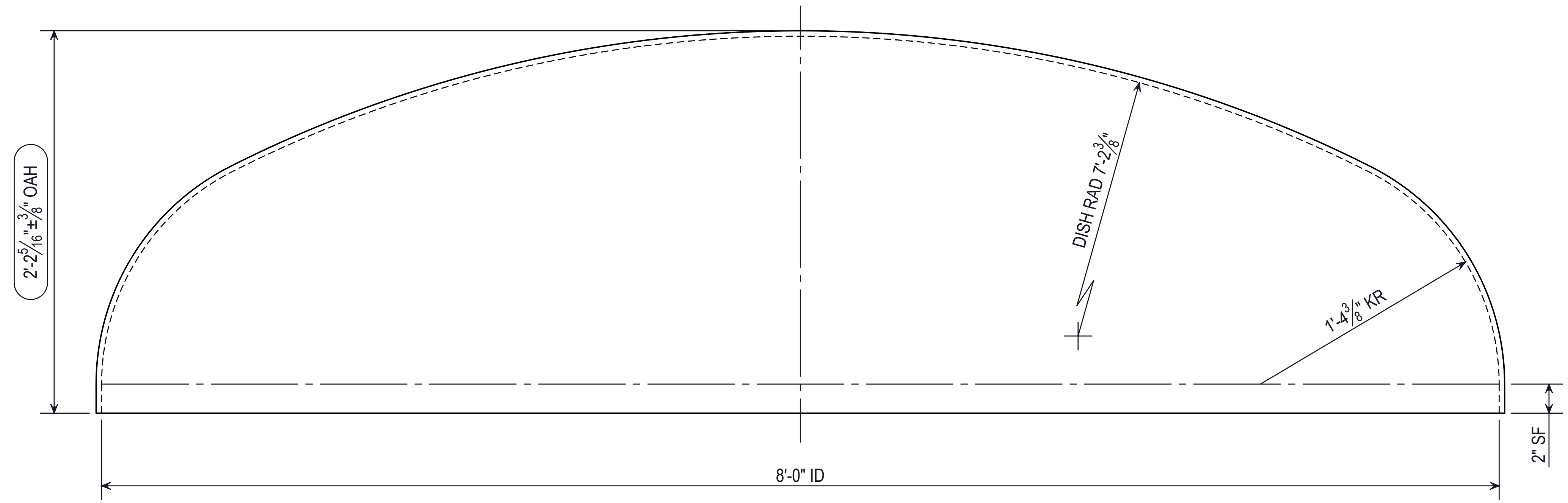
TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HEAD DETAILS

SCALE
SCALE 1:10

DRAWING NUMBER
Job Ph Sht Rev
24-018-01-020-1

FILE NAME 24-018-01-020
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
			ELLIPSOILDAL HEAD					
030-1		1	HD, .375" NOM THK (.313" MIN), 96" ID x 86.4" DISH RAD x 16.399" KR x 26.313" OAH w/ 2"SF		SA240-304/304L	1	1176	



HEAD ~ 030-1

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

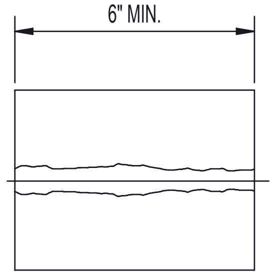
TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HEAD DETAILS

SCALE
SCALE 1:10

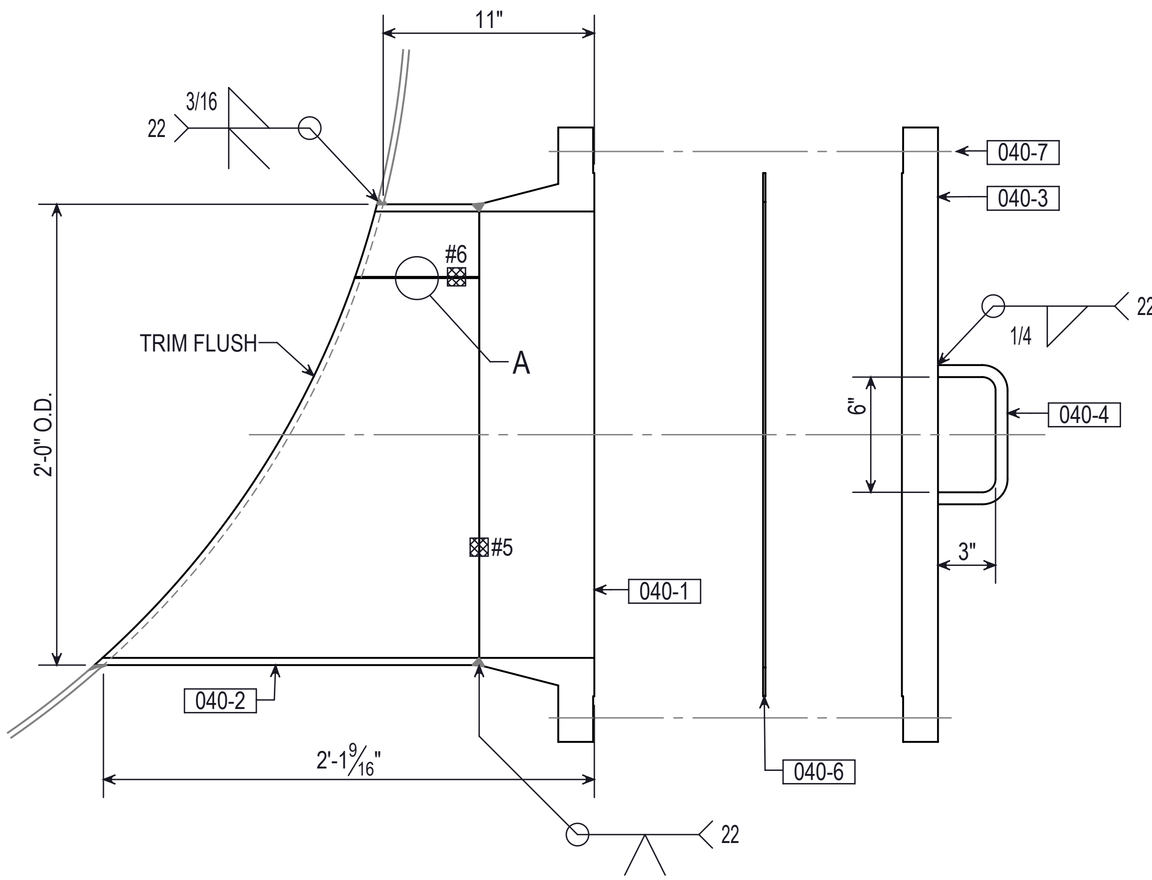
DRAWING NUMBER (Job Ph Sht Rev)
24-018-01-030-1

FILE NAME 24-018-01-030
BY CKS

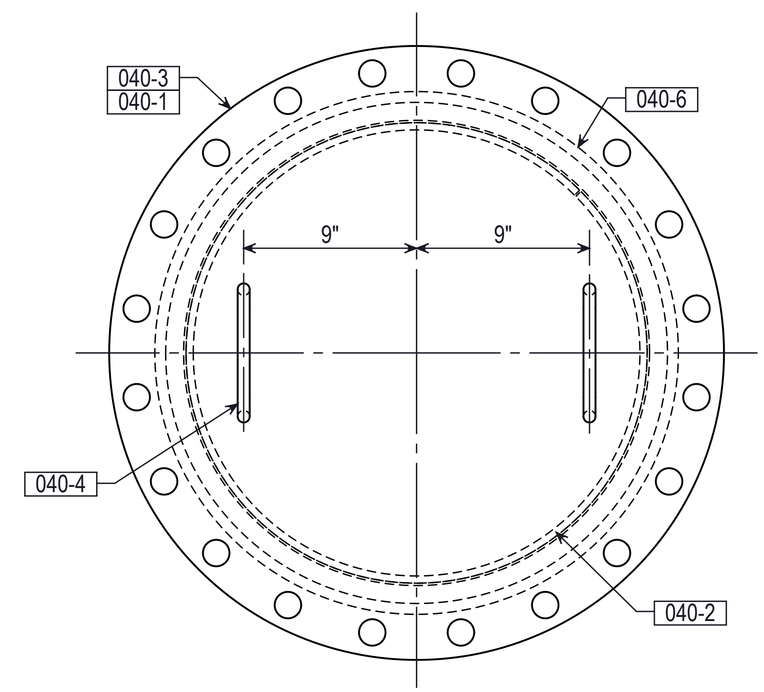
MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
040-N3		**1**	**MANWAY ~ 24"**				**838**	
040-1		1	FL, 24" 150# RF/WN SCH 40S BORE		SA182-F304/304L		269	
040-2		1	PL, .375" x 22.049" x 74.126"		SA240-304/304L		177	ROLL TO A 24" OD, SHOP TRIM
040-3		1	FL, 24" 150# RF BLD		SA182-F304/304L		417	
040-4		2	RB, 5/8" DIA	1'- 3/8"	SA479-304/304L		1	FORM PER DETAIL
040-6		1	G, 1/8" THK 24" 150# RING		GARLOCK 3000		1	
040-7		20	AT, 1 1/4" DIA x 7 1/2" LG. w/ (2) HN		SA193-B8/SA194-GR8		0	



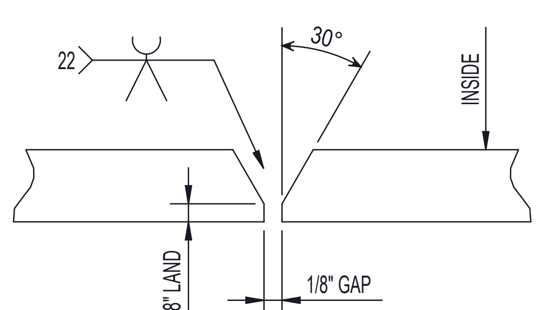
FILM DETAIL "A"
(2) REQUIRED



N3 ~ 24" MANWAY
ELEVATION - SIDE VIEW



N3 ~ 24" MANWAY
ELEVATION - FRONT VIEW



DETAIL A

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION.	NJB	DWC

REVISIONS

CERTIFIED CORRECT

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

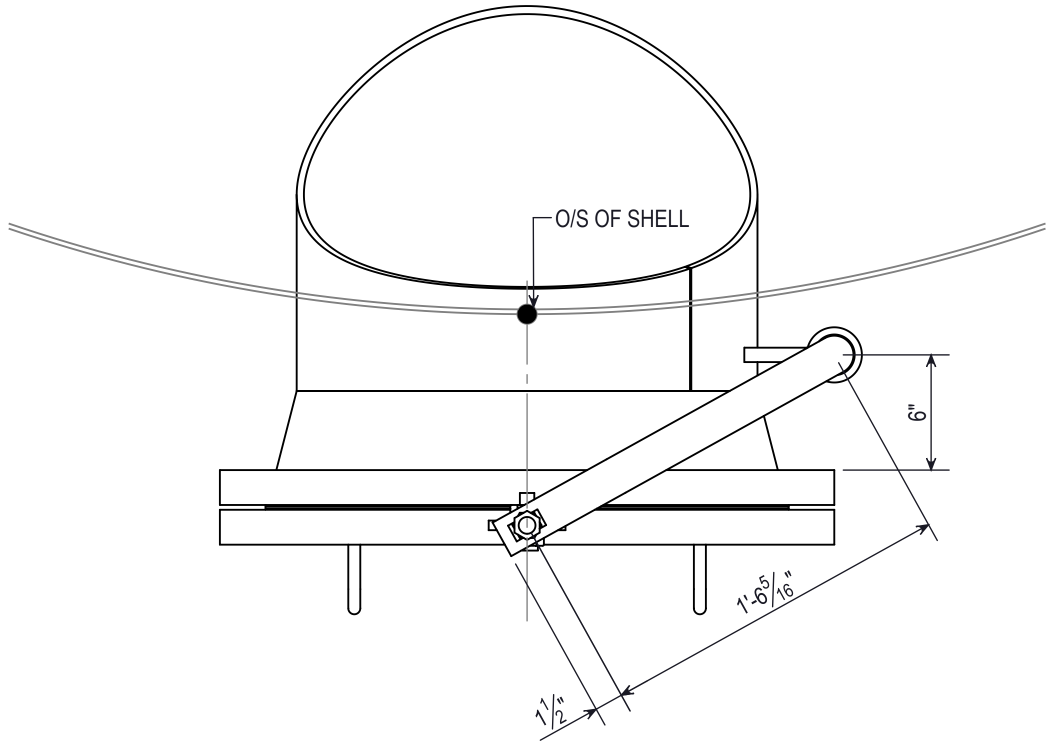
TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SHELL MANWAY DETAILS

SCALE
SCALE 1:10

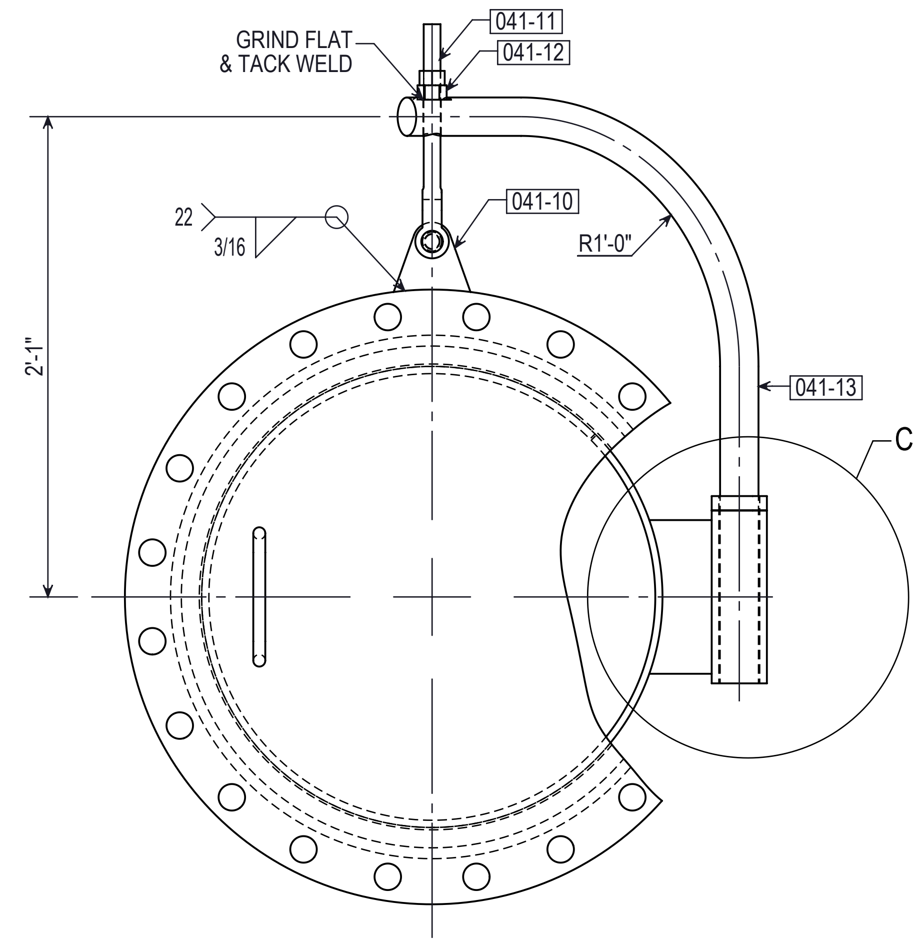
DRAWING NUMBER Job Ph Sht Rev
24-018-01-040-1

FILE NAME 24-018-01-040
BY CKS

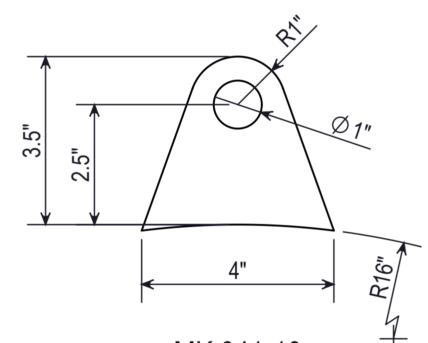
MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
040-N3		**1**	**MANWAY ~ 24"**				**838**	
041-8		1	PL, .75" x PATTERN		SA240-304/304L		5	
041-9		1	PI, 2 1/2" DIA SCH 160	9"	SA312-TP304/304L WLD		8	
041-10		1	PL, .5" x PATTERN		SA240-304/304L		1	
041-11		1	JAW END FITTING, 7/8"-9 x 12" LG., 1 1/8" OPENING WIDTH w/ 3/4" DIA PIN		GALVANIZED		3	McMASTER CARR P/N: 3001T26
041-12		2	HN, 7/8" DIA		SA194-2H HDG		0	
041-13		1	RB, 2" DIA	4'-6"	SA479-304/304L		39	SHOP TRIM
041-14		1	PI, 2 1/2" DIA SCH 160	3/4"	SA312-TP304/304L WLD		1	



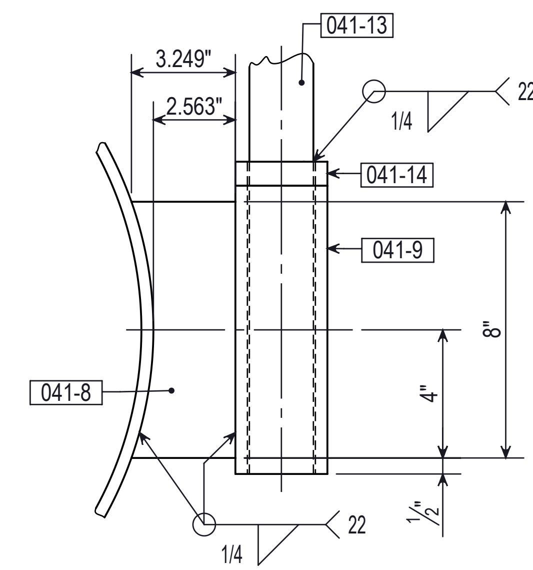
N3 ~ 24" MANWAY DAVIT
PLAN VIEW



N3 ~ 24" MANWAY DAVIT
ELEVATION - FRONT VIEW



MK 041-10
SCALE 1:4



DETAIL C
SCALE 1 : 6

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION.	NJB	DWC

REVISIONS

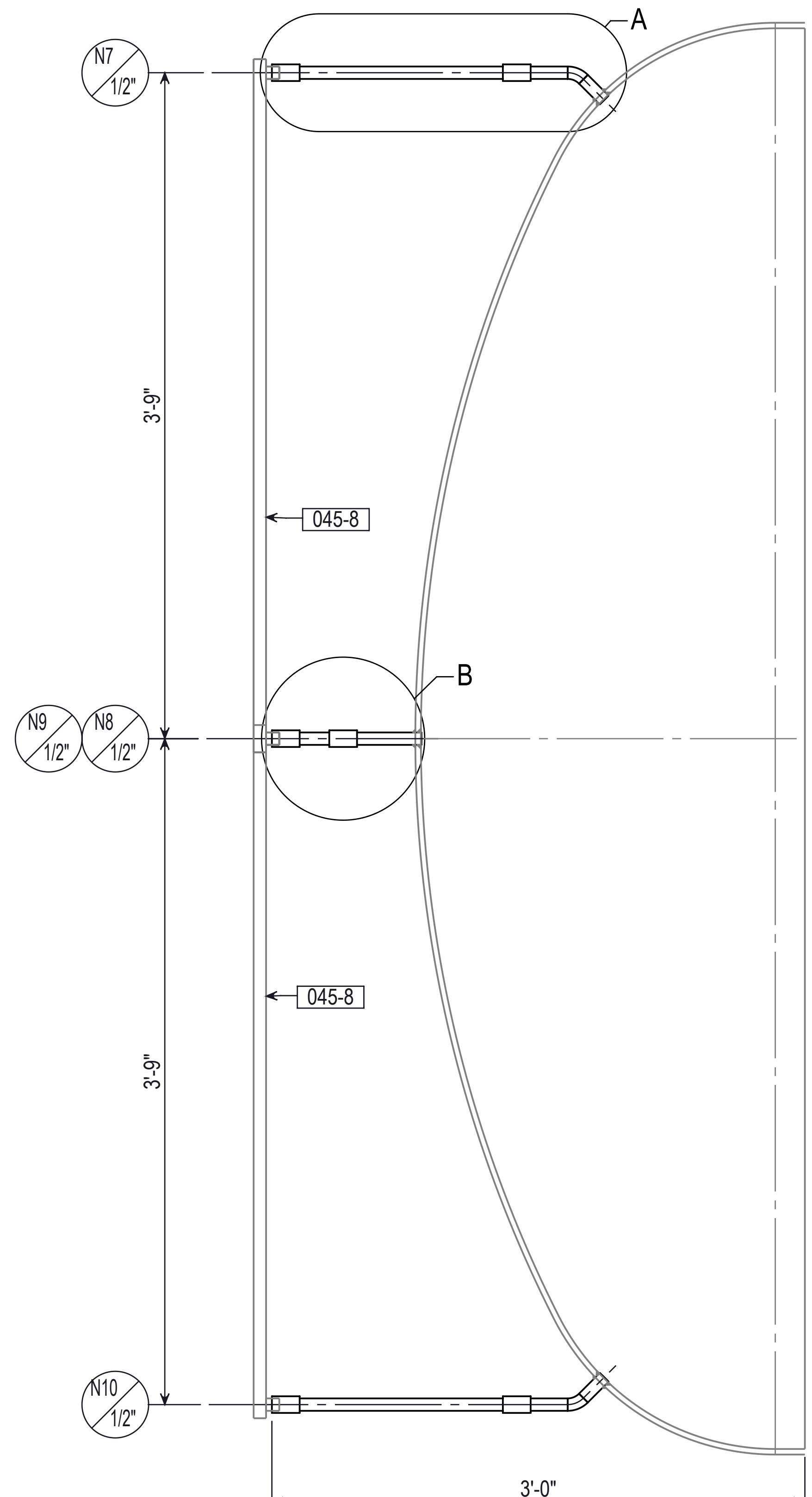
Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SHELL MANWAY DETAILS

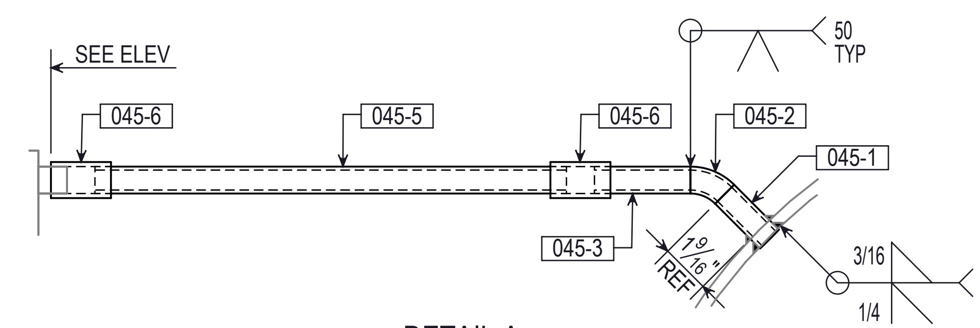
SCALE: SCALE 1:10
DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-041-1

FILE NAME 24-018-01-041
BY CKS

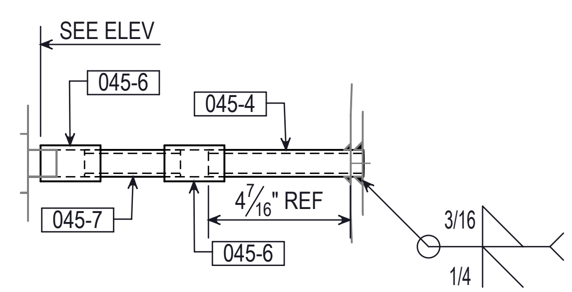
MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
045-N7		**1**	**VISUAL LEVEL GAUGE ~ 1/2"**				**1**	
045-N10		**1**	**VISUAL LEVEL GAUGE ~ 1/2"**				**1**	
045-1		2	PI, 1/2" DIA SCH 40S	5"	SA312-TP304/304L SMLS		0	SHOP TRIM
045-2		2	EL, 1/2" DIA SCH 40S 45°		SA403-WP304/304L		0	
045-3		2	PI, 1/2" DIA SCH 40S	3"	SA312-TP304/304L SMLS		0	THREAD ONE END
			N8 & N9 TANK ASSY PIECES					
045-4		2	PI, 1/2" DIA SCH 40S	7 7/16"	SA312-TP304/304L SMLS		1	THREAD ONE END, SHOP TRIM
			LEVEL GAUGE SHIPPING PIECES					
045-5	2		PI, 1/2" DIA SCH 40S	1'-2 3/4"	SA312-TP304/304L SMLS		1	THREAD BOTH ENDS
045-6	8		FC, 1/2" DIA 3000# THREADED		SA182-F304/304L		0	
045-7	2		PI, 1/2" DIA SCH 40S	3"	SA312-TP304/304L SMLS		0	THREAD BOTH ENDS
045-8	2		KENNCO K9900 SERIES LEVEL GAUGE, 1/2" DIA MNPT x 45" CL TO CL		--		0	P/N: K99M50-45-ABH-GS-ATM-150-NS



LEVEL GAUGE OVERALL ASSEMBLY
ELEVATION



DETAIL A
SCALE 1:6
SAME FOR N10, BUT MIRRORED



DETAIL B
SCALE 1:6

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION.	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
NOZZLE DETAILS

SCALE
SCALE 1:12

DRAWING NUMBER
Job Ph Sht Rev
24-018-01-045-1

FILE NAME 24-018-01-045
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
060-NP		**1**	**NAMEPLATE ASSEMBLY**				**6**	
060-1		1	PL, .188" x PATTERN		SA240-304/304L	4	6	
060-2		1	TATE ASME STANDARD NAMEPLATE		ALUMINIUM	16	0	

TATE METALWORKS INC.
(NAME OF MANUFACTURER)

32.78 PSI (kPa) AT 150 °F (°C)
MAX. ALLOWABLE WORKING PRESSURE

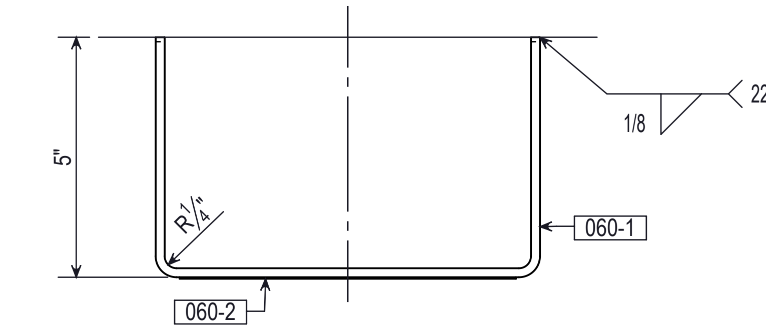
0 PSI (kPa) AT 150 °F (°C)
MAX. ALLOWABLE EXTERNAL WORKING PRESSURE
(IF SPECIFIED; SEE NOTE (1))

0 °F (°C) AT 32.78 PSI (kPa)
MIN. DESIGN METAL TEMPERATURE

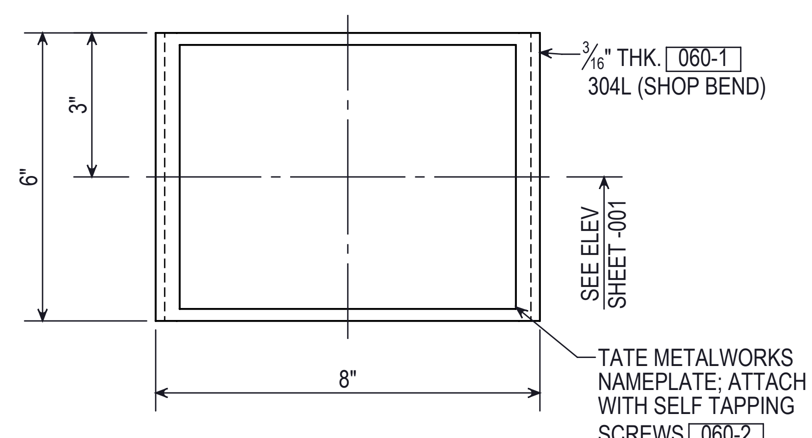
24-018-01
MANUFACTURER'S SERIAL NUMBER

2024
YEAR BUILT

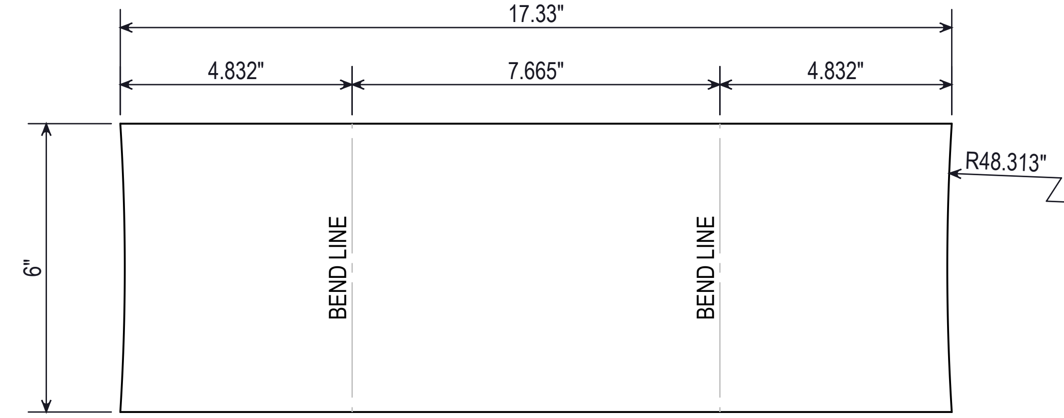
NAME PLATE FACSIMILE



NAMEPLATE ASSEMBLY ~ 060-NP
PLAN VIEW



NAMEPLATE ASSEMBLY ~ 060-NP
ELEVATION ~ FRONT



MK 060-1

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

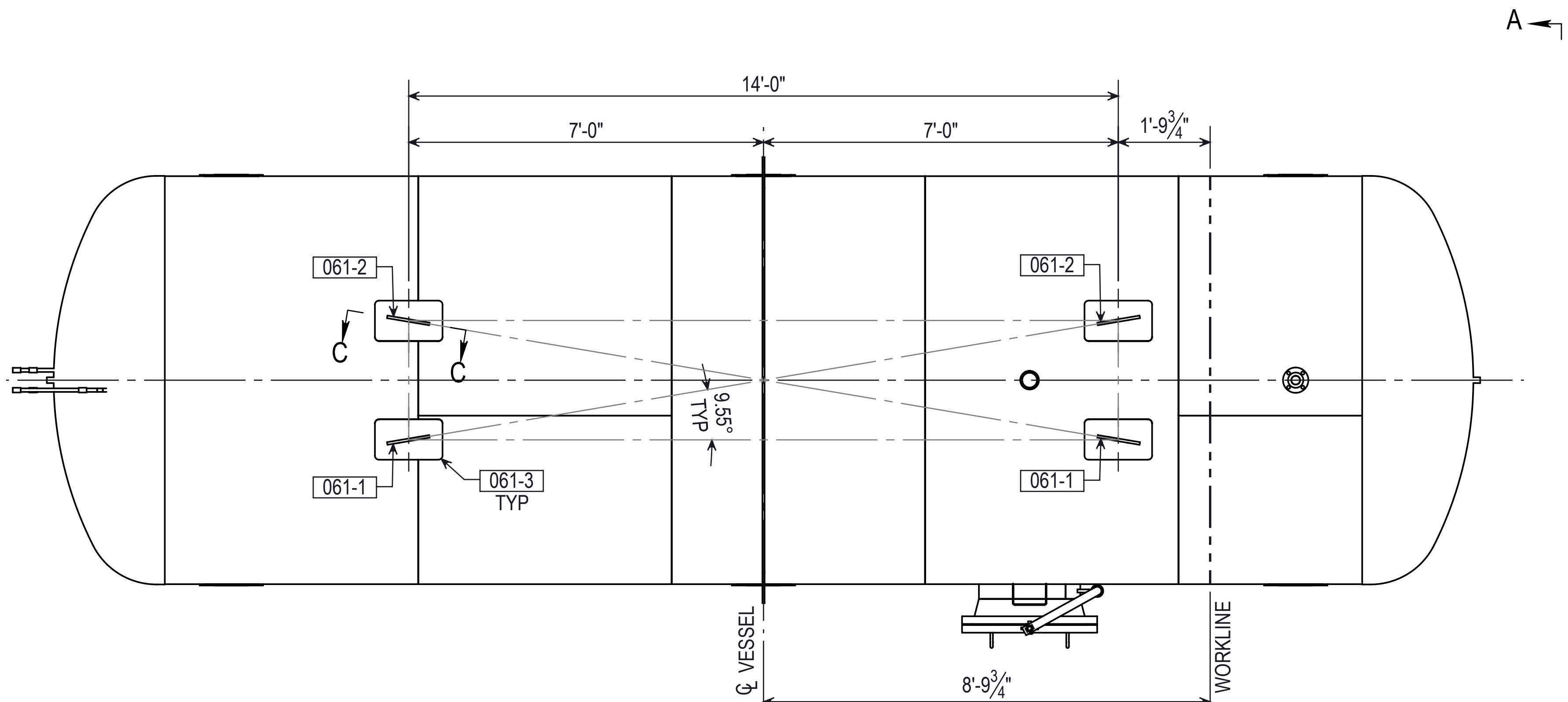
TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
MISCELLANEOUS DETAILS

SCALE
SCALE 1:4

DRAWING NUMBER
Job Ph Sht Rev
24-018-01-060-1

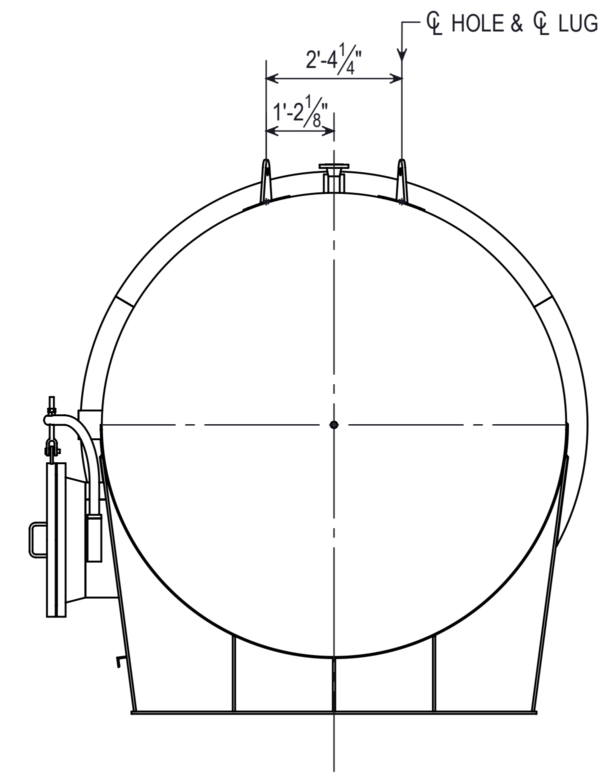
FILE NAME 24-018-01-060
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
			LIFTING LUG ASSEMBLY				**98**	
061-1		2	PL, .625" x PATTERN		SA240-304/304L		10	
061-2		2	PL, .625" x PATTERN		SA240-304/304L		10	
061-3		4	RP, .313" x 10" x 16"		SA240-304/304L		14	RADIUS CORNERS



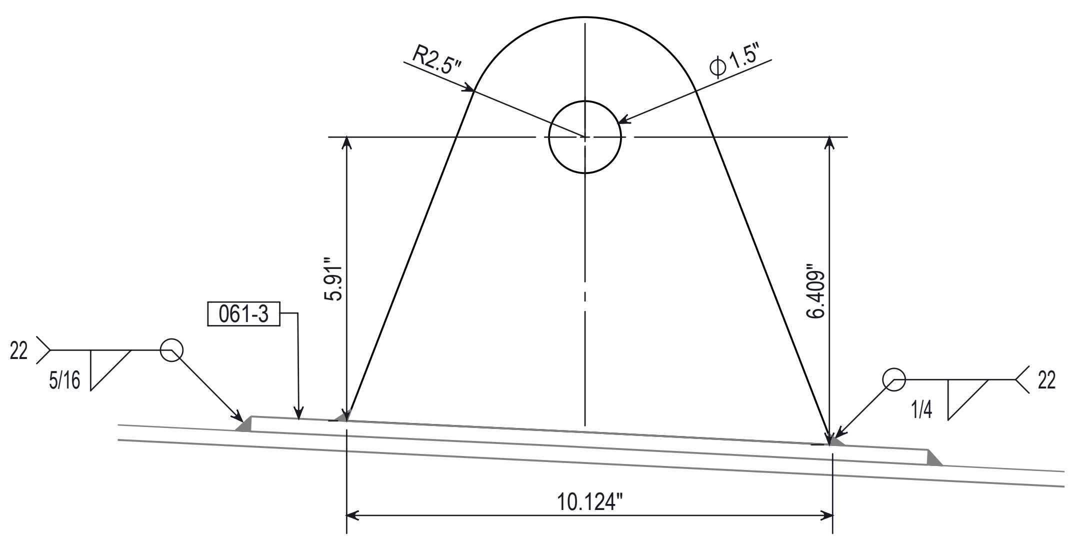
LIFTING LUG OVERALL ASSEMBLY

PLAN VIEW



SECTION A-A

EACH LUG REQUIRES A MINIMUM SHACKLE SIZE OF 4.75 TONS WITH A PIN SIZE OF 0.75 INCHES



MK 061-1 PATTERN

MK 061-2 PATTERN (OPP)

SCALE: 1:4

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

CERTIFIED CORRECT

Tate

METALWORKS, INC.

P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE

8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK

WESTROCK SEMINOLE ~ JACKSONVILLE, FL

MISCELLANEOUS DETAILS

SCALE

SCALE 1:40

DRAWING NUMBER

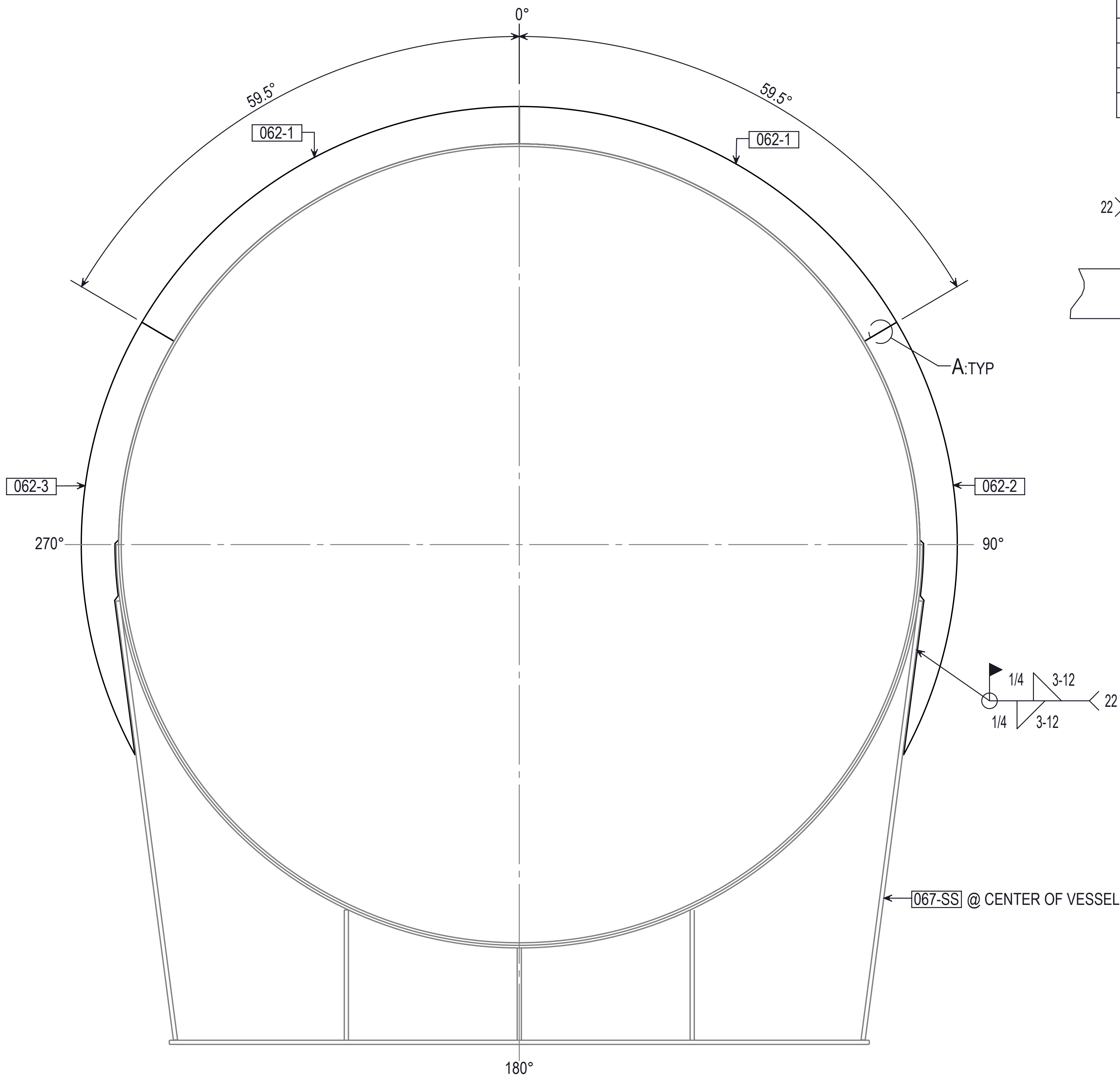
Job Pc Sht Rev

24-018-01-061-1

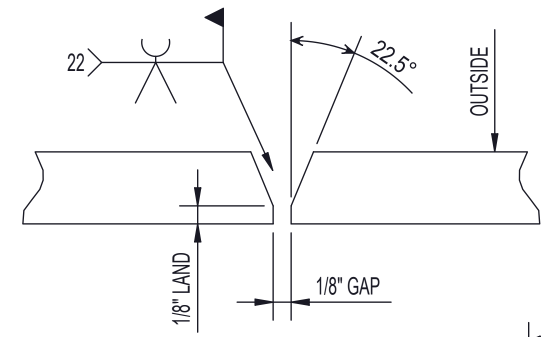
FILE NAME 24-018-01-061

BY CKS

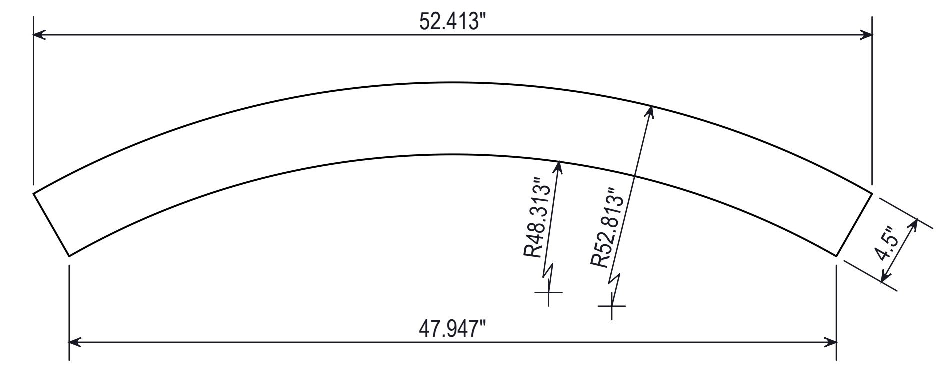
MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
			STIFFENING RING SHIPPING PIECES					
062-1	2		RS, .5" x PATTERN		SA240-304/304L		34	
062-2	1		RS, .5" x PATTERN		SA240-304/304L		28	
062-3	1		RS, .5" x PATTERN		SA240-304/304L		28	



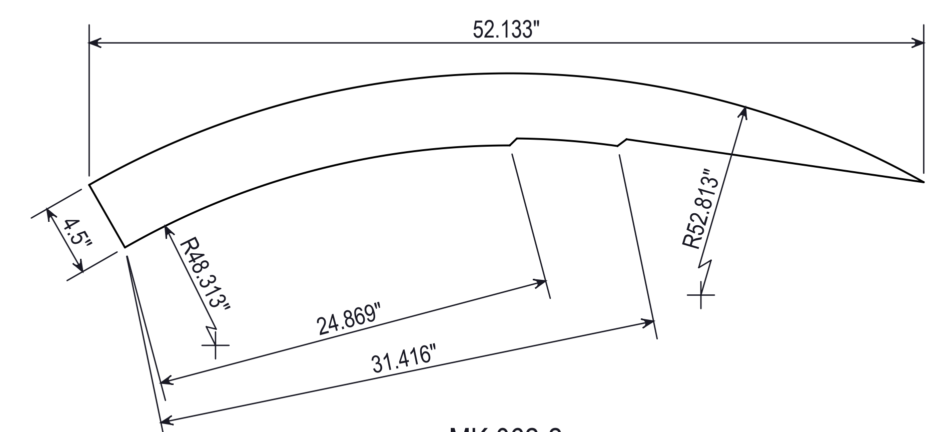
STIFFENING RING DETAILS
ELEVATION
ALIGN WITH ℄ OF SADDLE



DETAIL A



MK 062-1
SCALE 1:12



MK 062-2
MK 062-3 (MIRRORED, EXCEPT BEVEL)
SCALE 1:12

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2					
1	12/16/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

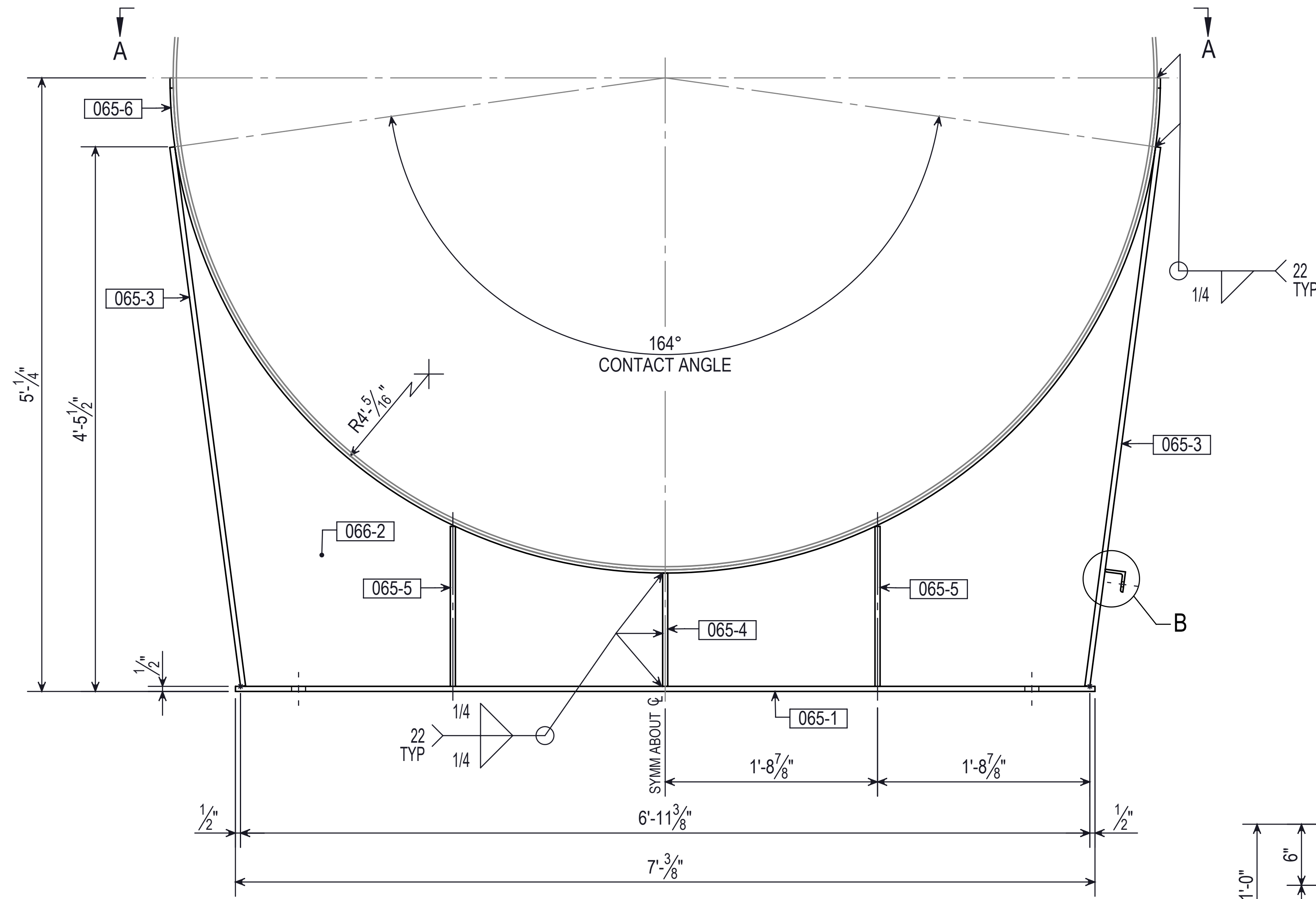
TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
MISCELLANEOUS DETAILS

SCALE
SCALE 1:16

DRAWING NUMBER
Job Ph Sht Rev
24-018-01-062-1

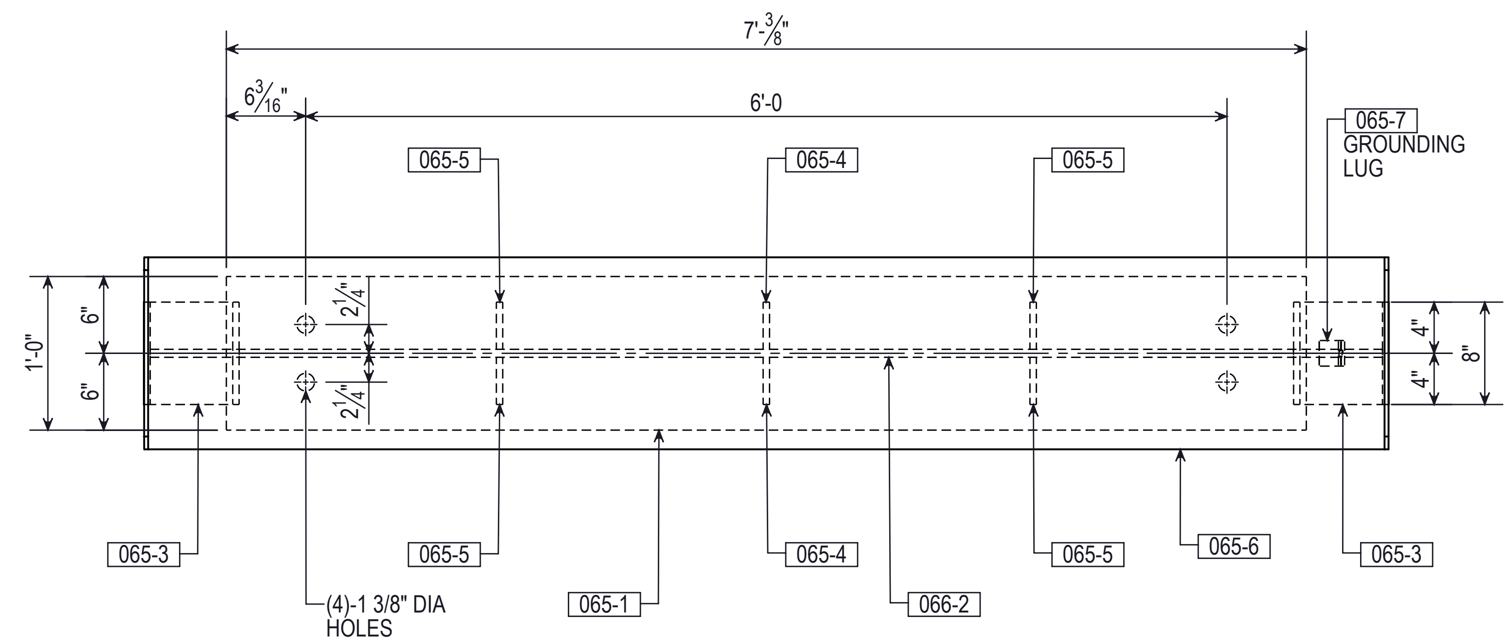
FILE NAME 24-018-01-062
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
065-FS		**1**	**FIXED SADDLE ASSEMBLY**				**824**	
065-1		1	PL, .5" x 12" x 84.4"		SA240-304/304L	6	146	w/ HOLES
066-2		1	PL, .625" x PATTERN		SA240-304/304L	10	303	
065-3		2	PL, .5" x 8" x 53.372"		SA240-304/304L	7	62	
065-4		2	PL, .5" x 3.688" x 11.125"		SA240-304/304L	8	6	
065-5		4	PL, .5" x 3.688" x 15.704"		SA240-304/304L	9	8	
065-6		1	RP, .313" x 15" x 152.269"		SA240-304/304L	5	206	ROLL TO 4'- 5/16" I/S RAD, RADIUS CORNERS
065-7		1	L, 2" x 2" x 1/4"	2"	SA479-304/304L	11	1	w/ HOLE

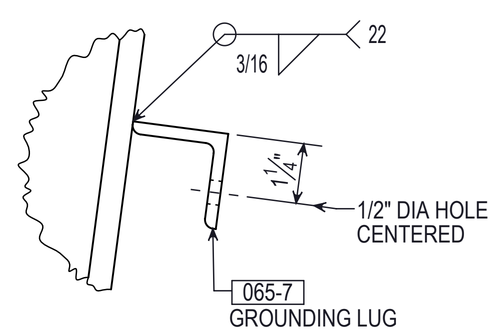


FIXED SADDLE ASSEMBLY ~ 065-FS

ELEVATION



SECTION A-A



DETAIL B

SCALE 1 : 4

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate

METALWORKS, INC.

P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE

8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK

WESTROCK SEMINOLE ~ JACKSONVILLE, FL

SADDLE DETAILS

SCALE

SCALE 1:15

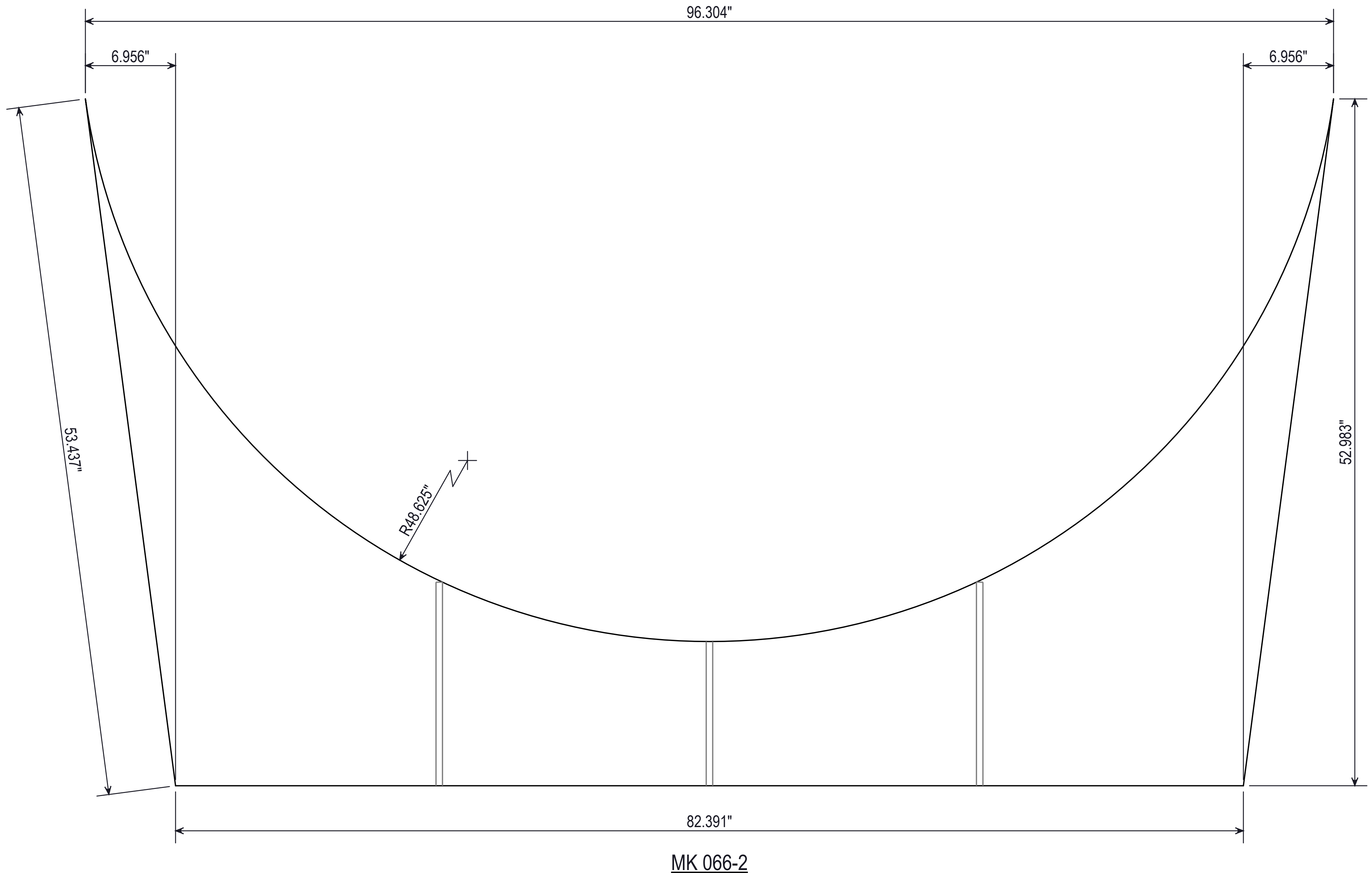
DRAWING NUMBER

Job Ph Sht Rev

24-018-01-065-1

FILE NAME 24-018-01-065

BY CKS



CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

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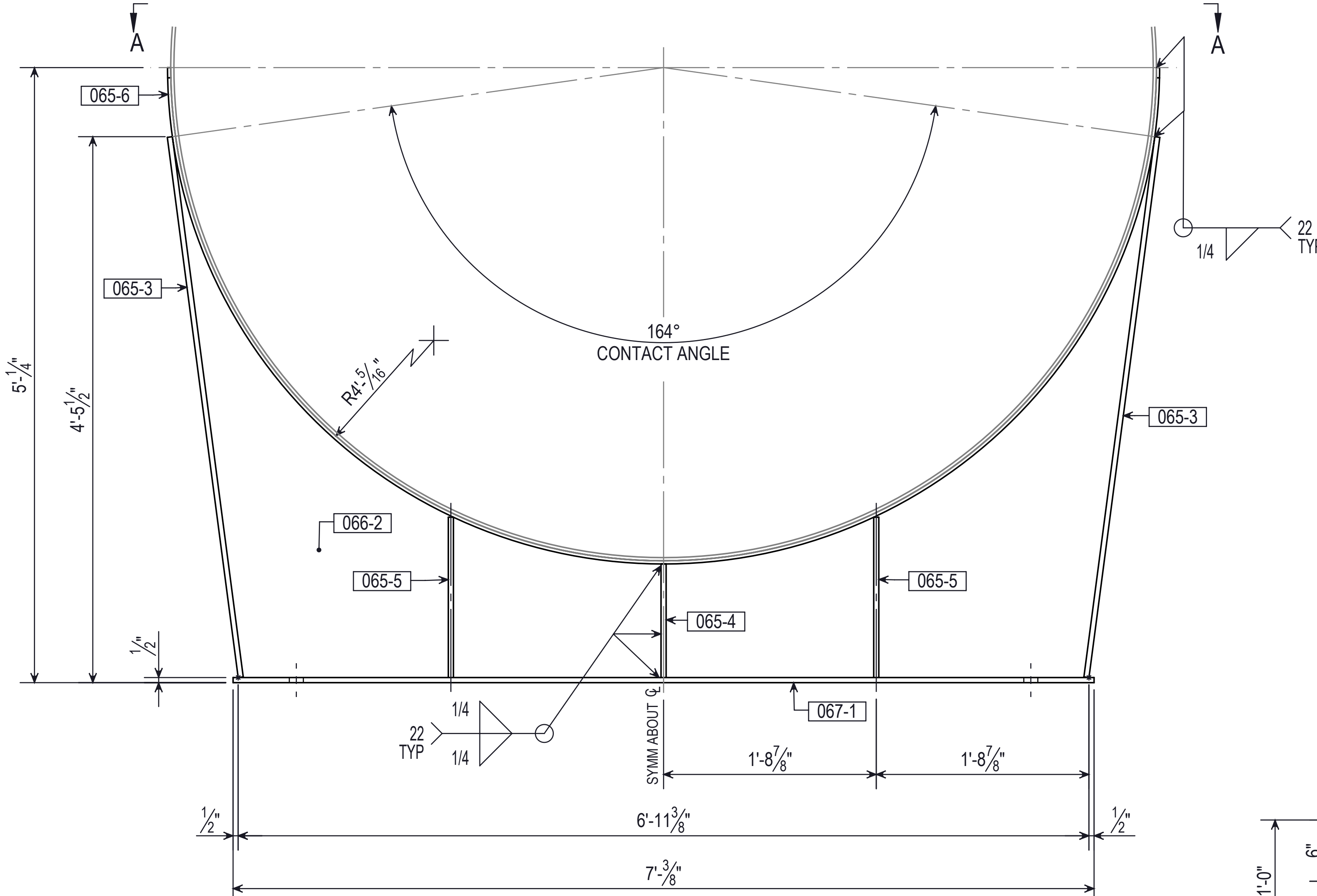
TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SADDLE DETAILS

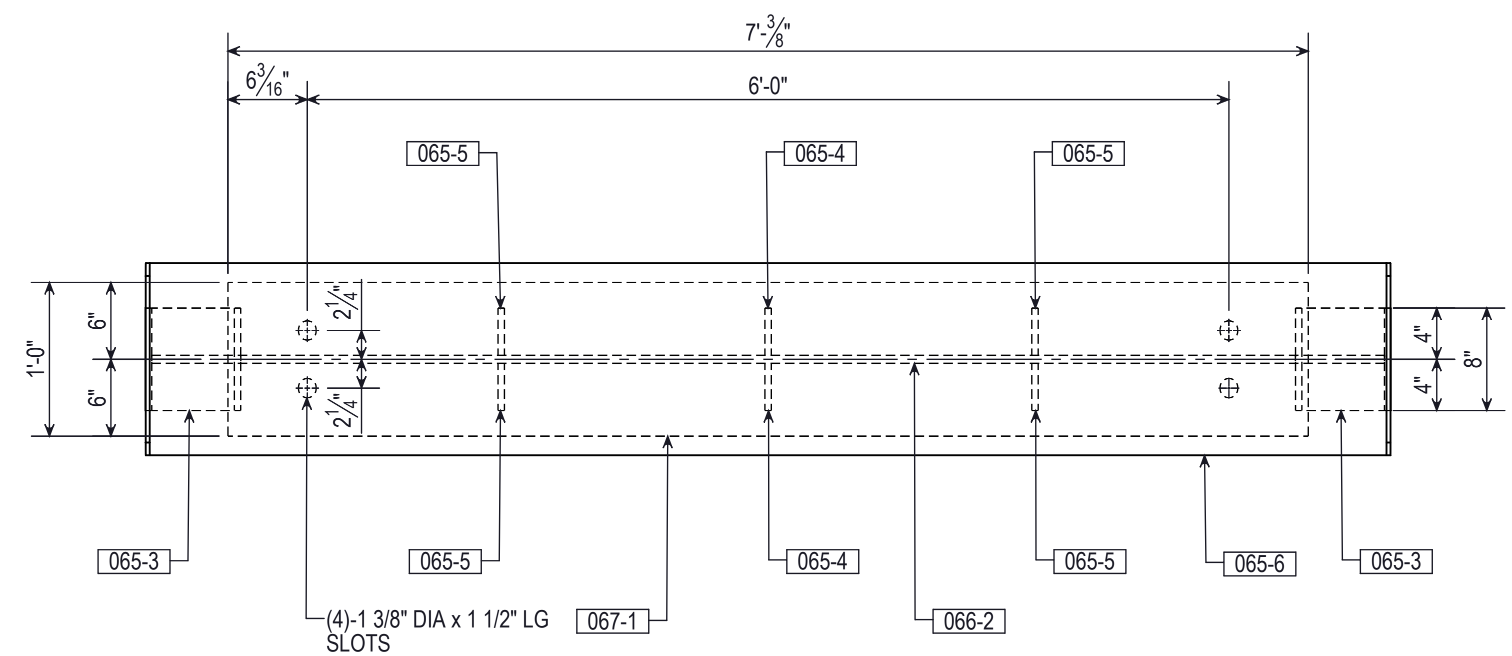
SCALE: SCALE 1:10
DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-066-1

FILE NAME 24-018-01-066
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
067-SS		**2**	**SLIDING SADDLE ASSEMBLY**				**823**	
067-1		2	PL, .5" x 12" x 84.4"		SA240-304/304L	6	145	w/ HOLES
066-2		2	PL, .625" x PATTERN		SA240-304/304L	10	303	
065-3		4	PL, .5" x 8" x 53.372"		SA240-304/304L	7	62	
065-4		4	PL, .5" x 3.688" x 11.125"		SA240-304/304L	8	6	
065-5		8	PL, .5" x 3.688" x 15.704"		SA240-304/304L	9	8	
065-6		2	RP, .313" x 15" x 152.269"		SA240-304/304L	5	206	ROLL TO 4'- 5/16" I/S RAD, RADIUS CORNERS



SLIDING SADDLE ASSEMBLY ~ 067-SS
ELEVATION
(2) REQUIRED



SECTION A-A

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

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TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SADDLE DETAILS

SCALE
SCALE 1:15

DRAWING NUMBER
Job Ph Sht Rev
24-018-01-067-1

FILE NAME 24-018-01-067
BY CKS

FOUNDATION LOAD SUMMARY

Saddle #1: Total Loading at Base (Right Sliding Saddle)				
Load	**Vessel Condition**	**Longitudinal Base Shear (lb_f)**	**Transverse Base Shear (lb_f)**	**Vertical Force (lb_f)**
Weight Only (D)	Operating, New	0	0	48,680
Weight Only (D)	Operating, Corroded	0	0	46,980
Thermal Expansion	Operating, New	21,906	0	0
Thermal Expansion	Operating, Corroded	21,141	0	0
Wind Only (0.6 * W)	Operating, New	567	657	0
Wind Only (0.6 * W)	Operating, Corroded	567	657	0
Seismic Only (0.7 * E)	Operating, New	2,670	1,340	2,582
Seismic Only (0.7 * E)	Operating, Corroded	2,574	1,293	2,490

Saddle #1: Total Loading at Base (Left Fixed Saddle)				
Load	**Vessel Condition**	**Longitudinal Base Shear (lb_f)**	**Transverse Base Shear (lb_f)**	**Vertical Force (lb_f)**
Weight Only (D)	Operating, New	0	0	48,274
Weight Only (D)	Operating, Corroded	0	0	46,564
Thermal Expansion	Operating, New	21,906	0	0
Thermal Expansion	Operating, Corroded	21,141	0	0
Wind Only (0.6 * W)	Operating, New	567	657	0
Wind Only (0.6 * W)	Operating, Corroded	567	657	0
Seismic Only (0.7 * E)	Operating, New	2,670	1,329	2,560
Seismic Only (0.7 * E)	Operating, Corroded	2,574	1,281	2,467

ALL VALUES REPORTED ARE SERVICE LOADS FOR ALLOWABLE STRESS DESIGN (ASD)

VERTICAL FORCE VALUES IN THE SEISMIC CASE INCLUDE THE 0.7 * 0.2 * S_{DS} DEAD LOAD FACTOR (COMPRESSIVE).
THE 0.7 TERM IS THE ASD LOAD COMBINATION FACTOR.

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
FOUNDATION LOAD DETAILS

SCALE
SCALE 1:10

DRAWING NUMBER (Job Ph Sht Rev)
24-018-01-070-1

FILE NAME 24-018-01-070
BY CKS

VESSEL HYDROTEST PROCEDURE:
TATE PROJECT NUMBER: 24-018, PHASE 01
CUSTOMER: WESTROCK JACKSONVILLE, FL
TANK NAME: PMO OIL TANK
TANK NUMBER: 303-150-00914
DESIGN CODE: ASME NON-STAMP

3 TEST:

1. COMPLETE ALL NDE REQUIREMENTS PER "TESTING PROCEDURES" AS OUTLINED ON DRAWING 24-018-01-000.
2. SET THE VESSEL IN THE SHOP, IN A HORIZONTAL POSITION WITH NOZZLE N5-3" AT THE TOP OF THE TANK AS A VENT.
3. INSTALL ALL BLIND FLANGES ON THE VESSEL, EXCLUDING NOZZLE N5-3" VENT. NOZZLE N5-3" VENT IS TO REMAIN OPEN THE ENTIRE TIME THE WATER SUPPLY IS CONNECTED TO THE VESSEL. THIS NOZZLE WILL ALSO BE USED TO OBSERVE THE FILLING OF THE VESSEL.
4. INSTALL THE VALVE AND TEST TREE ASSEMBLY ON NOZZLE N1-2".
5. CONNECT THE WATER SUPPLY/FIRE HOSE TO THE VALVE ASSEMBLY CONNECTED TO NOZZLE N1-2". DO NOT TURN ON THE WATER.
6. CONNECT THE PRESSURE HOSE TO NOZZLE N1-2" VALVE TREE (3/8" BALL VALVE CONNECTION)
7. WITH THE NOZZLE N5-3" VENT STILL OFF THE VESSEL, BEGIN FILLING THE VESSEL BY TURNING ON THE WATER SUPPLY, AND OPENING THE BALL VALVE CONNECTED TO NOZZLE N1-2".
8. FILL WITH WATER UNTIL THE VESSEL IS FULL. CLOSE BALL VALVE. DISCONNECT THE WATER SUPPLY.
9. INSTALL THE VENT ASSEMBLY ON NOZZLE N5-3" AND CLOSE BALL VALVE
10. THE VESSEL SHOULD BE COMPLETELY FULL OF WATER. THE PRESSURE GAUGE SHOULD READ 4.10 PSI.
11. THIS SHOULD BE HELD FOR ONE HOUR, WHILE INSPECTING THE VESSEL, VERIFYING THERE ARE NO LEAKS.
12. AFTER IT IS CONFIRMED THAT THERE ARE NO LEAKS, RELEASE THE PRESSURE BY SLOWLY OPENING THE BALL VALVE ON NOZZLE N5-3" VENT ASSEMBLY.
13. REMOVE THE VENT ASSEMBLY BLIND FLANGE FROM NOZZLE N5-3" VENT
14. CONNECT THE FILL/DRAIN HOSE TO NOZZLE N1-2", OPEN VALVE AND DRAIN THE VESSEL EMPTY.

GAUGE SIZE SHOULD BE BETWEEN 1.5 * TEST PRESSURE AND 4.0 * TEST PRESSURE PER ASME

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3	09/06/24	DWC	REVISED TEST TREE ATTACHMENT NOZZLE. ISSUED FOR CONSTRUCTION.	NJB	CKS
2	08/26/24	DWC	REVISED NOZZLE N5 FROM 2" TO 3". ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

REVISIONS

Tate
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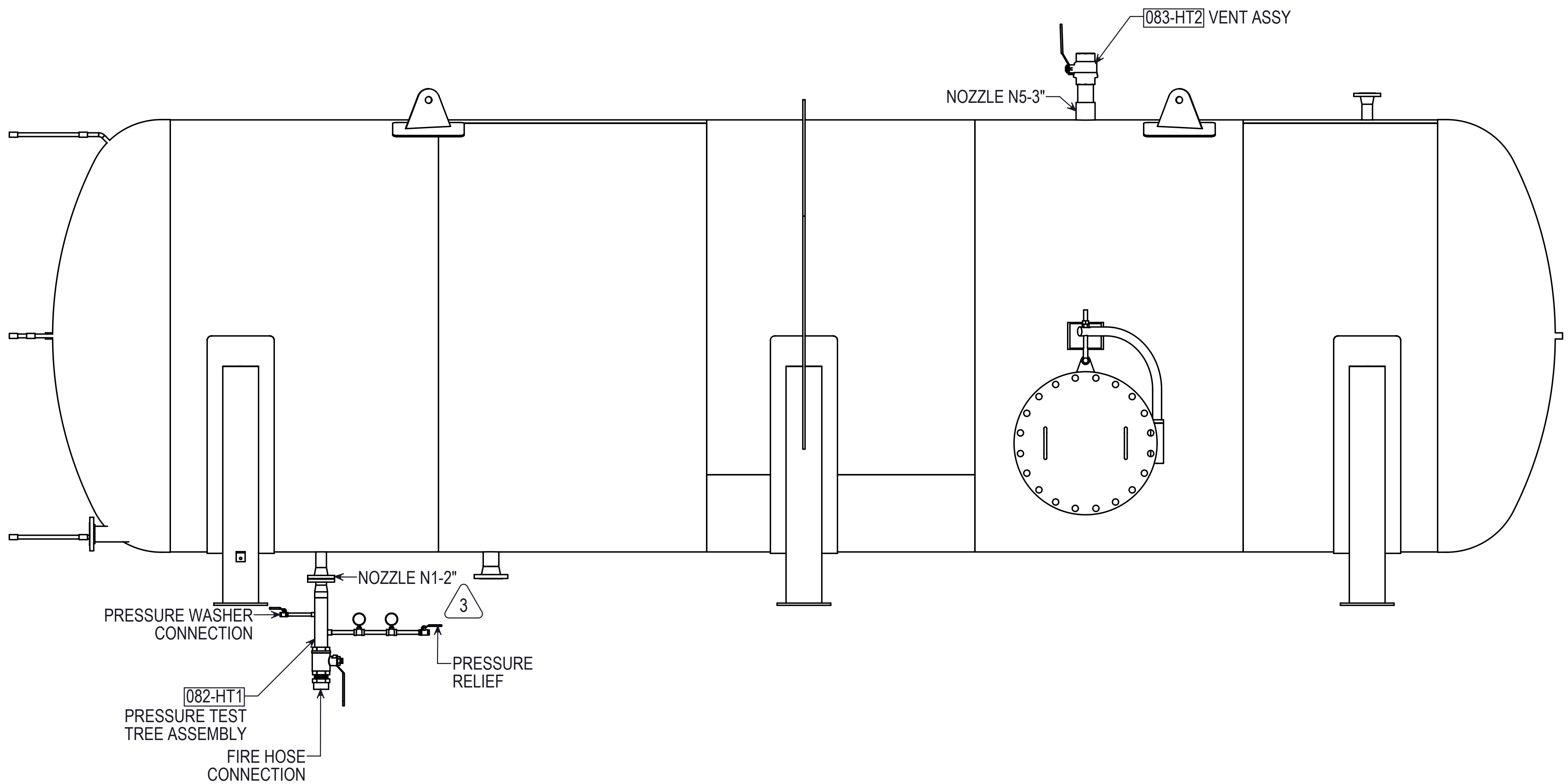
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HYDROSTATIC TEST DETAILS

SCALE: SCALE 1:1

DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-080-3

FILE NAME 24-018-01-080
BY CKS



VESSEL PRESSURE TEST CONFIGURATION

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3	09/06/24	DWC	REVISED TEST TREE ATTACHMENT NOZZLE. ISSUED FOR CONSTRUCTION.	NJB	CKS
2	08/26/24	DWC	REVISED NOZZLE N5 & 083-HT2 VENT ASSEMBLY. ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

REVISIONS

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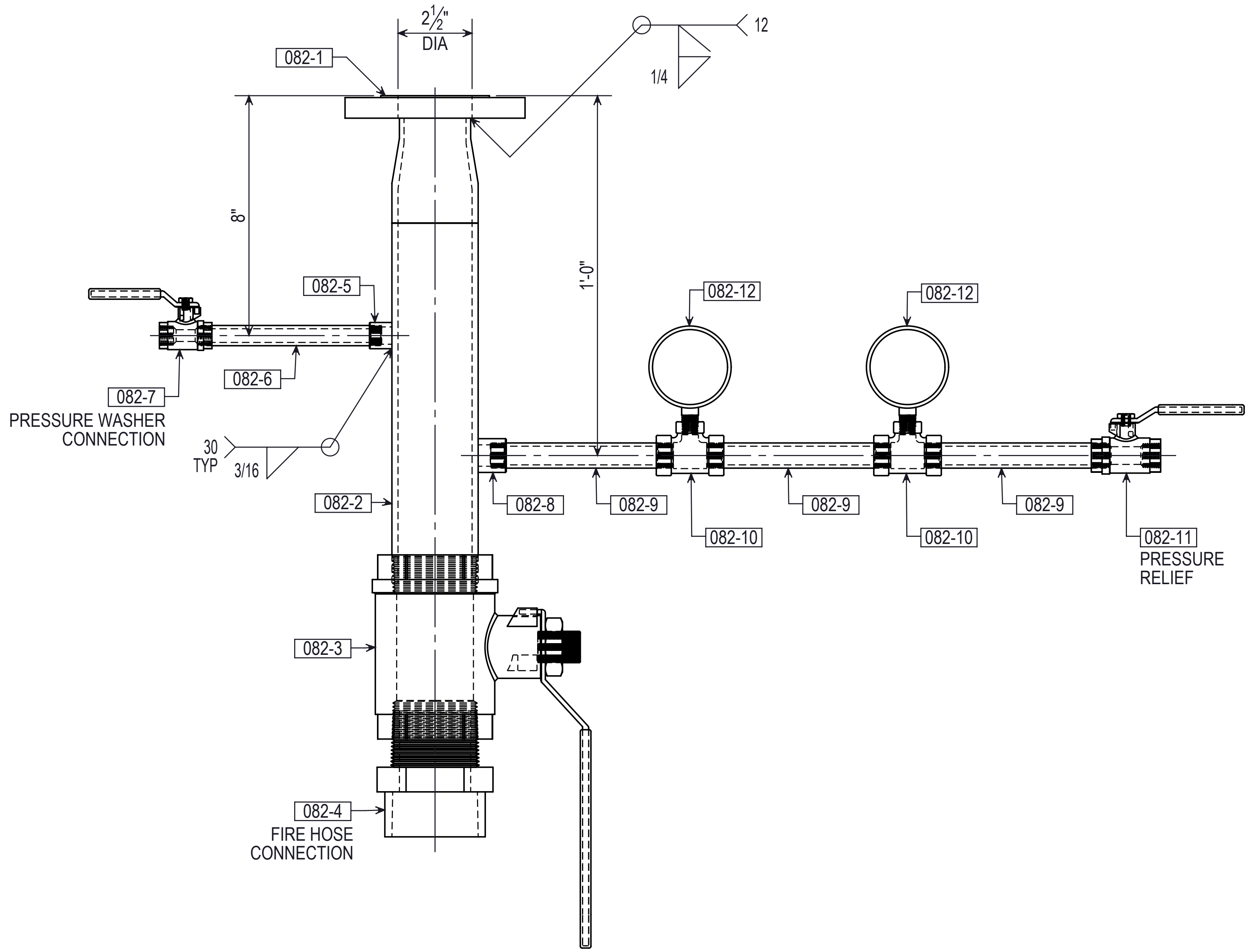
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HYDROSTATIC TEST DETAILS

SCALE
SCALE 1:32

DRAWING NUMBER
Job Ph Sht Rev
24-018-01-081-3

FILE NAME 24-018-01-081
BY CKS



2 PRESSURE TEST TREE ASSEMBLY ~ 082-HT1
ELEVATION

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
082-HT1		**1**	**PRESSURE TEST ASSEMBLY TREE**				**36**	
082-1		1	FL, 2" 150# RF BLD		SA105		4	w/ 2 1/2" DIA HOLE IN CENTER
082-2		1	PI, 2 1/2" DIA STD WT	1'	SA53-B ERW		6	THREAD ONE END
082-3		1	BALL VALVE, 2 1/2" NPT FEMALE, MAX PRESSURE 450 PSI @ 100°F, MAX STEAM PRESSURE 150 PSI @ 366°F, TEMP RANGE -50° TO 400°F		BRASS		16	McMASTER CARR P/N: 47865K71
082-4		1	FIRE HOSE CONNECTION, MALE ADAPTOR x FEMALE SWIVEL 2 1/2" NPT x 2 1/2" NH/MST		BRASS		3	McMASTER CARR P/N: 6494T63
082-5		1	HALF COUPLING, 3/8" DIA 3000# THREADED		SA234-WPB		0	
082-6		1	PI, 3/8" DIA STD WT	6"	SA53-B ERW		0	THREAD BOTH ENDS
082-7		1	BALL VALVE, 3/8" NPT FEMALE, MAX PRESSURE 600 PSI @ 100°F, MAX STEAM PRESSURE 150 PSI @ 366°F, TEMP RANGE -50° TO 400°F		BRASS		0	McMASTER CARR P/N: 47865K22
082-8		1	HALF COUPLING, 1/2" DIA 3000# THREADED		SA234-WPB		0	
082-9		3	PI, 1/2" DIA STD WT	6"	SA53-B ERW		0	THREAD BOTH ENDS
082-10		2	INLINE 300# THREADED REDUCING TEE, 1/2" x 1/4" PIPE DIA		IRON		1	McMASTER CARR P/N: 4627K332
082-11		1	BALL VALVE, 1/2" NPT FEMALE, MAX PRESSURE 600 PSI @ 100°F, MAX STEAM PRESSURE 150 PSI @ 366°F, TEMP RANGE -50° TO 400°F		BRASS		1	McMASTER CARR P/N: 47865K23
082-12		2	PRESSURE GAUGE, 2 1/2" FACE x 1/4" BTM MOUNT w/ CERTS, PRESSURE RANGE 0-300 PSI, TEMP RANGE -40° TO 150°		--			McMASTER CARR P/N: 9796T31
082-13		1	CONCENTRIC REDUCER, 2 1/2" x 2" STD WT		SA234-WPB		2	

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2	09/06/24	DWC	REVISED ATTACHMENT FLANGE SIZE. ISSUED FOR CONSTRUCTION.	NJB	CKS
1	08/26/24	DWC	ISSUED FOR CONSTRUCTION.	NJB	CKS

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

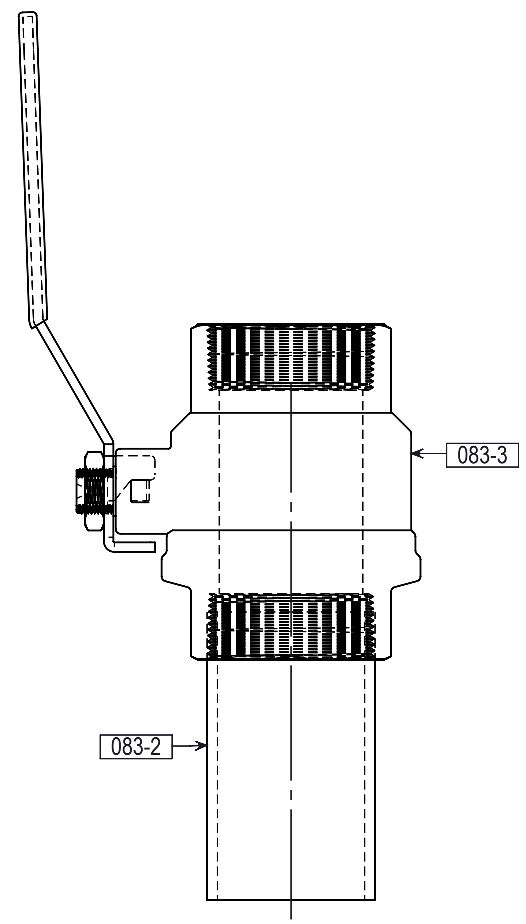
TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HYDROSTATIC TEST DETAILS

SCALE
SCALE 1:5

DRAWING NUMBER
Job Ph Sht Rev
24-018-01-082-2

FILE NAME 24-018-01-082
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
083-HT2		**1**	**VENT ASSEMBLY - 3"**				**25**	
083-2		1	PI, 3" STD WT PIPE NIPPLE	6"	SA53-B ERW		4	THREAD BOTH ENDS
083-3		1	BALL VALVE, 3" NPT FEMALE, MAX PRESSURE 450 PSI @ 100°F, MAX STEAM PRESSURE 150 PSI @ 366°F, TEMP RANGE -50° TO 400°F		BRASS		22	McMASTER CARR P/N: 47865K72



VENT ASSEMBLY ~ 083-HT2 2
ELEVATION

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2	08/26/24	DWC	REVISED VENT ASSEMBLY TO 3". ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

REVISIONS

Tate
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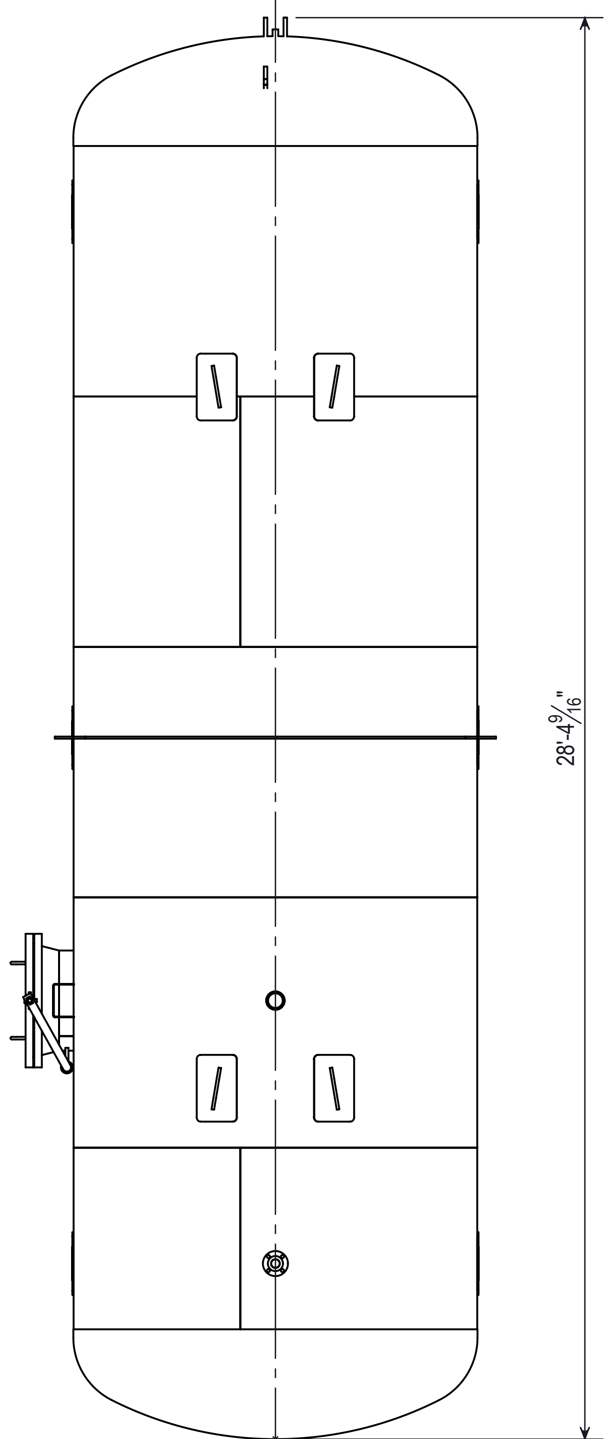
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HYDROSTATIC TEST DETAILS

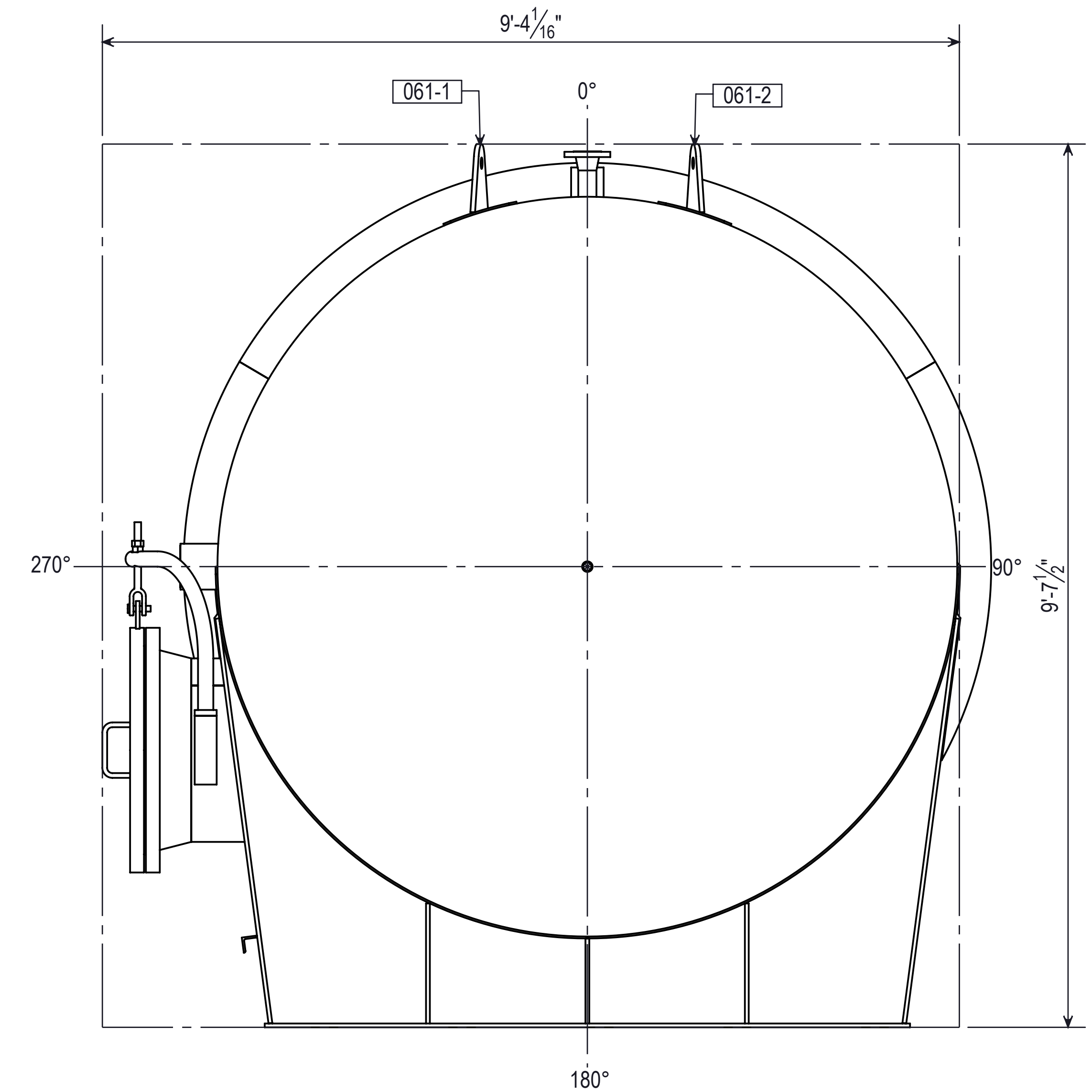
SCALE
SCALE 1:4

DRAWING NUMBER
Job Pn Sht Rev
24-018-01-083-2

FILE NAME 24-018-01-083
BY CKS



SHIPPING ENVELOPE
PLAN VIEW



SHIPPING ENVELOPE
ELEVATION
WEIGHT 13,906 LBS
SCALE: 1:24

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SHIPPING ENVELOPE

SCALE
SCALE 1:46

DRAWING NUMBER
Job Ph Sht Rev
24-018-01-090-1

FILE NAME 24-018-01-090
BY CKS

2.0 Design Calculations

24-018-01 - WestRock Seminole, Jacksonville, FL

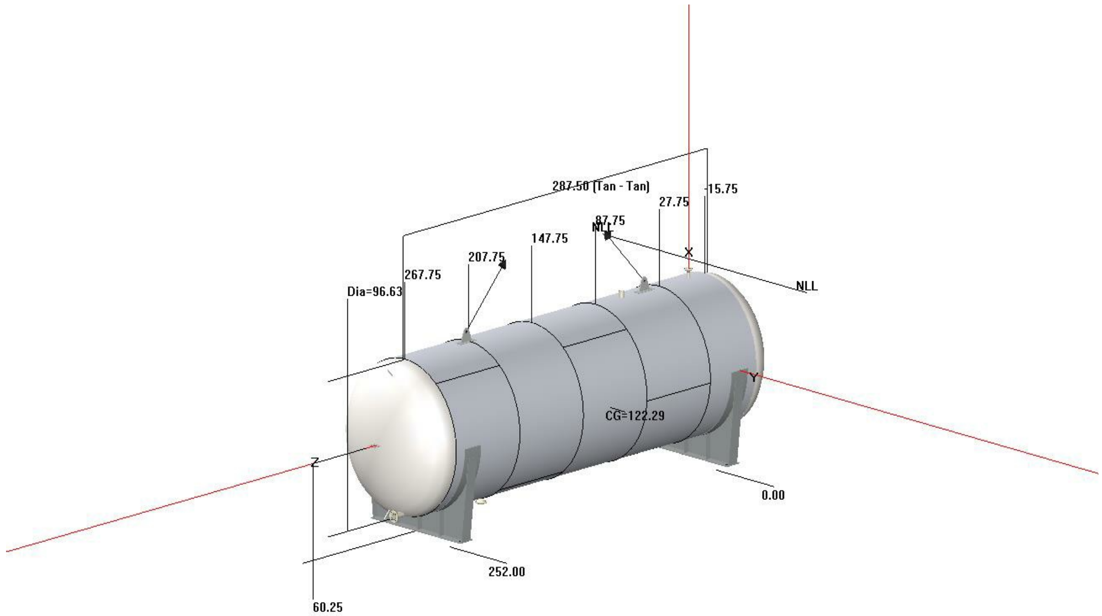
8’-0” ID x 23’-11.5” TL-TL Vessel

Paper Machine Bulk Oil Storage Tank

ASME SECTION VIII, DIV. 1 NON-STAMP CALCULATIONS

TABLE OF CONTENTS

Tate Metalworks



COMPRESS Pressure Vessel Design Calculations

Item:	Paper Machine Bulk Oil Storage Tank
Vessel No:	24-018-01
Customer:	WestRock Seminole
Contract:	Project Design
Designer:	NJB
Date:	Aug 26, 2024

Table of Contents

Deficiencies Summary

Deficiencies for Lifting Lug #1 (See Alternative Calc)
The local stresses in the WRC 537 calculation are excessive.

Deficiencies for Lifting Lug #2 (See Alternative Calc)
The local stresses in the WRC 537 calculation are excessive.

Warnings Summary

Warnings for Lifting Lug #1 (See Alternative Calc)
Pad width (2.5 in) is greater than 8*min[t , t_p] = 1.504 in. External loads may cause the pad to fail by buckling unless intermediate pad welds are used (See Bednar 7.5 paragraph 3). (warning)
Actual lug

$\frac{C_1}{C_2} < \frac{1}{4}, \frac{C_1}{C_2} = \frac{1}{4}$ used as this is the minimum ratio covered by WRC 537.
(warning)
The lug extends beyond the edge of Cylinder #2. (warning)

Warnings for Lifting Lug #2 (See Alternative Calc)
Pad width (2.5 in) is greater than 8*min[t , t_p] = 1.504 in. External loads may cause the pad to fail by buckling unless intermediate pad welds are used (See Bednar 7.5 paragraph 3). (warning)
Actual lug

$\frac{C_1}{C_2} < \frac{1}{4}, \frac{C_1}{C_2} = \frac{1}{4}$ used as this is the minimum ratio covered by WRC 537.
(warning)

Warnings for Saddle #1
Slotted bolt holes are specified on the saddle with the heavier weight. (warning)

Warnings for Vessel
Changes to steelmaking practices have increased the risk of brittle fracture at temperatures higher than the ASME impact test exemption temperatures. It is highly recommended that the following supplemental requirements be applied for SA-105, SA-106 B, SA-53 seamless, and SA-234: material composition should have a minimum Mn:C ratio of 5, and SA-105 flanges should require a grain size of 7 or finer. (warning)

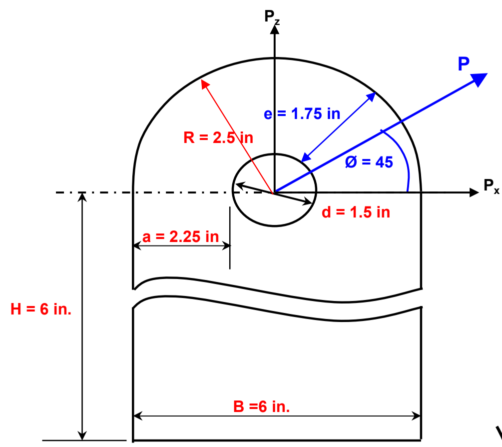
ASME B16.5 / B16.47 Flange Warnings Summary

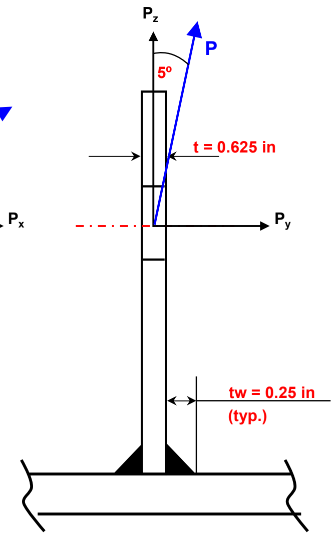
Flange	Applicable Warnings
Level Transmitter (N6)	1
Drain (N1)	1
Discharge (N2)	1, 2
Manway (N3)	1, 2
Fill (N4)	1, 2

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

Rounded Lug Design

Customer:	WestRock Seminole	
Job No:	24-018-01	
Date:	07/16/24	
By:	NJB	
Rev:	2	3/24/2024





Design Basis for Lift Lugs:

1) Use Normal AISC Bending Stress Allowables
2) Recommended plate thickness > (0.25 * Hole Diam.) but never less than 1/2"
3) Consider Size of Shackle Pin in relation to the Lug Radius, R and the Hole Diameter, d

Lug Material =	304/304L	
Lug Yield Stress (F_y):	30,000	Psi
Lug Ultimate Stress, (F_u):	75,000	Psi
Weld Ult. Stress:	75,000	Psi
Max. Tensile Weld Stress (Q):	22,500	Psi

Lug Dimensions & Loading Inputs:

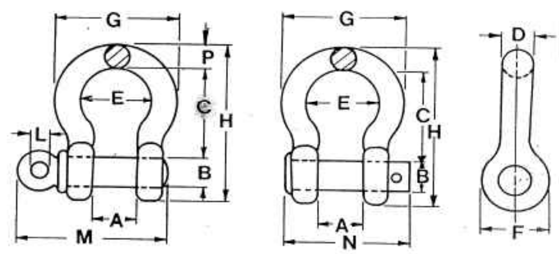
Thickness of Lift Lug (t) =	0.625	in.	min. t =	0.500	in. (Based on Note 2 above)	
Length of lug to Hole CL, (H) =	6	in.				
Lug Width, (B) =	6	in.	a =	2.250	in.	OK
Lug Radius, (R) =	2.5	in.	B = (2 * R) =	5	in.	
Diameter of Hole, (d) =	1.5	in.	e =[R - (d/2)] =	1.750	in.	OK
Fillet weld size (t_w) =	0.250	in.	Min Weld Size per Table J2.4 =	0.25	in.	
Required Weld Size =	0.203	in.				

Tension Load on Single Lug, (P) =	3.5	kips	(In the plane of the lug)
Load Increase S.F. =	2.00		
Design Tension Load, (P_u) =	7.00	kips	
Angle to Horizontal, Ø =	45.00	degrees	
Lateral Load, (P_y) =	0.00	kips	(Perpendicular to the lug) ← Note: If no load is given, the design assumes a perpendicular force based on a 5º offset
Lateral Load, (P_y) =	0.61	kips	(Perpendicular to the lug)

Shackle Inputs from Crosby Group Catalog

Will Shackles Be Used?	Yes	(Yes/No)	
Total Design Tension Load, P_u:	2.63	Tons	**
Shackle Size =	4.75	Tons	OK
Shackle Length, C =	2.81	in.	OK
Pin Size =	0.75	in.	OK***
Jaw Opening, A =	1.25	in.	OK

Shackle Dimensions



DRAFTING NOTE: On the drawing under the Lift Lug Detail, place the following note:

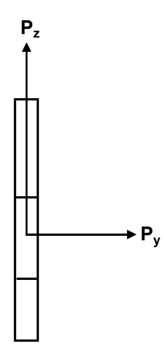
Each lug requires a minimum shackle size of 4.75 Tons with a Pin Size of 0.75 inches

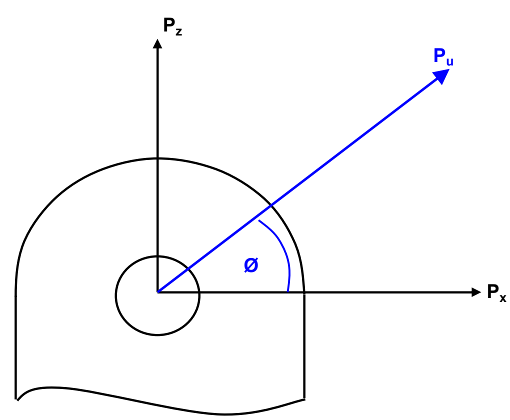
** The Tate lifting plans use a 1.5 design factor for all rigging. Therefore, the shackles will be sized based on this 1.5 factor since they are apart of the overall rigging system.

*** Tate standard is to provide minimum lift lug hole diameter of 3/8" larger than the pin

OK	Tension Failure Check at Sides of Hole
OK	Tension Fracture Check at Plate Edge
OK	Crushing Load Check on Plate
OK	Shear Failure Check at Plate Edge
OK	Combined Tension and Bending Stresses on the Lug
OK	Weld Stresses on the Lug

Total Design Tension Load, P_u:	7.00	kips
Design Force, P_x:	4.95	kips
Design Force, P_z:	4.95	kips
Design Force, P_y:	0.61	kips





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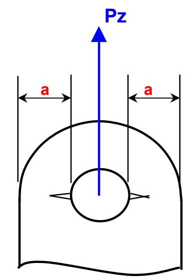
Four Potential Failure Modes for a Lug Plate



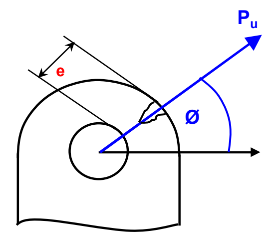
1.) Tension Failure at the Sides of the Hole (AISC Section D5.1)

$a = (B - d)/2 =$ 2.250 in.
$t =$ 0.625 in.
$F_u =$ 75 ksi

$P_u = 2 * a * t * F_u$

$P_u =$ 2*2.25*0.625*75 = 211 kips

$P_{allow.} = 0.2 * P_u =$ 42.19 kips
Tension Force, $P_z =$ 4.95 kips OK



2.) Crushing above the Pin and Tearing Tension Fracture at the Plate Edge (AISC Section J7)

Loose Fit Pin (Tearing Tension Failure)

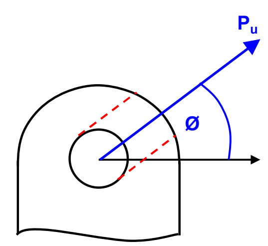
$P_{allow.} = (1.67 * F_b * t * e^2)/d$
$P_{allow.} =$ 38.36 kips
Design Tension Force, $P_u =$ 7.00 kips OK

$e = (R - d/2) =$ 1.750 in.
$F_b = 0.6 * F_y =$ 18 ksi
$t =$ 0.625 in.
$d =$ 1.5 in.

Snug Fit Pin (Crushing Load)

$P_{allow.} = 0.9 * F_y * t * d$
$P_{allow.} =$ 25.31 kips
Design Tension Force, $P_u =$ 7.00 kips OK

$F_y =$ 30 ksi



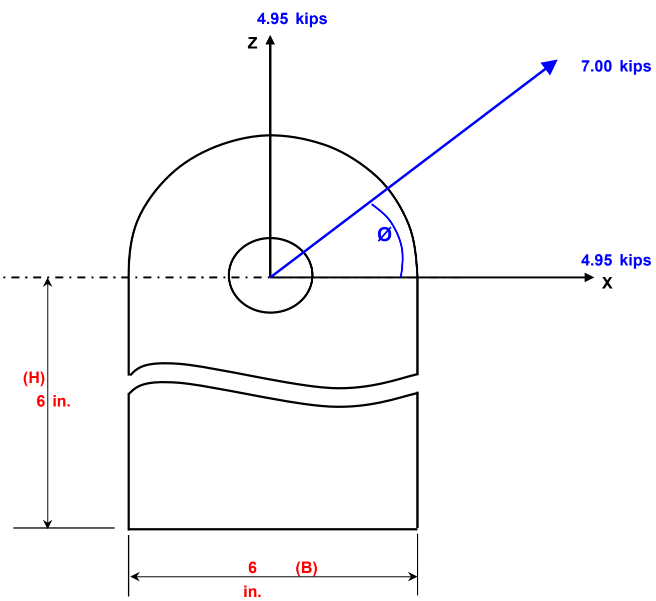
3.) Shear Failure in the Lug Plate as the Pin Attempts to Plow its Way Toward the Free Edge of the Plate (AISC Section J4.2)

$F_y =$ 30 ksi
$e =$ 1.750 in.
$t =$ 0.625 in.

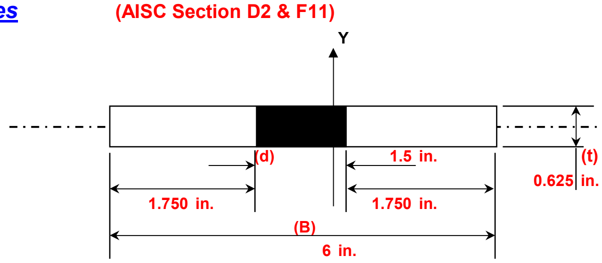
$P_u = 2 * (0.4 * F_y) * e * t$
$P_u =$ 26.25 kips
Design Tension Force, $P_u =$ 7.00 kips OK

4.) Dishing (Out of Plane Buckling) Failure of Relatively Thin Lug Plates which are Laterally Unrestrained

Dishing is prevented by establishing a minimum thickness limit.
Following Design Basis Note 2 above should take care of this problem



Lug Stresses (AISC Section D2 & F11)



Plan View

Lug Gross Area, $A_g =$ B * t
$A_g =$ 3.75 in^2

Lug Net Area, $A_n =$ (B * t) - (d * t)
$A_n =$ 2.81 in^2

Plastic Section Mod., $Z_y = (t * B^2)/4$
$Z_y =$ 5.63 in^3

Tension Force, $P_z =$ 4.95 kips
Lateral Force, $P_x =$ 4.95 kips
Lateral Force, $P_y =$ 0.61 kips
Moment, $M_y =$ 29.70 in-kips
Moment, $M_x =$ 3.66 in-kips

Plastic Section Mod., $Z_x = (B * t^2)/4$
$Z_x =$ 0.59 in^3

Yield Section Mod., $S_y = (t * B^2)/6$
$S_y =$ 3.75 in^3

Yield Section Mod., $S_x = (B * t^2)/6$
$S_x =$ 0.39 in^3

Lug Design

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Lug Stresses (AISC Section D2 & F11)

Tensile Strength (Chapter D2) — ASD Design

Section (a) Tensile Yielding in the Gross Section

Ω_t = 1.67

$P_n = F_y * A_g$
$P_t = P_n / \Omega_t$
F_y = 30 ksi
A_g = 3.75 in^2

$P_t = (F_y * A_g) / \Omega_t$
P_t = 67.37 kips

Section (b) Tensile Rupture in the Net Section

Ω_t = 2.00

$P_n = F_u * A_n$
$P_t = P_n / \Omega_t$
F_u = 75 ksi
A_n = 2.81 in^2

$P_t = (F_u * A_n) / \Omega_t$
P_t = 105.47 kips

Flexure Strength (Chapter F11) — ASD Design

Section 1 Yielding (Strong Axis Bending About Y-Axis)

Ω_b = 1.67

$M_n = F_y * Z_y$
$M_{ty} = M_n / \Omega_b$

$(B * H) / t^2$ = 92.16
$(0.08 * E) / F_y$ = 77.33
$(1.90 * E) / F_y$ = 1836.67

C_b = 1.0
F_y = 30 ksi
E = 29,000 ksi
Z_y = 5.63 in^3
S_y = 3.75 in^3
Yield Mom., $M_{yield} = F_y * S_y$ = 112.50 in-kips

if $(B * H) / t^2 \leq (0.08 * E) / F_y$

F11-1

$M_n = M_p = F_y * Z_y$ = N/A in-kips
$M_n \leq 1.6 * M_{yield}$ = N/A in-kips
M_n = N/A in-kips
$M_{ty} = M_n / \Omega_b$ = N/A in-kips

Section 1 Yielding (Weak Axis Bending About X-Axis)

Ω_b = 1.67
$M_n = F_y * Z_x$
$M_{tx} = M_n / \Omega_b$
F_y = 30 ksi
Z_x = 0.59 in^3
S_x = 0.39 in^3
Yield Mom., $M_{yield} = F_y * S_x$ = 11.72 in-kips

F11-1

$M_n = M_p = F_y * Z_x$ = 17.58 in-kips
$M_n \leq 1.6 * M_{yield}$ = 18.75 in-kips
M_n = 17.58 in-kips
$M_{tx} = M_n / \Omega_b$ = $\boxed{10.53}$ in-kips

Section 2 Lateral-Torsional Buckling (Strong Axis Bending Only)

if $(0.08 * E) / F_y < (B * H) / t^2 \leq (1.90 * E) / F_y$

F11-2

$M_n = C_b * [1.52 - 0.274 * (B*H/t^2) * (F_y/E)] * M_{yield} \leq M_p$
M_n = 168.06 in-kips
$M_n \leq M_p = F_y * Z_y$ = 168.75 in-kips
M_n = 168.06 in-kips
$M_{ty} = M_n / \Omega_b$ = $\boxed{100.64}$ in-kips

if $(B * H) / t^2 > (1.90 * E) / F_y$

F11-3

$M_n = F_{cr} * S_y \leq M_p$
M_n = N/A in-kips
$M_n \leq M_p = F_y * Z_y$ = N/A in-kips
M_n = N/A in-kips
$M_{ty} = M_n / \Omega_b$ = N/A in-kips

$F_{cr} = (1.9 * E * C_b) / (B*H/t^2)$
F_{cr} = $\boxed{597.87}$ ksi
S_y = $\boxed{3.75}$ in^3

Section 2 Lateral-Torsional Buckling Need Not Be Considered for Weak Axis Bending

Combined Stresses (Chapter H.1 & H1.2) — ASD Design

Section 1(a) For $P_z / P_t \geq 0.2$

H1-1a

$$\frac{P_z}{P_t} + \frac{8}{9}\left[\frac{M_y}{M_{ty}} + \frac{M_x}{M_{tx}}\right] \leq 1.00$$

N/A + N/A

N/A

P_z = 4.95 kips
P_t = 67.37 kips
M_y = 29.70 in-kips
M_{ty} = 100.64 in-kips
M_x = 3.66 in-kips
M_{tx} = 10.53 in-kips

Section 1(b) For $P_z / P_t < 0.2$

$\boxed{P_z / P_t = 0.07}$

H1-1b

$$\frac{P_z}{2 * P_t} + \frac{M_y}{M_{ty}} + \frac{M_x}{M_{tx}} \leq 1.00$$

0.037 + 0.295 + 0.348

0.680 < 1.00 OK

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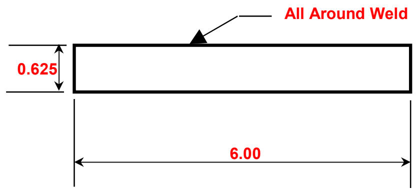
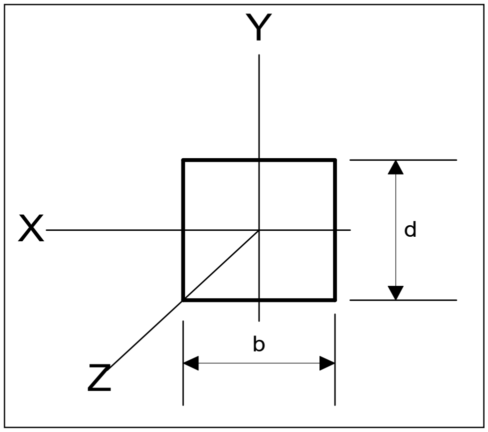
Weld Stresses





Tensile Weld Stress = 22.5 ksi

Initial Weld Size = 0.250 in.

Width of Weld, d = 0.625 in.

Length of Weld, b = 6.000 in.

P_x =	4.95	kips	M_x =	3.66	in-kips
P_y =	0.61	kips	M_y =	29.70	in-kips
P_z =	4.95	kips	M_z =	0.00	in-kips

$$f_x = \frac{P_x}{A_w} + \frac{M_z * c_y}{J_w}$$

$$f_y = \frac{P_y}{A_w} + \frac{M_z \cdot c_x}{J_w}$$

$$f_z = \frac{P_z}{A_w} + \frac{M_x}{S_{wx}} + \frac{M_y}{S_{wy}}$$

$$f_w = SQRT\,(f_x^2 + f_y^2 + f_z^2)$$

A_w =	13.25	in.	J_w =	48.46	in^3
S_{wx} =	3.88	in^2	c_x =	3.00	in.
S_{wy} =	15.75	in^2	c_y =	0.31	in.

f_x =	0.37	kips/in
f_y =	0.05	kips/in
f_z =	3.20	kips/in
f_w =	3.22	kips/in

Reqd. Fillet Weld Size = 0.203 in.
Initial Fillet Weld Size, t_w = 0.250 in. OK

References:
1.) AISC Manual of Steel Construction, 13th Edition
2.) "Design and Construction of Lifting Beams", by David T. Ricker, 4th quarter, 1991 AISC Journal
3.) The Crosby Group, Inc., General Catalog

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Job No: 24-018-01
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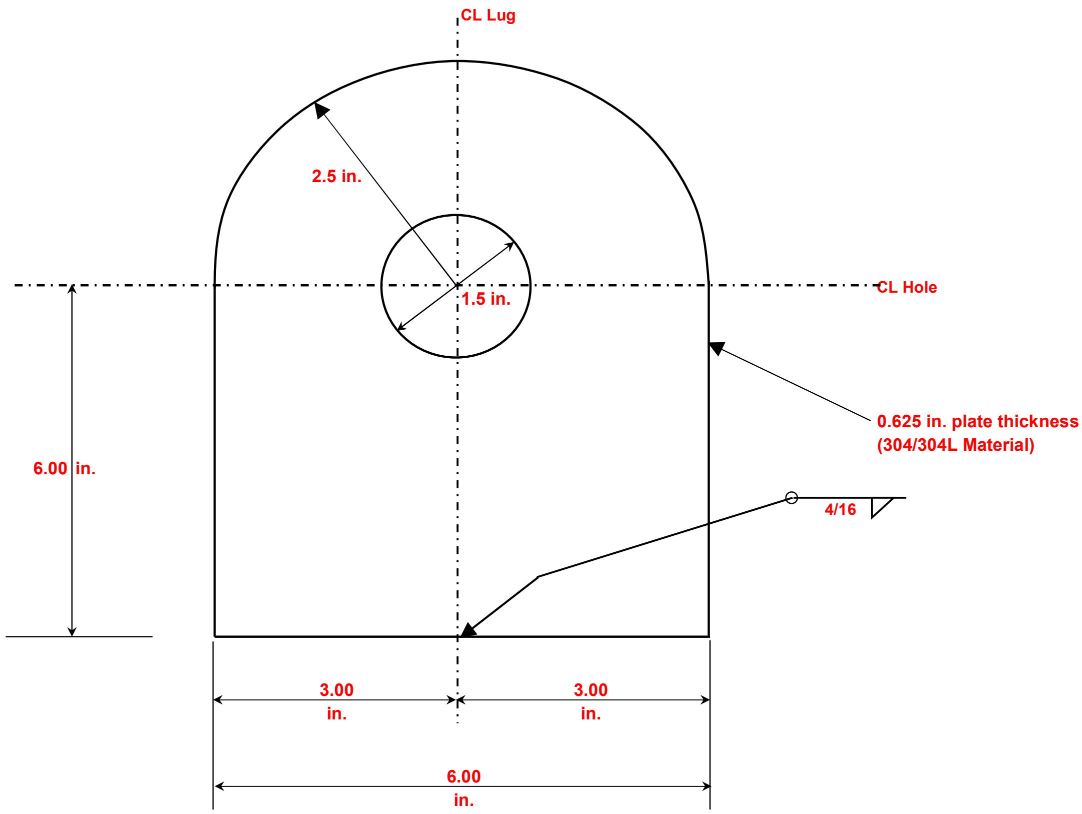
Lug Plate Layout Sketch



Note: Layout Sketch Not to Scale

Nozzle Schedule

Specifications										
Nozzle mark	Identifier	Size	Service	Materials		Impact Tested	Normalized	Fine Grain	Flange	Blind
N1	Drain	NPS 2 Sch 40S (Std)		Nozzle	SA-312 TP304 Wld pipe	No	No	No	NPS 2 Class 150 WN A105	No
N10	Lev Gauge Left Lower	NPS 0.5 Sch 40S (Std)	LEVEL	Nozzle	SA-312 TP304L Wld pipe	No	No	No	N/A	No
N11	Spin hole coupling 1	NPS 0.75 Class 3000 - Threaded Half Coupling	THRD	Nozzle	SA-182 F304 <= 5	No	No	No	N/A	No
N12	Spin hole coupling 2	NPS 0.75 Class 3000 - Threaded Half Coupling	THRD	Nozzle	SA-182 F304 <= 5	No	No	No	N/A	No
N2	Discharge	NPS 3 Sch 40S (Std)		Nozzle	SA-312 TP304 Wld pipe	No	No	No	NPS 3 Class 150 WN A182 F304	No
N3	Manway	24 OD x 0.375		Nozzle	SA-240 304	No	No	No	NPS 24 Class 150 WN A182 F304	NPS 24 Class 150 A182 F304
N4	Fill	NPS 2 Sch 40S (Std)		Nozzle	SA-312 TP304 Wld pipe	No	No	No	NPS 2 Class 150 WN A182 F304	No
N5	Vent	NPS 3 Class 3000 - Threaded Full Coupling	THRD	Nozzle	SA-182 F304 <= 5	No	No	No	N/A	No
N6	Level Transmitter	NPS 3 Sch 40S (Std)		Nozzle	SA-312 TP304 Wld pipe	No	No	No	NPS 3 Class 150 SO A105	No
N7	Lev Gauge Right Upper	NPS 0.5 Sch 40S (Std)	LEVEL	Nozzle	SA-312 TP304L Wld pipe	No	No	No	N/A	No
N8	Lev Gauge Right Lower	NPS 0.5 Sch 40S (Std)	LEVEL	Nozzle	SA-312 TP304L Wld pipe	No	No	No	N/A	No
N9	Lev Gauge Left Upper	NPS 0.5 Sch 40S (Std)	LEVEL	Nozzle	SA-312 TP304L Wld pipe	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)		
N1	2.375	0.154	0.154	Yes	Yes	0.313	N/A		N/A	N/A	0	Exempt
N10	0.84	0.109	0.109	Yes	Yes	0.313*	N/A		N/A	N/A	0	Exempt
N11	1.38	0.165	0.0625	Yes	Yes	0.313*	0.2997		N/A	N/A	0	100.0
N12	1.38	0.165	0.0625	Yes	Yes	0.313*	N/A		N/A	N/A	0	Exempt
N2	3.5	0.216	0.216	Yes	Yes	0.313	N/A		N/A	N/A	0	Exempt
N3	24	0.375	0.2268	Yes	Yes	0.313	0.2268		N/A	N/A	0	100.0
N4	2.375	0.154	0.154	Yes	Yes	0.313	N/A		N/A	N/A	0	Exempt
N5	4.25	0.375	0.0625	Yes	Yes	0.313	N/A		N/A	N/A	0	Exempt
N6	3.5	0.216	0.216	Yes	Yes	0.313*	0.2442		N/A	N/A	0	100.0
N7	0.84	0.109	0.109	Yes	Yes	0.313*	N/A		N/A	N/A	0	Exempt
N8	0.84	0.109	0.109	Yes	Yes	0.313*	N/A		N/A	N/A	0	Exempt
N9	0.84	0.109	0.109	Yes	Yes	0.313*	N/A		N/A	N/A	0	Exempt
*Head minimum thickness after forming												

Definitions	
t_n	Nozzle thickness
Req t_n	Nozzle thickness required per UG-45/UG-16 Increased for pipe to account for 12.5% pipe thickness tolerance
Nom t	Vessel wall thickness
Design t	Required vessel wall thickness due to pressure + corrosion allowance per UG-37
User t	Local vessel wall thickness (near opening)
A_a	Area available per UG-37, governing condition
A_r	Area required per UG-37, governing condition
Corr	Corrosion allowance on nozzle wall

Pressure Summary

Component Summary						
Identifier	P Design (psi)	T Design (°F)	MAWP (psi)	MDMT (°F)	MDMT Exemption	Impact Tested
Ellipsoidal Head #1	0	150	62.92	-320	Note 1	No
Straight Flange on Ellipsoidal Head #1	0	150	84.34	-320	Note 1	No
Cylinder #1	0	150	62.56	-320	Note 1	No
Cylinder #2	0	150	62.56	-320	Note 1	No
Cylinder #3	0	150	62.56	-320	Note 1	No
Cylinder #4	0	150	62.56	-320	Note 1	No
Cylinder #5	0	150	62.56	-320	Note 1	No
Straight Flange on Ellipsoidal Head #2	0	150	84.34	-320	Note 1	No
Ellipsoidal Head #2	0	150	62.92	-320	Note 1	No
Saddle #1	0	150	39.44	N/A	N/A	No
Saddle #1 wear plate	0	150	39.44	-320	Note 1	No
Drain (N1)	0	150	74.24	-55	Note 2	No
Lev Gauge Left Lower (N10)	0	150	74.83	-320	Note 3	No
Spin hole coupling 1 (N11)	0	150	78.91	-320	Note 4	No
Spin hole coupling 2 (N12)	0	150	85.03	-320	Note 4	No
Discharge (N2)	0	150	74.24	-320	Note 1	No
Manway (N3)	0	150	39.44	-320	Note 1	No
Fill (N4)	0	150	77.72	-320	Note 5	No
Vent (N5)	0	150	77.72	-320	Note 1	No
Level Transmitter (N6)	0	150	46.13	-55	Note 6	No
Lev Gauge Right Upper (N7)	0	150	77.91	-320	Note 7	No
Lev Gauge Right Lower (N8)	0	150	85.03	-320	Note 8	No
Lev Gauge Left Upper (N9)	0	150	85.03	-320	Note 8	No

Chamber Summary	
Design MDMT	0 °F
Rated MDMT	0 °F @ 39.44 psi
MAWP hot & corroded	39.44 psi @ 150 °F
(1) The rated MDMT is limited to the design MDMT based on the setting in the Calculations tab of the Set Mode dialog. (2) This pressure chamber is not designed for external pressure.	

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

Notes for MDMT Rating		
Note #	Exemption	Details
1.	Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
2.	Flange rating governs: Flange rated MDMT per UCS-66(b)(3) = -155°F (Coincident ratio = 0.1522) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	
3.	Impact test exempt per UHA-51(g) (coincident ratio = 0.0099)	
4.	Impact test exempt per UHA-51(g) (coincident ratio = 0.0066)	
5.	Impact test exempt per UHA-51(g) (coincident ratio = 0.0179)	
6.	Flange rating governs: Flange rated MDMT per UCS-66(b)(3) = -155°F (Coincident ratio = 0.1509) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	
7.	Impact test exempt per UHA-51(g) (coincident ratio = 0.0092)	
8.	Impact test exempt per UHA-51(g) (coincident ratio = 0.0095)	

Radiography Summary

UG-116 Radiography							
Component	Longitudinal Seam		Left Circumferential Seam		Right Circumferential Seam		Mark
	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	Category (Fig UW-3)	Radiography / Joint Type	
Ellipsoidal Head #1	A	Spot UW-11(b) / Type 1	N/A	N/A	B	Spot UW-11(b) / Type 1	RT3
Cylinder #1	A	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	RT3
Cylinder #2	A	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	RT3
Cylinder #3	A	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	RT3
Cylinder #4	A	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	RT3
Cylinder #5	A	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	RT3
Ellipsoidal Head #2	A	Spot UW-11(b) / Type 1	B	Spot UW-11(b) / Type 1	N/A	N/A	RT3
Nozzle	Longitudinal Seam		Nozzle to Vessel Circumferential Seam		Nozzle free end Circumferential Seam		
Level Transmitter (N6)	N/A	Welded pipe	D	N/A / Type 7	C	N/A / Type 4	N/A
Lev Gauge Left Lower (N10)	N/A	Welded pipe	D	N/A / Type 7	B	UW-11(b) exempt	N/A
Lev Gauge Right Lower (N8)	N/A	Welded pipe	D	N/A / Type 7	B	UW-11(b) exempt	N/A
Lev Gauge Left Upper (N9)	N/A	Welded pipe	D	N/A / Type 7	B	UW-11(b) exempt	N/A
Lev Gauge Right Upper (N7)	N/A	Welded pipe	D	N/A / Type 7	B	UW-11(b) exempt	N/A
Spin hole coupling 1 (N11)	A	Spot UW-11(b) / Type 1	D	N/A / Type 7	N/A	N/A	RT3
Drain (N1)	N/A	Welded pipe	D	N/A / Type 7	C	UW-11(b) exempt / Type 1	N/A
Discharge (N2)	N/A	Welded pipe	D	N/A / Type 7	C	UW-11(b) exempt / Type 1	N/A
Manway (N3)	A	Spot UW-11(b) / Type 1	D	N/A / Type 7	C	Spot UW-11(b) / Type 1	RT3
Vent (N5)	A	Spot UW-11(b) / Type 1	D	N/A / Type 7	N/A	N/A	RT3
Fill (N4)	N/A	Welded pipe	D	N/A / Type 7	C	UW-11(b) exempt / Type 1	N/A
Spin hole coupling 2 (N12)	A	Spot UW-11(b) / Type 1	D	N/A / Type 7	N/A	N/A	RT3
Nozzle Flange	Longitudinal Seam		Flange Face		Nozzle to Flange Circumferential Seam		
ASME B16.5/16.47 flange attached to Level Transmitter (N6)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	N/A / Type 4	N/A
ASME B16.5/16.47 flange attached to Drain (N1)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(b) exempt / Type 1	N/A
ASME B16.5/16.47 flange attached to Discharge (N2)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(b) exempt / Type 1	N/A
ASME B16.5/16.47 flange attached to Manway (N3)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	Spot UW-11(b) / Type 1	RT3
ASME B16.5/16.47 flange attached to Fill (N4)	N/A	Seamless No RT	N/A	N/A / Gasketed	C	UW-11(b) exempt / Type 1	N/A
Interpretation VIII-1 01-150 has been applied.							
UG-116(e) Required Marking: **RT3**							

Thickness Summary

Component Data								
Component Identifier	**Material**	**Diameter (in)**	**Length (in)**	**Nominal t (in)**	**Design t (in)**	**Total Corrosion (in)**	**Joint E**	**Load**
Ellipsoidal Head #1	SA-240 304	96 ID	24.313	0.313*	0.1355	0.125	0.85	Internal
Straight Flange on Ellipsoidal Head #1	SA-240 304	96 ID	2	0.375	0.1355	0.125	0.85	Internal
Cylinder #1	SA-240 304	96 ID	60	0.313	0.1355	0.125	0.85	Internal
Cylinder #2	SA-240 304	96 ID	60	0.313	0.1355	0.125	0.85	Internal
Cylinder #3	SA-240 304	96 ID	60	0.313	0.1355	0.125	0.85	Internal
Cylinder #4	SA-240 304	96 ID	60	0.313	0.1355	0.125	0.85	Internal
Cylinder #5	SA-240 304	96 ID	43.5	0.313	0.1355	0.125	0.85	Internal
Straight Flange on Ellipsoidal Head #2	SA-240 304	96 ID	2	0.375	0.1355	0.125	0.85	Internal
Ellipsoidal Head #2	SA-240 304	96 ID	24.313	0.313*	0.1355	0.125	0.85	Internal
*Head minimum thickness after forming								

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

Weight Summary

Weight (lb) Contributed by Vessel Elements											
Component	Metal New*	Metal Corroded	Insulation	Insulation Supports	Lining	Piping + Liquid	Operating Liquid		Test Liquid		Surface Area ft^2
							New	Corroded	New	Corroded	
Ellipsoidal Head #1	1,036.1	628.6	0	0	0	0	4,705.3	4,751.8	4,705.4	4,751.8	83
Cylinder #1	1,647.5	990.8	0	0	0	0	15,677.2	15,758.9	15,677.2	15,758.9	126
Cylinder #2	1,647	990.5	0	0	0	0	15,677.6	15,759.4	15,677.6	15,759.4	126
Cylinder #3	1,647.9	991.1	0	0	0	0	15,676.7	15,758.5	15,676.7	15,758.5	126
Cylinder #4	1,605.5	965.6	0	0	0	0	15,806.6	15,888.3	15,806.6	15,888.3	123
Cylinder #5	1,194.3	718.3	0	0	0	0	11,366.1	11,425.3	11,366.1	11,425.3	92
Ellipsoidal Head #2	1,037.2	629.3	0	0	0	0	4,703	4,749.4	4,703	4,749.5	83
Saddle #1	1,614	1,614	0	0	0	0	0	0	0	0	118
TOTAL:	**11,429.6**	**7,528.3**	**0**	**0**	**0**	**0**	**83,612.4**	**84,091.7**	**83,612.6**	**84,091.7**	**877**
*Shells with attached nozzles have weight reduced by material cut out for opening.											

Weight (lb) Contributed by Attachments										
Component	Body Flanges		Nozzles & Flanges		Packed Beds	Trays	Tray Supports	Rings & Clips	Vertical Loads	Surface Area ft^2
	New	Corroded	New	Corroded						
Ellipsoidal Head #1	0	0	17	16.9	0	0	0	0	0	1
Cylinder #1	0	0	7.2	7.2	0	0	0	0	0	1
Cylinder #2	0	0	14.9	13.3	0	0	0	17.2	0	2
Cylinder #3	0	0	0	0	0	0	0	0	931	0
Cylinder #4	0	0	895.5	894.5	0	0	0	23.1	0	20
Cylinder #5	0	0	7.2	7.2	0	0	0	0	0	1
Ellipsoidal Head #2	0	0	0.2	0.2	0	0	0	0	0	0
TOTAL:	**0**	**0**	**942**	**939.2**	**0**	**0**	**0**	**40.2**	**931**	**25**

Vessel Totals		
	New	Corroded
Operating Weight (lb)	96,955	93,544
Empty Weight (lb)	13,343	9,452
Test Weight (lb)	96,955	93,544
Surface Area (ft^2)	903	-
Capacity** (US gal)	10,011	10,069
**The vessel capacity does not include volume of nozzle, piping or other attachments.		

Vessel Lift Condition	
Vessel Lift Weight, New (lb)	13,343
Center of Gravity from Datum (in)	122.2933

Hydrostatic Test

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

Gauge pressure at 70°F $= 1.3 \cdot MAWP \cdot LSR$

$= 1.3 \cdot 39.44 \cdot 1$

$= 51.28 \quad \text{psi}$

Horizontal shop hydrostatic test				
Identifier	Local test pressure (psi)	Test liquid static head (psi)	UG-99(b) stress ratio	UG-99(b) pressure factor
Ellipsoidal Head #1 (1)	54.97	3.693	1	1.30
Straight Flange on Ellipsoidal Head #1	54.97	3.693	1	1.30
Cylinder #1	54.97	3.693	1	1.30
Cylinder #2	54.97	3.693	1	1.30
Cylinder #3	54.97	3.693	1	1.30
Cylinder #4	54.97	3.693	1	1.30
Cylinder #5	54.97	3.693	1	1.30
Straight Flange on Ellipsoidal Head #2	54.97	3.693	1	1.30
Ellipsoidal Head #2	54.97	3.693	1	1.30
Discharge (N2)	55.198	3.921	1	1.30
Drain (N1)	55.198	3.921	1	1.30
Fill (N4)	51.494	0.217	1	1.30
Lev Gauge Left Lower (N10)	54.974	3.697	1	1.30
Lev Gauge Left Upper (N9)	53.249	1.972	1	1.30
Lev Gauge Right Lower (N8)	53.249	1.972	1	1.30
Lev Gauge Right Upper (N7)	51.742	0.465	1	1.30
Level Transmitter (N6)	54.893	3.616	1	1.30
Manway (N3)	54.524	3.247	1	1.30
Spin hole coupling 1 (N11)	53.257	1.98	1	1.30
Spin hole coupling 2 (N12)	53.257	1.98	1	1.30
Vent (N5)	51.494	0.217	1	1.30
(1) Ellipsoidal Head #1 limits the UG-99(b) stress ratio. (2) The zero degree angular position is assumed to be up, and the test liquid height is assumed to the top-most flange.				

The field test condition has not been investigated.

Foundation Load Summary

Saddle #1: Total Loading at Base (Right Sliding Saddle)				
Load	**Vessel Condition**	**Longitudinal Base Shear (lb_f)**	**Transverse Base Shear (lb_f)**	**Vertical Force (lb_f)**
Weight Only (D)	Operating, New	0	0	48,679
Weight Only (D)	Operating, Corroded	0	0	46,979
Thermal Expansion	Operating, New	21,906	0	0
Thermal Expansion	Operating, Corroded	21,141	0	0
Wind Only (0.6 * W)	Operating, New	567	657	0
Wind Only (0.6 * W)	Operating, Corroded	567	657	0
Seismic Only (0.7 * E)	Operating, New	2,670	1,340	2,581
Seismic Only (0.7 * E)	Operating, Corroded	2,574	1,293	2,490

Saddle #1: Total Loading at Base (Left Fixed Saddle)				
Load	**Vessel Condition**	**Longitudinal Base Shear (lb_f)**	**Transverse Base Shear (lb_f)**	**Vertical Force (lb_f)**
Weight Only (D)	Operating, New	0	0	48,276
Weight Only (D)	Operating, Corroded	0	0	46,565
Thermal Expansion	Operating, New	21,906	0	0
Thermal Expansion	Operating, Corroded	21,141	0	0
Wind Only (0.6 * W)	Operating, New	567	657	0
Wind Only (0.6 * W)	Operating, Corroded	567	657	0
Seismic Only (0.7 * E)	Operating, New	2,670	1,329	2,560
Seismic Only (0.7 * E)	Operating, Corroded	2,574	1,281	2,467

All values reported are service loads for Allowable Stress Design (ASD).

Vertical Force values in the Seismic case represent the 0.7 * 0.2 * S_{DS} dead load factor (compressive). The 0.7 term is the ASD load combination factor.

Support Information	
Support Type	Saddle
Number of Saddles	2
Base Plate Length	84.4"
Base Plate Width	12"
Base Plate Thickness	0.5"
Base Plate Separation Distance CL-to-CL	252"
Right Saddle Distance from Datum	0"
Number of Anchor Bolts Per Base Plate	4
Bolt Size and Type	1" series 8 bolt
Bolt Hole Clearance	0.375"
Slotted Hole Length	1.5"
Center of Gravity (Distance from Datum)	122.2933"

Wind Code

Building Code: ASCE 7-22	
Elevation of base above grade	0.00 ft
Increase effective outer diameter by	0.00 ft
Wind Force Coefficient, Cf	0.5300
Risk Category (Table 1.5-1)	II
Basic Wind Speed, V	125.0000 mph
Exposure Category	B
Wind Directionality Factor, Kd	0.9500
Ground Elevation Factor, Ke	1.0000
Topographic Factor, Kzt	1.0000
Enforce minimum design load of 16 psf per ASCE 29.8:	Yes
Hazardous, toxic, or explosive contents	No

Wind Pressure (WP) Calculations

$$Kz = 2.41 \cdot \left(\frac{Z}{z_g}\right)^{\frac{2}{\alpha}}$$

$$= 2.41 \cdot \left(\frac{15.00}{3{,}280.00}\right)^{0.2667}$$

$$= 0.5729$$

$$qz = 0.00256 \cdot Kz \cdot Kzt \cdot Ke \cdot V^2$$

$$= 0.00256 \cdot 0.5729 \cdot 1.0000 \cdot 1.0000 \cdot 125.0000^{\;2}$$

$$= 22.9158 \quad \text{psf}$$

qz = 0.6 * max[22.9158, 16.0000]
= 13.7495 psf

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

Table Lookup Values	
α = 7.5000, z_g = 3,280.00 ft	[Table 26.11-1, page 278]

Shear calculations are reported in the saddle report.

Seismic Code

Seismic calculations are reported in the saddle report.

Ellipsoidal Head #1

ASME Section VIII Division 1, 2023 Edition					
Component		Ellipsoidal Head			
Material		SA-240 304 (II-D p. 92, ln. 14)			
Attached To		Cylinder #1			
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Maximize MDMT/ No MAWP**	
No	No	No	No	No	
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**	
Internal		0	150	0	
Static Liquid Head					
Condition		**P_s (psi)**	**H_s (in)**	**SG**	
Operating		3.7	102.438	1	
Test horizontal		3.69	102.313	1	
Dimensions					
Inner Diameter		96"			
Head Ratio		2			
Minimum Thickness		0.313"			
Corrosion	**Inner**	0.125"			
	Outer	0"			
Length L_{sf}		2"			
Nominal Thickness t_{sf}		0.375"			
Weight and Capacity					
		Weight (lb)[1]		**Capacity (US gal)[1]**	
New		1,036.14		564.02	
Corroded		628.64		569.58	
Radiography					
Category A joints		Spot UW-11(b) Type 1			
Head to shell seam		Spot UW-11(b) Type 1			

[1] includes straight flange

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.1355"
Maximum allowable working pressure (MAWP)	62.92 psi
Rated MDMT	-320°F

UHA-51 Material Toughness Requirements	
$t_r = \dfrac{43.14 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 43.14} =$	0.1217"
Stress ratio $= \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.1217 \cdot 0.85}{0.313 - 0.125} =$	0.5504
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

Factor K		
$K = \left(\frac{1}{6}\right) \cdot \left[2 + \left(\frac{D}{2 \cdot h}\right)^2\right]$		
Corroded	$K = \left(\frac{1}{6}\right) \cdot \left[2 + \left(\frac{96.25}{2 \cdot 24.125}\right)^2\right]$	0.9966
New	$K = \left(\frac{1}{6}\right) \cdot \left[2 + \left(\frac{96}{2 \cdot 24}\right)^2\right]$	1

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

$$t = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion} \quad = \frac{3.7 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 3.7} + 0.125 \quad = 0.1354"$$

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

$$P = \frac{2 \cdot S \cdot E \cdot t}{K \cdot D + 0.2 \cdot t} - P_s \quad = \frac{2 \cdot 20{,}000 \cdot 0.85 \cdot 0.188}{0.99655 \cdot 96.25 + 0.2 \cdot 0.188} - 3.7 \quad = 62.92 \text{ psi}$$

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

$$EFE = \left(\frac{75 \cdot t}{R_f}\right) \cdot \left(1 - \frac{R_f}{R_o}\right) = \left(\frac{75 \cdot 0.375}{16.5075}\right) \cdot \left(1 - \frac{16.5075}{\infty}\right) = 1.7038\,\%$$

ASME Section VIII Division 1 UG-81(a) Out-of-Roundness
Inside surface shall not deviate outside the shape by more than $1.25\,\%$ of D
Inside surface shall not deviate inside the shape by more than $0.625\,\%$ of D

Straight Flange on Ellipsoidal Head #1

ASME Section VIII Division 1, 2023 Edition					
Component		Cylinder			
Material		SA-240 304 (II-D p. 92, ln. 14)			
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Maximize MDMT/ No MAWP**	
No	No	No	No	No	
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**	
Internal		0	150	0	
Static Liquid Head					
Condition		P_s (psi)	H_s (in)	**SG**	
Operating		3.7	102.438	1	
Test horizontal		3.69	102.313	1	
Dimensions					
Inner Diameter		96"			
Length		2"			
Nominal Thickness		0.375"			
Corrosion	**Inner**	0.125"			
	Outer	0"			
Weight and Capacity					
		Weight (lb)		**Capacity (US gal)**	
New		65.85		62.67	
Corroded		43.96		63	
Radiography					
Longitudinal seam		Spot UW-11(b) Type 1			
Right Circumferential seam		Spot UW-11(b) Type 1			

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.1355"
Maximum allowable working pressure (MAWP)	84.34 psi
Rated MDMT	-320 °F

UHA-51 Material Toughness Requirements	
$t_r = \dfrac{43.14 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 43.14} =$	0.1223"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.1223 \cdot 0.85}{0.375 - 0.125} =$	0.4159
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

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

$$t = \frac{P \cdot R}{S \cdot E - 0.60 \cdot P} + \text{Corrosion} = \frac{3.7 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.60 \cdot 3.7} + 0.125 = 0.1355"$$

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

$$P = \frac{S \cdot E \cdot t}{R + 0.60 \cdot t} - P_s = \frac{20{,}000 \cdot 0.85 \cdot 0.25}{48.125{+}0.60 \cdot 0.25} - 3.7 = \underline{84.34} \text{ psi}$$

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

$$EFE = \left(\frac{50 \cdot t}{R_f}\right) \cdot \left(1 - \frac{R_f}{R_o}\right) = \left(\frac{50 \cdot 0.375}{48.1875}\right) \cdot \left(1 - \frac{48.1875}{\infty}\right) = 0.3891\,\%$$

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.375/0.25} = 0.000646$$

$$B = 7{,}163 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cHC} = \min(B, S) = 7{,}163 \text{ psi}$$

Allowable Compressive Stress, Hot and New- S_{cHN}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.375/0.375} = 0.000969$$

$$B = 8{,}415 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cHN} = \min(B, S) = 8{,}415 \text{ psi}$$

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.375/0.375} = 0.000969$$

$$B = 8{,}838 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cCN} = \min(B, S) = 8{,}838 \text{ psi}$$

Allowable Compressive Stress, Cold and Corroded- S_{cCC}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.375/0.25} = 0.000646$$

$$B = 7{,}466 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cC} \ = \ \min\left(B,S\right) =$ 7,466 psi

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.375/0.25} = 0.000646$$

$$B = 7{,}163 \quad \text{psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cVC} \ = \ \min\left(B,S\right) =$ 7,163 psi

ASME Section VIII Division 1 UG-80(a) Out-of-Roundness
$\left(D_{\max} - D_{\min}\right)$ shall not exceed 1% of D
When the cross section passes through an opening or within 1 I.D. of the opening, $\left(D_{\max} - D_{\min}\right)$ shall not exceed 1% of $D + 2\%$ of the inside diameter of the opening

Cylinder #1

ASME Section VIII Division 1, 2023 Edition				
Component		Cylinder		
Material		SA-240 304 (II-D p. 92, ln. 14)		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Maximize MDMT/ No MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		0	150	0
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		3.7	102.438	1
Test horizontal		3.69	102.313	1
Dimensions				
Inner Diameter		96"		
Length		60"		
Nominal Thickness		0.313"		
Corrosion	**Inner**	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		**Capacity (US gal)**
New		1,647.49		1,880.06
Corroded		990.83		1,889.86
Radiography				
Longitudinal seam		Spot UW-11(b) Type 1		
Left Circumferential seam		Spot UW-11(b) Type 1		
Right Circumferential seam		Spot UW-11(b) Type 1		

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.1355"
Maximum allowable working pressure (MAWP)	62.56 psi
Rated MDMT	-320 °F

UHA-51 Material Toughness Requirements	
$t_r = \frac{43.14 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 43.14} =$	0.1223"
$\text{Stress ratio} = \frac{t_r \cdot E^*}{t_n - c} = \frac{0.1223 \cdot 0.85}{0.313 - 0.125} =$	0.553
$\text{Stress ratio longitudinal} = \frac{7{,}278 \cdot 0.85}{20{,}000 \cdot 0.85} =$	0.3639
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

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

$$t = \frac{P \cdot R}{S \cdot E - 0.60 \cdot P} + \text{Corrosion} = \frac{3.7 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.60 \cdot 3.7} + 0.125 = 0.1355"$$

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

$$P = \frac{S \cdot E \cdot t}{R + 0.60 \cdot t} - P_s = \frac{20{,}000 \cdot 0.85 \cdot 0.188}{48.125 + 0.60 \cdot 0.188} - 3.7 = \underline{62.56} \text{ psi}$$

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

$$EFE = \left(\frac{50 \cdot t}{R_f}\right) \cdot \left(1 - \frac{R_f}{R_o}\right) = \left(\frac{50 \cdot 0.313}{48.1565}\right) \cdot \left(1 - \frac{48.1565}{\infty}\right) = 0.325\,\%$$

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$$B = 6{,}399 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cHC} = \min(B, S) = 6{,}399 \text{ psi}$$

Allowable Compressive Stress, Hot and New- S_{cHN}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.313} = 0.000810$$

$$B = 7{,}836 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cHN} = \min(B, S) = 7{,}836 \text{ psi}$$

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.313} = 0.000810$$

$$B = 8{,}202 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cCN} = \min(B, S) = 8{,}202 \text{ psi}$$

Allowable Compressive Stress, Cold and Corroded- S_{cCC}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$B = 6{,}635 \quad \text{psi}$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cC} = \min(B, S) =$ 6,635 psi

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$B = 6{,}399 \quad \text{psi}$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cVC} = \min(B, S) =$ 6,399 psi

ASME Section VIII Division 1 UG-80(a) Out-of-Roundness
$(D_{\max} - D_{\min})$ shall not exceed 1% of D
When the cross section passes through an opening or within 1 I.D. of the opening, $(D_{\max} - D_{\min})$ shall not exceed 1% of $D + 2\%$ of the inside diameter of the opening

Cylinder #2

<table>
<tr><th colspan="5">ASME Section VIII Division 1, 2023 Edition</th></tr>
<tr><td colspan="2">Component</td><td colspan="3">Cylinder</td></tr>
<tr><td colspan="2">Material</td><td colspan="3">SA-240 304 (II-D p. 92, ln. 14)</td></tr>
<tr><td>Impact Tested</td><td>Normalized</td><td>Fine Grain Practice</td><td>PWHT</td><td>Maximize MDMT/ No MAWP</td></tr>
<tr><td>No</td><td>No</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td colspan="2"></td><td>Design Pressure (psi)</td><td>Design Temperature (°F)</td><td>Design MDMT (°F)</td></tr>
<tr><td colspan="2">Internal</td><td>0</td><td>150</td><td>0</td></tr>
<tr><th colspan="5">Static Liquid Head</th></tr>
<tr><td colspan="2">Condition</td><td>P_s (psi)</td><td>H_s (in)</td><td>SG</td></tr>
<tr><td colspan="2">Operating</td><td>3.7</td><td>102.438</td><td>1</td></tr>
<tr><td colspan="2">Test horizontal</td><td>3.69</td><td>102.313</td><td>1</td></tr>
<tr><th colspan="5">Dimensions</th></tr>
<tr><td colspan="2">Inner Diameter</td><td colspan="3">96"</td></tr>
<tr><td colspan="2">Length</td><td colspan="3">60"</td></tr>
<tr><td colspan="2">Nominal Thickness</td><td colspan="3">0.313"</td></tr>
<tr><td rowspan="2">Corrosion</td><td>Inner</td><td colspan="3">0.125"</td></tr>
<tr><td>Outer</td><td colspan="3">0"</td></tr>
<tr><th colspan="5">Weight and Capacity</th></tr>
<tr><td colspan="2"></td><td colspan="2">Weight (lb)</td><td>Capacity (US gal)</td></tr>
<tr><td colspan="2">New</td><td colspan="2">1,647.02</td><td>1,880.06</td></tr>
<tr><td colspan="2">Corroded</td><td colspan="2">990.55</td><td>1,889.86</td></tr>
<tr><th colspan="5">Radiography</th></tr>
<tr><td colspan="2">Longitudinal seam</td><td colspan="3">Spot UW-11(b) Type 1</td></tr>
<tr><td colspan="2">Left Circumferential seam</td><td colspan="3">Spot UW-11(b) Type 1</td></tr>
<tr><td colspan="2">Right Circumferential seam</td><td colspan="3">Spot UW-11(b) Type 1</td></tr>
</table>

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.1355"
Maximum allowable working pressure (MAWP)	62.56 psi
Rated MDMT	-320 °F

<table>
<tr><th colspan="2">UHA-51 Material Toughness Requirements</th></tr>
<tr><td>$t_r = \frac{43.14 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 43.14} =$</td><td>0.1223"</td></tr>
<tr><td>$\text{Stress ratio} = \frac{t_r \cdot E^*}{t_n - c} = \frac{0.1223 \cdot 0.85}{0.313 - 0.125} =$</td><td>0.553</td></tr>
<tr><td>$\text{Stress ratio longitudinal} = \frac{7{,}278 \cdot 0.85}{20{,}000 \cdot 0.85} =$</td><td>0.3639</td></tr>
<tr><td colspan="2">Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F</td></tr>
<tr><td colspan="2">Material is exempt from impact testing at the Design MDMT of 0°F.</td></tr>
</table>

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

$$t = \frac{P \cdot R}{S \cdot E - 0.60 \cdot P} + \text{Corrosion} = \frac{3.7 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.60 \cdot 3.7} + 0.125 = 0.1355"$$

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

$$P = \frac{S \cdot E \cdot t}{R + 0.60 \cdot t} - P_s = \frac{20{,}000 \cdot 0.85 \cdot 0.188}{48.125{+}0.60 \cdot 0.188} - 3.7 = \underline{62.56} \text{ psi}$$

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

$$EFE = \left(\frac{50 \cdot t}{R_f}\right) \cdot \left(1 - \frac{R_f}{R_o}\right) = \left(\frac{50 \cdot 0.313}{48.1565}\right) \cdot \left(1 - \frac{48.1565}{\infty}\right) = 0.325\,\%$$

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$$B = 6{,}399 \ \ \text{psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \ \ \text{psi}$$

$$S_{cHC} \ = \ \min\ (B{,}S) = 6{,}399 \text{ psi}$$

Allowable Compressive Stress, Hot and New- S_{cHN}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.313} = 0.000810$$

$$B = 7{,}836 \ \ \text{psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \ \ \text{psi}$$

$$S_{cHN} \ = \ \min\ (B{,}S) = 7{,}836 \text{ psi}$$

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.313} = 0.000810$$

$$B = 8{,}202 \ \ \text{psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \ \ \text{psi}$$

$$S_{cCN} \ = \ \min\ (B{,}S) = 8{,}202 \text{ psi}$$

Allowable Compressive Stress, Cold and Corroded- S_{cCC}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$B = 6{,}635 \quad \text{psi}$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cC} = \min(B, S) = $ 6,635 psi

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$B = 6{,}399 \quad \text{psi}$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cVC} = \min(B, S) = $ 6,399 psi

ASME Section VIII Division 1 UG-80(a) Out-of-Roundness
$(D_{\max} - D_{\min})$ shall not exceed 1% of D
When the cross section passes through an opening or within 1 I.D. of the opening, $(D_{\max} - D_{\min})$ shall not exceed 1% of $D + 2\%$ of the inside diameter of the opening

Cylinder #3

ASME Section VIII Division 1, 2023 Edition					
Component		Cylinder			
Material		SA-240 304 (II-D p. 92, ln. 14)			
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Maximize MDMT/ No MAWP**	
No	No	No	No	No	
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**	
Internal		0	150	0	
Static Liquid Head					
Condition		P_S (psi)	H_S (in)	**SG**	
Operating		3.7	102.438	1	
Test horizontal		3.69	102.313	1	
Dimensions					
Inner Diameter		96"			
Length		60"			
Nominal Thickness		0.313"			
Corrosion	**Inner**	0.125"			
	Outer	0"			
Weight and Capacity					
		Weight (lb)		**Capacity (US gal)**	
New		1,647.89		1,880.06	
Corroded		991.07		1,889.86	
Radiography					
Longitudinal seam		Spot UW-11(b) Type 1			
Left Circumferential seam		Spot UW-11(b) Type 1			
Right Circumferential seam		Spot UW-11(b) Type 1			

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.1355"
Maximum allowable working pressure (MAWP)	62.56 psi
Rated MDMT	-320 °F

UHA-51 Material Toughness Requirements	
$t_r = \dfrac{43.14 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 43.14} =$	0.1223"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.1223 \cdot 0.85}{0.313 - 0.125} =$	0.553
$\text{Stress ratio longitudinal} = \dfrac{7{,}278 \cdot 0.85}{20{,}000 \cdot 0.85} =$	0.3639
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

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

$$t = \frac{P \cdot R}{S \cdot E - 0.60 \cdot P} + \text{Corrosion} = \frac{3.7 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.60 \cdot 3.7} + 0.125 = 0.1355"$$

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

$$P = \frac{S \cdot E \cdot t}{R + 0.60 \cdot t} - P_s = \frac{20{,}000 \cdot 0.85 \cdot 0.188}{48.125 + 0.60 \cdot 0.188} - 3.7 = 62.56 \text{ psi}$$

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

$$EFE = \left(\frac{50 \cdot t}{R_f}\right) \cdot \left(1 - \frac{R_f}{R_o}\right) = \left(\frac{50 \cdot 0.313}{48.1565}\right) \cdot \left(1 - \frac{48.1565}{\infty}\right) = 0.325\,\%$$

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

$$A = \frac{0.125}{R_o / t} = \frac{0.125}{48.313 / 0.188} = 0.000486$$

$$B = 6{,}399 \quad \text{psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$$S_{cHC} = \min\left(B, S\right) = 6{,}399 \text{ psi}$$

Allowable Compressive Stress, Hot and New- S_{cHN}, (table HA-1)

$$A = \frac{0.125}{R_o / t} = \frac{0.125}{48.313 / 0.313} = 0.000810$$

$$B = 7{,}836 \quad \text{psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$$S_{cHN} = \min\left(B, S\right) = 7{,}836 \text{ psi}$$

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

$$A = \frac{0.125}{R_o / t} = \frac{0.125}{48.313 / 0.313} = 0.000810$$

$$B = 8{,}202 \quad \text{psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$$S_{cCN} = \min\left(B, S\right) = 8{,}202 \text{ psi}$$

Allowable Compressive Stress, Cold and Corroded- S_{cCC}, (table HA-1)

$$A = \frac{0.125}{R_o / t} = \frac{0.125}{48.313 / 0.188} = 0.000486$$

$B = 6{,}635 \quad \text{psi}$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cC} = \min\,(B, S) = 6{,}635$ psi

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$B = 6{,}399 \quad \text{psi}$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cVC} = \min\,(B, S) = 6{,}399$ psi

ASME Section VIII Division 1 UG-80(a) Out-of-Roundness
$(D_{\max} - D_{\min})$ shall not exceed 1% of D
When the cross section passes through an opening or within 1 I.D. of the opening, $(D_{\max} - D_{\min})$ shall not exceed 1% of $D + 2\%$ of the inside diameter of the opening

Cylinder #4

ASME Section VIII Division 1, 2023 Edition				
Component		Cylinder		
Material		SA-240 304 (II-D p. 92, ln. 14)		
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Maximize MDMT/ No MAWP**
No	No	No	No	No
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**
Internal		0	150	0
Static Liquid Head				
Condition		**P_s (psi)**	**H_s (in)**	**SG**
Operating		3.7	102.438	1
Test horizontal		3.69	102.313	1
Dimensions				
Inner Diameter		96"		
Length		60"		
Nominal Thickness		0.313"		
Corrosion	**Inner**	0.125"		
	Outer	0"		
Weight and Capacity				
		Weight (lb)		**Capacity (US gal)**
New		1,605.54		1,880.06
Corroded		965.63		1,889.86
Radiography				
Longitudinal seam		Spot UW-11(b) Type 1		
Left Circumferential seam		Spot UW-11(b) Type 1		
Right Circumferential seam		Spot UW-11(b) Type 1		

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.1355"
Maximum allowable working pressure (MAWP)	62.56 psi
Rated MDMT	-320 °F

UHA-51 Material Toughness Requirements	
$t_r = \frac{43.14 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 43.14} =$	0.1223"
$\text{Stress ratio} = \frac{t_r \cdot E^*}{t_n - c} = \frac{0.1223 \cdot 0.85}{0.313 - 0.125} =$	0.553
$\text{Stress ratio longitudinal} = \frac{7{,}278 \cdot 0.85}{20{,}000 \cdot 0.85} =$	0.3639
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

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

$$t = \frac{P \cdot R}{S \cdot E - 0.60 \cdot P} + \text{Corrosion} = \frac{3.7 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.60 \cdot 3.7} + 0.125 = 0.1355''$$

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

$$P = \frac{S \cdot E \cdot t}{R + 0.60 \cdot t} - P_s = \frac{20{,}000 \cdot 0.85 \cdot 0.188}{48.125 + 0.60 \cdot 0.188} - 3.7 = 62.56 \text{ psi}$$

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

$$EFE = \left(\frac{50 \cdot t}{R_f}\right) \cdot \left(1 - \frac{R_f}{R_o}\right) = \left(\frac{50 \cdot 0.313}{48.1565}\right) \cdot \left(1 - \frac{48.1565}{\infty}\right) = 0.325\,\%$$

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$$B = 6{,}399 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cHC} = \min(B, S) = 6{,}399 \text{ psi}$$

Allowable Compressive Stress, Hot and New- S_{cHN}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.313} = 0.000810$$

$$B = 7{,}836 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cHN} = \min(B, S) = 7{,}836 \text{ psi}$$

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.313} = 0.000810$$

$$B = 8{,}202 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cCN} = \min(B, S) = 8{,}202 \text{ psi}$$

Allowable Compressive Stress, Cold and Corroded- S_{cCC}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$B = 6{,}635 \quad \text{psi}$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cC} = \min\,(B, S) = 6{,}635$ psi

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$B = 6{,}399 \quad \text{psi}$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cVC} = \min\,(B, S) = 6{,}399$ psi

ASME Section VIII Division 1 UG-80(a) Out-of-Roundness
$(D_{\max} - D_{\min})$ shall not exceed 1% of D
When the cross section passes through an opening or within 1 I.D. of the opening, $(D_{\max} - D_{\min})$ shall not exceed 1% of $D + 2\%$ of the inside diameter of the opening

Cylinder #5

ASME Section VIII Division 1, 2023 Edition					
Component		Cylinder			
Material		SA-240 304 (II-D p. 92, ln. 14)			
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Maximize MDMT/ No MAWP**	
No	No	No	No	No	
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**	
Internal		0	150	0	
Static Liquid Head					
Condition		P_s (psi)	H_s (in)	SG	
Operating		3.7	102.438	1	
Test horizontal		3.69	102.313	1	
Dimensions					
Inner Diameter		96"			
Length		43.5"			
Nominal Thickness		0.313"			
Corrosion	**Inner**	0.125"			
	Outer	0"			
Weight and Capacity					
		Weight (lb)		**Capacity (US gal)**	
New		1,194.32		1,363.04	
Corroded		718.29		1,370.15	
Radiography					
Longitudinal seam		Spot UW-11(b) Type 1			
Left Circumferential seam		Spot UW-11(b) Type 1			
Right Circumferential seam		Spot UW-11(b) Type 1			

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.1355"
Maximum allowable working pressure (MAWP)	62.56 psi
Rated MDMT	-320 °F

UHA-51 Material Toughness Requirements	
$t_r = \dfrac{43.14 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 43.14} =$	0.1223"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.1223 \cdot 0.85}{0.313 - 0.125} =$	0.553
$\text{Stress ratio longitudinal} = \dfrac{7{,}278 \cdot 0.85}{20{,}000 \cdot 0.85} =$	0.3639
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

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

$$t = \frac{P \cdot R}{S \cdot E - 0.60 \cdot P} + \text{Corrosion} = \frac{3.7 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.60 \cdot 3.7} + 0.125 = 0.1355"$$

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

$$P = \frac{S \cdot E \cdot t}{R + 0.60 \cdot t} - P_s = \frac{20{,}000 \cdot 0.85 \cdot 0.188}{48.125 + 0.60 \cdot 0.188} - 3.7 = \underline{62.56} \text{ psi}$$

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

$$EFE = \left(\frac{50 \cdot t}{R_f}\right) \cdot \left(1 - \frac{R_f}{R_o}\right) = \left(\frac{50 \cdot 0.313}{48.1565}\right) \cdot \left(1 - \frac{48.1565}{\infty}\right) = 0.325\,\%$$

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$$B = 6{,}399 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$S_{cHC} = \min(B, S) = 6{,}399$ psi

Allowable Compressive Stress, Hot and New- S_{cHN}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.313} = 0.000810$$

$$B = 7{,}836 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$S_{cHN} = \min(B, S) = 7{,}836$ psi

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.313} = 0.000810$$

$$B = 8{,}202 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$S_{cCN} = \min(B, S) = 8{,}202$ psi

Allowable Compressive Stress, Cold and Corroded- S_{cCC}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$B = 6{,}635 \quad \text{psi}$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cC} = \min(B, S) = 6{,}635$ psi

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.313/0.188} = 0.000486$$

$B = 6{,}399 \quad \text{psi}$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cVC} = \min(B, S) = 6{,}399$ psi

ASME Section VIII Division 1 UG-80(a) Out-of-Roundness
$(D_{\max} - D_{\min})$ shall not exceed 1% of D
When the cross section passes through an opening or within 1 I.D. of the opening, $(D_{\max} - D_{\min})$ shall not exceed 1% of $D + 2\%$ of the inside diameter of the opening

Ellipsoidal Head #2

ASME Section VIII Division 1, 2023 Edition					
Component		Ellipsoidal Head			
Material		SA-240 304 (II-D p. 92, ln. 14)			
Attached To		Cylinder #5			
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Maximize MDMT/ No MAWP**	
No	No	No	No	No	
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**	
Internal		0	150	0	
Static Liquid Head					
Condition		P_s **(psi)**	H_s **(in)**	**SG**	
Operating		3.7	102.438	1	
Test horizontal		3.69	102.313	1	
Dimensions					
Inner Diameter		96"			
Head Ratio		2			
Minimum Thickness		0.313"			
Corrosion	**Inner**	0.125"			
	Outer	0"			
Length L_{sf}		2"			
Nominal Thickness t_{sf}		0.375"			
Weight and Capacity					
		Weight (lb)[1]		**Capacity (US gal)**[1]	
New		1,037.21		564.02	
Corroded		629.29		569.58	
Radiography					
Category A joints		Spot UW-11(b) Type 1			
Head to shell seam		Spot UW-11(b) Type 1			

[1] includes straight flange

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.1355"
Maximum allowable working pressure (MAWP)	62.92 psi
Rated MDMT	-320°F

UHA-51 Material Toughness Requirements	
$t_r = \dfrac{43.14 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 43.14} =$	0.1217"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.1217 \cdot 0.85}{0.313 - 0.125} =$	0.5504
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

Factor K		
$K = \left(\frac{1}{6}\right) \cdot \left[2 + \left(\frac{D}{2 \cdot h}\right)^2\right]$		
Corroded	$K = \left(\frac{1}{6}\right) \cdot \left[2 + \left(\frac{96.25}{2 \cdot 24.125}\right)^2\right]$	0.9966
New	$K = \left(\frac{1}{6}\right) \cdot \left[2 + \left(\frac{96}{2 \cdot 24}\right)^2\right]$	1

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

$$t = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion} = \frac{3.7 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 3.7} + 0.125 = 0.1354"$$

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

$$P = \frac{2 \cdot S \cdot E \cdot t}{K \cdot D + 0.2 \cdot t} - P_s = \frac{2 \cdot 20{,}000 \cdot 0.85 \cdot 0.188}{0.99655 \cdot 96.25 + 0.2 \cdot 0.188} - 3.7 = 62.92 \text{ psi}$$

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

$$EFE = \left(\frac{75 \cdot t}{R_f}\right) \cdot \left(1 - \frac{R_f}{R_o}\right) = \left(\frac{75 \cdot 0.375}{16.5075}\right) \cdot \left(1 - \frac{16.5075}{\infty}\right) = 1.7038\,\%$$

ASME Section VIII Division 1 UG-81(a) Out-of-Roundness
Inside surface shall not deviate outside the shape by more than $1.25\,\%$ of D
Inside surface shall not deviate inside the shape by more than $0.625\,\%$ of D

Straight Flange on Ellipsoidal Head #2

ASME Section VIII Division 1, 2023 Edition					
Component		Cylinder			
Material		SA-240 304 (II-D p. 92, ln. 14)			
Impact Tested	**Normalized**	**Fine Grain Practice**	**PWHT**	**Maximize MDMT/ No MAWP**	
No	No	No	No	No	
		Design Pressure (psi)	**Design Temperature (°F)**	**Design MDMT (°F)**	
Internal		0	150	0	
Static Liquid Head					
Condition		**P_s (psi)**	**H_s (in)**	**SG**	
Operating		3.7	102.438	1	
Test horizontal		3.69	102.313	1	
Dimensions					
Inner Diameter		96"			
Length		2"			
Nominal Thickness		0.375"			
Corrosion	**Inner**	0.125"			
	Outer	0"			
Weight and Capacity					
		Weight (lb)		**Capacity (US gal)**	
New		65.85		62.67	
Corroded		43.96		63	
Radiography					
Longitudinal seam		Spot UW-11(b) Type 1			
Left Circumferential seam		Spot UW-11(b) Type 1			

Results Summary	
Governing condition	UG-16
Minimum thickness per UG-16	0.0625" + 0.125" = 0.1875"
Design thickness due to internal pressure (t)	0.1355"
Maximum allowable working pressure (MAWP)	84.34 psi
Rated MDMT	-320 °F

UHA-51 Material Toughness Requirements	
$t_r = \dfrac{43.14 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 43.14} =$	0.1223"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.1223 \cdot 0.85}{0.375 - 0.125} =$	0.4159
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

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

$$t = \frac{P \cdot R}{S \cdot E - 0.60 \cdot P} + \text{Corrosion} = \frac{3.7 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.60 \cdot 3.7} + 0.125 = 0.1355''$$

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

$$P = \frac{S \cdot E \cdot t}{R + 0.60 \cdot t} - P_s = \frac{20{,}000 \cdot 0.85 \cdot 0.25}{48.125 + 0.60 \cdot 0.25} - 3.7 = 84.34 \text{ psi}$$

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

$$EFE = \left(\frac{50 \cdot t}{R_f}\right) \cdot \left(1 - \frac{R_f}{R_o}\right) = \left(\frac{50 \cdot 0.375}{48.1875}\right) \cdot \left(1 - \frac{48.1875}{\infty}\right) = 0.3891\,\%$$

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.375/0.25} = 0.000646$$

$$B = 7{,}163 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cHC} = \min(B, S) = 7{,}163 \text{ psi}$$

Allowable Compressive Stress, Hot and New- S_{cHN}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.375/0.375} = 0.000969$$

$$B = 8{,}415 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cHN} = \min(B, S) = 8{,}415 \text{ psi}$$

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.375/0.375} = 0.000969$$

$$B = 8{,}838 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \text{ psi}$$

$$S_{cCN} = \min(B, S) = 8{,}838 \text{ psi}$$

Allowable Compressive Stress, Cold and Corroded- S_{cCC}, (table HA-1)

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.375/0.25} = 0.000646$$

$$B = 7{,}466 \text{ psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cC} = \min\left(B, S\right) =$ 7,466 psi

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

$$A = \frac{0.125}{R_o/t} = \frac{0.125}{48.375/0.25} = 0.000646$$

$$B = 7{,}163 \quad \text{psi}$$

$$S = \frac{20{,}000}{1.00} = 20{,}000 \quad \text{psi}$$

$S_{cVC} = \min\left(B, S\right) =$ 7,163 psi

ASME Section VIII Division 1 UG-80(a) Out-of-Roundness
$\left(D_{\max} - D_{\min}\right)$ shall not exceed 1% of D
When the cross section passes through an opening or within 1 I.D. of the opening, $\left(D_{\max} - D_{\min}\right)$ shall not exceed 1% of $D + 2\%$ of the inside diameter of the opening

Saddle #1

ASME Section VIII Division 1, 2023 Edition		
Saddle Material	SA-240 304	
Saddle Construction	Centered web	
Welded to Vessel	Yes	
Saddle Allowable Stress, S_s	20,000 psi	
Saddle Yield Stress, S_y	38,000 psi	
Foundation Allowable Stress	1,658 psi	
Design Pressure	**Left Saddle**	**Right Saddle**
Operating & New	43.14 psi	
Operating & Corr	43.14 psi	
Test	54.97 psi	
Dimensions		
Right saddle distance to datum	0"	
Tangent To Tangent Length, L	287.5"	
Saddle separation, L_s	252"	
Vessel Radius, R	48.313"	
Tangent Distance Left, A_l	17.75"	
Tangent Distance Right, A_r	17.75"	
Saddle Height, H_s	60.25"	
Saddle Contact Angle, θ	164°	
Web Plate Thickness, t_s	0.625"	
Base Plate Length, E	84.4"	
Base Plate Width, F	12"	
Base Plate Thickness, t_b	0.5"	
Number of Stiffening Ribs, n	5	
Largest Stiffening Rib Spacing, d_i	20.725"	
Stiffening Rib Thickness, t_w	0.5"	
Saddle Width, b	8"	
Reinforcing Plate		
Material	SA-240 304L (II-D p. 88, ln. 9)	
Impact Tested	No	
Normalized	No	
Fine Grain Practice	No	
PWHT	No	
Design MDMT	0°F	
Thickness, t_p	0.313"	
Width, W_p	15"	
Contact Angle, θ_w	180°	
Bolting		
Material		
Bolt Allowable Shear	15,000 psi	
Description	1" series 8 threaded	
Corrosion on root	0"	
Anchor Bolts per Saddle	4	
Base coefficient of friction, μ	0.45	
Hole Diameter	1.375"	

Slotted Hole in Which Saddle	Right Saddle	
Slotted Hole Length	1.5"	
Weight		
	Left Saddle	**Right Saddle**
Operating, Corroded	45,758 lb	46,172 lb
Operating, New	47,469 lb	47,872 lb
Hydrotest	47,436 lb	47,906 lb
Weight of Saddle Pair	1,614 lb	

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

UHA-51 Material Toughness Requirements Wear Plate	
$t_r = \dfrac{43.14 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 43.14} =$	0.1223"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.1223 \cdot 0.85}{0.313 - 0.125} =$	0.553
$\text{Stress ratio longitudinal} = \dfrac{7{,}278 \cdot 0.85}{20{,}000 \cdot 0.85} =$	0.3639
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

Stress Summary

Load	Condition	Saddle	Bending + pressure between saddles (psi)				Bending + pressure at the saddle (psi)			
			S_1 (+)	allow (+)	S_1 (-)	allow (-)	S_2 (+)	allow (+)	S_2 (-)	allow (-)
Seismic	Operating & New	Right Saddle	4,404	20,400	1,097	9,403	3,309	24,000	1	9,403
		Left Saddle					3,309	24,000	1	9,403
	Operating & Corr	Right Saddle	7,278	20,400	1,756	7,679	5,524	24,000	2	7,679
		Left Saddle					5,524	24,000	2	7,679
Wind	Operating & New	Right Saddle	4,366	20,400	1,059	9,403	3,309	24,000	1	9,403
		Left Saddle					3,309	24,000	1	9,403
	Operating & Corr	Right Saddle	7,218	20,400	1,696	7,679	5,524	24,000	2	7,679
		Left Saddle					5,524	24,000	2	7,679
	Test	Right Saddle	5,262	22,950	1,047	9,843	4,216	27,000	1	9,843
		Left Saddle					4,216	27,000	1	9,843
Weight	Operating & New	Right Saddle	4,348	17,000	1,041	7,836	3,309	20,000	1	7,836
		Left Saddle					3,309	20,000	1	7,836
	Operating & Corr	Right Saddle	7,188	17,000	1,667	6,399	5,524	20,000	2	6,399
		Left Saddle					5,524	20,000	2	6,399

Stress Summary												
Load	Condition	Saddle	Tangential shear (psi)		Circumferential stress (psi)			Stress over saddle (psi)		Splitting (psi)		
			S_3	allow	S_4 (horns)	S_4 (Wear plate)	allow (+/-)	S_5	allow	S_6	allow
Seismic	Operating & New	Right Saddle	1,221	16,000	-4,590	-7,730	30,000	5,663	13,350	1,241	13,333
		Left Saddle	1,211	16,000	-4,551	-7,665	30,000	5,615	13,350	1,231	13,333
	Operating & Corr	Right Saddle	1,958	16,000	-6,393	-18,118	30,000	7,568	13,350	1,197	13,333
		Left Saddle	1,941	16,000	-6,336	-17,956	30,000	7,500	13,350	1,186	13,333
Wind	Operating & New	Right Saddle	1,179	16,000	-4,430	-7,461	30,000	5,466	13,350	1,198	13,333
		Left Saddle	1,169	16,000	-4,393	-7,400	30,000	5,421	13,350	1,188	13,333
	Operating & Corr	Right Saddle	1,891	16,000	-6,175	-17,499	30,000	7,309	13,350	1,156	13,333
		Left Saddle	1,875	16,000	-6,120	-17,345	30,000	7,245	13,350	1,146	13,333
	Test	Right Saddle	1,166	21,600	-4,383	-7,382	27,000	5,408	27,000	1,185	34,200
		Left Saddle	1,155	21,600	-4,340	-7,310	27,000	5,355	27,000	1,174	34,200
Weight	Operating & New	Right Saddle	1,159	16,000	-4,355	-7,335	30,000	5,373	13,350	1,178	13,333
		Left Saddle	1,149	16,000	-4,318	-7,273	30,000	5,328	13,350	1,168	13,333
	Operating & Corr	Right Saddle	1,858	16,000	-6,066	-17,191	30,000	7,181	13,350	1,136	13,333
		Left Saddle	1,841	16,000	-6,012	-17,037	30,000	7,116	13,350	1,126	13,333

Seismic base shear on vessel	
Vessel is assumed to be a rigid structure.	
Method of seismic analysis	ASCE 7-22 ground supported
Vertical seismic accelerations considered	Yes
Importance factor, I_e	1
Site Class	D
Spectral response acceleration at short periods, S_s (%g)	16%
Spectral response acceleration at 1 second period, S_1 (%g)	6.3%
Adjusted spectral response acceleration at short periods, S_{MS} (%g)	20%
Adjusted spectral response acceleration at 1 second period, S_{M1} (%g)	13%
Risk Category (Table 1.5-1)	II
Hazardous, toxic, or explosive contents	No
Equations	
$S_{DS} = \left(\frac{2}{3}\right) \cdot S_{MS}$	
$S_{D1} = \left(\frac{2}{3}\right) \cdot S_{M1}$	
$F_p = 0.3 \cdot S_{DS} \cdot W \cdot I_e \cdot 0.7$	
Results	
$S_{DS} = \left(\frac{2}{3}\right) \cdot 0.2$	0.1333
$S_{D1} = \left(\frac{2}{3}\right) \cdot 0.13$	0.0867
Seismic Design Category (Section 11.6)	B
Corroded	
$F_p = 0.3 \cdot 0.1333 \cdot 91{,}930 \cdot 1 \cdot 0.7$	2,574.04 lb_f
New	
$F_p = 0.3 \cdot 0.1333 \cdot 95{,}341 \cdot 1 \cdot 0.7$	2,669.55 lb_f

Saddle reactions due to weight + seismic

V_v = vertical seismic force acting on the saddle

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

Seismic longitudinal reaction, Q_l

Seismic transverse reaction, Q_t

Equations

$$Q_l = \frac{V \cdot H_s}{L_s} + V_v$$

$$Q_t = \frac{V \cdot H_s}{R_o \cdot \mathrm{Sin}(\theta \ / \ 2)} + V_v$$

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

Results

Operating & New	Right Saddle	$Q_l = \frac{2{,}669.55 \cdot 60.25}{252} + 0.14 \cdot 0.1333 \cdot 47{,}872$	1,531.87 lb_f
		$Q_t = \frac{1{,}340.42 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)} + 0.14 \cdot 0.1333 \cdot 47{,}872$	2,581.64 lb_f
		$Q = 47{,}872 + \max\left[2{,}581.64, 1{,}531.87\right]$	50,453.64 lb_f
	Left Saddle	$Q_l = \frac{2{,}669.55 \cdot 60.25}{252} + 0.14 \cdot 0.1333 \cdot 47{,}469$	1,524.34 lb_f
		$Q_t = \frac{1{,}329.13 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)} + 0.14 \cdot 0.1333 \cdot 47{,}469$	2,559.91 lb_f
		$Q = 47{,}469 + \max\left[2{,}559.91, 1{,}524.34\right]$	50,028.91 lb_f
Operating & Corr	Right Saddle	$Q_l = \frac{2{,}574.04 \cdot 60.25}{252} + 0.14 \cdot 0.1333 \cdot 46{,}172$	1,477.3 lb_f
		$Q_t = \frac{1{,}292.82 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)} + 0.14 \cdot 0.1333 \cdot 46{,}172$	2,489.96 lb_f
		$Q = 46{,}172 + \max\left[2{,}489.96, 1{,}477.3\right]$	48,661.96 lb_f
	Left Saddle	$Q_l = \frac{2{,}574.04 \cdot 60.25}{252} + 0.14 \cdot 0.1333 \cdot 45{,}758$	1,469.57 lb_f
		$Q_t = \frac{1{,}281.22 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)} + 0.14 \cdot 0.1333 \cdot 45{,}758$	2,467.64 lb_f
		$Q = 45{,}758 + \max\left[2{,}467.64, 1{,}469.57\right]$	48,225.64 lb_f

Saddle reactions due to weight + wind

Wind longitudinal reaction, Q_l

Wind transverse reaction, Q_t

Wind pressure, P_w	13.7495 psf

Equations

$$V_{wt} = P_w \cdot K_d \cdot G \cdot \left(C_{f(\text{shell})} \cdot (\text{Projected shell area}) + C_{f(\text{saddle})} \cdot (\text{Projected saddle area})\right)$$

$$V_{we} = P_w \cdot K_d \cdot G \cdot \left(\frac{C_{f(\text{shell})} \cdot \pi \cdot R_o^2}{144} + C_{f(\text{saddle})} \cdot (\text{Projected saddle area})\right)$$

$Q_t = \dfrac{V_{wt} \cdot H_s}{R_o \cdot \text{Sin}(\theta \ / \ 2)}$
$Q_l = \dfrac{V_{we} \cdot H_s}{L_s}$
$Q = W + \max\left[Q_t, Q_l\right]$

Results			
Operating & New	Right Saddle	$V_{wt} = 13.75 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 109.189 + 2 \cdot 0.6632)$	657.24 lb_f
		$V_{we} = 13.75 \cdot 0.95 \cdot 0.85 \cdot \left(\dfrac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984\right)$	566.89 lb_f
		$Q_t = \dfrac{657.24 \cdot 60.25}{48.313 \cdot \text{Sin}(164 \ / \ 2)}$	827.69 lb_f
		$Q_l = \dfrac{566.89 \cdot 60.25}{252}$	135.54 lb_f
		$Q = 47{,}872 + \max\left[827.69, 135.54\right]$	48,699.69 lb_f
	Left Saddle	$V_{wt} = 13.75 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 109.189 + 2 \cdot 0.6632)$	657.24 lb_f
		$V_{we} = 13.75 \cdot 0.95 \cdot 0.85 \cdot \left(\dfrac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984\right)$	566.89 lb_f
		$Q_t = \dfrac{657.24 \cdot 60.25}{48.313 \cdot \text{Sin}(164 \ / \ 2)}$	827.69 lb_f
		$Q_l = \dfrac{566.89 \cdot 60.25}{252}$	135.54 lb_f
		$Q = 47{,}469 + \max\left[827.69, 135.54\right]$	48,296.69 lb_f
Operating & Corr	Right Saddle	$V_{wt} = 13.75 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 109.189 + 2 \cdot 0.6632)$	657.24 lb_f
		$V_{we} = 13.75 \cdot 0.95 \cdot 0.85 \cdot \left(\dfrac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984\right)$	566.89 lb_f
		$Q_t = \dfrac{657.24 \cdot 60.25}{48.313 \cdot \text{Sin}(164 \ / \ 2)}$	827.69 lb_f
		$Q_l = \dfrac{566.89 \cdot 60.25}{252}$	135.54 lb_f
		$Q = 46{,}172 + \max\left[827.69, 135.54\right]$	46,999.69 lb_f
	Left Saddle	$V_{wt} = 13.75 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 109.189 + 2 \cdot 0.6632)$	657.24 lb_f
		$V_{we} = 13.75 \cdot 0.95 \cdot 0.85 \cdot \left(\dfrac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984\right)$	566.89 lb_f
		$Q_t = \dfrac{657.24 \cdot 60.25}{48.313 \cdot \text{Sin}(164 \ / \ 2)}$	827.69 lb_f
		$Q_l = \dfrac{566.89 \cdot 60.25}{252}$	135.54 lb_f
		$Q = 45{,}758 + \max\left[827.69, 135.54\right]$	46,585.69 lb_f
		$V_{wt} = 4.54 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 109.189 + 2 \cdot 0.6632)$	216.89 lb_f
		$V_{we} = 4.54 \cdot 0.95 \cdot 0.85 \cdot \left(\dfrac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984\right)$	187.07 lb_f

Test	Right Saddle	$Q_t = \dfrac{216.89 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)}$	273.14 lb_f
		$Q_l = \dfrac{187.07 \cdot 60.25}{252}$	44.73 lb_f
		$Q = 47{,}906 + \max\ [273.14{,}44.73]$	48,179.14 lb_f
	Left Saddle	$V_{wt} = 4.54 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 109.189 + 2 \cdot 0.6632)$	216.89 lb_f
		$V_{we} = 4.54 \cdot 0.95 \cdot 0.85 \cdot \left(\dfrac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984\right)$	187.07 lb_f
		$Q_t = \dfrac{216.89 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)}$	273.14 lb_f
		$Q_l = \dfrac{187.07 \cdot 60.25}{252}$	44.73 lb_f
		$Q = 47{,}436 + \max\ [273.14{,}44.73]$	47,709.14 lb_f

Load Case 1: Seismic, Operating & New

Longitudinal stress between saddles (Seismic, Operating & New, right saddle loading and geometry govern)

$$S_1 = \pm \frac{3 \cdot K_1 \cdot Q \cdot (L \ / \ 12)}{\pi \cdot R^2 \cdot t} = \frac{3 \cdot 0.6896 \cdot 50{,}453.64 \cdot (287.5 \ / \ 12)}{\pi \cdot 48.1565^{\ 2} \cdot 0.313} = 1{,}097 \ \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48}{2 \cdot 0.313} = 3{,}308 \ \text{ psi}$$

Maximum tensile stress $S_{1t} = S_1 + S_p$ = 4,404 psi
Maximum compressive stress (shut down) $S_{1c} = S_1$ = 1,097 psi

Tensile stress is acceptable ($\leq 1.2 \cdot S \cdot E = 20{,}400 \ \text{ psi}$)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 9{,}403 \ \text{ psi}$)

Longitudinal stress at the right saddle (Seismic, Operating & New)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \ \text{ in}$$

Seismic vertical acceleration coefficient $m = 0.6667 \cdot 0.028 = 0.0187$

$$w = \frac{W_t \cdot (1 + m)}{L_e} = \frac{95{,}341 \cdot (1 + 0.0187)}{319.9173} = 303.58 \ \text{ lb}_f/\text{in}$$

Bending moment at the right saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_r \cdot A_r}{3} + \frac{A_r^2}{2} - \frac{R^2 - H_r^2}{4}\right)$$
$$= 303.58 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\ 2}}{2} - \frac{48.313^{\ 2} - 24.313^{\ 2}}{4}\right)$$
$$= 2{,}877.7 \ \text{ lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}877.7 \cdot 1}{\pi \cdot 48.1565^{\ 2} \cdot 0.313} = 1 \ \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48}{2 \cdot 0.313} = 3{,}308 \ \text{ psi}$$

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 3,309 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 1 psi

Tensile stress is acceptable ($\leq 1.2 \cdot S = 24{,}000$ psi)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 9{,}403$ psi)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 50{,}453.64}{48.1565 \cdot (0.313 + 0.313)} = 611 \text{ psi}$$

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

Tangential shear stress in the right head (Seismic, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 50{,}453.64}{48.1565 \cdot 0.313} = 1{,}221 \text{ psi}$$

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

Tangential shear stress in the shell at the wear plate edge (right saddle, Seismic, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 50{,}453.64}{48.1565 \cdot 0.313} = 869 \text{ psi}$$

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

Additional stress in the head used as a stiffener (right saddle, Seismic, Operating & New)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 50{,}453.64}{48.1565 \cdot 0.313} = 856 \text{ psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96 + 0.2 \cdot 0.313)}{2 \cdot 0.313} = 6{,}620 \text{ psi}$$

Total stress in the head $= S_{3h} + S_p = 7{,}475$ psi

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000$ psi)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$
$$= \frac{-50{,}453.64}{4 \cdot (0.313 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0061 \cdot 50{,}453.64 \cdot 48.1565}{287.5 \cdot \left(0.313^2 + 0.313^2\right)}$$
$$= -4{,}590 \text{ psi}$$

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

Circumferential stress at the right saddle wear plate horns (Seismic, Operating & New)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$
$$= \frac{-50{,}453.64}{4 \cdot 0.313 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0047 \cdot 50{,}453.64 \cdot 48.1565}{287.5 \cdot 0.313^2}$$
$$= -7{,}730 \text{ psi}$$

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000$ psi)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$
$$= \frac{0.6467 \cdot 50{,}453.64}{(0.313 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.626}\right)}$$
$$= 5{,}663 \text{ psi}$$

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350$ psi)

Saddle splitting load (right, Seismic, Operating & New)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 50{,}453.64}{11.6475} = 1{,}241 \text{ psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333 \text{ psi}\right)$

Longitudinal stress at the left saddle (Seismic, Operating & New)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \text{ in}$$

Seismic vertical acceleration coefficient $m = 0.6667 \cdot 0.028 = 0.0187$

$$w = \frac{W_t \cdot (1 + m)}{L_e} = \frac{95{,}341 \cdot (1 + 0.0187)}{319.9173} = 303.58 \text{ lb}_f/\text{in}$$

Bending moment at the left saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_l \cdot A_l}{3} + \frac{A_l^2}{2} - \frac{R^2 - H_l^2}{4}\right)$$
$$= 303.58 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^2}{2} - \frac{48.313^2 - 24.313^2}{4}\right)$$
$$= 2{,}877.7 \text{ lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}877.7 \cdot 1}{\pi \cdot 48.1565^2 \cdot 0.313} = 1 \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48}{2 \cdot 0.313} = 3{,}308 \text{ psi}$$

Maximum tensile stress S_{2t} = S_2 + S_p = 3,309 psi
Maximum compressive stress (shut down) S_{2c} = S_2 = 1 psi

Tensile stress is acceptable ($\leq 1.2 \cdot S = 24{,}000$ psi)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 9{,}403$ psi)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 50{,}028.91}{48.1565 \cdot (0.313 + 0.313)} = 605 \text{ psi}$$

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

Tangential shear stress in the left head (Seismic, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 50{,}028.91}{48.1565 \cdot 0.313} = 1{,}211 \ \text{psi}$$

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

Tangential shear stress in the shell at the wear plate edge (left saddle, Seismic, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 50{,}028.91}{48.1565 \cdot 0.313} = 862 \ \text{psi}$$

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

Additional stress in the head used as a stiffener (left saddle, Seismic, Operating & New)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 50{,}028.91}{48.1565 \cdot 0.313} = 848 \ \text{psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96 + 0.2 \cdot 0.313)}{2 \cdot 0.313} = 6{,}620 \ \text{psi}$$

Total stress in the head $= S_{3h} + S_p = 7{,}468 \ \text{psi}$

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000 \ \text{psi}$)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$
$$= \frac{-50{,}028.91}{4 \cdot (0.313 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0061 \cdot 50{,}028.91 \cdot 48.1565}{287.5 \cdot \left(0.313^2 + 0.313^2\right)}$$
$$= -4{,}551 \ \text{psi}$$

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

Circumferential stress at the left saddle wear plate horns (Seismic, Operating & New)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$
$$= \frac{-50{,}028.91}{4 \cdot 0.313 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0047 \cdot 50{,}028.91 \cdot 48.1565}{287.5 \cdot 0.313^2}$$
$$= -7{,}665 \ \text{psi}$$

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000 \ \text{psi}$)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$
$$= \frac{0.6467 \cdot 50{,}028.91}{(0.313 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.626}\right)}$$
$$= 5{,}615 \ \text{psi}$$

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350 \ \text{psi}$)

Saddle splitting load (left, Seismic, Operating & New)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 50{,}028.91}{11.6475} = 1{,}231 \quad \text{psi}$$

Stress in saddle is acceptable $\left(\le \frac{2}{3} \cdot S_s = 13{,}333 \quad \text{psi} \right)$

Load Case 2: Seismic, Operating & Corr

Longitudinal stress between saddles (Seismic, Operating & Corr, right saddle loading and geometry govern)

$$S_1 = \pm \frac{3 \cdot K_1 \cdot Q \cdot (L \ / \ 12)}{\pi \cdot R^2 \cdot t} = \frac{3 \cdot 0.6896 \cdot 48{,}661.96 \cdot (287.5 \ / \ 12)}{\pi \cdot 48.219^{\ 2} \cdot 0.188} = 1{,}756 \quad \text{psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48.125}{2 \cdot 0.188} = 5{,}522 \quad \text{psi}$$

Maximum tensile stress S_{1t} = S_1 + S_p = 7,278 psi
Maximum compressive stress (shut down) S_{1c} = S_1 = 1,756 psi

Tensile stress is acceptable ($\le 1.2 \cdot S \cdot E = 20{,}400 \quad \text{psi}$)

Compressive stress is acceptable ($\le 1.2 \cdot S_c = 7{,}679 \quad \text{psi}$)

Longitudinal stress at the right saddle (Seismic, Operating & Corr)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \quad \text{in}$$

Seismic vertical acceleration coefficient $m = 0.6667 \cdot 0.028 = 0.0187$

$$w = \frac{W_t \cdot (1 + m)}{L_e} = \frac{91{,}930 \cdot (1 + 0.0187)}{319.9173} = 292.72 \quad \text{lb}_f/\text{in}$$

Bending moment at the right saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_r \cdot A_r}{3} + \frac{A_r^2}{2} - \frac{R^2 - H_r^2}{4} \right)$$

$$= 292.72 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\ 2}}{2} - \frac{48.313^{\ 2} - 24.313^{\ 2}}{4} \right)$$

$$= 2{,}774.7 \quad \text{lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}774.7 \cdot 1}{\pi \cdot 48.219^{\ 2} \cdot 0.188} = 2 \quad \text{psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48.125}{2 \cdot 0.188} = 5{,}522 \quad \text{psi}$$

Maximum tensile stress S_{2t} = S_2 + S_p = 5,524 psi
Maximum compressive stress (shut down) S_{2c} = S_2 = 2 psi

Tensile stress is acceptable ($\le 1.2 \cdot S = 24{,}000 \quad \text{psi}$)

Compressive stress is acceptable ($\le 1.2 \cdot S_c = 7{,}679 \quad \text{psi}$)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 48{,}661.96}{48.219 \cdot (0.188 + 0.313)} = 735 \quad \text{psi}$$

Tangential shear stress is acceptable ($\le 0.8 \cdot S = 16{,}000 \quad \text{psi}$)

Tangential shear stress in the right head (Seismic, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 48{,}661.96}{48.219 \cdot 0.188} = 1{,}958 \text{ psi}$$

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

Tangential shear stress in the shell at the wear plate edge (right saddle, Seismic, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 48{,}661.96}{48.219 \cdot 0.188} = 1{,}394 \text{ psi}$$

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

Additional stress in the head used as a stiffener (right saddle, Seismic, Operating & Corr)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 48{,}661.96}{48.219 \cdot 0.188} = 1{,}372 \text{ psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96.25 + 0.2 \cdot 0.188)}{2 \cdot 0.188} = 11{,}048 \text{ psi}$$

Total stress in the head $= S_{3h} + S_p = 12{,}420$ psi

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000$ psi)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$

$$= \frac{-48{,}661.96}{4 \cdot (0.188 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0061 \cdot 48{,}661.96 \cdot 48.219}{287.5 \cdot \left(0.188^2 + 0.313^2\right)}$$

$$= -6{,}393 \text{ psi}$$

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

Circumferential stress at the right saddle wear plate horns (Seismic, Operating & Corr)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$

$$= \frac{-48{,}661.96}{4 \cdot 0.188 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0047 \cdot 48{,}661.96 \cdot 48.219}{287.5 \cdot 0.188^2}$$

$$= -18{,}118 \text{ psi}$$

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000$ psi)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$

$$= \frac{0.6467 \cdot 48{,}661.96}{(0.188 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.501}\right)}$$

$$= 7{,}568 \text{ psi}$$

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350$ psi)

Saddle splitting load (right, Seismic, Operating & Corr)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 48{,}661.96}{11.6475} = 1{,}197 \text{ psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333 \text{ psi} \right)$

Longitudinal stress at the left saddle (Seismic, Operating & Corr)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \text{ in}$$

Seismic vertical acceleration coefficient $m = 0.6667 \cdot 0.028 = 0.0187$

$$w = \frac{W_t \cdot (1+m)}{L_e} = \frac{91{,}930 \cdot (1+0.0187)}{319.9173} = 292.72 \text{ lb}_f/\text{in}$$

Bending moment at the left saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_l \cdot A_l}{3} + \frac{A_l^2}{2} - \frac{R^2 - H_l^2}{4} \right)$$

$$= 292.72 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\ 2}}{2} - \frac{48.313^{\ 2} - 24.313^{\ 2}}{4} \right)$$

$$= 2{,}774.7 \text{ lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}774.7 \cdot 1}{\pi \cdot 48.219^{\ 2} \cdot 0.188} = 2 \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48.125}{2 \cdot 0.188} = 5{,}522 \text{ psi}$$

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 5,524 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 2 psi

Tensile stress is acceptable ($\leq 1.2 \cdot S = 24{,}000$ psi)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 7{,}679$ psi)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 48{,}225.64}{48.219 \cdot (0.188 + 0.313)} = 728 \text{ psi}$$

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

Tangential shear stress in the left head (Seismic, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 48{,}225.64}{48.219 \cdot 0.188} = 1{,}941 \text{ psi}$$

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

Tangential shear stress in the shell at the wear plate edge (left saddle, Seismic, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 48{,}225.64}{48.219 \cdot 0.188} = 1{,}382 \text{ psi}$$

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

Additional stress in the head used as a stiffener (left saddle, Seismic, Operating & Corr)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 48{,}225.64}{48.219 \cdot 0.188} = 1{,}360 \text{ psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96.25 + 0.2 \cdot 0.188)}{2 \cdot 0.188} = 11{,}048 \text{ psi}$$

Total stress in the head $= S_{3h} + S_p = 12{,}408 \text{ psi}$

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000 \text{ psi}$)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$

$$= \frac{-48{,}225.64}{4 \cdot (0.188 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0061 \cdot 48{,}225.64 \cdot 48.219}{287.5 \cdot \left(0.188^2 + 0.313^2\right)}$$

$= -6{,}336$ psi

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

Circumferential stress at the left saddle wear plate horns (Seismic, Operating & Corr)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$

$$= \frac{-48{,}225.64}{4 \cdot 0.188 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0047 \cdot 48{,}225.64 \cdot 48.219}{287.5 \cdot 0.188^2}$$

$= -17{,}956$ psi

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000 \text{ psi}$)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$

$$= \frac{0.6467 \cdot 48{,}225.64}{(0.188 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.501}\right)}$$

$= 7{,}500$ psi

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350 \text{ psi}$)

Saddle splitting load (left, Seismic, Operating & Corr)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 48{,}225.64}{11.6475} = 1{,}186 \text{ psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333 \text{ psi}\right)$

Load Case 3: Wind, Operating & New

Longitudinal stress between saddles (Wind, Operating & New, right saddle loading and geometry govern)

$$S_1 = \pm \frac{3 \cdot K_1 \cdot Q \cdot (L \;/\; 12)}{\pi \cdot R^2 \cdot t} = \frac{3 \cdot 0.6896 \cdot 48{,}699.69 \cdot (287.5 \;/\; 12)}{\pi \cdot 48.1565^2 \cdot 0.313} = 1{,}059 \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48}{2 \cdot 0.313} = 3{,}308 \text{ psi}$$

Maximum tensile stress $S_{1t} = S_1 + S_p$ = 4,366 psi
Maximum compressive stress (shut down) $S_{1c} = S_1$ = 1,059 psi

Tensile stress is acceptable ($\leq 1.2 \cdot S \cdot E = 20{,}400 \text{ psi}$)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 9{,}403 \text{ psi}$)

Longitudinal stress at the right saddle (Wind, Operating & New)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \text{ in}$$

$$w = \frac{W_t}{L_e} = \frac{95{,}341}{319.9173} = 298.02 \text{ lb}_f/\text{in}$$

Bending moment at the right saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_r \cdot A_r}{3} + \frac{A_r^2}{2} - \frac{R^2 - H_r^2}{4}\right)$$
$$= 298.02 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\,2}}{2} - \frac{48.313^{\,2} - 24.313^{\,2}}{4}\right)$$
$$= 2{,}824.9 \text{ lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}824.9 \cdot 1}{\pi \cdot 48.1565^{\,2} \cdot 0.313} = 1 \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48}{2 \cdot 0.313} = 3{,}308 \text{ psi}$$

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 3,309 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 1 psi

Tensile stress is acceptable ($\leq 1.2 \cdot S = 24{,}000 \text{ psi}$)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 9{,}403 \text{ psi}$)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 48{,}699.69}{48.1565 \cdot (0.313 + 0.313)} = 589 \text{ psi}$$

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

Tangential shear stress in the right head (Wind, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 48{,}699.69}{48.1565 \cdot 0.313} = 1{,}179 \text{ psi}$$

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

Tangential shear stress in the shell at the wear plate edge (right saddle, Wind, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 48{,}699.69}{48.1565 \cdot 0.313} = 839 \text{ psi}$$

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

Additional stress in the head used as a stiffener (right saddle, Wind, Operating & New)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 48{,}699.69}{48.1565 \cdot 0.313} = 826 \ \text{psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96 + 0.2 \cdot 0.313)}{2 \cdot 0.313} = 6{,}620 \ \text{psi}$$

Total stress in the head $= S_{3h} + S_p = 7{,}445 \ \text{psi}$

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000 \ \text{psi}$)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$

$$= \frac{-48{,}699.69}{4 \cdot (0.313 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0061 \cdot 48{,}699.69 \cdot 48.1565}{287.5 \cdot \left(0.313^{\,2} + 0.313^{\,2}\right)}$$

$= \underline{-4{,}430} \ \text{psi}$

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

Circumferential stress at the right saddle wear plate horns (Wind, Operating & New)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$

$$= \frac{-48{,}699.69}{4 \cdot 0.313 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0047 \cdot 48{,}699.69 \cdot 48.1565}{287.5 \cdot 0.313^{\,2}}$$

$= \underline{-7{,}461} \ \text{psi}$

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000 \ \text{psi}$)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$

$$= \frac{0.6467 \cdot 48{,}699.69}{(0.313 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.626}\right)}$$

$= \underline{5{,}466} \ \text{psi}$

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350 \ \text{psi}$)

Saddle splitting load (right, Wind, Operating & New)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 48{,}699.69}{11.6475} = \underline{1{,}198} \ \text{psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333 \ \text{psi}\right)$

Longitudinal stress at the left saddle (Wind, Operating & New)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \ \text{in}$$

$$w = \frac{W_t}{L_e} = \frac{95{,}341}{319.9173} = 298.02 \ \text{lb}_f/\text{in}$$

Bending moment at the left saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_l \cdot A_l}{3} + \frac{A_l^2}{2} - \frac{R^2 - H_l^2}{4} \right)$$

$$= 298.02 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\ 2}}{2} - \frac{48.313^{\ 2} - 24.313^{\ 2}}{4} \right)$$

$$= 2{,}824.9 \ \ \mathrm{lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}824.9 \cdot 1}{\pi \cdot 48.1565^{\ 2} \cdot 0.313} = 1 \ \ \mathrm{psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48}{2 \cdot 0.313} = 3{,}308 \ \ \mathrm{psi}$$

Maximum tensile stress S_{2t} = S_2 + S_p = 3,309 psi
Maximum compressive stress (shut down) S_{2c} = S_2 = 1 psi

Tensile stress is acceptable ($\leq 1.2 \cdot S = 24{,}000 \ \ \mathrm{psi}$)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 9{,}403 \ \ \mathrm{psi}$)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 48{,}296.69}{48.1565 \cdot (0.313 + 0.313)} = 584 \ \ \mathrm{psi}$$

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

Tangential shear stress in the left head (Wind, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 48{,}296.69}{48.1565 \cdot 0.313} = 1{,}169 \ \ \mathrm{psi}$$

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

Tangential shear stress in the shell at the wear plate edge (left saddle, Wind, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 48{,}296.69}{48.1565 \cdot 0.313} = 832 \ \ \mathrm{psi}$$

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

Additional stress in the head used as a stiffener (left saddle, Wind, Operating & New)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 48{,}296.69}{48.1565 \cdot 0.313} = 819 \ \ \mathrm{psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96 + 0.2 \cdot 0.313)}{2 \cdot 0.313} = 6{,}620 \ \ \mathrm{psi}$$

Total stress in the head $= S_{3h} + S_p = 7{,}439 \ \ \mathrm{psi}$

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000 \ \ \mathrm{psi}$)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$

$$= \frac{-48{,}296.69}{4 \cdot (0.313 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0061 \cdot 48{,}296.69 \cdot 48.1565}{287.5 \cdot \left(0.313^{\ 2} + 0.313^{\ 2}\right)}$$

$= \underline{-4,393}$ psi

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

Circumferential stress at the left saddle wear plate horns (Wind, Operating & New)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$

$$= \frac{-48{,}296.69}{4 \cdot 0.313 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0047 \cdot 48{,}296.69 \cdot 48.1565}{287.5 \cdot 0.313^2}$$

$= \underline{-7,400}$ psi

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000$ psi)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$

$$= \frac{0.6467 \cdot 48{,}296.69}{(0.313 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.626}\right)}$$

$= \underline{5,421}$ psi

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350$ psi)

Saddle splitting load (left, Wind, Operating & New)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 48{,}296.69}{11.6475} = \underline{1,188} \text{ psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333 \text{ psi}\right)$

Load Case 4: Wind, Operating & Corr

Longitudinal stress between saddles (Wind, Operating & Corr, right saddle loading and geometry govern)

$$S_1 = \pm \frac{3 \cdot K_1 \cdot Q \cdot (L \ / \ 12)}{\pi \cdot R^2 \cdot t} = \frac{3 \cdot 0.6896 \cdot 46{,}999.69 \cdot (287.5 \ / \ 12)}{\pi \cdot 48.219^2 \cdot 0.188} = 1{,}696 \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48.125}{2 \cdot 0.188} = 5{,}522 \text{ psi}$$

Maximum tensile stress S_{1t} = S_1 + S_p = 7,218 psi
Maximum compressive stress (shut down) S_{1c} = S_1 = 1,696 psi

Tensile stress is acceptable ($\leq 1.2 \cdot S \cdot E = 20{,}400$ psi)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 7{,}679$ psi)

Longitudinal stress at the right saddle (Wind, Operating & Corr)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \text{ in}$$

$$w = \frac{W_t}{L_e} = \frac{91{,}930}{319.9173} = 287.36 \text{ lb}_f/\text{in}$$

Bending moment at the right saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_r \cdot A_r}{3} + \frac{A_r^2}{2} - \frac{R^2 - H_r^2}{4} \right)$$

$$= 287.36 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\ 2}}{2} - \frac{48.313^{\ 2} - 24.313^{\ 2}}{4} \right)$$

$$= 2{,}723.9 \quad \mathrm{lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}723.9 \cdot 1}{\pi \cdot 48.219^{\ 2} \cdot 0.188} = 2 \quad \mathrm{psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48.125}{2 \cdot 0.188} = 5{,}522 \quad \mathrm{psi}$$

Maximum tensile stress S_{2t} = S_2 + S_p = 5,524 psi
Maximum compressive stress (shut down) S_{2c} = S_2 = 2 psi

Tensile stress is acceptable ($\leq 1.2 \cdot S = 24{,}000 \quad \mathrm{psi}$)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 7{,}679 \quad \mathrm{psi}$)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 46{,}999.69}{48.219 \cdot (0.188 + 0.313)} = 710 \quad \mathrm{psi}$$

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

Tangential shear stress in the right head (Wind, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 46{,}999.69}{48.219 \cdot 0.188} = 1{,}891 \quad \mathrm{psi}$$

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

Tangential shear stress in the shell at the wear plate edge (right saddle, Wind, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 46{,}999.69}{48.219 \cdot 0.188} = 1{,}346 \quad \mathrm{psi}$$

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

Additional stress in the head used as a stiffener (right saddle, Wind, Operating & Corr)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 46{,}999.69}{48.219 \cdot 0.188} = 1{,}325 \quad \mathrm{psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96.25 + 0.2 \cdot 0.188)}{2 \cdot 0.188} = 11{,}048 \quad \mathrm{psi}$$

Total stress in the head $= S_{3h} + S_p = 12{,}373 \quad \mathrm{psi}$

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000 \quad \mathrm{psi}$)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$

$$= \frac{-46{,}999.69}{4 \cdot (0.188 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0061 \cdot 46{,}999.69 \cdot 48.219}{287.5 \cdot \left(0.188^{\ 2} + 0.313^{\ 2}\right)}$$

$= \underline{-6{,}175}$ psi

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

Circumferential stress at the right saddle wear plate horns (Wind, Operating & Corr)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$

$$= \frac{-46{,}999.69}{4 \cdot 0.188 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0047 \cdot 46{,}999.69 \cdot 48.219}{287.5 \cdot 0.188^{2}}$$

$= \underline{-17{,}499}$ psi

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000$ psi)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$

$$= \frac{0.6467 \cdot 46{,}999.69}{(0.188 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.501}\right)}$$

$= \underline{7{,}309}$ psi

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350$ psi)

Saddle splitting load (right, Wind, Operating & Corr)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 46{,}999.69}{11.6475} = \underline{1{,}156} \text{ psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333 \text{ psi}\right)$

Longitudinal stress at the left saddle (Wind, Operating & Corr)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \text{ in}$$

$$w = \frac{W_t}{L_e} = \frac{91{,}930}{319.9173} = 287.36 \text{ lb}_f/\text{in}$$

Bending moment at the left saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_l \cdot A_l}{3} + \frac{A_l^2}{2} - \frac{R^2 - H_l^2}{4}\right)$$

$$= 287.36 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{2}}{2} - \frac{48.313^{2} - 24.313^{2}}{4}\right)$$

$= 2{,}723.9$ lb$_f$-in

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}723.9 \cdot 1}{\pi \cdot 48.219^{2} \cdot 0.188} = 2 \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48.125}{2 \cdot 0.188} = 5{,}522 \text{ psi}$$

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 5,524 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 2 psi

Tensile stress is acceptable ($\leq 1.2 \cdot S = 24{,}000$ psi)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 7{,}679$ psi)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 46{,}585.69}{48.219 \cdot (0.188 + 0.313)} = 703 \text{ psi}$$

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

Tangential shear stress in the left head (Wind, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 46{,}585.69}{48.219 \cdot 0.188} = 1{,}875 \text{ psi}$$

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

Tangential shear stress in the shell at the wear plate edge (left saddle, Wind, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 46{,}585.69}{48.219 \cdot 0.188} = 1{,}335 \text{ psi}$$

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

Additional stress in the head used as a stiffener (left saddle, Wind, Operating & Corr)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 46{,}585.69}{48.219 \cdot 0.188} = 1{,}314 \text{ psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96.25 + 0.2 \cdot 0.188)}{2 \cdot 0.188} = 11{,}048 \text{ psi}$$

Total stress in the head $= S_{3h} + S_p = 12{,}361$ psi

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000$ psi)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$
$$= \frac{-46{,}585.69}{4 \cdot (0.188 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0061 \cdot 46{,}585.69 \cdot 48.219}{287.5 \cdot \left(0.188^2 + 0.313^2\right)}$$
$$= -6{,}120 \text{ psi}$$

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

Circumferential stress at the left saddle wear plate horns (Wind, Operating & Corr)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$
$$= \frac{-46{,}585.69}{4 \cdot 0.188 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0047 \cdot 46{,}585.69 \cdot 48.219}{287.5 \cdot 0.188^2}$$
$$= -17{,}345 \text{ psi}$$

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000$ psi)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$

$$= \frac{0.6467 \cdot 46{,}585.69}{(0.188 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.501}\right)}$$

$$= \underline{7{,}245} \;\; \text{psi}$$

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350 \;\; \text{psi}$)

Saddle splitting load (left, Wind, Operating & Corr)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 46{,}585.69}{11.6475} = \underline{1{,}146} \;\; \text{psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333 \;\; \text{psi}\right)$

Load Case 5: Wind, Test

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

$$S_1 = \pm \frac{3 \cdot K_1 \cdot Q \cdot (L \;\; / \;\; 12)}{\pi \cdot R^2 \cdot t} = \frac{3 \cdot 0.6896 \cdot 48{,}179.14 \cdot (287.5 \;\; / \;\; 12)}{\pi \cdot 48.1565^{\;2} \cdot 0.313} = 1{,}047 \;\; \text{psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{54.97 \cdot 48}{2 \cdot 0.313} = 4{,}215 \;\; \text{psi}$$

Maximum tensile stress S_{1t} = S_1 + S_p = 5,262 psi
Maximum compressive stress (shut down) S_{1c} = S_1 = 1,047 psi

Tensile stress is acceptable ($\leq 0.9 \cdot S_y \cdot E = 22{,}950 \;\; \text{psi}$)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 9{,}843 \;\; \text{psi}$)

Longitudinal stress at the right saddle (Wind, Test)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \;\; \text{in}$$

$$w = \frac{W_t}{L_e} = \frac{95{,}342}{319.9173} = 298.02 \;\; \text{lb}_f/\text{in}$$

Bending moment at the right saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_r \cdot A_r}{3} + \frac{A_r^2}{2} - \frac{R^2 - H_r^2}{4}\right)$$

$$= 298.02 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\;2}}{2} - \frac{48.313^{\;2} - 24.313^{\;2}}{4}\right)$$

$$= 2{,}825 \;\; \text{lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}825 \cdot 1}{\pi \cdot 48.1565^{\;2} \cdot 0.313} = 1 \;\; \text{psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{54.97 \cdot 48}{2 \cdot 0.313} = 4{,}215 \;\; \text{psi}$$

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 4,216 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 1 psi

Tensile stress is acceptable ($\leq 0.9 \cdot S_y = 27{,}000$ psi)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 9{,}843$ psi)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 48{,}179.14}{48.1565 \cdot (0.313 + 0.313)} = 583 \text{ psi}$$

Tangential shear stress is acceptable ($\leq 0.8 \cdot (0.9 \cdot S_y) = 21{,}600$ psi)

Tangential shear stress in the right head (Wind, Test)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 48{,}179.14}{48.1565 \cdot 0.313} = 1{,}166 \text{ psi}$$

Tangential shear stress is acceptable ($\leq 0.8 \cdot (0.9 \cdot S_y) = 21{,}600$ psi)

Tangential shear stress in the shell at the wear plate edge (right saddle, Wind, Test)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 48{,}179.14}{48.1565 \cdot 0.313} = 830 \text{ psi}$$

Tangential shear stress is acceptable ($\leq 0.8 \cdot (0.9 \cdot S_y) = 21{,}600$ psi)

Additional stress in the head used as a stiffener (right saddle, Wind, Test)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 48{,}179.14}{48.1565 \cdot 0.313} = 817 \text{ psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{54.97 \cdot (1 \cdot 96 + 0.2 \cdot 0.313)}{2 \cdot 0.313} = 8{,}435 \text{ psi}$$

Total stress in the head $= S_{3h} + S_p = 9{,}252$ psi

Stress in the head is acceptable ($\leq 0.9 \cdot S_y = 27{,}000$ psi)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$
$$= \frac{-48{,}179.14}{4 \cdot (0.313 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0061 \cdot 48{,}179.14 \cdot 48.1565}{287.5 \cdot \left(0.313^2 + 0.313^2\right)}$$
$$= -4{,}383 \text{ psi}$$

Circumferential stress at saddle horns is acceptable ($\leq 0.9 \cdot S_y = 27{,}000$ psi)

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

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$
$$= \frac{-48{,}179.14}{4 \cdot 0.313 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0047 \cdot 48{,}179.14 \cdot 48.1565}{287.5 \cdot 0.313^2}$$
$$= -7{,}382 \text{ psi}$$

Circumferential stress at wear plate horns is acceptable ($\leq 0.9 \cdot S_y = 27{,}000$ psi)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$

$$= \frac{0.6467 \cdot 48{,}179.14}{(0.313 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.626}\right)}$$

$$= \underline{5{,}408} \ \ \text{psi}$$

Ring compression in shell is acceptable ($\leq 0.9 \cdot S_y = 27{,}000$ psi)

Saddle splitting load (right, Wind, Test)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 48{,}179.14}{11.6475} = \underline{1{,}185} \ \ \text{psi}$$

Stress in saddle is acceptable ($\leq 0.9 \cdot S_y = 34{,}200$ psi)

Longitudinal stress at the left saddle (Wind, Test)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \ \ \text{in}$$

$$w = \frac{W_t}{L_e} = \frac{95{,}342}{319.9173} = 298.02 \ \ \text{lb}_f/\text{in}$$

Bending moment at the left saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_l \cdot A_l}{3} + \frac{A_l^2}{2} - \frac{R^2 - H_l^2}{4}\right)$$

$$= 298.02 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\ 2}}{2} - \frac{48.313^{\ 2} - 24.313^{\ 2}}{4}\right)$$

$$= 2{,}825 \ \ \text{lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}825 \cdot 1}{\pi \cdot 48.1565^{\ 2} \cdot 0.313} = 1 \ \ \text{psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{54.97 \cdot 48}{2 \cdot 0.313} = 4{,}215 \ \ \text{psi}$$

Maximum tensile stress S_{2t} = S_2 + S_p = 4,216 psi
Maximum compressive stress (shut down) S_{2c} = S_2 = 1 psi

Tensile stress is acceptable ($\leq 0.9 \cdot S_y = 27{,}000$ psi)

Compressive stress is acceptable ($\leq 1.2 \cdot S_c = 9{,}843$ psi)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 47{,}709.14}{48.1565 \cdot (0.313 + 0.313)} = \underline{577} \ \ \text{psi}$$

Tangential shear stress is acceptable ($\leq 0.8 \cdot (0.9 \cdot S_y) = 21{,}600$ psi)

Tangential shear stress in the left head (Wind, Test)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 47{,}709.14}{48.1565 \cdot 0.313} = \underline{1{,}155} \ \ \text{psi}$$

Tangential shear stress is acceptable ($\leq 0.8 \cdot (0.9 \cdot S_y) = 21{,}600$ psi)

Tangential shear stress in the shell at the wear plate edge (left saddle, Wind, Test)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 47{,}709.14}{48.1565 \cdot 0.313} = \underline{822} \text{ psi}$$

Tangential shear stress is acceptable ($\leq 0.8 \cdot (0.9 \cdot S_y) = 21{,}600$ psi)

Additional stress in the head used as a stiffener (left saddle, Wind, Test)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 47{,}709.14}{48.1565 \cdot 0.313} = 809 \text{ psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{54.97 \cdot (1 \cdot 96 + 0.2 \cdot 0.313)}{2 \cdot 0.313} = 8{,}435 \text{ psi}$$

Total stress in the head $= S_{3h} + S_p = 9{,}244$ psi

Stress in the head is acceptable ($\leq 0.9 \cdot S_y = 27{,}000$ psi)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$
$$= \frac{-47{,}709.14}{4 \cdot (0.313 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0061 \cdot 47{,}709.14 \cdot 48.1565}{287.5 \cdot \left(0.313^{\ 2} + 0.313^{\ 2}\right)}$$
$$= \underline{-4{,}340} \text{ psi}$$

Circumferential stress at saddle horns is acceptable ($\leq 0.9 \cdot S_y = 27{,}000$ psi)

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

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$
$$= \frac{-47{,}709.14}{4 \cdot 0.313 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0047 \cdot 47{,}709.14 \cdot 48.1565}{287.5 \cdot 0.313^{\ 2}}$$
$$= \underline{-7{,}310} \text{ psi}$$

Circumferential stress at wear plate horns is acceptable ($\leq 0.9 \cdot S_y = 27{,}000$ psi)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$
$$= \frac{0.6467 \cdot 47{,}709.14}{(0.313 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.626}\right)}$$
$$= \underline{5{,}355} \text{ psi}$$

Ring compression in shell is acceptable ($\leq 0.9 \cdot S_y = 27{,}000$ psi)

Saddle splitting load (left, Wind, Test)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 47{,}709.14}{11.6475} = \underline{1{,}174} \text{ psi}$$

Stress in saddle is acceptable ($\leq 0.9 \cdot S_y = 34{,}200$ psi)

Load Case 6: Weight, Operating & New

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

$$S_1 = \pm \frac{3 \cdot K_1 \cdot Q \cdot (L \; / \; 12)}{\pi \cdot R^2 \cdot t} = \frac{3 \cdot 0.6896 \cdot 47{,}872 \cdot (287.5 \; / \; 12)}{\pi \cdot 48.1565^{\;2} \cdot 0.313} = 1{,}041 \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48}{2 \cdot 0.313} = 3{,}308 \text{ psi}$$

Maximum tensile stress S_{1t} = S_1 + S_p = 4,348 psi
Maximum compressive stress (shut down) S_{1c} = S_1 = 1,041 psi

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

Compressive stress is acceptable ($\leq S_c = 7{,}836$ psi)

Longitudinal stress at the right saddle (Weight, Operating & New)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \text{ in}$$

$$w = \frac{W_t}{L_e} = \frac{95{,}341}{319.9173} = 298.02 \text{ lb}_f\text{/in}$$

Bending moment at the right saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_r \cdot A_r}{3} + \frac{A_r^2}{2} - \frac{R^2 - H_r^2}{4} \right)$$
$$= 298.02 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\;2}}{2} - \frac{48.313^{\;2} - 24.313^{\;2}}{4} \right)$$
$$= 2{,}824.9 \text{ lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}824.9 \cdot 1}{\pi \cdot 48.1565^{\;2} \cdot 0.313} = 1 \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48}{2 \cdot 0.313} = 3{,}308 \text{ psi}$$

Maximum tensile stress S_{2t} = S_2 + S_p = 3,309 psi
Maximum compressive stress (shut down) S_{2c} = S_2 = 1 psi

Tensile stress is acceptable ($\leq S = 20{,}000$ psi)

Compressive stress is acceptable ($\leq S_c = 7{,}836$ psi)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 47{,}872}{48.1565 \cdot (0.313 + 0.313)} = 579 \text{ psi}$$

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

Tangential shear stress in the right head (Weight, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 47{,}872}{48.1565 \cdot 0.313} = 1{,}159 \text{ psi}$$

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

Tangential shear stress in the shell at the wear plate edge (right saddle, Weight, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 47{,}872}{48.1565 \cdot 0.313} = 825 \text{ psi}$$

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

Additional stress in the head used as a stiffener (right saddle, Weight, Operating & New)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 47{,}872}{48.1565 \cdot 0.313} = 812 \text{ psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96 + 0.2 \cdot 0.313)}{2 \cdot 0.313} = 6{,}620 \text{ psi}$$

Total stress in the head $= S_{3h} + S_p = 7{,}431$ psi

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000$ psi)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$

$$= \frac{-47{,}872}{4 \cdot (0.313 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0061 \cdot 47{,}872 \cdot 48.1565}{287.5 \cdot \left(0.313^2 + 0.313^2\right)}$$

$$= -4{,}355 \text{ psi}$$

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

Circumferential stress at the right saddle wear plate horns (Weight, Operating & New)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$

$$= \frac{-47{,}872}{4 \cdot 0.313 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0047 \cdot 47{,}872 \cdot 48.1565}{287.5 \cdot 0.313^2}$$

$$= -7{,}335 \text{ psi}$$

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000$ psi)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$

$$= \frac{0.6467 \cdot 47{,}872}{(0.313 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.626}\right)}$$

$$= 5{,}373 \text{ psi}$$

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350$ psi)

Saddle splitting load (right, Weight, Operating & New)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 47{,}872}{11.6475} = 1{,}178 \text{ psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333 \ \ \text{psi}\right)$

Longitudinal stress at the left saddle (Weight, Operating & New)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \ \ \text{in}$$

$$w = \frac{W_t}{L_e} = \frac{95{,}341}{319.9173} = 298.02 \ \ \text{lb}_f/\text{in}$$

Bending moment at the left saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_l \cdot A_l}{3} + \frac{A_l^2}{2} - \frac{R^2 - H_l^2}{4}\right)$$

$$= 298.02 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\ 2}}{2} - \frac{48.313^{\ 2} - 24.313^{\ 2}}{4}\right)$$

$$= 2{,}824.9 \ \ \text{lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}824.9 \cdot 1}{\pi \cdot 48.1565^{\ 2} \cdot 0.313} = 1 \ \ \text{psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48}{2 \cdot 0.313} = 3{,}308 \ \ \text{psi}$$

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 3,309 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 1 psi

Tensile stress is acceptable $(\leq S = 20{,}000 \ \ \text{psi})$

Compressive stress is acceptable $(\leq S_c = 7{,}836 \ \ \text{psi})$

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 47{,}469}{48.1565 \cdot (0.313 + 0.313)} = 574 \ \ \text{psi}$$

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

Tangential shear stress in the left head (Weight, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 47{,}469}{48.1565 \cdot 0.313} = 1{,}149 \ \ \text{psi}$$

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

Tangential shear stress in the shell at the wear plate edge (left saddle, Weight, Operating & New)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 47{,}469}{48.1565 \cdot 0.313} = 818 \ \ \text{psi}$$

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

Additional stress in the head used as a stiffener (left saddle, Weight, Operating & New)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 47{,}469}{48.1565 \cdot 0.313} = 805 \ \ \text{psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96 + 0.2 \cdot 0.313)}{2 \cdot 0.313} = 6{,}620 \ \ \text{psi}$$

Total stress in the head $= S_{3h} + S_p = 7{,}425 \ \ \text{psi}$

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000$ psi)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$

$$= \frac{-47{,}469}{4 \cdot (0.313 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0061 \cdot 47{,}469 \cdot 48.1565}{287.5 \cdot \left(0.313^2 + 0.313^2\right)}$$

$= -4{,}318$ psi

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

Circumferential stress at the left saddle wear plate horns (Weight, Operating & New)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$

$$= \frac{-47{,}469}{4 \cdot 0.313 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.313}\right)} - \frac{12 \cdot 0.0047 \cdot 47{,}469 \cdot 48.1565}{287.5 \cdot 0.313^2}$$

$= -7{,}273$ psi

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000$ psi)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$

$$= \frac{0.6467 \cdot 47{,}469}{(0.313 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.626}\right)}$$

$= 5{,}328$ psi

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350$ psi)

Saddle splitting load (left, Weight, Operating & New)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 47{,}469}{11.6475} = 1{,}168 \text{ psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333 \text{ psi} \right)$

Load Case 7: Weight, Operating & Corr

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

$$S_1 = \pm \frac{3 \cdot K_1 \cdot Q \cdot (L \;/\; 12)}{\pi \cdot R^2 \cdot t} = \frac{3 \cdot 0.6896 \cdot 46{,}172 \cdot (287.5 \;/\; 12)}{\pi \cdot 48.219^2 \cdot 0.188} = 1{,}667 \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48.125}{2 \cdot 0.188} = 5{,}522 \text{ psi}$$

Maximum tensile stress $S_{1t} = S_1 + S_p$ = 7,188 psi
Maximum compressive stress (shut down) $S_{1c} = S_1$ = 1,667 psi

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

Compressive stress is acceptable ($\leq S_c = 6{,}399 \text{ psi}$)

Longitudinal stress at the right saddle (Weight, Operating & Corr)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \text{ in}$$

$$w = \frac{W_t}{L_e} = \frac{91{,}930}{319.9173} = 287.36 \text{ lb}_f/\text{in}$$

Bending moment at the right saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_r \cdot A_r}{3} + \frac{A_r^2}{2} - \frac{R^2 - H_r^2}{4} \right)$$

$$= 287.36 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\ 2}}{2} - \frac{48.313^{\ 2} - 24.313^{\ 2}}{4} \right)$$

$$= 2{,}723.9 \text{ lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}723.9 \cdot 1}{\pi \cdot 48.219^{\ 2} \cdot 0.188} = 2 \text{ psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48.125}{2 \cdot 0.188} = 5{,}522 \text{ psi}$$

Maximum tensile stress S_{2t} = S_2 + S_p = 5,524 psi
Maximum compressive stress (shut down) S_{2c} = S_2 = 2 psi

Tensile stress is acceptable ($\leq S = 20{,}000 \text{ psi}$)

Compressive stress is acceptable ($\leq S_c = 6{,}399 \text{ psi}$)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 46{,}172}{48.219 \cdot (0.188 + 0.313)} = 697 \text{ psi}$$

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

Tangential shear stress in the right head (Weight, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 46{,}172}{48.219 \cdot 0.188} = 1{,}858 \text{ psi}$$

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

Tangential shear stress in the shell at the wear plate edge (right saddle, Weight, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 46{,}172}{48.219 \cdot 0.188} = 1{,}323 \text{ psi}$$

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

Additional stress in the head used as a stiffener (right saddle, Weight, Operating & Corr)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 46{,}172}{48.219 \cdot 0.188} = 1{,}302 \text{ psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96.25 + 0.2 \cdot 0.188)}{2 \cdot 0.188} = 11{,}048 \text{ psi}$$

Total stress in the head $= S_{3h} + S_p = 12{,}350 \text{ psi}$

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000$ psi)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$

$$= \frac{-46{,}172}{4 \cdot (0.188 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0061 \cdot 46{,}172 \cdot 48.219}{287.5 \cdot \left(0.188^{\ 2} + 0.313^{\ 2}\right)}$$

$= \underline{-6{,}066}$ psi

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

Circumferential stress at the right saddle wear plate horns (Weight, Operating & Corr)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$

$$= \frac{-46{,}172}{4 \cdot 0.188 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0047 \cdot 46{,}172 \cdot 48.219}{287.5 \cdot 0.188^{\ 2}}$$

$= \underline{-17{,}191}$ psi

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000$ psi)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$

$$= \frac{0.6467 \cdot 46{,}172}{(0.188 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.501}\right)}$$

$= \underline{7{,}181}$ psi

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350$ psi)

Saddle splitting load (right, Weight, Operating & Corr)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 46{,}172}{11.6475} = \underline{1{,}136} \text{ psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333 \text{ psi}\right)$

Longitudinal stress at the left saddle (Weight, Operating & Corr)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 287.5 + \frac{2 \cdot 24.313}{3} = 319.9173 \text{ in}$$

$$w = \frac{W_t}{L_e} = \frac{91{,}930}{319.9173} = 287.36 \text{ lb}_f/\text{in}$$

Bending moment at the left saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_l \cdot A_l}{3} + \frac{A_l^2}{2} - \frac{R^2 - H_l^2}{4}\right)$$

$$= 287.36 \cdot \left(\frac{2 \cdot 24.313 \cdot 17.75}{3} + \frac{17.75^{\ 2}}{2} - \frac{48.313^{\ 2} - 24.313^{\ 2}}{4}\right)$$

$= 2{,}723.9 \ \ \text{lb}_f\text{-in}$

$$S_2 = \pm\frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{2{,}723.9 \cdot 1}{\pi \cdot 48.219^{\ 2} \cdot 0.188} = 2 \ \text{psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{43.14 \cdot 48.125}{2 \cdot 0.188} = 5{,}522 \ \text{psi}$$

Maximum tensile stress S_{2t} = S_2 + S_p = 5,524 psi
Maximum compressive stress (shut down) S_{2c} = S_2 = 2 psi

Tensile stress is acceptable ($\leq S = 20{,}000 \ \text{psi}$)

Compressive stress is acceptable ($\leq S_c = 6{,}399 \ \text{psi}$)

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

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot (t + t_p)} = \frac{0.3648 \cdot 45{,}758}{48.219 \cdot (0.188 + 0.313)} = 691 \ \text{psi}$$

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

Tangential shear stress in the left head (Weight, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t_h} = \frac{0.3648 \cdot 45{,}758}{48.219 \cdot 0.188} = 1{,}841 \ \text{psi}$$

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

Tangential shear stress in the shell at the wear plate edge (left saddle, Weight, Operating & Corr)

$$S_3 = \frac{K_{2.3} \cdot Q}{R \cdot t} = \frac{0.2597 \cdot 45{,}758}{48.219 \cdot 0.188} = 1{,}311 \ \text{psi}$$

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

Additional stress in the head used as a stiffener (left saddle, Weight, Operating & Corr)

$$S_{3h} = \frac{K_{2.4} \cdot Q}{R \cdot t_h} = \frac{0.2556 \cdot 45{,}758}{48.219 \cdot 0.188} = 1{,}290 \ \text{psi}$$

$$S_p = \frac{P \cdot (K \cdot D_i + 0.2 \cdot t_h)}{2 \cdot t_h} = \frac{43.14 \cdot (1 \cdot 96.25 + 0.2 \cdot 0.188)}{2 \cdot 0.188} = 11{,}048 \ \text{psi}$$

Total stress in the head $= S_{3h} + S_p = 12{,}338 \ \text{psi}$

Stress in the head is acceptable ($\leq 1.25 \cdot S_h = 25{,}000 \ \text{psi}$)

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

$$S_4 = \frac{-Q}{4 \cdot (t + t_p) \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot \left(t^2 + t_p^2\right)}$$
$$= \frac{-45{,}758}{4 \cdot (0.188 + 0.313) \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0061 \cdot 45{,}758 \cdot 48.219}{287.5 \cdot \left(0.188^{\ 2} + 0.313^{\ 2}\right)}$$
$$= -6{,}012 \ \text{psi}$$

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

Circumferential stress at the left saddle wear plate horns (Weight, Operating & Corr)

$$S_4 = \frac{-Q}{4 \cdot t \cdot \left(b + 1.56 \cdot \sqrt{R_o \cdot t}\right)} - \frac{12 \cdot K_3 \cdot Q \cdot R}{L \cdot t^2}$$

$$= \frac{-45{,}758}{4 \cdot 0.188 \cdot \left(8 + 1.56 \cdot \sqrt{48.313 \cdot 0.188}\right)} - \frac{12 \cdot 0.0047 \cdot 45{,}758 \cdot 48.219}{287.5 \cdot 0.188^{\,2}}$$

$= \underline{-17{,}037}\ \ \text{psi}$

Circumferential stress at wear plate horns is acceptable ($\leq 1.5 \cdot S_a = 30{,}000\ \ \text{psi}$)

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

$$S_5 = \frac{K_5 \cdot Q}{(t + t_p) \cdot \left(t_s + 1.56 \cdot \sqrt{R_o \cdot t_c}\right)}$$

$$= \frac{0.6467 \cdot 45{,}758}{(0.188 + 0.313) \cdot \left(0.625 + 1.56 \cdot \sqrt{48.313 \cdot 0.501}\right)}$$

$= \underline{7{,}116}\ \ \text{psi}$

Ring compression in shell is acceptable ($\leq 0.5 \cdot S_y = 13{,}350\ \ \text{psi}$)

Saddle splitting load (left, Weight, Operating & Corr)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 45{,}758}{11.6475} = \underline{1{,}126}\ \ \text{psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333\ \ \text{psi}\right)$

Shear stress in anchor bolting, one end slotted

Maximum seismic or wind base shear $= 2{,}669.55\ \ \text{lb}_f$

Thermal expansion base shear $= W \cdot \mu$ = 48,679*0.45 $= 21{,}905.55\ \ \text{lb}_f$

Corroded root area for a 1" series 8 threaded bolt $= 0.551\ \ \text{in}^2$ (4 per saddle)

Bolt shear stress = $\frac{21{,}905.55}{0.551 \cdot 1 \cdot 4} = 9{,}939\ \ \text{psi}$

Anchor bolt stress is acceptable (≤ 15,000 psi)

Shear stress in anchor bolting, transverse

Maximum seismic or wind base shear $= 2{,}669.55\ \ \text{lb}_f$

Corroded root area for a 1" series 8 threaded bolt $= 0.551\ \ \text{in}^2$ (4 per saddle)

Bolt shear stress = $\frac{2{,}669.55}{0.551 \cdot 2 \cdot 4} = 606\ \ \text{psi}$

Anchor bolt stress is acceptable (≤ 15,000 psi)

Web plate buckling check (Escoe pg 251)

Allowable compressive stress S_c = min(20,000 , 30,511) = 20,000 psi

$$S_c = \frac{K_i \cdot \pi^2 \cdot E}{12 \cdot \left(1 - 0.3^{\,2}\right) \cdot \left(\frac{d_i}{t_s}\right)^2} = \frac{1.28 \cdot \pi^2 \cdot 29\text{E}{+}06}{12 \cdot \left(1 - 0.3^{\,2}\right) \cdot \left(\frac{20.725}{0.625}\right)^2} = 30{,}511\ \ \text{psi}$$

Allowable compressive load on the saddle

$$b_e = \frac{d_i \cdot t_s}{(d_i \cdot t_s) + 2 \cdot t_w \cdot (b-1)} = \frac{20.725 \cdot 0.625}{(20.725 \cdot 0.625) + 2 \cdot 0.5 \cdot (8-1)} = 0.6492$$

$$F_b = n \cdot (A_s + 2 \cdot b_e \cdot t_s) \cdot S_c = 5 \cdot (3.6875 + 2 \cdot 0.6492 \cdot 0.625) \cdot 20{,}000 = 449{,}897.22 \ \ \text{lb}_f$$

Saddle loading of 51,260.64 lb_f is ≤ F_b; satisfactory.

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

$$\sigma_b = \frac{V \cdot (H_s - x_o) \cdot y}{I} + \frac{Q}{A} = \frac{2{,}669.55 \cdot (60.25 - 33.4292) \cdot 4}{107.3} + \frac{50{,}453.64}{78.241} = 3{,}314 \ \ \text{psi}$$

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

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

$$\sigma_b = \frac{V \cdot (H_s - x_o) \cdot y}{I} + \frac{Q}{A} = \frac{24{,}575.1 \cdot (60.25 - 33.4292) \cdot 4}{107.3} + \frac{50{,}453.64}{78.241} = 25{,}216 \ \ \text{psi}$$

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

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

where $a = 20.725, b = 5.6875 \ \ \text{in}$

$$t_b = \sqrt{\frac{\beta_1 \cdot q \cdot b^2}{1.5 \cdot S_a}} = \sqrt{\frac{3 \cdot 51 \cdot 5.6875^{\ 2}}{1.5 \cdot 20{,}000}} = 0.4046 \ \ \text{in}$$

The base plate thickness of 0.5 in is adequate.

Foundation bearing check

$$S_f = \frac{Q_{\max}}{F \cdot E} = \frac{51{,}260.64}{12 \cdot 84.4} = 51 \ \ \text{psi}$$

Concrete bearing stress ≤ 1,658 psi ; satisfactory.

Slotted hole length (Process Industry Practices VEFV1100)

$$\Delta_t = \max\left[|T_{amb} - T_s|, |T_{amb} - MDMT|\right] = \max\left[|70 - 150|, |70 - 0|\right] = 80\,^\circ F$$

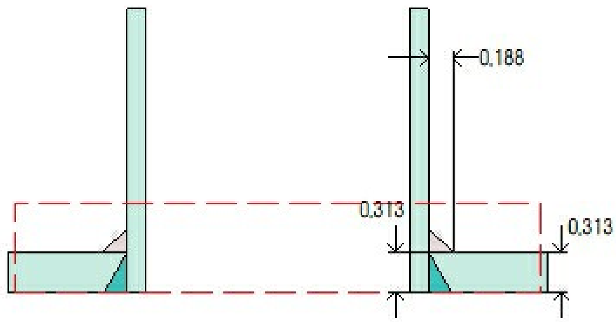
$$S_L = 2 \cdot L_s \cdot \alpha \cdot \Delta_t = 2 \cdot 252 \cdot 8.8\text{E-}06 \cdot 80 = 0.3548''$$

Actual slot length is greater than or equal to the minimum (1.5" ≥ 0.3548"); satisfactory.

Saddle (Middle)

ASME Section VIII Division 1, 2023 Edition	
Inputs	
Load Orientation	Vertical Load
Position from datum	126"
Direction Angle	0.00°
Magnitude of Force	931 lb
Loading Conditions	
Present When Operating	Yes
Included in Vessel Lift Weight	Yes
Present When Vessel is Empty	Yes
Present During Test	Yes

Drain (N1)

ASME Section VIII Division 1, 2023 Edition	
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	Cylinder #1
Orientation	180°
Nozzle center line offset to datum line	234"
End of nozzle to shell center	54.313"
Passes through a Category A joint	No
Nozzle	
Description	NPS 2 Sch 40S (Std)
Access opening	No
Material specification	SA-312 TP304 Wld pipe (II-D p. 92, ln. 27)
Inside diameter, new	2.067"
Pipe nominal wall thickness	0.154"
Pipe minimum wall thickness[1]	0.1348"
Corrosion allowance	0"
Projection available outside vessel, Lpr	3.5"
Projection available outside vessel to flange face, Lf	6"
Local vessel minimum thickness	0.313"
Liquid static head included	3.7 psi
Welds	
Inner fillet, Leg_{41}	0.188"
Nozzle to vessel groove weld	0.313"
Radiography	
Longitudinal seam	Welded pipe
Circumferential seam	Full UW-11(a) Type 1

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

ASME B16.5-2020 Flange	
Description	NPS 2 Class 150 WN A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 418, ln. 32)
Blind included	No
Rated MDMT	-55°F
Liquid static head	3.92 psi
MAWP rating	272.5 psi @ 150°F
MAP rating	285 psi @ 70°F
Hydrotest rating	450 psi @ 70°F
PWHT performed	No
Produced to Fine Grain Practice and Supplied in Heat Treated Condition	No
Impact Tested	No
Circumferential joint radiography	Full UW-11(a) Type 1
Notes	
Flange rated MDMT per UCS-66(b)(3) = -155°F (Coincident ratio = 0.1522) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \dfrac{43.15 \cdot 1.0335}{17{,}000 \cdot 1 - 0.6 \cdot 43.15} =$	0.0026"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.0026 \cdot 1}{0.1348 - 0} =$	0.0195
Impact test exempt per UHA-51(g) (coincident ratio = 0.0195)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 3.7 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)							0.1339	0.1348

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})	0.1078	0.1316	weld size is adequate

Calculations for internal pressure 3.7 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[2.067,\ 1.0335 + (0.154 - 0) + (0.313 - 0.125)\right]$$

$$= 2.067\ \text{in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.154 - 0) + 0\right]$$

$$= 0.385\ \text{in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{3.7045 \cdot 1.0335}{20{,}000 \cdot 1 - 0.6 \cdot 3.7045}$$

$$= 0.0002\ \text{in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{3.7045 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 3.7045}$$

$$= 0.0089\ \text{in}$$

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

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{3.7045 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 3.7045}$$

$$= 0.0105 \quad \text{in}$$

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

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \min\left[0.75,\ t_n,\ t\right] =$ 0.154 in

$t_{c(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] =$ 0.1078 in

$t_{c(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316 \quad \text{in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{3.9211 \cdot 1.0335}{17{,}000 \cdot 1 - 0.6 \cdot 3.9211} + 0$$

$$= 0.0002 \quad \text{in}$$

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

$$= \max\left[0.0002,\ 0\right]$$

$$= 0.0002 \quad \text{in}$$

$$t_{b1} = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{3.7045 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 3.7045} + 0.125$$

$$= 0.1339 \quad \text{in}$$

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

$$= \max\left[0.1339,\ 0.0625\right]$$

$$= 0.1339 \quad \text{in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.1348,\ 0.1339\right]$$

$$= 0.1339 \quad \text{in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0.0002,\ 0.1339\right]$$

$$= 0.1339 \quad \text{in}$$

Available nozzle wall thickness new, $t_n = 0.875 \cdot 0.154 = 0.1348$ in

The nozzle neck thickness is adequate.

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 = 77.95 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.1348	0.1348

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})	0.1078	0.1316	weld size is adequate

Calculations for internal pressure 77.95 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ \ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[2.067,\ \ 1.0335 + (0.154 - 0) + (0.313 - 0.125)\right]$$

$$= 2.067 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ \ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ \ 2.5 \cdot (0.154 - 0) + 0\right]$$

$$= 0.385 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{77.948 \cdot 1.0335}{20{,}000 \cdot 1 - 0.6 \cdot 77.948}$$

$$= 0.004 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{77.948 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 77.948}$$

$$= 0.188 \text{ in}$$

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

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{77.948 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 77.948}$$

$$= 0.2213 \text{ in}$$

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

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \min\left[0.75,\ t_n,\ t\right] =$ 0.154 in

$t_{c(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] =$ 0.1078 in

$t_{c(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{78.1646 \cdot 1.0335}{17{,}000 \cdot 1 - 0.6 \cdot 78.1646} + 0$$

$$= 0.0048 \text{ in}$$

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

$$= \max\left[0.0048,\ 0\right]$$

$$= 0.0048 \text{ in}$$

$$t_{b1} = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{77.948 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 77.948} + 0.125$$

$$= 0.313 \text{ in}$$

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

$$= \max\left[0.313,\ 0.0625\right]$$

$$= 0.313 \text{ in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.1348,\ 0.313\right]$$

$$= 0.1348 \text{ in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

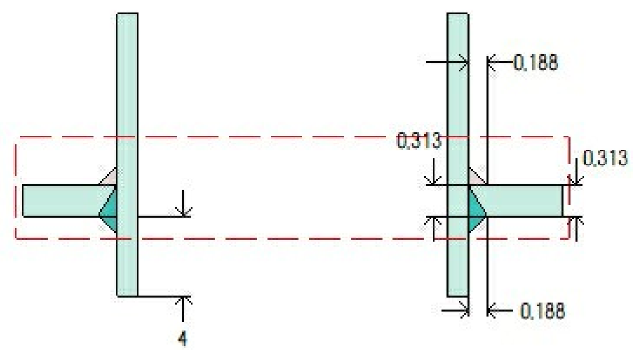
$$= \max\left[0.0048,\ 0.1348\right]$$

$$= 0.1348 \text{ in}$$

Available nozzle wall thickness new, t_n = $0.875 \cdot 0.154$ = 0.1348 in

The nozzle neck thickness is adequate.

Discharge (N2)

ASME Section VIII Division 1, 2023 Edition	
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	Cylinder #2
Orientation	180°
Nozzle center line offset to datum line	196"
End of nozzle to shell center	54.313"
Passes through a Category A joint	No
Nozzle	
Description	NPS 3 Sch 40S (Std)
Access opening	No
Material specification	SA-312 TP304 Wld pipe (II-D p. 92, ln. 27)
Inside diameter, new	3.068"
Pipe nominal wall thickness	0.216"
Pipe minimum wall thickness[1]	0.189"
Corrosion allowance	0"
Projection available outside vessel, Lpr	3.25"
Internal projection, h_{new}	4"
Projection available outside vessel to flange face, Lf	6"
Local vessel minimum thickness	0.313"
Liquid static head included	3.7 psi
Welds	
Inner fillet, Leg_{41}	0.188"
Lower fillet, Leg_{43}	0.188"
Nozzle to vessel groove weld	0.313"
Radiography	
Longitudinal seam	Welded pipe
Circumferential seam	Full UW-11(a) Type 1

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

ASME B16.5-2020 Flange	
Description	NPS 3 Class 150 WN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 426, ln. 4)
Blind included	No
Rated MDMT	-320°F
Liquid static head	3.92 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Produced to Fine Grain Practice and Supplied in Heat Treated Condition	No
Impact Tested	No
Circumferential joint radiography	Full UW-11(a) Type 1
Notes	
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F	

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \dfrac{43.15 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 43.15} =$	0.104"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.104 \cdot 1}{0.313 - 0.125} =$	0.553
$\text{Stress ratio longitudinal} = \dfrac{7{,}278 \cdot 1}{20{,}000 \cdot 1} =$	0.3639
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 3.7 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)							0.1339	0.189

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})	0.1316	0.1316	weld size is adequate

Calculations for internal pressure 3.7 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[3.068,\ 1.534 + (0.216 - 0) + (0.313 - 0.125)\right]$$

$$= 3.068 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.216 - 0) + 0\right]$$

$$= 0.47 \text{ in}$$

Inner Normal Limit of reinforcement per UG-40

$$L_I = \min\left[h,\ 2.5 \cdot (t - C),\ 2.5 \cdot (t_i - C_n - C)\right]$$

$$= \min\left[3.875,\ 2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.216 - 0 - 0.125)\right]$$

$$= 0.2275 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{3.7045 \cdot 1.534}{20{,}000 \cdot 1 - 0.6 \cdot 3.7045}$$

$$= 0.0003 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{3.7045 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 3.7045}$$

$$= 0.0089 \text{ in}$$

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

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{3.7045 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 3.7045}$$

$$= 0.0105 \text{ in}$$

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

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \min\left[0.75,\ t_n,\ t\right] =$ 0.188 in

$t_{c(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] =$ 0.1316 in

$t_{c(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{3.9211 \cdot 1.534}{17{,}000 \cdot 1 - 0.6 \cdot 3.9211} + 0$$

$$= 0.0004 \text{ in}$$

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

$$= \max\left[0.0004,\ 0\right]$$

$$= 0.0004 \text{ in}$$

$$t_{b1} = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{3.7045 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 3.7045} + 0.125$$

$$= 0.1339 \text{ in}$$

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

$$= \max\left[0.1339,\ 0.0625\right]$$

$$= 0.1339 \text{ in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.189,\ 0.1339\right]$$

$$= 0.1339 \text{ in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0.0004,\ 0.1339\right]$$

$$= \underline{0.1339}\ \text{in}$$

Available nozzle wall thickness new, t_n = $0.875 \cdot 0.216$ = 0.189 in

The nozzle neck thickness is adequate.

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 = 77.95 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.189	0.189

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})	0.1316	0.1316	weld size is adequate

Calculations for internal pressure 77.95 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[3.068,\ 1.534 + (0.216 - 0) + (0.313 - 0.125)\right]$$

$$= 3.068 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.216 - 0) + 0\right]$$

$$= 0.47 \text{ in}$$

Inner Normal Limit of reinforcement per UG-40

$$L_I = \min\left[h,\ 2.5 \cdot (t - C),\ 2.5 \cdot (t_i - C_n - C)\right]$$

$$= \min\left[3.875,\ 2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.216 - 0 - 0.125)\right]$$

$$= 0.2275 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{77.948 \cdot 1.534}{20{,}000 \cdot 1 - 0.6 \cdot 77.948}$$

$$= 0.006 \text{ in}$$

Required thickness t_r from UG-37(a)

$t_r = \dfrac{P \cdot R}{S \cdot E - 0.6 \cdot P}$

$= \dfrac{77.948 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 77.948}$

$= 0.188 \text{ in}$

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

$t_r = \dfrac{P \cdot R}{S \cdot E - 0.6 \cdot P}$

$= \dfrac{77.948 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 77.948}$

$= 0.2213 \text{ in}$

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

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \min\left[0.75,\ t_n,\ t\right] =$ 0.188 in

$t_{c(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] =$ 0.1316 in

$t_{c(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$t_{a\text{UG-27}} = \dfrac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$

$= \dfrac{78.1646 \cdot 1.534}{17{,}000 \cdot 1 - 0.6 \cdot 78.1646} + 0$

$= 0.0071 \text{ in}$

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

$= \max\left[0.0071,\ 0\right]$

$= 0.0071 \text{ in}$

$t_{b1} = \dfrac{P \cdot R}{S \cdot E - 0.6 \cdot P} + \text{Corrosion}$

$= \dfrac{77.948 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 77.948} + 0.125$

$= 0.313 \text{ in}$

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

$= \max\left[0.313,\ 0.0625\right]$

$= 0.313 \text{ in}$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.189,\ 0.313\right]$$

$$= 0.189\ \text{in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0.0071,\ 0.189\right]$$

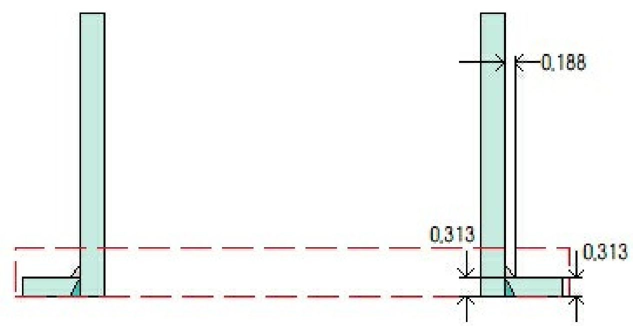
$$= 0.189\ \text{in}$$

Available nozzle wall thickness new, t_n = $0.875 \cdot 0.216$ = 0.189 in

The nozzle neck thickness is adequate.

Manway (N3)

ASME Section VIII Division 1, 2023 Edition	



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

Location and Orientation	
Located on	Cylinder #4
Orientation	270°
Nozzle center line offset to datum line	63"
End of nozzle to shell center	56.313"
Offset from center, Lo	-24"
Passes through a Category A joint	No
Nozzle	
Access opening	No
Material specification	SA-240 304 (II-D p. 92, ln. 14)
Inside diameter, new	23.25"
Nominal wall thickness	0.375"
Corrosion allowance	0"
Opening chord length	27.2172"
Projection available outside vessel, Lpr	3.514"
Projection available outside vessel to flange face, Lf	9.514"
Local vessel minimum thickness	0.313"
Liquid static head included	2.83 psi
Welds	
Inner fillet, Leg_{41}	0.188"
Nozzle to vessel groove weld	0.313"
Radiography	
Longitudinal seam	Spot UW-11(b) Type 1
Circumferential seam	Spot UW-11(b) Type 1

ASME B16.5-2020 Flange	
Description	NPS 24 Class 150 WN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 426, ln. 4)
Blind included	Yes
Rated MDMT	-320°F
Liquid static head	2.83 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Produced to Fine Grain Practice and Supplied in Heat Treated Condition	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(b) Type 1
Bore diameter, B (specified by purchaser)	23.44"
Notes	
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F	

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \dfrac{42.27 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 42.27} =$	0.1018"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.1018 \cdot 1}{0.313 - 0.125} =$	0.5417
$\text{Stress ratio longitudinal} = \dfrac{7{,}278 \cdot 1}{20{,}000 \cdot 1} =$	0.3639
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 2.83 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
0.0925	5.4106	5.0243	0.351	–	–	0.0353	0.1318	0.375

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.1316	0.1316	weld size is adequate

Calculations for internal pressure 2.83 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[27.2172,\ 13.6086 + (0.375 - 0) + (0.313 - 0.125)\right]$$

$$= 27.2172 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.375 - 0) + 0\right]$$

$$= 0.47 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{2.8269 \cdot 11.625}{20{,}000 \cdot 1 - 0.6 \cdot 2.8269}$$

$$= 0.0016 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{2.8269 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 2.8269}$$

$$= 0.0068 \text{ in}$$

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

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{2.8269 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 2.8269}$$

$$= 0.008 \ \ \mathrm{in}$$

Area required per UG-37(c)

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

f_{r1} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

f_{r2} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

$$A = d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1})$$

$$= 27.2172 \cdot 0.0068 \cdot 0.5 + 2 \cdot 0.375 \cdot 0.0068 \cdot 0.5 \cdot (1 - 1)$$

= 0.0925 in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= 5.0243 in^2

$$= d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$$

$$= 27.2172 \cdot (1 \cdot 0.188 - 0.5 \cdot 0.0068) - 2 \cdot 0.375 \cdot (1 \cdot 0.188 - 0.5 \cdot 0.0068) \cdot (1 - 1)$$

$$= 5.0243 \ \ \mathrm{in}^2$$

$$= 2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$$

$$= 2 \cdot (0.188 + 0.375) \cdot (1 \cdot 0.188 - 0.5 \cdot 0.0068) - 2 \cdot 0.375 \cdot (1 \cdot 0.188 - 0.5 \cdot 0.0068) \cdot (1 - 1)$$

$$= 0.2079 \ \ \mathrm{in}^2$$

A_2 = smaller of the following= 0.351 in^2

$$= 5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t$$

$$= 5 \cdot (0.375 - 0.0016) \cdot 1 \cdot 0.188$$

$$= 0.351 \ \ \mathrm{in}^2$$

$$= 5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t_n$$

$$= 5 \cdot (0.375 - 0.0016) \cdot 1 \cdot 0.375$$

$$= 0.7001 \ \ \mathrm{in}^2$$

$$A_{41} = Leg^2 \cdot f_{r2}$$

$$= 0.188^{\,2} \cdot 1$$

= 0.0353 in^2

$$Area = A_1 + A_2 + A_{41}$$
$$= 5.0243 + 0.351 + 0.0353$$
$$= 5.4106 \text{ in}^2$$

As Area >= A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \min\left[0.75,\ t_n,\ t\right] =$ 0.188 in

$t_{c(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] =$ 0.1316 in

$t_{c(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$
$$= \frac{2.8269 \cdot 11.625}{20{,}000 \cdot 0.85 - 0.6 \cdot 2.8269} + 0$$
$$= 0.0019 \text{ in}$$

$$t_a = \max\left[t_{a\text{UG-27}},\ t_{a\text{UG-22}}\right]$$
$$= \max\left[0.0019,\ 0\right]$$
$$= 0.0019 \text{ in}$$

$$t_{b1} = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P} + \text{Corrosion}$$
$$= \frac{2.8269 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 2.8269} + 0.125$$
$$= 0.1318 \text{ in}$$

$$t_{b1} = \max\left[t_{b1},\ t_{b\text{UG16}}\right]$$
$$= \max\left[0.1318,\ 0.0625\right]$$
$$= 0.1318 \text{ in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$
$$= \min\left[0.3281,\ 0.1318\right]$$
$$= 0.1318 \text{ in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$
$$= \max\left[0.0019,\ 0.1318\right]$$
$$= 0.1318 \text{ in}$$

Available nozzle wall thickness new, t_n = 0.375 in

The nozzle neck thickness is adequate.

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

$$EFE = \left(\frac{50 \cdot t}{R_f}\right) \cdot \left(1 - \frac{R_f}{R_o}\right) = \left(\frac{50 \cdot 0.375}{11.8125}\right) \cdot \left(1 - \frac{11.8125}{\infty}\right) = 1.5873\,\%$$

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 = 77.95 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}
2.5584	2.9035	2.5584	0.3098	–	–	0.0353	0.313	0.375

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.1316	0.1316	weld size is adequate

Calculations for internal pressure 77.95 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[27.2172,\ 13.6086 + (0.375 - 0) + (0.313 - 0.125)\right]$$

$$= 27.2172 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.375 - 0) + 0\right]$$

$$= 0.47 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{77.9478 \cdot 11.625}{20{,}000 \cdot 1 - 0.6 \cdot 77.9478}$$

$$= 0.0454 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{77.9478 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 77.9478}$$

$$= 0.188 \text{ in}$$

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

t_r = $\dfrac{P \cdot R}{S \cdot E - 0.6 \cdot P}$

= $\dfrac{77.9478 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 77.9478}$

= 0.2213 in

Area required per UG-37(c)

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

f_{r1} = lesser of 1 or $\dfrac{S_n}{S_v}$ = 1

f_{r2} = lesser of 1 or $\dfrac{S_n}{S_v}$ = 1

A = $d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1})$

= $27.2172 \cdot 0.188 \cdot 0.5 + 2 \cdot 0.375 \cdot 0.188 \cdot 0.5 \cdot (1 - 1)$

= 2.5584 in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= 2.5584 in^2

= $d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $27.2172 \cdot (1 \cdot 0.188 - 0.5 \cdot 0.188) - 2 \cdot 0.375 \cdot (1 \cdot 0.188 - 0.5 \cdot 0.188) \cdot (1 - 1)$

= 2.5584 in^2

= $2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $2 \cdot (0.188 + 0.375) \cdot (1 \cdot 0.188 - 0.5 \cdot 0.188) - 2 \cdot 0.375 \cdot (1 \cdot 0.188 - 0.5 \cdot 0.188) \cdot (1 - 1)$

= 0.1058 in^2

A_2 = smaller of the following= 0.3098 in^2

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t$

= $5 \cdot (0.375 - 0.0454) \cdot 1 \cdot 0.188$

= 0.3098 in^2

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t_n$

= $5 \cdot (0.375 - 0.0454) \cdot 1 \cdot 0.375$

= 0.618 in^2

A_{41} = $Leg^2 \cdot f_{r2}$

= $0.188^2 \cdot 1$

= 0.0353 in^2

$$
\begin{aligned}
Area &= A_1 + A_2 + A_{41} \\
&= 2.5584 + 0.3098 + 0.0353 \\
&= 2.9035 \text{ in}^2
\end{aligned}
$$

As Area >= A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \min\left[0.75,\ t_n,\ t\right] =$ 0.188 in

$t_{c(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] =$ 0.1316 in

$t_{c(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$
\begin{aligned}
t_{a\text{UG-27}} &= \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion} \\
&= \frac{77.9478 \cdot 11.625}{20{,}000 \cdot 0.85 - 0.6 \cdot 77.9478} + 0 \\
&= 0.0534 \text{ in}
\end{aligned}
$$

$$
\begin{aligned}
t_a &= \max\left[t_{a\text{UG-27}},\ t_{a\text{UG-22}}\right] \\
&= \max\left[0.0534,\ 0\right] \\
&= 0.0534 \text{ in}
\end{aligned}
$$

$$
\begin{aligned}
t_{b1} &= \frac{P \cdot R}{S \cdot E - 0.6 \cdot P} + \text{Corrosion} \\
&= \frac{77.9478 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 77.9478} + 0.125 \\
&= 0.313 \text{ in}
\end{aligned}
$$

$$
\begin{aligned}
t_{b1} &= \max\left[t_{b1},\ t_{b\text{UG16}}\right] \\
&= \max\left[0.313,\ 0.0625\right] \\
&= 0.313 \text{ in}
\end{aligned}
$$

$$
\begin{aligned}
t_b &= \min\left[t_{b3},\ t_{b1}\right] \\
&= \min\left[0.3281,\ 0.313\right] \\
&= 0.313 \text{ in}
\end{aligned}
$$

$$
\begin{aligned}
t_{\text{UG-45}} &= \max\left[t_a,\ t_b\right] \\
&= \max\left[0.0534,\ 0.313\right] \\
&= 0.313 \text{ in}
\end{aligned}
$$

Available nozzle wall thickness new, t_n = 0.375 in

The nozzle neck thickness is adequate.

Reinforcement check in the plane parallel to the longitudinal axis

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 2.83 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
0.1581	4.5992	4.2129	0.351	–	–	0.0353	0.1318	0.375

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.1316	0.1316	weld size is adequate

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[23.25,\ 11.625 + (0.375 - 0) + (0.313 - 0.125)\right]$$

$$= 23.25 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.375 - 0) + 0\right]$$

$$= 0.47 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{2.8269 \cdot 11.625}{20{,}000 \cdot 1 - 0.6 \cdot 2.8269}$$

$$= 0.0016 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{2.8269 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 2.8269}$$

$$= 0.0068 \text{ in}$$

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

t_r = $\frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$

= $\frac{2.8269 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 2.8269}$

= $0.008 \ \text{in}$

Area required per UG-37(c)

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

f_{r1} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

f_{r2} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

A = $d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1})$

= $23.25 \cdot 0.0068 \cdot 1 + 2 \cdot 0.375 \cdot 0.0068 \cdot 1 \cdot (1 - 1)$

= 0.1581 in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= 4.2129 in^2

= $d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $23.25 \cdot (1 \cdot 0.188 - 1 \cdot 0.0068) - 2 \cdot 0.375 \cdot (1 \cdot 0.188 - 1 \cdot 0.0068) \cdot (1 - 1)$

= $4.2129 \ \text{in}^2$

= $2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $2 \cdot (0.188 + 0.375) \cdot (1 \cdot 0.188 - 1 \cdot 0.0068) - 2 \cdot 0.375 \cdot (1 \cdot 0.188 - 1 \cdot 0.0068) \cdot (1 - 1)$

= $0.204 \ \text{in}^2$

A_2 = smaller of the following= 0.351 in^2

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t$

= $5 \cdot (0.375 - 0.0016) \cdot 1 \cdot 0.188$

= $0.351 \ \text{in}^2$

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t_n$

= $5 \cdot (0.375 - 0.0016) \cdot 1 \cdot 0.375$

= $0.7001 \ \text{in}^2$

A_{41} = $Leg^2 \cdot f_{r2}$

= $0.188^{\,2} \cdot 1$

= 0.0353 in^2

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

$$= 4.2129 + 0.351 + 0.0353$$

$$= \underline{4.5992} \text{ in}^2$$

As Area >= A the reinforcement is adequate.

UG-45 Nozzle Neck Thickness Check

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{2.8269 \cdot 11.625}{20{,}000 \cdot 0.85 - 0.6 \cdot 2.8269} + 0$$

$$= 0.0019 \text{ in}$$

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

$$= \max\left[0.0019,\ 0\right]$$

$$= 0.0019 \text{ in}$$

$$t_{b1} = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{2.8269 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 2.8269} + 0.125$$

$$= 0.1318 \text{ in}$$

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

$$= \max\left[0.1318,\ 0.0625\right]$$

$$= 0.1318 \text{ in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.3281,\ 0.1318\right]$$

$$= 0.1318 \text{ in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0.0019,\ 0.1318\right]$$

$$= \underline{0.1318} \text{ in}$$

Available nozzle wall thickness new, t_n = 0.375 in

The nozzle neck thickness is adequate.

Reinforcement check in the plane parallel to the longitudinal axis

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 = 42.27 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}
2.3678	2.3679	2.0032	0.3294	–	–	0.0353	0.2268	0.375

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

UW-16 Weld Sizing Summary			
Weld description	Required weld throat size (in)	Actual weld throat size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.1316	0.1316	weld size is adequate

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[23.25,\ 11.625 + (0.375 - 0) + (0.313 - 0.125)\right]$$

$$= 23.25 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.375 - 0) + 0\right]$$

$$= 0.47 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{42.2709 \cdot 11.625}{20{,}000 \cdot 1 - 0.6 \cdot 42.2709}$$

$$= 0.0246 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{42.2709 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 42.2709}$$

$$= 0.1018 \text{ in}$$

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

t_r = $\frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$

= $\frac{42.2709 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 42.2709}$

= 0.1198 in

Area required per UG-37(c)

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

f_{r1} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

f_{r2} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

A = $d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1})$

= $23.25 \cdot 0.1018 \cdot 1 + 2 \cdot 0.375 \cdot 0.1018 \cdot 1 \cdot (1 - 1)$

= 2.3678 in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= 2.0032 in^2

= $d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $23.25 \cdot (1 \cdot 0.188 - 1 \cdot 0.1018) - 2 \cdot 0.375 \cdot (1 \cdot 0.188 - 1 \cdot 0.1018) \cdot (1 - 1)$

= 2.0032 in^2

= $2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $2 \cdot (0.188 + 0.375) \cdot (1 \cdot 0.188 - 1 \cdot 0.1018) - 2 \cdot 0.375 \cdot (1 \cdot 0.188 - 1 \cdot 0.1018) \cdot (1 - 1)$

= 0.097 in^2

A_2 = smaller of the following= 0.3294 in^2

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t$

= $5 \cdot (0.375 - 0.0246) \cdot 1 \cdot 0.188$

= 0.3294 in^2

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t_n$

= $5 \cdot (0.375 - 0.0246) \cdot 1 \cdot 0.375$

= 0.657 in^2

A_{41} = $Leg^2 \cdot f_{r2}$

= $0.188^2 \cdot 1$

= 0.0353 in^2

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

$$= 2.0032 + 0.3294 + 0.0353$$

$$= 2.3679 \text{ in}^2$$

As Area >= A the reinforcement is adequate.

UG-45 Nozzle Neck Thickness Check

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{42.2709 \cdot 11.625}{20{,}000 \cdot 0.85 - 0.6 \cdot 42.2709} + 0$$

$$= 0.0289 \text{ in}$$

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

$$= \max\left[0.0289,\ 0\right]$$

$$= 0.0289 \text{ in}$$

$$t_{b1} = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{42.2709 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 42.2709} + 0.125$$

$$= 0.2268 \text{ in}$$

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

$$= \max\left[0.2268,\ 0.0625\right]$$

$$= 0.2268 \text{ in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.3281,\ 0.2268\right]$$

$$= 0.2268 \text{ in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0.0289,\ 0.2268\right]$$

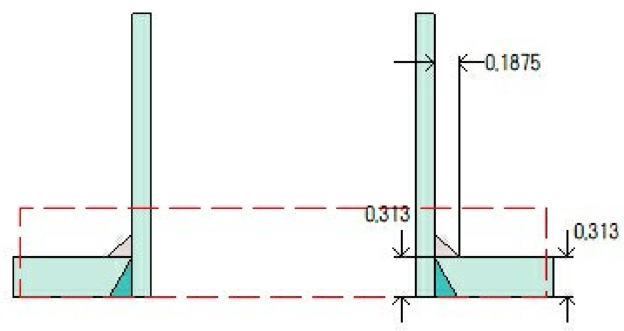
$$= 0.2268 \text{ in}$$

Available nozzle wall thickness new, t_n = 0.375 in

The nozzle neck thickness is adequate.

Fill (N4)

ASME Section VIII Division 1, 2023 Edition	



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

Location and Orientation	
Located on	Cylinder #5
Orientation	0°
Nozzle center line offset to datum line	0"
End of nozzle to shell center	54.313"
Passes through a Category A joint	No

Nozzle	
Description	NPS 2 Sch 40S (Std)
Access opening	No
Material specification	SA-312 TP304 Wld pipe (II-D p. 92, ln. 27)
Inside diameter, new	2.067"
Pipe nominal wall thickness	0.154"
Pipe minimum wall thickness[1]	0.1348"
Corrosion allowance	0"
Projection available outside vessel, Lpr	3.5"
Projection available outside vessel to flange face, Lf	6"
Local vessel minimum thickness	0.313"
Liquid static head included	0.22 psi

Welds	
Inner fillet, Leg_{41}	0.1875"
Nozzle to vessel groove weld	0.313"

Radiography	
Longitudinal seam	Welded pipe
Circumferential seam	Spot UW-11(b) Type 1

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

ASME B16.5-2020 Flange	
Description	NPS 2 Class 150 WN A182 F304
Bolt Material	SA-193 B8 1 Bolt (II-D p. 426, ln. 4)
Blind included	No
Rated MDMT	-320°F
Liquid static head	0 psi
MAWP rating	252.5 psi @ 150°F
MAP rating	275 psi @ 70°F
Hydrotest rating	425 psi @ 70°F
PWHT performed	No
Produced to Fine Grain Practice and Supplied in Heat Treated Condition	No
Impact Tested	No
Circumferential joint radiography	Spot UW-11(b) Type 1
Notes	
Flange rated MDMT per UHA-51(d)(1)(a) = -320°F Bolts rated MDMT = -320°F	

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \dfrac{39.66 \cdot 1.0335}{17{,}000 \cdot 1 - 0.6 \cdot 39.66} =$	0.0024"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.0024 \cdot 1}{0.1348 - 0} =$	0.0179
Impact test exempt per UHA-51(g) (coincident ratio = 0.0179)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 0.22 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)							0.1255	0.1348

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})	0.1078	0.1313	weld size is adequate

Calculations for internal pressure 0.22 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[2.067,\ 1.0335 + (0.154 - 0) + (0.313 - 0.125)\right]$$

$$= 2.067 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.154 - 0) + 0\right]$$

$$= 0.385 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{0.2166 \cdot 1.0335}{20{,}000 \cdot 1 - 0.6 \cdot 0.2166}$$

$$= 0 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{0.2166 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 0.2166}$$

$$= 0.0005 \text{ in}$$

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

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{0.2166 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 0.2166}$$

$$= 0.0006 \text{ in}$$

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

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \min\left[0.75,\ t_n,\ t\right] =$ 0.154 in

$t_{c(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] =$ 0.1078 in

$t_{c(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.1875 = 0.1313 \text{ in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{0.2166 \cdot 1.0335}{17{,}000 \cdot 1 - 0.6 \cdot 0.2166} + 0$$

$$= 0 \text{ in}$$

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

$$= \max\left[0,\ 0\right]$$

$$= 0 \text{ in}$$

$$t_{b1} = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{0.2166 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 0.2166} + 0.125$$

$$= 0.1255 \text{ in}$$

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

$$= \max\left[0.1255,\ 0.0625\right]$$

$$= 0.1255 \text{ in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.1348,\ 0.1255\right]$$

$$= 0.1255 \text{ in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0,\ 0.1255\right]$$

$$= 0.1255 \text{ in}$$

Available nozzle wall thickness new, t_n = $0.875 \cdot 0.154$ = 0.1348 in

The nozzle neck thickness is adequate.

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 = 77.94 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.1348	0.1348

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})	0.1078	0.1313	weld size is adequate

Calculations for internal pressure 77.94 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ \ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[2.067,\ \ 1.0335 + (0.154 - 0) + (0.313 - 0.125)\right]$$

$$= 2.067 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ \ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ \ 2.5 \cdot (0.154 - 0) + 0\right]$$

$$= 0.385 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{77.9411 \cdot 1.0335}{20{,}000 \cdot 1 - 0.6 \cdot 77.9411}$$

$$= 0.004 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{77.9411 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 77.9411}$$

$$= 0.188 \text{ in}$$

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

$t_r = \dfrac{P \cdot R}{S \cdot E - 0.6 \cdot P}$

$= \dfrac{77.9411 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 77.9411}$

$= 0.2213 \ \text{in}$

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

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \min\,[0.75,\ t_n,\ t] =$ 0.154 in

$t_{c(\min)} = \min\,[0.25,\ 0.7 \cdot t_{\min}] =$ 0.1078 in

$t_{c(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.1875 = 0.1313 \ \text{in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

$t_{a\text{UG-27}} = \dfrac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$

$= \dfrac{77.9411 \cdot 1.0335}{17{,}000 \cdot 1 - 0.6 \cdot 77.9411} + 0$

$= 0.0048 \ \text{in}$

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

$= \max\,[0.0048,\ 0]$

$= 0.0048 \ \text{in}$

$t_{b1} = \dfrac{P \cdot R}{S \cdot E - 0.6 \cdot P} + \text{Corrosion}$

$= \dfrac{77.9411 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 77.9411} + 0.125$

$= 0.313 \ \text{in}$

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

$= \max\,[0.313,\ 0.0625]$

$= 0.313 \ \text{in}$

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

$= \min\,[0.1348,\ 0.313]$

$= 0.1348 \ \text{in}$

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

$= \max\,[0.0048,\ 0.1348]$

$=$ 0.1348 in

Available nozzle wall thickness new, t_n = $0.875 \cdot 0.154$ = 0.1348 in

The nozzle neck thickness is adequate.

Vent (N5)

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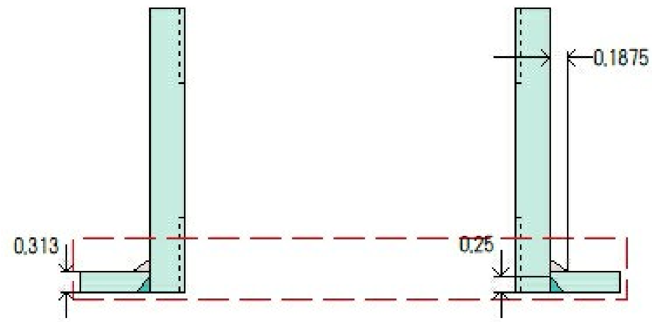	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	Cylinder #4
Orientation	0°
Nozzle center line offset to datum line	63"
End of nozzle to shell center	52.2029"
Passes through a Category A joint	No
Nozzle	
Service	Threaded (THRD)
Description	NPS 3 Class 3000 - Threaded Full Coupling
Access opening	No
Material specification	SA-182 F304 ≤ 5 (II-D p. 92, ln. 4)
Inside diameter, new	3.5"
Nominal wall thickness	0.375"
Corrosion allowance	0"
Projection available outside vessel, Lpr	3.8899"
Local vessel minimum thickness	0.313"
Liquid static head included	0.22 psi
Welds	
Inner fillet, Leg_{41}	0.1875"
Nozzle to vessel groove weld	0.25"
Radiography	
Longitudinal seam	Spot UW-11(b) Type 1

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \dfrac{39.66 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 39.66} =$	0.0956"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.0956 \cdot 1}{0.313 - 0.125} =$	0.5082
$\text{Stress ratio longitudinal} = \dfrac{7{,}278 \cdot 1}{20{,}000 \cdot 1} =$	0.3639
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 0.22 psi @ 150 °F							The nozzle passes UG-44	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.0625	0.375

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

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0938	0.1313	weld size is adequate
Nozzle to shell groove (Lower)	0.0938	0.125	weld size is adequate

Calculations for internal pressure 0.22 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[3.5,\ 1.75 + (0.375 - 0) + (0.313 - 0.125)\right]$$

$$= 3.5 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.375 - 0) + 0\right]$$

$$= 0.47 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{0.2166 \cdot 1.75}{20{,}000 \cdot 1 - 0.6 \cdot 0.2166}$$

$$= 0 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{0.2166 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 0.2166}$$

$$= 0.0005 \text{ in}$$

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

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{0.2166 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 0.2166}$$

$$= 0.0006 \text{ in}$$

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

UW-16(f)(2)(b) Weld Check

$t_{\text{min}} = \min\left[0.75,\ t_n,\ t\right] = 0.188$ in

$t_{1(\text{min})}$ or $t_{2(\text{min})} = \min\left[0.09375,\ 0.7 \cdot t_{\text{min}}\right] = 0.0938$ in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.1875 = 0.1313$ in

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125$ in

The weld size t_2 is satisfactory.

UG-44 Thickness Check - ASME B16.11 Coupling

$$t_{a\text{App 1-1}} = \frac{P \cdot R_o}{S_n \cdot E + 0.4 \cdot P} + \text{Corrosion}$$

$$= \frac{0.2166 \cdot 2.125}{20{,}000 \cdot 0.85 + 0.4 \cdot 0.2166} + 0$$

$$= 0 \text{ in}$$

$$t_{a\text{UG-44}} = \max\left[t_{a\text{App 1-1}},\ t_{b\text{UG16}}\right]$$

$$= \max\left[0,\ 0.0625\right]$$

$$= 0.0625 \text{ in}$$

Available nozzle wall thickness new, t_n = 0.375 in

The nozzle neck thickness is adequate.

Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 77.94 psi @ 150 °F							The nozzle passes UG-44	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.0625	0.375

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

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0938	0.1313	weld size is adequate
Nozzle to shell groove (Lower)	0.0938	0.125	weld size is adequate

Calculations for internal pressure 77.94 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[3.5,\ 1.75 + (0.375 - 0) + (0.313 - 0.125)\right]$$

$$= 3.5 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.375 - 0) + 0\right]$$

$$= 0.47 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{77.9411 \cdot 1.75}{20{,}000 \cdot 1 - 0.6 \cdot 77.9411}$$

$$= 0.0068 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{77.9411 \cdot 48.125}{20{,}000 \cdot 1 - 0.6 \cdot 77.9411}$$

$$= 0.188 \text{ in}$$

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

$$t_r = \frac{P \cdot R}{S \cdot E - 0.6 \cdot P}$$

$$= \frac{77.9411 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 77.9411}$$

$$= 0.2213 \quad \text{in}$$

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

UW-16(f)(2)(b) Weld Check

$t_{\min} = \min\left[0.75,\ t_n,\ t\right] = 0.188 \quad \text{in}$

$t_{1(\min)}$ or $t_{2(\min)} = \min\left[0.09375,\ 0.7 \cdot t_{\min}\right] = 0.0938 \quad \text{in}$

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.1875 = 0.1313 \quad \text{in}$

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125 \quad \text{in}$

The weld size t_2 is satisfactory.

UG-44 Thickness Check - ASME B16.11 Coupling

$$t_{a\text{App 1-1}} = \frac{P \cdot R_o}{S_n \cdot E + 0.4 \cdot P} + \text{Corrosion}$$

$$= \frac{77.9411 \cdot 2.125}{20{,}000 \cdot 0.85 + 0.4 \cdot 77.9411} + 0$$

$$= 0.0097 \quad \text{in}$$

$$t_{a\text{UG-44}} = \max\left[t_{a\text{App 1-1}},\ t_{b\text{UG16}}\right]$$

$$= \max\left[0.0097,\ 0.0625\right]$$

$$= 0.0625 \quad \text{in}$$

Available nozzle wall thickness new, t_n = 0.375 in

The nozzle neck thickness is adequate.

Level Transmitter (N6)

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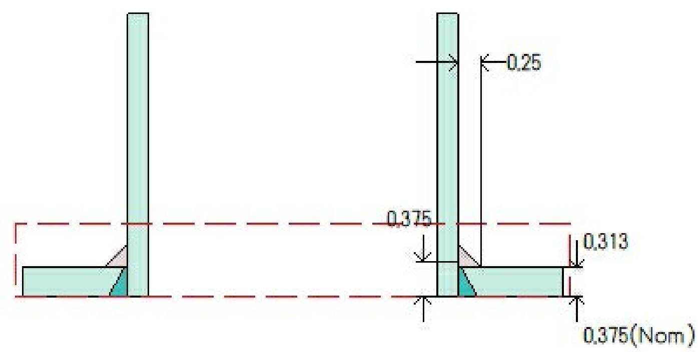
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	Ellipsoidal Head #1
Orientation	170°
End of nozzle to datum line	286.5852"
Calculated as hillside	Yes
Distance to head center, R	45"
Passes through a Category A joint	No
Nozzle	
Description	NPS 3 Sch 40S (Std)
Access opening	No
Material specification	SA-312 TP304 Wld pipe (II-D p. 92, ln. 27)
Inside diameter, new	3.068"
Pipe nominal wall thickness	0.216"
Pipe minimum wall thickness[1]	0.189"
Corrosion allowance	0"
Opening chord length	5.2016"
Projection available outside vessel, Lpr	5.784"
Projection available outside vessel to flange face, Lf	6"
Local vessel minimum thickness	0.313"
Liquid static head included	3.56 psi
Welds	
Inner fillet, Leg_{41}	0.25"
Nozzle to vessel groove weld	0.375"
Radiography	
Longitudinal seam	Welded pipe

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

ASME B16.5-2020 Flange	
Description	NPS 3 Class 150 SO A105
Bolt Material	SA-193 B7 Bolt <= 2 1/2 (II-D p. 418, ln. 32)
Blind included	No
Rated MDMT	-55°F
Liquid static head	3.56 psi
MAWP rating	272.5 psi @ 150°F
MAP rating	285 psi @ 70°F
Hydrotest rating	450 psi @ 70°F
External fillet weld leg (UW-21)	0.3024" (0.3024" min)
Internal fillet weld leg (UW-21)	0.216" (0.216" min)
PWHT performed	No
Produced to Fine Grain Practice and Supplied in Heat Treated Condition	No
Impact Tested	No
UW-21 Flange Welds	
$X_{\min} = \min\left[1.4 \cdot t_n , g_0\right] = \left[1.4 \cdot 0.216 , 0.34\right] =$	0.3024"
$\text{External Leg}_{\min} = X_{\min} + \frac{C_o}{0.7} = 0.3024 + \frac{0}{0.7} =$	0.3024"
$\text{Internal Leg}_{\min} = \min\left[t_n , 0.25" + \frac{C_i}{0.7}\right] = \min\left[0.216 , 0.25 + \frac{0}{0.7}\right] =$	0.216"
Notes	
Flange rated MDMT per UCS-66(b)(3) = -155°F (Coincident ratio = 0.1509) Bolts rated MDMT per Fig UCS-66 note (c) = -55°F	

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \frac{43 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 43} =$	0.1031"
$\text{Stress ratio} = \frac{t_r \cdot E^*}{t_n - c} = \frac{0.1031 \cdot 1}{0.313 - 0.125} =$	0.5486
Rated MDMT per UHA-51(d)(1)(a), (carbon content does not exceed 0.10%) = -320°F	
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 3.56 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
0.0444	1.1988	0.9335	0.2028	–	–	0.0625	0.1335	0.189

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})	0.1512	0.175	weld size is adequate

Calculations for internal pressure 3.56 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[5.2016,\ 2.6008 + (0.216 - 0) + (0.313 - 0.125)\right]$$

$$= 5.2016 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.216 - 0) + 0\right]$$

$$= 0.47 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{3.5602 \cdot 1.534}{20{,}000 \cdot 1 - 0.6 \cdot 3.5602}$$

$$= 0.0003 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{3.56 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 3.56} = 0.0085 \text{ in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{3.56 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 3.56} = 0.01 \text{ in}$$

Area required per UG-37(c)

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

f_{r1} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

f_{r2} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

A = $d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1})$

= $5.2016 \cdot 0.0085 \cdot 1 + 2 \cdot 0.216 \cdot 0.0085 \cdot 1 \cdot (1 - 1)$

= 0.0444 in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= 0.9335 in^2

= $d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $5.2016 \cdot (1 \cdot 0.188 - 1 \cdot 0.0085) - 2 \cdot 0.216 \cdot (1 \cdot 0.188 - 1 \cdot 0.0085) \cdot (1 - 1)$

= $0.9335 \ \text{in}^2$

= $2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $2 \cdot (0.188 + 0.216) \cdot (1 \cdot 0.188 - 1 \cdot 0.0085) - 2 \cdot 0.216 \cdot (1 \cdot 0.188 - 1 \cdot 0.0085) \cdot (1 - 1)$

= $0.145 \ \text{in}^2$

A_2 = smaller of the following= 0.2028 in^2

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t$

= $5 \cdot (0.216 - 0.0003) \cdot 1 \cdot 0.188$

= $0.2028 \ \text{in}^2$

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t_n$

= $5 \cdot (0.216 - 0.0003) \cdot 1 \cdot 0.216$

= $0.233 \ \text{in}^2$

A_{41} = $Leg^2 \cdot f_{r2}$

= $0.25^2 \cdot 1$

= 0.0625 in^2

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

$= 0.9335 + 0.2028 + 0.0625$

= 1.1988 in^2

As Area >= A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \min\,[0.75,\ t_n,\ t] =$ 0.216 in

$t_{c(\min)} = \min\,[0.25,\ 0.7 \cdot t_{\min}] =$ 0.1512 in

$t_{c(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.25 = 0.175 \ \text{in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{3.5602 \cdot 1.534}{17{,}000 \cdot 1 - 0.6 \cdot 3.5602} + 0$$

$$= 0.0003 \quad \text{in}$$

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

$$= \max\left[0.0003,\ 0\right]$$

$$= 0.0003 \quad \text{in}$$

$$t_{b1} = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion}$$

$$= \frac{3.56 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 3.56} + 0.125$$

$$= 0.1335 \quad \text{in}$$

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

$$= \max\left[0.1335,\ 0.0625\right]$$

$$= 0.1335 \quad \text{in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.189,\ 0.1335\right]$$

$$= 0.1335 \quad \text{in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0.0003,\ 0.1335\right]$$

$$= 0.1335 \quad \text{in}$$

Available nozzle wall thickness new, t_n = $0.875 \cdot 0.216$ = 0.189 in

The nozzle neck thickness is adequate.

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 = 49.69 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
0.6199	0.62	0.358	0.1995	–	–	0.0625	0.189	0.189

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})	0.1512	0.175	weld size is adequate

Calculations for internal pressure 49.69 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ \ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[5.2016,\ \ 2.6008 + (0.216 - 0) + (0.313 - 0.125)\right]$$

$$= 5.2016 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ \ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ \ 2.5 \cdot (0.216 - 0) + 0\right]$$

$$= 0.47 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{49.6894 \cdot 1.534}{20{,}000 \cdot 1 - 0.6 \cdot 49.6894}$$

$$= 0.0038 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{49.69 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 49.69} = 0.1192 \text{ in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{49.69 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 49.69} = 0.1402 \text{ in}$$

Area required per UG-37(c)

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

f_{r1} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

f_{r2} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

A = $d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1})$

= $5.2016 \cdot 0.1192 \cdot 1 + 2 \cdot 0.216 \cdot 0.1192 \cdot 1 \cdot (1 - 1)$

= 0.6199 in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= 0.358 in^2

= $d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $5.2016 \cdot (1 \cdot 0.188 - 1 \cdot 0.1192) - 2 \cdot 0.216 \cdot (1 \cdot 0.188 - 1 \cdot 0.1192) \cdot (1 - 1)$

= $0.358 \ \text{in}^2$

= $2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $2 \cdot (0.188 + 0.216) \cdot (1 \cdot 0.188 - 1 \cdot 0.1192) - 2 \cdot 0.216 \cdot (1 \cdot 0.188 - 1 \cdot 0.1192) \cdot (1 - 1)$

= $0.0556 \ \text{in}^2$

A_2 = smaller of the following= 0.1995 in^2

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t$

= $5 \cdot (0.216 - 0.0038) \cdot 1 \cdot 0.188$

= $0.1995 \ \text{in}^2$

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t_n$

= $5 \cdot (0.216 - 0.0038) \cdot 1 \cdot 0.216$

= $0.2292 \ \text{in}^2$

A_{41} = $Leg^2 \cdot f_{r2}$

= $0.25^{\,2} \cdot 1$

= 0.0625 in^2

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

= $0.358 + 0.1995 + 0.0625$

= 0.62 in^2

As Area >= A the reinforcement is adequate.

UW-16(c) Weld Check

Fillet weld: $t_{\min} = \min\left[0.75,\ t_n,\ t\right] =$ 0.216 in

$t_{c(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] =$ 0.1512 in

$t_{c(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.25 = 0.175 \ \text{in}$

The fillet weld size is satisfactory.

Weld strength calculations are not required for this detail which conforms to Fig. UW-16.1, sketch (c-e).

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{49.6894 \cdot 1.534}{17{,}000 \cdot 1 - 0.6 \cdot 49.6894} + 0$$

$$= 0.0045 \quad \text{in}$$

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

$$= \max\left[0.0045,\ 0\right]$$

$$= 0.0045 \quad \text{in}$$

$$t_{b1} = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion}$$

$$= \frac{49.69 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 49.69} + 0.125$$

$$= 0.2442 \quad \text{in}$$

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

$$= \max\left[0.2442,\ 0.0625\right]$$

$$= 0.2442 \quad \text{in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.189,\ 0.2442\right]$$

$$= 0.189 \quad \text{in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0.0045,\ 0.189\right]$$

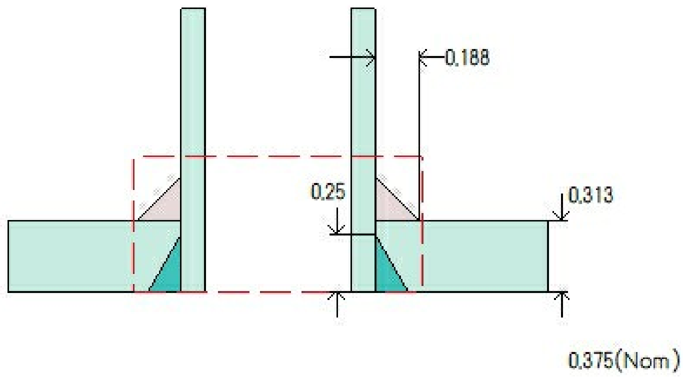
$$= 0.189 \quad \text{in}$$

Available nozzle wall thickness new, t_n = $0.875 \cdot 0.216$ = 0.189 in

The nozzle neck thickness is adequate.

Lev Gauge Right Upper (N7)

ASME Section VIII Division 1, 2023 Edition	



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

Location and Orientation	
Located on	Ellipsoidal Head #1
Orientation	3.11°
End of nozzle to datum line	286.7806"
Calculated as hillside	No
Distance to head center, R	41.5"
Passes through a Category A joint	No

Nozzle	
Service	Level Indicator (LEVEL)
Description	NPS 0.5 Sch 40S (Std)
Access opening	No
Material specification	SA-312 TP304L Wld pipe (II-D p. 88, ln. 16)
Inside diameter, new	0.622"
Pipe nominal wall thickness	0.109"
Pipe minimum wall thickness[1]	0.0954"
Corrosion allowance	0"
Projection available outside vessel, Lpr	6"
Local vessel minimum thickness	0.313"
Liquid static head included	0.46 psi

Welds	
Inner fillet, Leg_{41}	0.188"
Nozzle to vessel groove weld	0.25"

Radiography	
Longitudinal seam	Welded pipe
Circumferential seam	Full UW-11(a) Type 1

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

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \frac{39.91 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 39.91} =$	0.0009"
$\text{Stress ratio} = \frac{t_r \cdot E^*}{t_n - c} = \frac{0.0009 \cdot 1}{0.0954 - 0} =$	0.0092
Impact test exempt per UHA-51(g) (coincident ratio = 0.0092)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 0.46 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)							0.0954	0.0954

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 size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0763	0.1316	weld size is adequate
Combined weld check (t_1 + t_2)	0.1362	0.2566	weld size is adequate
Nozzle to shell groove (Lower)	0.0763	0.125	weld size is adequate

Calculations for internal pressure 0.46 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$
$$= \max\left[0.622,\ 0.311 + (0.109 - 0) + (0.313 - 0.125)\right]$$
$$= 0.622 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$
$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.109 - 0) + 0\right]$$
$$= 0.2725 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$
$$= \frac{0.4647 \cdot 0.311}{16{,}700 \cdot 1 - 0.6 \cdot 0.4647}$$
$$= 0 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{0.46 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 0.46} = 0.0011 \text{ in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{0.46 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 0.46} = 0.0013 \text{ in}$$

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

UW-16(d) Weld Check

$t_{\min} = \min\left[0.75,\ t_n,\ t\right] = 0.109$ in

$t_{1(\min)}$ or $t_{2(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] =$ 0.0763 in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316$ in

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125$ in

The weld size t_2 is satisfactory.

$t_1 + t_2 = 0.2566 \geq 1.25 \cdot t_{\min} =$ 0.1362

The combined weld sizes for t_1 and t_2 are satisfactory.

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{0.4647 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 0.4647} + 0$$

$$= 0 \text{ in}$$

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

$$= \max\left[0,\ 0\right]$$

$$= 0 \text{ in}$$

$$t_{b1} = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion}$$

$$= \frac{0.46 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 0.46} + 0.125$$

$$= 0.1261 \text{ in}$$

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

$$= \max\left[0.1261,\ 0.0625\right]$$

$$= 0.1261 \text{ in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.0954,\ 0.1261\right]$$

$$= 0.0954 \text{ in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0,\ 0.0954\right]$$

$$= 0.0954 \text{ in}$$

Available nozzle wall thickness new, $t_n = 0.875 \cdot 0.109 = 0.0954$ in

The nozzle neck thickness is adequate.

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 = 78.37 psi @ 150 °F							The nozzle passes UG-45	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.0954	0.0954

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 size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0763	0.1316	weld size is adequate
Combined weld check (t_1 + t_2)	0.1362	0.2566	weld size is adequate
Nozzle to shell groove (Lower)	0.0763	0.125	weld size is adequate

Calculations for internal pressure 78.37 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[0.622,\ 0.311 + (0.109 - 0) + (0.313 - 0.125)\right]$$

$$= 0.622 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.109 - 0) + 0\right]$$

$$= 0.2725 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{78.3704 \cdot 0.311}{16{,}700 \cdot 1 - 0.6 \cdot 78.3704}$$

$$= 0.0015 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{78.37 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 78.37} = 0.188 \text{ in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{78.37 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 78.37} = 0.2212 \text{ in}$$

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

UW-16(d) Weld Check

$t_{\text{min}} = \min[0.75,\ t_n,\ t] = 0.109$ in

$t_{1(\text{min})}$ or $t_{2(\text{min})} = \min[0.25,\ 0.7 \cdot t_{\text{min}}] = 0.0763$ in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316$ in

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125$ in

The weld size t_2 is satisfactory.

$t_1 + t_2 = 0.2566 \geq 1.25 \cdot t_{\text{min}} = 0.1362$

The combined weld sizes for t_1 and t_2 are satisfactory.

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{78.3704 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 78.3704} + 0$$

$$= 0.0017 \text{ in}$$

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

$$= \max[0.0017,\ 0]$$

$$= 0.0017 \text{ in}$$

$$t_{b1} = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion}$$

$$= \frac{78.37 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 78.37} + 0.125$$

$$= 0.313 \text{ in}$$

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

$$= \max[0.313,\ 0.0625]$$

$$= 0.313 \text{ in}$$

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

$$= \min[0.0954,\ 0.313]$$

$$= 0.0954 \text{ in}$$

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

$$= \max[0.0017,\ 0.0954]$$

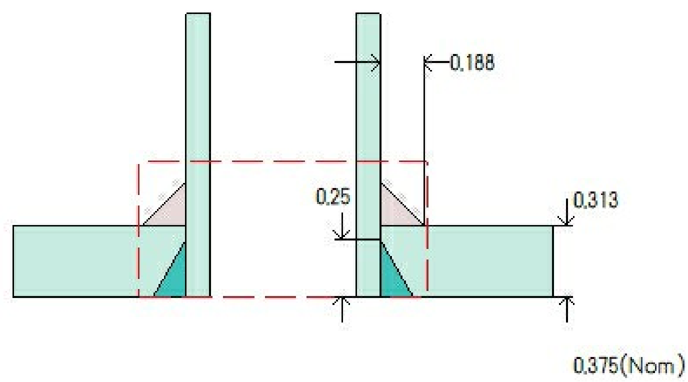
$$= 0.0954 \text{ in}$$

Available nozzle wall thickness new, $t_n = 0.875 \cdot 0.109 = 0.0954$ in

The nozzle neck thickness is adequate.

Lev Gauge Right Lower (N8)

ASME Section VIII Division 1, 2023 Edition	



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

Location and Orientation	
Located on	Ellipsoidal Head #1
Orientation	90°
End of nozzle to datum line	300.0309"
Calculated as hillside	No
Distance to head center, R	2.375"
Passes through a Category A joint	No
Nozzle	
Service	Level Indicator (LEVEL)
Description	NPS 0.5 Sch 40S (Std)
Access opening	No
Material specification	SA-312 TP304L Wld pipe (II-D p. 88, ln. 16)
Inside diameter, new	0.622"
Pipe nominal wall thickness	0.109"
Pipe minimum wall thickness[1]	0.0954"
Corrosion allowance	0"
Projection available outside vessel, Lpr	6"
Local vessel minimum thickness	0.313"
Liquid static head included	1.96 psi
Welds	
Inner fillet, Leg_{41}	0.188"
Nozzle to vessel groove weld	0.25"
Radiography	
Longitudinal seam	Welded pipe

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

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \dfrac{41.4 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 41.4} =$	0.0009"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.0009 \cdot 1}{0.0954 - 0} =$	0.0095
Impact test exempt per UHA-51(g) (coincident ratio = 0.0095)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1.96 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)							0.0954	0.0954

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 size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0763	0.1316	weld size is adequate
Combined weld check (t_1 + t_2)	0.1362	0.2566	weld size is adequate
Nozzle to shell groove (Lower)	0.0763	0.125	weld size is adequate

Calculations for internal pressure 1.96 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[0.622,\ 0.311 + (0.109 - 0) + (0.313 - 0.125)\right]$$

$$= 0.622 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.109 - 0) + 0\right]$$

$$= 0.2725 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{1.9605 \cdot 0.311}{16{,}700 \cdot 1 - 0.6 \cdot 1.9605}$$

$$= 0 \text{ in}$$

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

$$t_r = \frac{P \cdot K_1 \cdot D}{2 \cdot S \cdot E - 0.2 \cdot P}$$

$$= \frac{1.9605 \cdot 0.8977 \cdot 96.25}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 1.9605}$$

$$= 0.0042 \text{ in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{1.96 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 1.96} = 0.0055 \text{ in}$$

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

UW-16(d) Weld Check

$t_{\min} = \min[0.75,\ t_n,\ t] = 0.109$ in

$t_{1(\min)}$ or $t_{2(\min)} = \min[0.25,\ 0.7 \cdot t_{\min}] = 0.0763$ in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316$ in

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125$ in

The weld size t_2 is satisfactory.

$t_1 + t_2 = 0.2566 \geq 1.25 \cdot t_{\min} = 0.1362$

The combined weld sizes for t_1 and t_2 are satisfactory.

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{1.9605 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 1.9605} + 0$$

$$= 0 \text{ in}$$

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

$$= \max[0,\ 0]$$

$$= 0 \text{ in}$$

$$t_{b1} = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion}$$

$$= \frac{1.96 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 1.96} + 0.125$$

$$= 0.1297 \text{ in}$$

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

$$= \max[0.1297,\ 0.0625]$$

$$= 0.1297 \text{ in}$$

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

$$= \min[0.0954,\ 0.1297]$$

$$= 0.0954 \text{ in}$$

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

$$= \max[0,\ 0.0954]$$

$$= 0.0954 \text{ in}$$

Available nozzle wall thickness new, $t_n = 0.875 \cdot 0.109 = 0.0954$ in

The nozzle neck thickness is adequate.

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 = 86.99 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)							0.0954	0.0954

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 size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0763	0.1316	weld size is adequate
Combined weld check (t_1 + t_2)	0.1362	0.2566	weld size is adequate
Nozzle to shell groove (Lower)	0.0763	0.125	weld size is adequate

Calculations for internal pressure 86.99 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ \ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[0.622,\ \ 0.311 + (0.109 - 0) + (0.313 - 0.125)\right]$$

$$= 0.622 \quad \text{in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ \ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ \ 2.5 \cdot (0.109 - 0) + 0\right]$$

$$= 0.2725 \quad \text{in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{86.9901 \cdot 0.311}{16{,}700 \cdot 1 - 0.6 \cdot 86.9901}$$

$$= 0.0016 \quad \text{in}$$

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

$$t_r = \frac{P \cdot K_1 \cdot D}{2 \cdot S \cdot E - 0.2 \cdot P}$$

$$= \frac{86.9901 \cdot 0.8977 \cdot 96.25}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 86.9901}$$

$$= 0.188 \quad \text{in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{86.99 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 86.99} = 0.2455 \text{ in}$$

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

UW-16(d) Weld Check

$t_{\min} = \min\left[0.75,\ t_n,\ t\right] = 0.109$ in

$t_{1(\min)}$ or $t_{2(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] = 0.0763$ in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316$ in

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125$ in

The weld size t_2 is satisfactory.

$t_1 + t_2 = 0.2566 \geq 1.25 \cdot t_{\min} = 0.1362$

The combined weld sizes for t_1 and t_2 are satisfactory.

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{86.9901 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 86.9901} + 0$$

$$= 0.0019 \text{ in}$$

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

$$= \max\left[0.0019,\ 0\right]$$

$$= 0.0019 \text{ in}$$

$$t_{b1} = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion}$$

$$= \frac{86.99 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 86.99} + 0.125$$

$$= 0.3337 \text{ in}$$

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

$$= \max\left[0.3337,\ 0.0625\right]$$

$$= 0.3337 \text{ in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.0954,\ 0.3337\right]$$

$$= 0.0954 \text{ in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

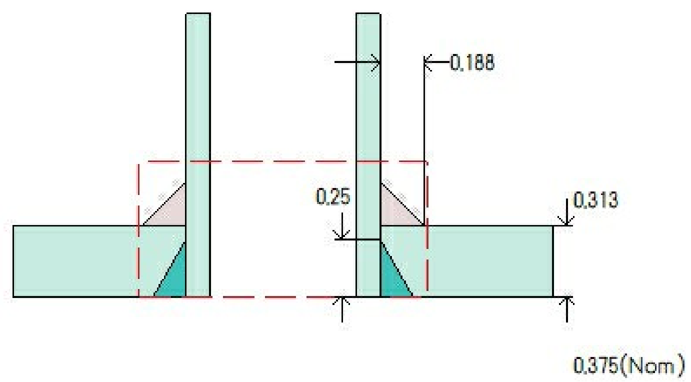
$$= \max\left[0.0019,\ 0.0954\right]$$

$$= 0.0954 \text{ in}$$

Available nozzle wall thickness new, t_n = $0.875 \cdot 0.109$ = 0.0954 in

The nozzle neck thickness is adequate.

Lev Gauge Left Upper (N9)

ASME Section VIII Division 1, 2023 Edition	
	
Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	Ellipsoidal Head #1
Orientation	270°
End of nozzle to datum line	300.0309"
Calculated as hillside	No
Distance to head center, R	2.375"
Passes through a Category A joint	No
Nozzle	
Service	Level Indicator (LEVEL)
Description	NPS 0.5 Sch 40S (Std)
Access opening	No
Material specification	SA-312 TP304L Wld pipe (II-D p. 88, ln. 16)
Inside diameter, new	0.622"
Pipe nominal wall thickness	0.109"
Pipe minimum wall thickness[1]	0.0954"
Corrosion allowance	0"
Projection available outside vessel, Lpr	6"
Local vessel minimum thickness	0.313"
Liquid static head included	1.96 psi
Welds	
Inner fillet, Leg_{41}	0.188"
Nozzle to vessel groove weld	0.25"
Radiography	
Longitudinal seam	Welded pipe

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

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \frac{41.4 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 41.4} =$	0.0009"
$\text{Stress ratio} = \frac{t_r \cdot E^*}{t_n - c} = \frac{0.0009 \cdot 1}{0.0954 - 0} =$	0.0095
Impact test exempt per UHA-51(g) (coincident ratio = 0.0095)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 1.96 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)							0.0954	0.0954

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 size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0763	0.1316	weld size is adequate
Combined weld check (t_1 + t_2)	0.1362	0.2566	weld size is adequate
Nozzle to shell groove (Lower)	0.0763	0.125	weld size is adequate

Calculations for internal pressure 1.96 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[0.622,\ 0.311 + (0.109 - 0) + (0.313 - 0.125)\right]$$

$$= 0.622 \ \text{in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.109 - 0) + 0\right]$$

$$= 0.2725 \ \text{in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{1.9605 \cdot 0.311}{16{,}700 \cdot 1 - 0.6 \cdot 1.9605}$$

$$= 0 \ \text{in}$$

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

$$t_r = \frac{P \cdot K_1 \cdot D}{2 \cdot S \cdot E - 0.2 \cdot P}$$

$$= \frac{1.9605 \cdot 0.8977 \cdot 96.25}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 1.9605}$$

$$= 0.0042 \ \text{in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{1.96 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 1.96} = 0.0055 \ \text{in}$$

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

UW-16(d) Weld Check

$t_{\min} = \min\left[0.75,\ t_n,\ t\right] = 0.109$ in

$t_{1(\min)}$ or $t_{2(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] = 0.0763$ in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316$ in

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125$ in

The weld size t_2 is satisfactory.

$t_1 + t_2 = 0.2566 \geq 1.25 \cdot t_{\min} = 0.1362$

The combined weld sizes for t_1 and t_2 are satisfactory.

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{1.9605 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 1.9605} + 0$$

$$= 0 \text{ in}$$

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

$$= \max\left[0,\ 0\right]$$

$$= 0 \text{ in}$$

$$t_{b1} = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion}$$

$$= \frac{1.96 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 1.96} + 0.125$$

$$= 0.1297 \text{ in}$$

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

$$= \max\left[0.1297,\ 0.0625\right]$$

$$= 0.1297 \text{ in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.0954,\ 0.1297\right]$$

$$= 0.0954 \text{ in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0,\ 0.0954\right]$$

$$= 0.0954 \text{ in}$$

Available nozzle wall thickness new, $t_n = 0.875 \cdot 0.109 = 0.0954$ in

The nozzle neck thickness is adequate.

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 = 86.99 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)							0.0954	0.0954

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 size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0763	0.1316	weld size is adequate
Combined weld check (t_1 + t_2)	0.1362	0.2566	weld size is adequate
Nozzle to shell groove (Lower)	0.0763	0.125	weld size is adequate

Calculations for internal pressure 86.99 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[0.622,\ 0.311 + (0.109 - 0) + (0.313 - 0.125)\right]$$

$$= 0.622 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.109 - 0) + 0\right]$$

$$= 0.2725 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{86.9901 \cdot 0.311}{16{,}700 \cdot 1 - 0.6 \cdot 86.9901}$$

$$= 0.0016 \text{ in}$$

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

$$t_r = \frac{P \cdot K_1 \cdot D}{2 \cdot S \cdot E - 0.2 \cdot P}$$

$$= \frac{86.9901 \cdot 0.8977 \cdot 96.25}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 86.9901}$$

$$= 0.188 \text{ in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{86.99 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 86.99} = 0.2455 \text{ in}$$

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

UW-16(d) Weld Check

$t_{\text{min}} = \min[0.75,\ t_n,\ t] = 0.109$ in

$t_{1(\text{min})}$ or $t_{2(\text{min})} = \min[0.25,\ 0.7 \cdot t_{\text{min}}] = 0.0763$ in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316$ in

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125$ in

The weld size t_2 is satisfactory.

$t_1 + t_2 = 0.2566 \geq 1.25 \cdot t_{\text{min}} = 0.1362$

The combined weld sizes for t_1 and t_2 are satisfactory.

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{86.9901 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 86.9901} + 0$$

$$= 0.0019 \text{ in}$$

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

$$= \max[0.0019,\ 0]$$

$$= 0.0019 \text{ in}$$

$$t_{b1} = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion}$$

$$= \frac{86.99 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 86.99} + 0.125$$

$$= 0.3337 \text{ in}$$

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

$$= \max[0.3337,\ 0.0625]$$

$$= 0.3337 \text{ in}$$

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

$$= \min[0.0954,\ 0.3337]$$

$$= 0.0954 \text{ in}$$

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

$$= \max[0.0019,\ 0.0954]$$

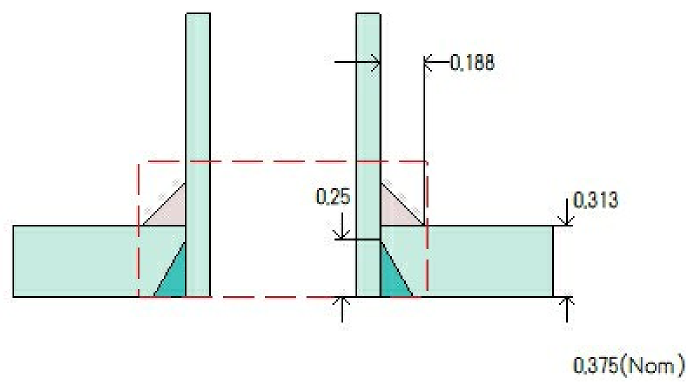
$$= 0.0954 \text{ in}$$

Available nozzle wall thickness new, t_n = $0.875 \cdot 0.109$ = 0.0954 in

The nozzle neck thickness is adequate.

Lev Gauge Left Lower (N10)

ASME Section VIII Division 1, 2023 Edition	



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

Location and Orientation	
Located on	Ellipsoidal Head #1
Orientation	183.11°
End of nozzle to datum line	284.8023"
Calculated as hillside	No
Distance to head center, R	43.5"
Passes through a Category A joint	No
Nozzle	
Service	Level Indicator (LEVEL)
Description	NPS 0.5 Sch 40S (Std)
Access opening	No
Material specification	SA-312 TP304L Wld pipe (II-D p. 88, ln. 16)
Inside diameter, new	0.622"
Pipe nominal wall thickness	0.109"
Pipe minimum wall thickness[1]	0.0954"
Corrosion allowance	0"
Projection available outside vessel, Lpr	6.4625"
Local vessel minimum thickness	0.313"
Liquid static head included	3.53 psi
Welds	
Inner fillet, Leg_{41}	0.188"
Nozzle to vessel groove weld	0.25"
Radiography	
Longitudinal seam	Welded pipe

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

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \frac{42.97 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 42.97} =$	0.0009"
$\text{Stress ratio} = \frac{t_r \cdot E^*}{t_n - c} = \frac{0.0009 \cdot 1}{0.0954 - 0} =$	0.0099
Impact test exempt per UHA-51(g) (coincident ratio = 0.0099)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-45 Summary (in)	
For P = 3.53 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)							0.0954	0.0954

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 size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0763	0.1316	weld size is adequate
Combined weld check (t_1 + t_2)	0.1362	0.2566	weld size is adequate
Nozzle to shell groove (Lower)	0.0763	0.125	weld size is adequate

Calculations for internal pressure 3.53 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[0.622,\ 0.311 + (0.109 - 0) + (0.313 - 0.125)\right]$$

$$= 0.622 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.109 - 0) + 0\right]$$

$$= 0.2725 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{3.5285 \cdot 0.311}{16{,}700 \cdot 1 - 0.6 \cdot 3.5285}$$

$$= 0.0001 \text{ in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{3.53 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 3.53} = 0.0085 \text{ in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{3.53 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 3.53} = 0.01 \text{ in}$$

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

UW-16(d) Weld Check

$t_{\min} = \min\left[0.75,\ t_n,\ t\right] = 0.109$ in

$t_{1(\min)}$ or $t_{2(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] = 0.0763$ in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316$ in

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125$ in

The weld size t_2 is satisfactory.

$t_1 + t_2 = 0.2566 \geq 1.25 \cdot t_{\min} = 0.1362$

The combined weld sizes for t_1 and t_2 are satisfactory.

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{3.6958 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 3.6958} + 0$$

$$= 0.0001 \text{ in}$$

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

$$= \max\left[0.0001,\ 0\right]$$

$$= 0.0001 \text{ in}$$

$$t_{b1} = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion}$$

$$= \frac{3.53 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 3.53} + 0.125$$

$$= 0.1335 \text{ in}$$

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

$$= \max\left[0.1335,\ 0.0625\right]$$

$$= 0.1335 \text{ in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.0954,\ 0.1335\right]$$

$$= 0.0954 \text{ in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0.0001,\ 0.0954\right]$$

$$= 0.0954 \text{ in}$$

Available nozzle wall thickness new, $t_n = 0.875 \cdot 0.109 = 0.0954$ in

The nozzle neck thickness is adequate.

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 = 78.36 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)							0.0954	0.0954

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 size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0763	0.1316	weld size is adequate
Combined weld check (t_1 + t_2)	0.1362	0.2566	weld size is adequate
Nozzle to shell groove (Lower)	0.0763	0.125	weld size is adequate

Calculations for internal pressure 78.36 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[0.622,\ 0.311 + (0.109 - 0) + (0.313 - 0.125)\right]$$

$$= 0.622 \ \text{in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.109 - 0) + 0\right]$$

$$= 0.2725 \ \text{in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{78.3633 \cdot 0.311}{16{,}700 \cdot 1 - 0.6 \cdot 78.3633}$$

$$= 0.0015 \ \text{in}$$

Required thickness t_r from UG-37(a)

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{78.36 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 78.36} = 0.188 \ \text{in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{78.36 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 78.36} = 0.2212 \ \text{in}$$

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

UW-16(d) Weld Check

$t_{\min} = \min\left[0.75,\ t_n,\ t\right] = 0.109\ \text{ in}$

$t_{1(\min)}\ \text{ or }\ t_{2(\min)} = \min\left[0.25,\ 0.7 \cdot t_{\min}\right] =$ 0.0763 in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.188 = 0.1316\ \text{ in}$

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125\ \text{ in}$

The weld size t_2 is satisfactory.

$t_1 + t_2 = 0.2566 \geq 1.25 \cdot t_{\min} =$ 0.1362

The combined weld sizes for t_1 and t_2 are satisfactory.

UG-45 Nozzle Neck Thickness Check

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{UG-27}} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P} + \text{Corrosion}$$

$$= \frac{78.5306 \cdot 0.311}{14{,}200 \cdot 1 - 0.6 \cdot 78.5306} + 0$$

$$= 0.0017\ \text{ in}$$

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

$$= \max\left[0.0017,\ 0\right]$$

$$= 0.0017\ \text{ in}$$

$$t_{b1} = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} + \text{Corrosion}$$

$$= \frac{78.36 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 78.36} + 0.125$$

$$= 0.313\ \text{ in}$$

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

$$= \max\left[0.313,\ 0.0625\right]$$

$$= 0.313\ \text{ in}$$

$$t_b = \min\left[t_{b3},\ t_{b1}\right]$$

$$= \min\left[0.0954,\ 0.313\right]$$

$$= 0.0954\ \text{ in}$$

$$t_{\text{UG-45}} = \max\left[t_a,\ t_b\right]$$

$$= \max\left[0.0017,\ 0.0954\right]$$

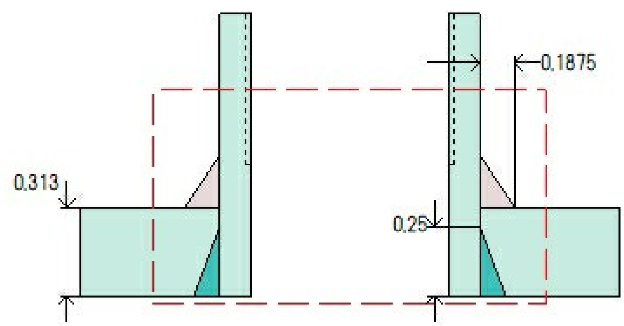
$$= 0.0954\ \text{ in}$$

Available nozzle wall thickness new, $t_n = 0.875 \cdot 0.109 = 0.0954$ in

The nozzle neck thickness is adequate.

Spin hole coupling 1 (N11)

ASME Section VIII Division 1, 2023 Edition	



Note: round inside edges per UG-76(c)	
Location and Orientation	
Located on	Ellipsoidal Head #1
Orientation	0°
End of nozzle to datum line	294.7475"
Calculated as hillside	No
Distance to head center, R	0"
Passes through a Category A joint	No
Nozzle	
Service	Threaded (THRD)
Description	NPS 0.75 Class 3000 - Threaded Half Coupling
Access opening	No
Material specification	SA-182 F304 ≤ 5 (II-D p. 92, ln. 4)
Inside diameter, new	1.05"
Nominal wall thickness	0.165"
Corrosion allowance	0"
Projection available outside vessel, Lpr	0.687"
Local vessel minimum thickness	0.313"
Liquid static head included	1.96 psi
Welds	
Inner fillet, Leg_{41}	0.1875"
Nozzle to vessel groove weld	0.25"
Radiography	
Longitudinal seam	Spot UW-11(b) Type 1

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \dfrac{41.4 \cdot 0.525}{20{,}000 \cdot 0.85 - 0.6 \cdot 41.4} =$	0.0013"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.0013 \cdot 0.85}{0.165 - 0} =$	0.0066
Impact test exempt per UHA-51(g) (coincident ratio = 0.0066)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 1.96 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-44	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
0.0044	0.3642	0.193	0.136	–	–	0.0352	0.0625	0.165

UG-41 Weld Failure Path Analysis Summary (lb_f)				
All failure paths are stronger than the applicable weld loads				
Weld load W	Weld load W_{1-1}	Path 1-1 strength	Weld load W_{2-2}	Path 2-2 strength
-2,558.29	3,424	8,391.82	4,664.8	7,993.39

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0938	0.1313	weld size is adequate
Nozzle to shell groove (Lower)	0.0938	0.125	weld size is adequate

Calculations for internal pressure 1.96 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[1.05,\ 0.525 + (0.165 - 0) + (0.313 - 0.125)\right]$$

$$= 1.05 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.165 - 0) + 0\right]$$

$$= 0.4125 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{1.9605 \cdot 0.525}{20{,}000 \cdot 1 - 0.6 \cdot 1.9605}$$

$$= 0.0001 \text{ in}$$

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

$$t_r = \frac{P \cdot K_1 \cdot D}{2 \cdot S \cdot E - 0.2 \cdot P}$$

$$= \frac{1.9605 \cdot 0.8977 \cdot 96.25}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 1.9605}$$

$$= 0.0042 \text{ in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{1.96 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 1.96} = 0.0055 \text{ in}$$

Opening N8 is too close per UG-36(c)(3)(d) to allow an exemption per UG-36(c)(3)(a). Reinforcement calculations performed.

Area required per UG-37(c)

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

f_{r1} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

f_{r2} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

$$A = d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1})$$

$$= 1.05 \cdot 0.0042 \cdot 1 + 2 \cdot 0.165 \cdot 0.0042 \cdot 1 \cdot (1 - 1)$$

= 0.0044 in^2

Area available from FIG. UG-37.1

A_1 = larger of the following= 0.193 in^2

$$= d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$$

$$= 1.05 \cdot (1 \cdot 0.188 - 1 \cdot 0.0042) - 2 \cdot 0.165 \cdot (1 \cdot 0.188 - 1 \cdot 0.0042) \cdot (1 - 1)$$

$$= 0.193 \text{ in}^2$$

$$= 2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$$

$$= 2 \cdot (0.188 + 0.165) \cdot (1 \cdot 0.188 - 1 \cdot 0.0042) - 2 \cdot 0.165 \cdot (1 \cdot 0.188 - 1 \cdot 0.0042) \cdot (1 - 1)$$

$$= 0.1297 \text{ in}^2$$

A_2 = smaller of the following= 0.136 in^2

$$= 5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t$$

$$= 5 \cdot (0.165 - 0.0001) \cdot 1 \cdot 0.188$$

$$= 0.155 \text{ in}^2$$

$$= 5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t_n$$

$$= 5 \cdot (0.165 - 0.0001) \cdot 1 \cdot 0.165$$

$$= 0.136 \text{ in}^2$$

$$A_{41} = Leg^2 \cdot f_{r2}$$

$$= 0.1875^2 \cdot 1$$

= 0.0352 in^2

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

$$= 0.193 + 0.136 + 0.0352$$

= 0.3642 in^2

As Area >= A the reinforcement is adequate.

UW-16(f)(2)(b) Weld Check

$t_{\min} = \min\left[0.75,\ t_n,\ t\right] = 0.165$ in

$t_{1(\min)}$ or $t_{2(\min)} = \min\left[0.09375,\ 0.7 \cdot t_{\min}\right] = 0.0938$ in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.1875 = 0.1313$ in

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125$ in

The weld size t_2 is satisfactory.

UG-44 Thickness Check - ASME B16.11 Coupling

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{App 1-1}} = \frac{P \cdot R_o}{S_n \cdot E + 0.4 \cdot P} + \text{Corrosion}$$

$$= \frac{1.9605 \cdot 0.69}{20{,}000 \cdot 0.85 + 0.4 \cdot 1.9605} + 0$$

$$= 0.0001 \text{ in}$$

$$t_{a\text{UG-44}} = \max\left[t_{a\text{App 1-1}},\ t_{b\text{UG16}}\right]$$

$$= \max\left[0.0001,\ 0.0625\right]$$

$$= 0.0625 \text{ in}$$

Available nozzle wall thickness new, t_n = 0.165 in

The nozzle neck thickness is adequate.

Allowable stresses in joints UG-45 and UW-15(c)

Groove weld in tension:	$0.74 \cdot 20{,}000$ =	14,800 psi
Nozzle wall in shear:	$0.7 \cdot 20{,}000$ =	14,000 psi
Inner fillet weld in shear:	$0.49 \cdot 20{,}000$ =	9,800 psi

Strength of welded joints:

(1) Inner fillet weld in shear

$\frac{\pi}{2} \cdot \text{Nozzle OD} \cdot \text{Leg} \cdot S_i = \frac{\pi}{2} \cdot 1.38 \cdot 0.1875 \cdot 9{,}800$ = 3,983.15 lb_f

(3) Nozzle wall in shear

$\frac{\pi}{2} \cdot \text{Mean nozzle dia} \cdot t_n \cdot S_n = \frac{\pi}{2} \cdot 1.215 \cdot 0.165 \cdot 14{,}000$ = 4,408.68 lb_f

(4) Groove weld in tension

$\frac{\pi}{2} \cdot \text{Nozzle OD} \cdot t_w \cdot S_g = \frac{\pi}{2} \cdot 1.38 \cdot 0.125 \cdot 14{,}800$ = 4,010.24 lb_f

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

W = $(A - A_1 + 2 \cdot t_n \cdot f_{r1} \cdot (E_1 \cdot t - F \cdot t_r)) \cdot S_v$

= $(0.0044 - 0.193 + 2 \cdot 0.165 \cdot 1 \cdot (1 \cdot 0.188 - 1 \cdot 0.0042)) \cdot 20{,}000$

= -2,558.29 lb_f

$W_{1\text{-}1}$ = $(A_2 + A_5 + A_{41} + A_{42}) \cdot S_v$

= $(0.136 + 0 + 0.0352 + 0) \cdot 20{,}000$

= 3,424 lb_f

$W_{2\text{-}2}$ = $(A_2 + A_3 + A_{41} + A_{43} + 2 \cdot t_n \cdot t \cdot f_{r1}) \cdot S_v$

= $(0.136 + 0 + 0.0352 + 0 + 2 \cdot 0.165 \cdot 0.188 \cdot 1) \cdot 20{,}000$

= 4,664.8 lb_f

Load for path 1-1 lesser of W or $W_{1\text{-}1}$ = -2,558.29 lb_f
Path 1-1 through (1) & (3) = 3,983.15 + 4,408.68 = 8,391.82 lb_f
Path 1-1 is stronger than W so it is acceptable per UG-41(b)(2).

Load for path 2-2 lesser of W or $W_{2\text{-}2}$ = -2,558.29 lb_f
Path 2-2 through (1), (4) = 3,983.15 + 4,010.24 = 7,993.39 lb_f
Path 2-2 is stronger than W so it is acceptable per UG-41(b)(2).

Reinforcement Calculations for MAWP

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

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 80.87 psi @ 150 °F The opening is adequately reinforced							The nozzle passes UG-44	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
0.1835	0.1835	0.0139	0.1344	–	–	0.0352	0.0625	0.165

UG-41 Weld Failure Path Analysis Summary (lb_f)				
All failure paths are stronger than the applicable weld loads				
Weld load W	Weld load W_{1-1}	Path 1-1 strength	Weld load W_{2-2}	Path 2-2 strength
3,479.2	3,392	8,391.82	4,632.8	7,993.39

UW-16 Weld Sizing Summary			
Weld description	Required weld size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0938	0.1313	weld size is adequate
Nozzle to shell groove (Lower)	0.0938	0.125	weld size is adequate

Calculations for internal pressure 80.87 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[1.05,\ 0.525 + (0.165 - 0) + (0.313 - 0.125)\right]$$

$$= 1.05 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.165 - 0) + 0\right]$$

$$= 0.4125 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{80.8675 \cdot 0.525}{20{,}000 \cdot 1 - 0.6 \cdot 80.8675}$$

$$= 0.0021 \text{ in}$$

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

$$t_r = \frac{P \cdot K_1 \cdot D}{2 \cdot S \cdot E - 0.2 \cdot P}$$

$$= \frac{80.8675 \cdot 0.8977 \cdot 96.25}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 80.8675}$$

$$= 0.1748 \text{ in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{80.87 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 80.87} = 0.2282 \text{ in}$$

Opening N8 is too close per UG-36(c)(3)(d) to allow an exemption per UG-36(c)(3)(a). Reinforcement calculations performed.

Area required per UG-37(c)

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

f_{r1} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

f_{r2} = lesser of 1 or $\frac{S_n}{S_v}$ = 1

A = $d \cdot t_r \cdot F + 2 \cdot t_n \cdot t_r \cdot F \cdot (1 - f_{r1})$

= $1.05 \cdot 0.1748 \cdot 1 + 2 \cdot 0.165 \cdot 0.1748 \cdot 1 \cdot (1 - 1)$

= 0.1835 in²

Area available from FIG. UG-37.1

A_1 = larger of the following= 0.0139 in²

= $d \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $1.05 \cdot (1 \cdot 0.188 - 1 \cdot 0.1748) - 2 \cdot 0.165 \cdot (1 \cdot 0.188 - 1 \cdot 0.1748) \cdot (1 - 1)$

= 0.0139 in^2

= $2 \cdot (t + t_n) \cdot (E_1 \cdot t - F \cdot t_r) - 2 \cdot t_n \cdot (E_1 \cdot t - F \cdot t_r) \cdot (1 - f_{r1})$

= $2 \cdot (0.188 + 0.165) \cdot (1 \cdot 0.188 - 1 \cdot 0.1748) - 2 \cdot 0.165 \cdot (1 \cdot 0.188 - 1 \cdot 0.1748) \cdot (1 - 1)$

= 0.0094 in^2

A_2 = smaller of the following= 0.1344 in²

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t$

= $5 \cdot (0.165 - 0.0021) \cdot 1 \cdot 0.188$

= 0.1531 in^2

= $5 \cdot (t_n - t_{rn}) \cdot f_{r2} \cdot t_n$

= $5 \cdot (0.165 - 0.0021) \cdot 1 \cdot 0.165$

= 0.1344 in^2

A_{41} = $Leg^2 \cdot f_{r2}$

= $0.1875^2 \cdot 1$

= 0.0352 in²

$$Area = A_1 + A_2 + A_{41}$$
$$= 0.0139 + 0.1344 + 0.0352$$
$$= 0.1835 \text{ in}^2$$

As Area >= A the reinforcement is adequate.

UW-16(f)(2)(b) Weld Check

$t_{\min} = \min[0.75,\ t_n,\ t] = 0.165$ in

$t_{1(\min)}$ or $t_{2(\min)} = \min[0.09375,\ 0.7 \cdot t_{\min}] = 0.0938$ in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.1875 = 0.1313$ in

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125$ in

The weld size t_2 is satisfactory.

UG-44 Thickness Check - ASME B16.11 Coupling

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{App 1-1}} = \frac{P \cdot R_o}{S_n \cdot E + 0.4 \cdot P} + \text{Corrosion}$$
$$= \frac{80.8675 \cdot 0.69}{20{,}000 \cdot 0.85 + 0.4 \cdot 80.8675} + 0$$
$$= 0.0033 \text{ in}$$

$$t_{a\text{UG-44}} = \max[t_{a\text{App 1-1}},\ t_{b\text{UG16}}]$$
$$= \max[0.0033,\ 0.0625]$$
$$= 0.0625 \text{ in}$$

Available nozzle wall thickness new, t_n = 0.165 in

The nozzle neck thickness is adequate.

Allowable stresses in joints UG-45 and UW-15(c)

Groove weld in tension:	$0.74 \cdot 20{,}000$	=	14,800 psi
Nozzle wall in shear:	$0.7 \cdot 20{,}000$	=	14,000 psi
Inner fillet weld in shear:	$0.49 \cdot 20{,}000$	=	9,800 psi

Strength of welded joints:

(1) Inner fillet weld in shear
$\frac{\pi}{2} \cdot \text{Nozzle OD} \cdot \text{Leg} \cdot S_i = \frac{\pi}{2} \cdot 1.38 \cdot 0.1875 \cdot 9{,}800$ = 3,983.15 lb_f

(3) Nozzle wall in shear
$\frac{\pi}{2} \cdot \text{Mean nozzle dia} \cdot t_n \cdot S_n = \frac{\pi}{2} \cdot 1.215 \cdot 0.165 \cdot 14{,}000$ = 4,408.68 lb_f

(4) Groove weld in tension
$\frac{\pi}{2} \cdot \text{Nozzle OD} \cdot t_w \cdot S_g = \frac{\pi}{2} \cdot 1.38 \cdot 0.125 \cdot 14{,}800$ = 4,010.24 lb_f

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

W = $(A - A_1 + 2 \cdot t_n \cdot f_{r1} \cdot (E_1 \cdot t - F \cdot t_r)) \cdot S_v$

= $(0.1835 - 0.0139 + 2 \cdot 0.165 \cdot 1 \cdot (1 \cdot 0.188 - 1 \cdot 0.1748)) \cdot 20{,}000$

= 3,479.2 lb_f

W_{1-1} = $(A_2 + A_5 + A_{41} + A_{42}) \cdot S_v$

= $(0.1344 + 0 + 0.0352 + 0) \cdot 20{,}000$

= 3,392 lb_f

W_{2-2} = $(A_2 + A_3 + A_{41} + A_{43} + 2 \cdot t_n \cdot t \cdot f_{r1}) \cdot S_v$

= $(0.1344 + 0 + 0.0352 + 0 + 2 \cdot 0.165 \cdot 0.188 \cdot 1) \cdot 20{,}000$

= 4,632.8 lb_f

Load for path 1-1 lesser of W or W_{1-1} = 3,392 lb_f
Path 1-1 through (1) & (3) = 3,983.15 + 4,408.68 = 8,391.82 lb_f
Path 1-1 is stronger than W_{1-1} so it is acceptable per UG-41(b)(1).

Load for path 2-2 lesser of W or W_{2-2} = 3,479.2 lb_f
Path 2-2 through (1), (4) = 3,983.15 + 4,010.24 = 7,993.39 lb_f
Path 2-2 is stronger than W so it is acceptable per UG-41(b)(2).

Spin hole coupling 2 (N12)

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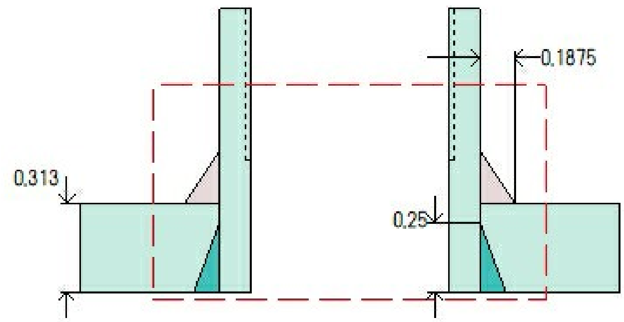


Note: round inside edges per UG-76(c)

Location and Orientation	
Located on	Ellipsoidal Head #2
Orientation	0°
End of nozzle to datum line	-42.7475"
Calculated as hillside	No
Distance to head center, R	0"
Passes through a Category A joint	No
Nozzle	
Service	Threaded (THRD)
Description	NPS 0.75 Class 3000 - Threaded Half Coupling
Access opening	No
Material specification	SA-182 F304 ≤ 5 (II-D p. 92, ln. 4)
Inside diameter, new	1.05"
Nominal wall thickness	0.165"
Corrosion allowance	0"
Projection available outside vessel, Lpr	0.687"
Local vessel minimum thickness	0.313"
Liquid static head included	1.96 psi
Welds	
Inner fillet, Leg_{41}	0.1875"
Nozzle to vessel groove weld	0.25"
Radiography	
Longitudinal seam	Spot UW-11(b) Type 1

UHA-51 Material Toughness Requirements Nozzle	
$t_r = \frac{41.4 \cdot 0.525}{20{,}000 \cdot 0.85 - 0.6 \cdot 41.4} =$	0.0013"
$\text{Stress ratio} = \frac{t_r \cdot E^*}{t_n - c} = \frac{0.0013 \cdot 0.85}{0.165 - 0} =$	0.0066
Impact test exempt per UHA-51(g) (coincident ratio = 0.0066)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of 0°F.	

Reinforcement Calculations for Internal Pressure

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 1.96 psi @ 150 °F							The nozzle passes UG-44	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.0625	0.165

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 size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0938	0.1313	weld size is adequate
Nozzle to shell groove (Lower)	0.0938	0.125	weld size is adequate

Calculations for internal pressure 1.96 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[1.05,\ 0.525 + (0.165 - 0) + (0.313 - 0.125)\right]$$

$$= 1.05 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.165 - 0) + 0\right]$$

$$= 0.4125 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{1.9605 \cdot 0.525}{20{,}000 \cdot 1 - 0.6 \cdot 1.9605}$$

$$= 0.0001 \text{ in}$$

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

$$t_r = \frac{P \cdot K_1 \cdot D}{2 \cdot S \cdot E - 0.2 \cdot P}$$

$$= \frac{1.9605 \cdot 0.8977 \cdot 96.25}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 1.9605}$$

$$= 0.0042 \text{ in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{1.96 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 1.96} = 0.0055 \text{ in}$$

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

UW-16(f)(2)(b) Weld Check

$t_{\min} = \min\left[0.75,\ t_n,\ t\right] = 0.165$ in

$t_{1(\min)}$ or $t_{2(\min)} = \min\left[0.09375,\ 0.7 \cdot t_{\min}\right] = 0.0938$ in

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.1875 = 0.1313$ in

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125$ in

The weld size t_2 is satisfactory.

UG-44 Thickness Check - ASME B16.11 Coupling

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{App 1-1}} = \frac{P \cdot R_o}{S_n \cdot E + 0.4 \cdot P} + \text{Corrosion}$$

$$= \frac{1.9605 \cdot 0.69}{20{,}000 \cdot 0.85 + 0.4 \cdot 1.9605} + 0$$

$$= 0.0001 \text{ in}$$

$$t_{a\text{UG-44}} = \max\left[t_{a\text{App 1-1}},\ t_{b\text{UG16}}\right]$$

$$= \max\left[0.0001,\ 0.0625\right]$$

$$= 0.0625 \text{ in}$$

Available nozzle wall thickness new, t_n = 0.165 in

The nozzle neck thickness is adequate.

Reinforcement Calculations for MAWP

The vessel wall thickness governs the MAWP of this nozzle.

UG-37 Area Calculation Summary (in^2)							UG-44 Summary (in)	
For P = 86.99 psi @ 150 °F							The nozzle passes UG-44	
A required	A available	A_1	A_2	A_3	A_5	A welds	t_{req}	t_{min}
This nozzle is exempt from area calculations per UG-36(c)(3)(a)							0.0625	0.165

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 size (in)	Actual weld size (in)	Status
Nozzle to shell fillet (Leg_{41})	0.0938	0.1313	weld size is adequate
Nozzle to shell groove (Lower)	0.0938	0.125	weld size is adequate

Calculations for internal pressure 86.99 psi @ 150 °F

Parallel Limit of reinforcement per UG-40

$$L_R = \max\left[d,\ R_n + (t_n - C_n) + (t - C)\right]$$

$$= \max\left[1.05,\ 0.525 + (0.165 - 0) + (0.313 - 0.125)\right]$$

$$= 1.05 \text{ in}$$

Outer Normal Limit of reinforcement per UG-40

$$L_H = \min\left[2.5 \cdot (t - C),\ 2.5 \cdot (t_n - C_n) + t_e\right]$$

$$= \min\left[2.5 \cdot (0.313 - 0.125),\ 2.5 \cdot (0.165 - 0) + 0\right]$$

$$= 0.4125 \text{ in}$$

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

$$t_{rn} = \frac{P \cdot R_n}{S_n \cdot E - 0.6 \cdot P}$$

$$= \frac{86.9901 \cdot 0.525}{20{,}000 \cdot 1 - 0.6 \cdot 86.9901}$$

$$= 0.0023 \text{ in}$$

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

$$t_r = \frac{P \cdot K_1 \cdot D}{2 \cdot S \cdot E - 0.2 \cdot P}$$

$$= \frac{86.9901 \cdot 0.8977 \cdot 96.25}{2 \cdot 20{,}000 \cdot 1 - 0.2 \cdot 86.9901}$$

$$= 0.188 \text{ in}$$

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

$$t_r = \frac{P \cdot D \cdot K}{2 \cdot S \cdot E - 0.2 \cdot P} = \frac{86.99 \cdot 96.25 \cdot 0.99655}{2 \cdot 20{,}000 \cdot 0.85 - 0.2 \cdot 86.99} = 0.2455 \text{ in}$$

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

UW-16(f)(2)(b) Weld Check

$t_{\text{min}} = \min\left[0.75,\ t_n,\ t\right] = 0.165 \text{ in}$

$t_{1(\text{min})} \text{ or } t_{2(\text{min})} = \min\left[0.09375,\ 0.7 \cdot t_{\text{min}}\right] = 0.0938 \text{ in}$

$t_{1(actual)} = 0.7 \cdot \text{Leg} = 0.7 \cdot 0.1875 = 0.1313 \text{ in}$

The weld size t_1 is satisfactory.

$t_{2(actual)} = 0.125 \text{ in}$

The weld size t_2 is satisfactory.

UG-44 Thickness Check - ASME B16.11 Coupling

Interpretation VIII-1-83-66 has been applied.

$$t_{a\text{App 1-1}} = \frac{P \cdot R_o}{S_n \cdot E + 0.4 \cdot P} + \text{Corrosion}$$

$$= \frac{86.9901 \cdot 0.69}{20{,}000 \cdot 0.85 + 0.4 \cdot 86.9901} + 0$$

$$= 0.0035 \text{ in}$$

$$t_{a\text{UG-44}} = \max\left[t_{a\text{App 1-1}},\ t_{b\text{UG16}}\right]$$

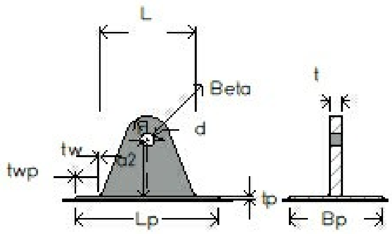
$$= \max\left[0.0035,\ 0.0625\right]$$

$$= 0.0625 \text{ in}$$

Available nozzle wall thickness new, t_n = 0.165 in

The nozzle neck thickness is adequate.

Lifting Lug #1 (See Alternative Calc)

Geometry Inputs	
	
Attached To	Cylinder #2
Material	304/304L
Orientation	Longitudinal
Distance of Lift Point From Datum	210"
Angular Position	0°
Length, L	10"
Height, H	8.5"
Lug Radius, R	2.5"
Thickness, t	0.625"
Hole Diameter, d	1.5"
Pin Diameter, Dp	1.0092"
Distance from Load to Shell or Pad, a_2	6"
Load Angle Normal to Vessel, β	-45°
Load Angle from Vertical, ϕ	-45°
Welds	
Size, t_w	0.25"
Reinforcement Pad	
Width, B_p	5"
Length, L_p	15"
Thickness, t_p	0.313"
Weld Size, t_{wp}	0.25"

Intermediate Values	
Load Factor	1.5000
Vessel Weight (new, incl. Load Factor), W	20,014.2 lb
Lug Weight (new), W_{lug}	17.2 lb
Distance from Center of Gravity to this lug, x_1	87.7067"
Distance from Center of Gravity to second lug, x_2	80.2933"
Allowable Stress, Tensile, σ_t	19,980 psi
Allowable Stress, Shear, σ_s	13,320 psi
Allowable Stress, Bearing, σ_p	29,970 psi
Allowable Stress, Bending, σ_b	22,201 psi
Allowable Stress, Weld Shear, $\tau_{allowable}$	13,320 psi
Allowable Stress set to 1/3 Sy per ASME B30.20	No

Summary Values	
Required Lift Pin Diameter, d_{reqd}	0.8041"
Required Lug Thickness, t_{reqd}	0.4472"
Lug Stress Ratio, σ_{ratio}	0.32
Weld Shear Stress Ratio, τ_{ratio}	0.83
Lug Design	Acceptable
Local Stresses WRC 537	**Unacceptable**

Lift Forces

F_r = force on vessel at lug

$$F_r = \left[\frac{W}{\cos(\phi_1)}\right] \cdot \left(1 - \frac{x_1}{x_1 + x_2}\right) = \frac{20{,}014.2}{\cos(-45)} \cdot \left(1 - \frac{87.7067}{87.7067 + 80.2933}\right) = 13{,}528 \text{ lb}_f$$

where 'x$_1$' is the distance between this lug and the center of gravity

'x$_2$' is the distance between the second lift lug and the center of gravity

Lug Pin Diameter - Shear stress

$$d_{\text{reqd}} = \sqrt{\frac{2 \cdot F_v}{\pi \cdot \sigma_s}}$$

$$= \sqrt{\frac{2 \cdot 13{,}528}{\pi \cdot 13{,}320}} = 0.8041"$$

$$\frac{d_{reqd}}{D_p} = \frac{0.8041}{1.0092} = 0.80 \quad \text{Acceptable}$$

$$\sigma = \frac{F_v}{A}$$

$$= \frac{F_v}{2 \cdot (0.25 \cdot \pi \cdot D_p^2)}$$

$$= \frac{13{,}528}{2 \cdot (0.25 \cdot \pi \cdot 1.0092^{\ 2})} = 8{,}455 \text{ psi}$$

$$\frac{\sigma}{\sigma_s} = \frac{8{,}455}{13{,}320} = 0.63 \quad \text{Acceptable}$$

Lug Thickness - Tensile stress

$$t_{\text{reqd}} = \frac{F_v}{(L_d - d) \cdot \sigma_t}$$

$$= \frac{13{,}528}{(5.3648 - 1.5) \cdot 19{,}980} = 0.1752"$$

$$\frac{t_{\text{reqd}}}{t} = \frac{0.1752}{0.625} = 0.28 \quad \text{Acceptable}$$

$$\sigma = \frac{F_v}{A}$$

$$= \frac{F_v}{(L_d - d) \cdot t}$$

$$= \frac{13{,}528}{(5.3648 - 1.5) \cdot 0.625} = 5{,}600 \ \text{psi}$$

$$\frac{\sigma}{\sigma_t} = \frac{5{,}600}{19{,}980} = 0.28 \quad \text{Acceptable}$$

Lug Thickness - Bearing stress

$$t_{\text{reqd}} = \frac{F_v}{D_p \cdot \sigma_p}$$

$$= \frac{13{,}528}{1.0092 \cdot 29{,}970} = 0.4472"$$

$$\frac{t_{\text{reqd}}}{t} = \frac{0.4472}{0.625} = 0.72 \quad \text{Acceptable}$$

$$\sigma = \frac{F_v}{A_{\text{bearing}}}$$

$$= \frac{F_v}{D_p \cdot (t)}$$

$$= \frac{13{,}528}{1.0092 \cdot (0.625)} = 21{,}446 \ \text{psi}$$

$$\frac{\sigma}{\sigma_p} = \frac{21{,}446}{29{,}970} = 0.72 \quad \text{Acceptable}$$

Lug Thickness - Shear stress

$$t_{\text{reqd}} = \frac{\frac{F_v}{\sigma_s}}{2 \cdot L_{\text{shear}}}$$

$$= \frac{\frac{13{,}528}{13{,}320}}{2 \cdot 1.8516} = 0.2742''$$

$$\frac{t_{\text{reqd}}}{t} = \frac{0.2742}{0.625} = 0.44 \quad \text{Acceptable}$$

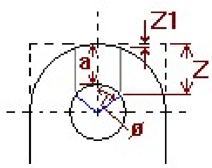
$$\tau = \frac{F_v}{A_{\text{shear}}}$$

$$= \frac{F_v}{2 \cdot t \cdot L_{\text{shear}}}$$

$$= \frac{13{,}528}{2 \cdot 0.625 \cdot 1.8516} = 5{,}845 \ \text{psi}$$

$$\frac{\tau}{\sigma_s} = \frac{5{,}845}{13{,}320} = 0.44 \quad \text{Acceptable}$$

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



$$\phi = 55 \cdot \frac{D_p}{d}$$

$$= 55 \cdot \frac{1.0092}{1.5}$$

$$= 37.0049^\circ$$

$$L_{\text{shear}} = (H - a2 - 0.5 \cdot d) + 0.5 \cdot D_p \cdot (1 - \cos(\phi))$$

$$= (8.5 - 6 - 0.5 \cdot 1.5) + 0.5 \cdot 1.0092 \cdot (1 - \cos(37.0049))$$

$$= 1.8516''$$

Lug Plate Stress

Lug stress tensile + bending during lift:

$$\sigma_{\text{ratio}} = \left[\frac{F_{\text{ten}}}{A_{\text{ten}} \cdot \sigma_t}\right] + \left[\frac{M_{\text{bend}}}{Z_{\text{bend}} \cdot \sigma_b}\right] \leq 1$$

$$= \left[\frac{F_r \cdot \cos(\beta)}{t \cdot L \cdot \sigma_t}\right] + \left[\frac{6 \cdot |F_r \cdot \sin(\beta) \cdot \text{Hght} - F_r \cdot \cos(\beta) \cdot a_1|}{t \cdot L_2 \cdot \sigma_b}\right] \leq 1$$

$$= 13{,}528 \cdot \frac{\cos(-45.0)}{0.625 \cdot 10 \cdot 19{,}980} + 6 \cdot \frac{|13{,}528 \cdot \sin(-45.0) \cdot 6 - 13{,}528 \cdot \cos(-45.0) \cdot 0|}{0.625 \cdot 10^2 \cdot 22{,}201}$$

$$= 0.32 \quad \text{Acceptable}$$

Weld Stress

Weld stress, tensile, bending and shear during lift:

Direct shear:

Shear stress at lift angle -45.00°; lift force = 13,528 lb_f

$$A_{\text{weld}} = 2 \cdot (0.707) \cdot t_w \cdot (L + t)$$

$$= 2 \cdot (0.707) \cdot 0.25 \cdot (10 + 0.625) = 3.7559 \ \text{in}^2$$

$$\tau_t = F_{\text{lug}} \cdot \frac{\cos(\beta)}{A_{\text{weld}}}$$

$$= 13{,}528 \cdot \frac{\cos(-45.0)}{3.7559} = 2{,}547 \ \text{psi}$$

$$\tau_s = F_{\text{lug}} \cdot \frac{\sin(\beta)}{A_{\text{weld}}}$$

$$= 13{,}528 \cdot \frac{\sin(-45.0)}{3.7559} = -2{,}547 \ \text{psi}$$

$$\tau_b = M \cdot \frac{c}{I}$$

$$= 3 \cdot \frac{F_{\text{lug}} \cdot \sin(\beta) \cdot Hght - F_{\text{lug}} \cdot \cos(\beta) \cdot a_1}{0.707 \cdot h \cdot L \cdot (3 \cdot t + L)}$$

$$= 3 \cdot \frac{|13{,}528 \cdot \sin(-45.0) \cdot 6 - 13{,}528 \cdot \cos(-45.0) \cdot (0)|}{20.9891}$$

$$= 8{,}203 \ \text{psi}$$

$$\tau_{\text{ratio}} = \frac{\sqrt{(\tau_t + \tau_b)^2 + \tau_s^2}}{\tau_{\text{allowable}}} \leq 1$$

$$= \frac{\sqrt{(2{,}547 + 8{,}203)^2 + (-2{,}547)^2}}{13{,}320}$$

= 0.83 Acceptable

Pad Weld Stress, tensile, bending and shear during lift:

Direct shear:

Shear stress at lift angle -45.00°; lift force = 13,528 lb_f

$$A_{\text{weld}} = 2 \cdot (0.707) \cdot t_{w\_p} \cdot (L_p + B_p)$$

$$= 2 \cdot (0.707) \cdot 0.25 \cdot (15 + 5) = 7.07 \ \text{in}^2$$

$$\tau_t = F_{\text{lug}} \cdot \frac{\cos(\beta)}{A_{\text{weld}}}$$

$$= 13{,}528 \cdot \frac{\cos(-45.0)}{7.07} = 1{,}353 \ \text{psi}$$

$$\tau_s = F_{\text{lug}} \cdot \frac{\sin(\beta)}{A_{\text{weld}}}$$

$$= 13{,}528 \cdot \frac{\sin(-45.0)}{7.07} = -1{,}353 \ \text{psi}$$

$$\tau_b = M \cdot \frac{c}{I}$$

$$= 3 \cdot \frac{F_{\text{lug}} \cdot \sin(\beta) \cdot Hght - F_{\text{lug}} \cdot \cos(\beta) \cdot a_1}{0.707 \cdot h_p \cdot L_p \cdot (3 \cdot W_p + L_p)}$$

$$= 3 \cdot \frac{|13{,}528 \cdot \sin(-45.0) \cdot 6.313 - 13{,}528 \cdot \cos(-45.0) \cdot (0)|}{79.5375}$$

$$= 2{,}278 \ \text{psi}$$

$$\tau_{\text{ratio}} = \frac{\sqrt{(\tau_t + \tau_b)^2 + \tau_s^2}}{\tau_{\text{allowable}}} \leq 1$$

$$= \frac{\sqrt{(1{,}353 + 2{,}278)^2 + (-1{,}353)^2}}{13{,}320}$$

= 0.29 Acceptable

WRC 537 Analysis

Geometry	
Height (radial)	8.5"
Width (circumferential)	0.625"
Length	10"
Fillet Weld Size:	0.25"
Located On	Cylinder #2 (205" from right end)
Location Angle	0.00°
Reinforcement Pad	
Thickness	0.313"
Width	5"
Length	15"
Weld Size	0.25"

Applied Loads	
Radial load, P_r	-9,565.53 lb_f
Circumferential moment, M_c	0 lb_f-in
Circumferential shear, V_c	0 lb_f
Longitudinal moment, M_L	-60,387.2 lb_f-in
Longitudinal shear, V_L	-9,565.53 lb_f
Torsion moment, M_t	0 lb_f-in
Internal pressure, P	0 psi
Mean shell radius, R_m	48.1565"
Design factor	3

Maximum stresses due to the applied loads at the lug edge

$$\gamma = \frac{R_m}{T} = \frac{48.1565}{0.626} = 76.9273$$

$$C_1 = 0.5625, C_2 = 2.25 \ \text{in}$$

Note: Actual lug $\frac{C_1}{C_2} < \frac{1}{4}, \frac{C_1}{C_2} = \frac{1}{4}$ used as this is the minimum ratio covered by WRC 537.

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

Local longitudinal pressure stress $= \dfrac{P \cdot R_i}{2 \cdot T} = 0$ psi

Maximum combined stress $(P_L + P_b + Q) = 95{,}105$ psi

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

WRC 537: The combined stress (P_L+P_b+Q) is excessive

Maximum local primary membrane stress $(P_L) = 7{,}186$ psi

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

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

Stresses at the lug edge per WRC Bulletin 537										
Figure	**Y**	**β**	A_u	A_l	B_u	B_l	C_u	C_l	D_u	D_l
3C*	16.6138	0.0346	0	0	0	0	5,272	5,272	5,272	5,272
4C*	14.4605	0.028	4,588	4,588	4,588	4,588	0	0	0	0
1C	0.2536	0.0206	0	0	0	0	37,144	-37,144	37,144	-37,144
2C-1	0.2106	0.0206	30,838	-30,838	30,838	-30,838	0	0	0	0
3A*	0.4328	0.0185	0	0	0	0	0	0	0	0
1A	0.1041	0.0222	0	0	0	0	0	0	0	0
3B*	3.3057	0.0294	2,598	2,598	-2,598	-2,598	0	0	0	0
1B-1	0.0646	0.0245	50,573	-50,573	-50,573	50,573	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total circumferential stress			88,597	-74,225	-17,745	21,725	42,416	-31,872	42,416	-31,872
Primary membrane circumferential stress*			7,186	7,186	1,990	1,990	5,272	5,272	5,272	5,272
3C*	17.015	0.028	5,399	5,399	5,399	5,399	0	0	0	0
4C*	14.4985	0.0346	0	0	0	0	4,600	4,600	4,600	4,600
1C-1	0.2173	0.0292	31,832	-31,832	31,832	-31,832	0	0	0	0
2C	0.1734	0.0292	0	0	0	0	25,393	-25,393	25,393	-25,393
4A*	0.7452	0.0185	0	0	0	0	0	0	0	0
2A	0.0619	0.0283	0	0	0	0	0	0	0	0
4B*	0.8647	0.0294	1,315	1,315	-1,315	-1,315	0	0	0	0
2B-1	0.0999	0.0339	56,559	-56,559	-56,559	56,559	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total longitudinal stress			95,105	-81,677	-20,643	28,811	29,993	-20,793	29,993	-20,793
Primary membrane longitudinal stress*			6,714	6,714	4,084	4,084	4,600	4,600	4,600	4,600
Shear from M_t			0	0	0	0	0	0	0	0
Circ shear from V_c			0	0	0	0	0	0	0	0
Long shear from V_L			0	0	0	0	1,698	1,698	-1,698	-1,698
Total Shear stress			0	0	0	0	1,698	1,698	-1,698	-1,698
Combined stress (P_L+P_b+Q)			95,105	-81,677	-20,643	28,811	42,644	-32,126	42,644	-32,126
* denotes primary stress.										

Maximum stresses due to the applied loads at the pad edge

$$\gamma = \frac{R_m}{T} = \frac{48.1565}{0.313} = 153.8546$$

$C_1 = 2.75, C_2 = 7.75 \ \text{in}$

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

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

Maximum combined stress $(P_L + P_b + Q) = 73{,}718 \ \text{psi}$

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

WRC 537: The combined stress (P_L+P_b+Q) is excessive (at pad edge)

Maximum local primary membrane stress $(P_L) = 22{,}045 \ \text{psi}$

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

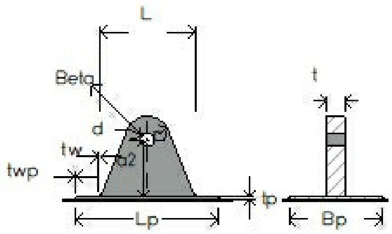
The maximum local primary membrane stress (P_L) is within allowable limits.

Stresses at the pad edge per WRC Bulletin 537										
Figure	Y	β	A_u	A_l	B_u	B_l	C_u	C_l	D_u	D_l
3C*	8.958	0.1354	0	0	0	0	5,685	5,685	5,685	5,685
4C*	22.463	0.1124	14,255	14,255	14,255	14,255	0	0	0	0
1C	0.077	0.086	0	0	0	0	45,100	-45,100	45,100	-45,100
2C-1	0.0506	0.086	29,653	-29,653	29,653	-29,653	0	0	0	0
3A*	5.8476	0.0807	0	0	0	0	0	0	0	0
1A	0.0867	0.0874	0	0	0	0	0	0	0	0
3B*	15.645	0.1139	7,790	7,790	-7,790	-7,790	0	0	0	0
1B-1	0.0269	0.0939	22,020	-22,020	-22,020	22,020	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total circumferential stress			73,718	-29,628	14,098	-1,168	50,785	-39,415	50,785	-39,415
Primary membrane circumferential stress*			22,045	22,045	6,465	6,465	5,685	5,685	5,685	5,685
3C*	11.0758	0.1124	7,029	7,029	7,029	7,029	0	0	0	0
4C*	21.2459	0.1354	0	0	0	0	13,483	13,483	13,483	13,483
1C-1	0.0582	0.1165	34,117	-34,117	34,117	-34,117	0	0	0	0
2C	0.0329	0.1165	0	0	0	0	19,289	-19,289	19,289	-19,289
4A*	9.8589	0.0807	0	0	0	0	0	0	0	0
2A	0.0346	0.1059	0	0	0	0	0	0	0	0
4B*	6.4549	0.1139	5,614	5,614	-5,614	-5,614	0	0	0	0
2B-1	0.0266	0.1178	17,318	-17,318	-17,318	17,318	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total longitudinal stress			64,078	-38,792	18,214	-15,384	32,772	-5,806	32,772	-5,806
Primary membrane longitudinal stress*			12,643	12,643	1,415	1,415	13,483	13,483	13,483	13,483
Shear from M_t			0	0	0	0	0	0	0	0
Circ shear from V_c			0	0	0	0	0	0	0	0
Long shear from V_L			0	0	0	0	986	986	-986	-986
Total Shear stress			0	0	0	0	986	986	-986	-986
Combined stress (P_L+P_b+Q)			73,718	-38,792	18,214	-15,384	50,839	-39,444	50,839	-39,444

* denotes primary stress.

Lifting Lug #2 (See Alternative Calc)

Geometry Inputs	



Attached To	Cylinder #4
Material	304/304L
Orientation	Longitudinal
Distance of Lift Point From Datum	42"
Angular Position	0°
Length, L	10"
Height, H	8.5"
Lug Radius, R	2.5"
Thickness, t	1"
Hole Diameter, d	1.5"
Pin Diameter, Dp	0.9376"
Distance from Load to Shell or Pad, a_2	6"
Load Angle Normal to Vessel, β	45°
Load Angle from Vertical, ϕ	45°
Welds	
Size, t_w	0.25"
Reinforcement Pad	
Width, B_p	5"
Length, L_p	15"
Thickness, t_p	0.313"
Weld Size, t_{wp}	0.25"

Intermediate Values	
Load Factor	1.5000
Vessel Weight (new, incl. Load Factor), W	20,014.2 lb
Lug Weight (new), W_{lug}	23.1 lb
Distance from Center of Gravity to this lug, x_1	80.2933"
Distance from Center of Gravity to second lug, x_2	87.7067"
Allowable Stress, Tensile, σ_t	19,980 psi
Allowable Stress, Shear, σ_s	13,320 psi
Allowable Stress, Bearing, σ_p	29,970 psi
Allowable Stress, Bending, σ_b	22,201 psi
Allowable Stress, Weld Shear, $\tau_{allowable}$	13,320 psi
Allowable Stress set to 1/3 Sy per ASME B30.20	No

Summary Values	
Required Lift Pin Diameter, d_{reqd}	0.8404"
Required Lug Thickness, t_{reqd}	0.5259"
Lug Stress Ratio, σ_{ratio}	0.22
Weld Shear Stress Ratio, τ_{ratio}	0.84
Lug Design	Acceptable
Local Stresses WRC 537	**Unacceptable**

Lift Forces

F_r = force on vessel at lug

$$F_r = \left[\frac{W}{\cos(\phi_1)}\right] \cdot \left(1 - \frac{x_1}{x_1 + x_2}\right) = \frac{20{,}014.2}{\cos(45)} \cdot \left(1 - \frac{80.2933}{80.2933 + 87.7067}\right) = 14{,}777 \text{ lb}_f$$

where 'x$_1$' is the distance between this lug and the center of gravity

'x$_2$' is the distance between the second lift lug and the center of gravity

Lug Pin Diameter - Shear stress

$$d_{reqd} = \sqrt{\frac{2 \cdot F_v}{\pi \cdot \sigma_s}}$$

$$= \sqrt{\frac{2 \cdot 14{,}777}{\pi \cdot 13{,}320}} = 0.8404''$$

$$\frac{d_{reqd}}{D_p} = \frac{0.8404}{0.9376} = 0.90 \quad \text{Acceptable}$$

$$\sigma = \frac{F_v}{A}$$

$$= \frac{F_v}{2 \cdot (0.25 \cdot \pi \cdot D_p^2)}$$

$$= \frac{14{,}777}{2 \cdot (0.25 \cdot \pi \cdot 0.9376^{\ 2})} = 10{,}702 \text{ psi}$$

$$\frac{\sigma}{\sigma_s} = \frac{10{,}702}{13{,}320} = 0.8 \quad \text{Acceptable}$$

Lug Thickness - Tensile stress

$$t_{\text{reqd}} = \frac{F_v}{(L_d - d) \cdot \sigma_t}$$

$$= \frac{14{,}777}{(5.3648 - 1.5) \cdot 19{,}980} = 0.1914"$$

$$\frac{t_{\text{reqd}}}{t} = \frac{0.1914}{1} = 0.19$$ Acceptable

$$\sigma = \frac{F_v}{A}$$

$$= \frac{F_v}{(L_d - d) \cdot t}$$

$$= \frac{14{,}777}{(5.3648 - 1.5) \cdot 1} = 3{,}823 \text{ psi}$$

$$\frac{\sigma}{\sigma_t} = \frac{3{,}823}{19{,}980} = 0.19$$ Acceptable

Lug Thickness - Bearing stress

$$t_{\text{reqd}} = \frac{F_v}{D_p \cdot \sigma_p}$$

$$= \frac{14{,}777}{0.9376 \cdot 29{,}970} =$$ 0.5259"

$$\frac{t_{\text{reqd}}}{t} = \frac{0.5259}{1} = 0.53$$ Acceptable

$$\sigma = \frac{F_v}{A_{\text{bearing}}}$$

$$= \frac{F_v}{D_p \cdot (t)}$$

$$= \frac{14{,}777}{0.9376 \cdot (1)} = 15{,}761 \text{ psi}$$

$$\frac{\sigma}{\sigma_p} = \frac{15{,}761}{29{,}970} = 0.53$$ Acceptable

Lug Thickness - Shear stress

$$t_{\text{reqd}} = \frac{\frac{F_v}{\sigma_s}}{2 \cdot L_{\text{shear}}}$$

$$= \frac{\frac{14{,}777}{13{,}320}}{2 \cdot 1.8319} = \text{0.3028"}$$

$$\frac{t_{\text{reqd}}}{t} = \frac{0.3028}{1} = 0.30$$ Acceptable

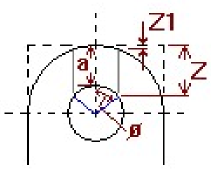
$$\tau = \frac{F_v}{A_{\text{shear}}}$$

$$= \frac{F_v}{2 \cdot t \cdot L_{\text{shear}}}$$

$$= \frac{14{,}777}{2 \cdot 1 \cdot 1.8319} = 4{,}033 \text{ psi}$$

$$\frac{\tau}{\sigma_s} = \frac{4{,}033}{13{,}320} = 0.3$$ Acceptable

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



$$\phi = 55 \cdot \frac{D_p}{d}$$

$$= 55 \cdot \frac{0.9376}{1.5}$$

$$= 34.3774^{\circ}$$

$$L_{\text{shear}} = (H - a2 - 0.5 \cdot d) + 0.5 \cdot D_p \cdot (1 - \cos(\phi))$$

$$= (8.5 - 6 - 0.5 \cdot 1.5) + 0.5 \cdot 0.9376 \cdot (1 - \cos(34.3774))$$

$$= \text{1.8319"}$$

Lug Plate Stress

Lug stress tensile + bending during lift:

$$\sigma_{\text{ratio}} = \left[\frac{F_{\text{ten}}}{A_{\text{ten}} \cdot \sigma_t}\right] + \left[\frac{M_{\text{bend}}}{Z_{\text{bend}} \cdot \sigma_b}\right] \leq 1$$

$$= \left[\frac{F_r \cdot \cos(\beta)}{t \cdot L \cdot \sigma_t}\right] + \left[\frac{6 \cdot |F_r \cdot \sin(\beta) \cdot \text{Hght} - F_r \cdot \cos(\beta) \cdot a_1|}{t \cdot L_2 \cdot \sigma_b}\right] \leq 1$$

$$= 14{,}777 \cdot \frac{\cos(45.0)}{1 \cdot 10 \cdot 19{,}980} + 6 \cdot \frac{|14{,}777 \cdot \sin(45.0) \cdot 6 - 14{,}777 \cdot \cos(45.0) \cdot 0|}{1 \cdot 10^2 \cdot 22{,}201}$$

= 0.22 Acceptable

Weld Stress

Weld stress, tensile, bending and shear during lift:

Direct shear:

Shear stress at lift angle 45.00°; lift force = 14,777 lb_f

$$A_{\text{weld}} = 2 \cdot (0.707) \cdot t_w \cdot (L + t)$$

$$= 2 \cdot (0.707) \cdot 0.25 \cdot (10 + 1) = 3.8885 \ \text{in}^2$$

$$\tau_t = F_{\text{lug}} \cdot \frac{\cos(\beta)}{A_{\text{weld}}}$$

$$= 14{,}777 \cdot \frac{\cos(45.0)}{3.8885} = 2{,}687 \ \text{psi}$$

$$\tau_s = F_{\text{lug}} \cdot \frac{\sin(\beta)}{A_{\text{weld}}}$$

$$= 14{,}777 \cdot \frac{\sin(45.0)}{3.8885} = 2{,}687 \ \text{psi}$$

$$\tau_b = M \cdot \frac{c}{I}$$

$$= 3 \cdot \frac{F_{\text{lug}} \cdot \sin(\beta) \cdot Hght - F_{\text{lug}} \cdot \cos(\beta) \cdot a_1}{0.707 \cdot h \cdot L \cdot (3 \cdot t + L)}$$

$$= 3 \cdot \frac{|14{,}777 \cdot \sin(45.0) \cdot 6 - 14{,}777 \cdot \cos(45.0) \cdot (0)|}{22.9775}$$

$$= 8{,}185 \ \text{psi}$$

$$\tau_{\text{ratio}} = \frac{\sqrt{(\tau_t + \tau_b)^2 + \tau_s^2}}{\tau_{\text{allowable}}} \le 1$$

$$= \frac{\sqrt{(2{,}687 + 8{,}185)^2 + (2{,}687)^2}}{13{,}320}$$

= 0.84 Acceptable

Pad Weld Stress, tensile, bending and shear during lift:

Direct shear:

Shear stress at lift angle 45.00°; lift force = 14,777 lb_f

$$A_{\text{weld}} = 2 \cdot (0.707) \cdot t_{w\_p} \cdot (L_p + B_p)$$

$$= 2 \cdot (0.707) \cdot 0.25 \cdot (15 + 5) = 7.07 \ \text{in}^2$$

$$\tau_t = F_{\text{lug}} \cdot \frac{\cos(\beta)}{A_{\text{weld}}}$$

$$= 14{,}777 \cdot \frac{\cos(45.0)}{7.07} = 1{,}478 \ \text{psi}$$

$$\tau_s = F_{\text{lug}} \cdot \frac{\sin(\beta)}{A_{\text{weld}}}$$

$$= 14{,}777 \cdot \frac{\sin(45.0)}{7.07} = 1{,}478 \ \text{psi}$$

$$\tau_b = M \cdot \frac{c}{I}$$

$$= 3 \cdot \frac{F_{\text{lug}} \cdot \sin(\beta) \cdot Hght - F_{\text{lug}} \cdot \cos(\beta) \cdot a_1}{0.707 \cdot h_p \cdot L_p \cdot (3 \cdot W_p + L_p)}$$

$$= 3 \cdot \frac{|14{,}777 \cdot \sin(45.0) \cdot 6.313 - 14{,}777 \cdot \cos(45.0) \cdot (0)|}{79.5375}$$

$$= 2{,}488 \ \text{psi}$$

$$\tau_{\text{ratio}} = \frac{\sqrt{(\tau_t + \tau_b)^2 + \tau_s^2}}{\tau_{\text{allowable}}} \leq 1$$

$$= \frac{\sqrt{(1{,}478 + 2{,}488)^2 + (1{,}478)^2}}{13{,}320}$$

= 0.32 Acceptable

WRC 537 Analysis

Geometry	
Height (radial)	8.5"
Width (circumferential)	1"
Length	10"
Fillet Weld Size:	0.25"
Located On	Cylinder #4 (37" from right end)
Location Angle	0.00°
Reinforcement Pad	
Thickness	0.313"
Width	5"
Length	15"
Weld Size	0.25"

Applied Loads	
Radial load, P_r	-10,448.71 lb_f
Circumferential moment, M_c	0 lb_f-in
Circumferential shear, V_c	0 lb_f
Longitudinal moment, M_L	65,962.7 lb_f-in
Longitudinal shear, V_L	10,448.71 lb_f
Torsion moment, M_t	0 lb_f-in
Internal pressure, P	0 psi
Mean shell radius, R_m	48.1565"
Design factor	3

Maximum stresses due to the applied loads at the lug edge

$$\gamma = \frac{R_m}{T} = \frac{48.1565}{0.626} = 76.9273$$

$$C_1 = 0.75, C_2 = 3 \ \text{in}$$

Note: Actual lug $\frac{C_1}{C_2} < \frac{1}{4}, \frac{C_1}{C_2} = \frac{1}{4}$ used as this is the minimum ratio covered by WRC 537.

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

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

Maximum combined stress $(P_L + P_b + Q) = 80{,}267 \ \ \text{psi}$

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

WRC 537: The combined stress (P_L+P_b+Q) is excessive

Maximum local primary membrane stress $(P_L) = 7{,}901 \ \ \text{psi}$

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

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

Stresses at the lug edge per WRC Bulletin 537										
Figure	Y	β	A_u	A_l	B_u	B_l	C_u	C_l	D_u	D_l
3C*	15.9366	0.0461	0	0	0	0	5,524	5,524	5,524	5,524
4C*	14.525	0.0374	5,034	5,034	5,034	5,034	0	0	0	0
1C	0.2299	0.0274	0	0	0	0	36,784	-36,784	36,784	-36,784
2C-1	0.1816	0.0274	29,046	-29,046	29,046	-29,046	0	0	0	0
3A*	0.6479	0.0247	0	0	0	0	0	0	0	0
1A	0.1036	0.0296	0	0	0	0	0	0	0	0
3B*	4.453	0.0392	-2,867	-2,867	2,867	2,867	0	0	0	0
1B-1	0.0621	0.0327	-39,827	39,827	39,827	-39,827	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total circumferential stress			-8,614	12,948	76,774	-60,972	42,308	-31,260	42,308	-31,260
Primary membrane circumferential stress*			2,167	2,167	7,901	7,901	5,524	5,524	5,524	5,524
3C*	16.4487	0.0374	5,701	5,701	5,701	5,701	0	0	0	0
4C*	14.6291	0.0461	0	0	0	0	5,071	5,071	5,071	5,071
1C-1	0.1893	0.0389	30,284	-30,284	30,284	-30,284	0	0	0	0
2C	0.1474	0.0389	0	0	0	0	23,575	-23,575	23,575	-23,575
4A*	1.2263	0.0247	0	0	0	0	0	0	0	0
2A	0.0605	0.0378	0	0	0	0	0	0	0	0
4B*	1.2109	0.0392	-1,509	-1,509	1,509	1,509	0	0	0	0
2B-1	0.0922	0.0452	-42,773	42,773	42,773	-42,773	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total longitudinal stress			-8,297	16,681	80,267	-65,847	28,646	-18,504	28,646	-18,504
Primary membrane longitudinal stress*			4,192	4,192	7,210	7,210	5,071	5,071	5,071	5,071
Shear from M_t			0	0	0	0	0	0	0	0
Circ shear from V_c			0	0	0	0	0	0	0	0
Long shear from V_L			0	0	0	0	-1,391	-1,391	1,391	1,391
Total Shear stress			0	0	0	0	-1,391	-1,391	1,391	1,391
Combined stress (P_L+P_b+Q)			-8,614	16,681	80,267	-65,847	42,448	-31,410	42,448	-31,410
* denotes primary stress.										

Maximum stresses due to the applied loads at the pad edge

$$\gamma = \frac{R_m}{T} = \frac{48.1565}{0.313} = 153.8546$$

$$C_1 = 2.75, C_2 = 7.75 \quad \text{in}$$

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

Local longitudinal pressure stress $= \dfrac{P \cdot R_i}{2 \cdot T} = 0 \quad \text{psi}$

Maximum combined stress $(P_L + P_b + Q) = 80{,}525 \quad \text{psi}$

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

WRC 537: The combined stress (P_L+P_b+Q) is excessive (at pad edge)

Maximum local primary membrane stress $(P_L) = 24{,}081 \quad \text{psi}$

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

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

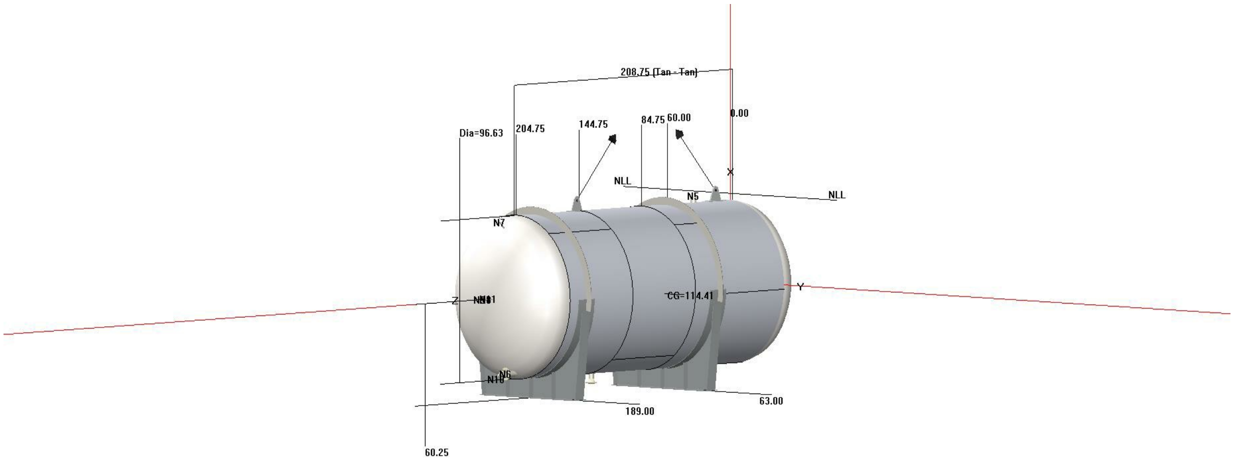
Stresses at the pad edge per WRC Bulletin 537										
Figure	**Y**	**β**	**A_u**	**A_l**	**B_u**	**B_l**	**C_u**	**C_l**	**D_u**	**D_l**
3C*	8.958	0.1354	0	0	0	0	6,210	6,210	6,210	6,210
4C*	22.463	0.1124	15,572	15,572	15,572	15,572	0	0	0	0
1C	0.077	0.086	0	0	0	0	49,264	-49,264	49,264	-49,264
2C-1	0.0506	0.086	32,391	-32,391	32,391	-32,391	0	0	0	0
3A*	5.8476	0.0807	0	0	0	0	0	0	0	0
1A	0.0867	0.0874	0	0	0	0	0	0	0	0
3B*	15.645	0.1139	-8,509	-8,509	8,509	8,509	0	0	0	0
1B-1	0.0269	0.0939	-24,053	24,053	24,053	-24,053	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total circumferential stress			15,401	-1,275	80,525	-32,363	55,474	-43,054	55,474	-43,054
Primary membrane circumferential stress*			7,063	7,063	24,081	24,081	6,210	6,210	6,210	6,210
3C*	11.0758	0.1124	7,678	7,678	7,678	7,678	0	0	0	0
4C*	21.2459	0.1354	0	0	0	0	14,728	14,728	14,728	14,728
1C-1	0.0582	0.1165	37,267	-37,267	37,267	-37,267	0	0	0	0
2C	0.0329	0.1165	0	0	0	0	21,070	-21,070	21,070	-21,070
4A*	9.8589	0.0807	0	0	0	0	0	0	0	0
2A	0.0346	0.1059	0	0	0	0	0	0	0	0
4B*	6.4549	0.1139	-6,133	-6,133	6,133	6,133	0	0	0	0
2B-1	0.0266	0.1178	-18,917	18,917	18,917	-18,917	0	0	0	0
Pressure stress*			0	0	0	0	0	0	0	0
Total longitudinal stress			19,895	-16,805	69,995	-42,373	35,798	-6,342	35,798	-6,342
Primary membrane longitudinal stress*			1,545	1,545	13,811	13,811	14,728	14,728	14,728	14,728
Shear from M_t			0	0	0	0	0	0	0	0
Circ shear from V_c			0	0	0	0	0	0	0	0
Long shear from V_L			0	0	0	0	-1,077	-1,077	1,077	1,077
Total Shear stress			0	0	0	0	-1,077	-1,077	1,077	1,077
Combined stress (P_L+P_b+Q)			19,895	-16,805	80,525	-42,373	55,533	-43,086	55,533	-43,086

* denotes primary stress.

Liquid Level bounded by Ellipsoidal Head #2

ASME Section VIII Division 1, 2023 Edition	
Location from Center Line (in)	54.313
Operating Liquid Specific Gravity	1

Tate Metalworks



COMPRESS Pressure Vessel Design Calculations

Item:	Paper Machine Bulk Oil Storage Tank
Vessel No:	24-018-01
Customer:	WestRock Seminole
Contract:	Project Design
Designer:	NJB
Date:	12/12/2024

Middle Saddle Design

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Middle Saddle

ASME Section VIII Division 1, 2023 Edition		
Saddle Material	SA-240 304	
Saddle Construction	Centered web	
Welded to Vessel	Yes	
Saddle Allowable Stress, S_s	20,000 psi	
Saddle Yield Stress, S_y	30,000 psi	
Foundation Allowable Stress	1,658 psi	
Design Pressure	**Left Saddle**	**Right Saddle**
Operating & New	3.62 psi	
Operating & Corr	3.62 psi	
Test	3.62 psi	
Dimensions		
Right saddle distance to datum	63"	
Tangent To Tangent Length, L	208.75"	
Saddle separation, L_s	126"	
Vessel Radius, R	48.313"	
Tangent Distance Left, A_l	17.75"	
Tangent Distance Right, A_r	65"	
Saddle Height, H_s	60.25"	
Saddle Contact Angle, θ	164°	
Web Plate Thickness, t_s	0.625"	
Base Plate Length, E	84.4"	
Base Plate Width, F	12"	
Base Plate Thickness, t_b	0.5"	
Number of Stiffening Ribs, n	5	
Largest Stiffening Rib Spacing, d_i	20.725"	
Stiffening Rib Thickness, t_w	0.5"	
Saddle Width, b	8"	
Reinforcing Plate		
Material	SA-240 304 (II-D p. 92, ln. 14)	
Impact Tested	No	
Normalized	No	
Fine Grain Practice	No	
PWHT	No	
Design MDMT	0°F	
Thickness, t_p	0.313"	
Width, W_p	15"	
Contact Angle, θ_w	180°	
Bolting		
Material		
Bolt Allowable Shear	15,000 psi	
Description	1.125" series 8 threaded	
Corrosion on root	0"	
Anchor Bolts per Saddle	4	
Base coefficient of friction, μ	0.45	
Hole Diameter	1.5"	

Slotted Hole in Which Saddle	Right Saddle
Slotted Hole Length	1.5"
Stiffening Rings	
Material	SA-240 304
Description	1/2x4.5 Flat Bar
Location	outside shell
Number of Rings	1
Distance from Center of Saddle	0"
Max Depth to Thickness Ratio	12
Corrosion	0"
Also Acts as Vacuum Ring	No

Weight		
	Left Saddle	**Right Saddle**
Operating, Corroded	21,494 lb	46,886 lb
Operating, New	22,583 lb	48,047 lb
Hydrotest	22,510 lb	48,120 lb
Weight of Saddle Pair	1,840 lb	

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

UHA-51 Material Toughness Requirements Right Saddle Wear Plate	
$t_r = \dfrac{3.62 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 3.62} =$	0.0103"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.0103 \cdot 0.85}{0.313 - 0.125} =$	0.0464
$\text{Stress ratio longitudinal} = \dfrac{1{,}037 \cdot 1}{20{,}000 \cdot 1} =$	0.0518
Impact test exempt per UHA-51(g) (coincident ratio = 0.0464)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of 0°F.	

UHA-51 Material Toughness Requirements Left Saddle Wear Plate	
$t_r = \dfrac{3.62 \cdot 48.125}{20{,}000 \cdot 0.85 - 0.6 \cdot 3.62} =$	0.0103"
$\text{Stress ratio} = \dfrac{t_r \cdot E^*}{t_n - c} = \dfrac{0.0103 \cdot 0.85}{0.313 - 0.125} =$	0.0464
$\text{Stress ratio longitudinal} = \dfrac{979 \cdot 0.85}{20{,}000 \cdot 0.85} =$	0.049
Impact test exempt per UHA-51(g) (coincident ratio = 0.0464)	
Rated MDMT =	-320°F
Material is exempt from impact testing at the Design MDMT of 0°F.	

Stress Summary										
Load	Condition	Saddle	Bending + pressure between saddles (psi)				Bending + pressure at the saddle (psi)			
			S_1 (+)	allow (+)	S_1 (-)	allow (-)	S_2 (+)	allow (+)	S_2 (-)	allow (-)
Seismic	Operating & New	Right Saddle	-82	20,400	-359	9,403	634	24,000	356	9,403
		Left Saddle					279	24,000	1	9,403
	Operating & Corr	Right Saddle	-118	20,400	-582	7,679	1,037	24,000	573	7,679
		Left Saddle					466	24,000	2	7,679
Wind	Operating & New	Right Saddle	-71	20,400	-349	9,403	627	24,000	350	9,403
		Left Saddle					279	24,000	1	9,403
	Operating & Corr	Right Saddle	-102	20,400	-565	7,679	1,026	24,000	563	7,679
		Left Saddle					465	24,000	2	7,679
	Test	Right Saddle	-66	22,950	-344	9,843	627	27,000	350	9,843
		Left Saddle					279	27,000	1	9,843
Weight	Operating & New	Right Saddle	-63	17,000	-341	7,836	627	20,000	350	7,836
		Left Saddle					279	20,000	1	7,836
	Operating & Corr	Right Saddle	-88	17,000	-552	6,399	1,026	20,000	563	6,399
		Left Saddle					465	20,000	2	6,399

Stress Summary										
Load	Condition	Saddle	Tangential shear (psi)		Splitting (psi)		Stiffener ring stress (psi)			
			S_3	allow	S_6	allow	S_7 (shell)	allow (+/-)	S_7 (ring)	allow (+/-)
Seismic	Operating & New	Right Saddle	558	16,000	1,246	13,333	6,022	30,000	-23,734	30,000
		Left Saddle	292	16,000	589	13,333	3,140	30,000	-11,225	30,000
	Operating & Corr	Right Saddle	912	16,000	1,215	13,333	10,667	30,000	-27,550	30,000
		Left Saddle	456	16,000	561	13,333	5,423	30,000	-12,717	30,000
Wind	Operating & New	Right Saddle	536	16,000	1,209	13,333	5,862	30,000	-23,041	30,000
		Left Saddle	283	16,000	574	13,333	3,075	30,000	-10,943	30,000
	Operating & Corr	Right Saddle	877	16,000	1,181	13,333	10,388	30,000	-26,760	30,000
		Left Saddle	443	16,000	548	13,333	5,314	30,000	-12,409	30,000
	Test	Right Saddle	522	21,600	1,193	27,000	5,790	27,000	-22,726	27,000
		Left Saddle	271	21,600	560	27,000	3,012	27,000	-10,669	27,000
Weight	Operating & New	Right Saddle	513	16,000	1,182	13,333	5,742	30,000	-22,520	30,000
		Left Saddle	267	16,000	555	13,333	2,993	30,000	-10,585	30,000
	Operating & Corr	Right Saddle	838	16,000	1,153	13,333	10,169	30,000	-26,140	30,000
		Left Saddle	417	16,000	529	13,333	5,164	30,000	-11,983	30,000

Seismic base shear on vessel	
Vessel is assumed to be a rigid structure.	
Method of seismic analysis	ASCE 7-22 ground supported
Vertical seismic accelerations considered	Yes
Importance factor, I_e	1
Site Class	D
Spectral response acceleration at short periods, S_s (%g)	16%
Spectral response acceleration at 1 second period, S_1 (%g)	6.3%
Adjusted spectral response acceleration at short periods, S_{MS} (%g)	20%
Adjusted spectral response acceleration at 1 second period, S_{M1} (%g)	13%
Risk Category (Table 1.5-1)	II
Hazardous, toxic, or explosive contents	No
Equations	
$S_{DS} = \left(\frac{2}{3}\right) \cdot S_{MS}$	
$S_{D1} = \left(\frac{2}{3}\right) \cdot S_{M1}$	
$F_p = 0.3 \cdot S_{DS} \cdot W \cdot I_e \cdot 0.7$	
Results	
$S_{DS} = \left(\frac{2}{3}\right) \cdot 0.2$	0.1333
$S_{D1} = \left(\frac{2}{3}\right) \cdot 0.13$	0.0867
Seismic Design Category (Section 11.6)	B
Corroded	
$F_p = 0.3 \cdot 0.1333 \cdot 68{,}380 \cdot 1 \cdot 0.7$	1,914.64 lb_f
New	
$F_p = 0.3 \cdot 0.1333 \cdot 70{,}630 \cdot 1 \cdot 0.7$	1,977.64 lb_f

Saddle reactions due to weight + seismic			
V_v = vertical seismic force acting on the saddle			
V = horizontal seismic shear acting on the saddle (worst case if not slotted)			
Seismic longitudinal reaction, Q_l			
Seismic transverse reaction, Q_t			
Equations			
$Q_l = \frac{V \cdot H_s}{L_s} + V_v$			
$Q_t = \frac{V \cdot H_s}{R_o \cdot \text{Sin}(\theta \;/\; 2)} + V_v$			
$Q = W + \max\,[Q_t, Q_l]$			
Results			
Operating & New	Right Saddle	$Q_l = \frac{1{,}977.64 \cdot 60.25}{126} + 0.14 \cdot 0.1333 \cdot 48{,}047$	1,842.53 lb_f
		$Q_t = \frac{1{,}345.32 \cdot 60.25}{48.313 \cdot \text{Sin}(164 \;/\; 2)} + 0.14 \cdot 0.1333 \cdot 48{,}047$	2,591.08 lb_f
		$Q = 48{,}047 + \max\,[2{,}591.08, 1{,}842.53]$	50,638.08 lb_f
	Left Saddle	$Q_l = \frac{1{,}977.64 \cdot 60.25}{126} + 0.14 \cdot 0.1333 \cdot 22{,}583$	1,367.21 lb_f
		$Q_t = \frac{632.32 \cdot 60.25}{48.313 \cdot \text{Sin}(164 \;/\; 2)} + 0.14 \cdot 0.1333 \cdot 22{,}583$	1,217.86 lb_f
		$Q = 22{,}583 + \max\,[1{,}217.86, 1{,}367.21]$	23,950.21 lb_f
Operating & Corr	Right Saddle	$Q_l = \frac{1{,}914.64 \cdot 60.25}{126} + 0.14 \cdot 0.1333 \cdot 46{,}886$	1,790.74 lb_f
		$Q_t = \frac{1{,}312.81 \cdot 60.25}{48.313 \cdot \text{Sin}(164 \;/\; 2)} + 0.14 \cdot 0.1333 \cdot 46{,}886$	2,528.47 lb_f
		$Q = 46{,}886 + \max\,[2{,}528.47, 1{,}790.74]$	49,414.47 lb_f
	Left Saddle	$Q_l = \frac{1{,}914.64 \cdot 60.25}{126} + 0.14 \cdot 0.1333 \cdot 21{,}494$	1,316.75 lb_f
		$Q_t = \frac{601.83 \cdot 60.25}{48.313 \cdot \text{Sin}(164 \;/\; 2)} + 0.14 \cdot 0.1333 \cdot 21{,}494$	1,159.13 lb_f
		$Q = 21{,}494 + \max\,[1{,}159.13, 1{,}316.75]$	22,810.75 lb_f

Saddle reactions due to weight + wind	
Wind longitudinal reaction, Q_l	
Wind transverse reaction, Q_t	
Wind pressure, P_w	20.4277 psf
Equations	
$V_{wt} = P_w \cdot K_d \cdot G \cdot (C_{f(\text{shell})} \cdot (\text{Projected shell area}) + C_{f(\text{saddle})} \cdot (\text{Projected saddle area}))$	
$V_{we} = P_w \cdot K_d \cdot G \cdot \left(\frac{C_{f(\text{shell})} \cdot \pi \cdot R_o^2}{144} + C_{f(\text{saddle})} \cdot (\text{Projected saddle area})\right)$	

$$Q_t = \frac{V_{wt} \cdot H_s}{R_o \cdot \mathrm{Sin}(\theta \ / \ 2)}$$

$$Q_l = \frac{V_{we} \cdot H_s}{L_s}$$

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

Results

Operating & New	Right Saddle	$V_{wt} = 20.43 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 98.5558 + 2 \cdot 0.6632)$	883.51 lb_f
		$V_{we} = 20.43 \cdot 0.95 \cdot 0.85 \cdot \left(\frac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984 \right)$	842.23 lb_f
		$Q_t = \frac{883.51 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)}$	1,112.63 lb_f
		$Q_l = \frac{842.23 \cdot 60.25}{126}$	402.73 lb_f
		$Q = 48{,}047 + \max\ [1{,}112.63{,}402.73]$	49,159.63 lb_f
	Left Saddle	$V_{wt} = 20.43 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 66.9152 + 2 \cdot 0.6632)$	606.89 lb_f
		$V_{we} = 20.43 \cdot 0.95 \cdot 0.85 \cdot \left(\frac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984 \right)$	842.23 lb_f
		$Q_t = \frac{606.89 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)}$	764.27 lb_f
		$Q_l = \frac{842.23 \cdot 60.25}{126}$	402.73 lb_f
		$Q = 22{,}583 + \max\ [764.27{,}402.73]$	23,347.27 lb_f
Operating & Corr	Right Saddle	$V_{wt} = 20.43 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 98.5558 + 2 \cdot 0.6632)$	883.51 lb_f
		$V_{we} = 20.43 \cdot 0.95 \cdot 0.85 \cdot \left(\frac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984 \right)$	842.23 lb_f
		$Q_t = \frac{883.51 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)}$	1,112.63 lb_f
		$Q_l = \frac{842.23 \cdot 60.25}{126}$	402.73 lb_f
		$Q = 46{,}886 + \max\ [1{,}112.63{,}402.73]$	47,998.63 lb_f
	Left Saddle	$V_{wt} = 20.43 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 66.9152 + 2 \cdot 0.6632)$	606.89 lb_f
		$V_{we} = 20.43 \cdot 0.95 \cdot 0.85 \cdot \left(\frac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984 \right)$	842.23 lb_f
		$Q_t = \frac{606.89 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)}$	764.27 lb_f
		$Q_l = \frac{842.23 \cdot 60.25}{126}$	402.73 lb_f
		$Q = 21{,}494 + \max\ [764.27{,}402.73]$	22,258.27 lb_f
		$V_{wt} = 6.74 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 98.5558 + 2 \cdot 0.6632)$	291.56 lb_f
		$V_{we} = 6.74 \cdot 0.95 \cdot 0.85 \cdot \left(\frac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984 \right)$	277.94 lb_f

Test	Right Saddle	$Q_t = \dfrac{291.56 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)}$	367.17 lb_f
		$Q_l = \dfrac{277.94 \cdot 60.25}{126}$	132.9 lb_f
		$Q = 48{,}120 + \max\ [367.17{,}132.9]$	48,487.17 lb_f
	Left Saddle	$V_{wt} = 6.74 \cdot 0.95 \cdot 0.85 \cdot (0.53 \cdot 66.9152 + 2 \cdot 0.6632)$	200.27 lb_f
		$V_{we} = 6.74 \cdot 0.95 \cdot 0.85 \cdot \left(\dfrac{0.5 \cdot \pi \cdot 48.313^{\ 2}}{144} + 2 \cdot 12.7984\right)$	277.94 lb_f
		$Q_t = \dfrac{200.27 \cdot 60.25}{48.313 \cdot \mathrm{Sin}(164 \ / \ 2)}$	252.21 lb_f
		$Q_l = \dfrac{277.94 \cdot 60.25}{126}$	132.9 lb_f
		$Q = 22{,}510 + \max\ [252.21{,}132.9]$	22,762.21 lb_f

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

$$S_1 = \pm \frac{3 \cdot K_1 \cdot Q \cdot (L \ / \ 12)}{\pi \cdot R^2 \cdot t} = \frac{3 \cdot 0.5947 \cdot 21{,}494 \cdot (208.75 \ / \ 12)}{\pi \cdot 48.219^{\ 2} \cdot 0.188} = 486 \ \ \text{psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{3.62 \cdot 48.125}{2 \cdot 0.188} = 464 \ \ \text{psi}$$

Maximum tensile stress $S_{1t} = S_1 + S_p$ = 949 psi
Maximum compressive stress (shut down) $S_{1c} = S_1$ = 486 psi

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

Compressive stress is acceptable ($\leq S_c = 6{,}399 \ \ \text{psi}$)

Longitudinal stress at the right saddle (Weight, Operating & Corr)

$$L_e = \frac{2 \cdot H_l}{3} + L + \frac{2 \cdot H_r}{3} = \frac{2 \cdot 24.313}{3} + 208.75 + \frac{2 \cdot 24.19}{3} = 241.0853 \ \ \text{in}$$

$$w = \frac{W_t}{L_e} = \frac{68{,}380}{241.0853} = 283.63 \ \ \text{lb}_f/\text{in}$$

Bending moment at the right saddle:

$$M_q = w \cdot \left(\frac{2 \cdot H_r \cdot A_r}{3} + \frac{A_r^2}{2} - \frac{R^2 - H_r^2}{4}\right)$$
$$= 283.63 \cdot \left(\frac{2 \cdot 24.19 \cdot 65}{3} + \frac{65^{\ 2}}{2} - \frac{48.313^{\ 2} - 24.19^{\ 2}}{4}\right)$$
$$= 772{,}473.2 \ \ \text{lb}_f\text{-in}$$

$$S_2 = \pm \frac{M_q \cdot K_1{}'}{\pi \cdot R^2 \cdot t} = \frac{772{,}473.2 \cdot 1}{\pi \cdot 48.219^{\ 2} \cdot 0.188} = 563 \ \ \text{psi}$$

$$S_p = \frac{P \cdot R}{2 \cdot t} = \frac{3.62 \cdot 48.125}{2 \cdot 0.188} = 464 \ \ \text{psi}$$

Maximum tensile stress $S_{2t} = S_2 + S_p$ = 1,026 psi
Maximum compressive stress (shut down) $S_{2c} = S_2$ = 563 psi

Tensile stress is acceptable ($\leq S = 20{,}000 \quad \text{psi}$)

Compressive stress is acceptable ($\leq S_c = 6{,}399 \quad \text{psi}$)

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

$$Q_{shear} = Q - w \cdot \left(A_r + \frac{2 \cdot H_r}{3} \right) = 49{,}414.47 - 288.93 \cdot \left(65 + \frac{2 \cdot 24.19}{3} \right) = 25{,}974.66 \quad \text{lb}_f$$

$$S_3 = \frac{K_{2.1} \cdot Q_{shear}}{R \cdot t} = \frac{0.3183 \cdot 25{,}974.66}{48.219 \cdot 0.188} = 912 \quad \text{psi}$$

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

Saddle splitting load (right, Seismic, Operating & New)

Area resisting splitting force = Web area + wear plate area

$A_e = H_{eff} \cdot t_s + t_p \cdot W_p = 11.124 \cdot 0.625 + 0.313 \cdot 15$ = 11.6475 in^2

$$S_6 = \frac{K_8 \cdot Q}{A_e} = \frac{0.2865 \cdot 50{,}638.08}{11.6475} = 1{,}246 \quad \text{psi}$$

Stress in saddle is acceptable $\left(\leq \frac{2}{3} \cdot S_s = 13{,}333 \quad \text{psi} \right)$

Stiffener ring calculations, stress in shell (Seismic, Operating & Corr, right)

Ring moment of inertia:	I_r =	3.8	in^4
Ring cross sectional area:	A =	2.25	in^2
Combined shell/ring inertia:	I =	7.28	in^4
NA distance to shell extreme fiber:	C_1 =	1.7782	in
NA distance to ring extreme fiber:	C_2 =	2.9098	in
Hoop stress in shell:	S_c =	927	psi

$$S_7 = -\frac{K_7 \cdot Q}{A} + \frac{K_6 \cdot Q \cdot R \cdot C_1}{I} + S_c$$
$$= -\frac{0.2791 \cdot 49{,}414.47}{3.1314} + \frac{0.0243 \cdot 49{,}414.47 \cdot 48.219 \cdot 1.7782}{7.2791} + 927$$
$$= 10{,}667 \quad \text{psi}$$

Local stress in the shell is acceptable ($\leq 1.5 \cdot S = 30{,}000 \quad \text{psi}$)

Stiffener ring calculations, stress in ring (Seismic, Operating & Corr, right)

$$S_7 = -\frac{K_7 \cdot Q}{A} - \frac{K_6 \cdot Q \cdot R \cdot C_2}{I}$$
$$= -\frac{0.2791 \cdot 49{,}414.47}{3.1314} - \frac{0.0243 \cdot 49{,}414.47 \cdot 48.219 \cdot 2.9098}{7.2791}$$
$$= -27{,}550 \quad \text{psi}$$

Stress in the ring is acceptable ($\leq 1.5 \cdot S_r = 30{,}000 \quad \text{psi}$)

Shear stress in anchor bolting, one end slotted

Maximum seismic or wind base shear $= 1{,}977.64 \quad \text{lb}_f$

Thermal expansion base shear $= W \cdot \mu$ = 48,967*0.45 $= 22{,}035.15 \quad \text{lb}_f$

Corroded root area for a 1.125" series 8 threaded bolt $= 0.728 \quad \text{in}^2$ (4 per saddle)

Bolt shear stress = $\dfrac{22{,}035.15}{0.728 \cdot 1 \cdot 4} = 7{,}567 \quad \text{psi}$

Anchor bolt stress is acceptable (≤ 15,000 psi)

Shear stress in anchor bolting, transverse

Maximum seismic or wind base shear $= 1{,}977.64 \quad \text{lb}_f$

Corroded root area for a 1.125" series 8 threaded bolt $= 0.728 \quad \text{in}^2$ (4 per saddle)

Bolt shear stress = $\dfrac{1{,}977.64}{0.728 \cdot 2 \cdot 4} = 340 \quad \text{psi}$

Anchor bolt stress is acceptable (≤ 15,000 psi)

Web plate buckling check (Escoe pg 251)

Allowable compressive stress S_c = min(20,000 , 30,511) = 20,000 psi

$$S_c = \frac{K_i \cdot \pi^2 \cdot E}{12 \cdot \left(1 - 0.3^{\,2}\right) \cdot \left(\frac{d_i}{t_s}\right)^2} = \frac{1.28 \cdot \pi^2 \cdot 29\text{E+06}}{12 \cdot \left(1 - 0.3^{\,2}\right) \cdot \left(\frac{20.725}{0.625}\right)^2} = 30{,}511 \quad \text{psi}$$

Allowable compressive load on the saddle

$$b_e = \frac{d_i \cdot t_s}{(d_i \cdot t_s) + 2 \cdot t_w \cdot (b - 1)} = \frac{20.725 \cdot 0.625}{(20.725 \cdot 0.625) + 2 \cdot 0.5 \cdot (8 - 1)} = 0.6492$$

$$F_b = n \cdot (A_s + 2 \cdot b_e \cdot t_s) \cdot S_c = 5 \cdot (3.6875 + 2 \cdot 0.6492 \cdot 0.625) \cdot 20{,}000 = 449{,}897.22 \quad \text{lb}_f$$

Saddle loading of 51,558.08 lb_f is ≤ F_b; satisfactory.

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

$$\sigma_b = \frac{V \cdot (H_s - x_o) \cdot y}{I} + \frac{Q}{A} = \frac{1{,}977.64 \cdot (60.25 - 33.4292) \cdot 4}{107.3} + \frac{50{,}638.08}{78.241} = 2{,}624 \quad \text{psi}$$

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

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

$$\sigma_b = \frac{V \cdot (H_s - x_o) \cdot y}{I} + \frac{Q}{A} = \frac{24{,}012.79 \cdot (60.25 - 33.4292) \cdot 4}{107.3} + \frac{50{,}638.08}{78.241} = 24{,}656 \quad \text{psi}$$

The secondary bending + axial stress in the saddle ≤ 2*S_y = 60,000 psi; satisfactory.

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

where $a = 20.725, b = 5.6875 \quad \text{in}$

$$t_b = \sqrt{\frac{\beta_1 \cdot q \cdot b^2}{1.5 \cdot S_a}} = \sqrt{\frac{3 \cdot 51 \cdot 5.6875^{\,2}}{1.5 \cdot 20{,}000}} = 0.4058 \quad \text{in}$$

The base plate thickness of 0.5 in is adequate.

Foundation bearing check

$$S_f = \frac{Q_{\max}}{F \cdot E} = \frac{51{,}558.08}{12 \cdot 84.4} = 51 \quad \text{psi}$$

Concrete bearing stress ≤ 1,658 psi ; satisfactory.

Slotted hole length (Process Industry Practices VEFV1100)

$$\Delta_t = \max\left[|T_{amb} - T_s|, |T_{amb} - MDMT|\right] = \max\left[|70 - 150|, |70 - 0|\right] = 80\,^\circ F$$

$S_L = 2 \cdot L_s \cdot \alpha \cdot \Delta_t = 2 \cdot 126 \cdot 8.8\text{E-}06 \cdot 80 = 0.1774$"

Actual slot length is greater than or equal to the minimum (1.5" ≥ 0.1774"); satisfactory.

3.0 Material Test Reports

FORM U-2A MANUFACTURER'S PARTIAL DATA REPORT (ALTERNATIVE FORM)
A Part of a Pressure Vessel Fabricated by One Manufacturer for Another Manufacturer
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by BRIGHTON TRU-EDGE HEADS, 11861 MOSTELLER ROAD, CINCINNATI, OH 45241
(Name and address of Manufacturer)

2. Manufactured for TATE METAL WORKS, PO BOX 171, SPARTANBURG SC 29304
(Name and address of Purchaser)

3. Location of installation Unknown
(Name and address)

4. Type ELLIP HEAD 96" ID X 0.375" THK — [Description of vessel part (shell, two-piece head, tube bundle)]
1073801-1 — (Manufacturer's serial number)
(CRN)
(National Board number)
PO # 24018-00001 — (Drawing number)
(Drawing prepared by)
2024 — (Year built)

5. ASME Code, Section VIII, Div. 1 2023 Edition — [Edition and Addenda, if applicable (date)]
(Code Case number)
[Special service per UG-120(d)]

6. Shell (a) Number of course(s): (b) Overall length

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

Body Flanges on Shells

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

7. Heads: (a) SA240-304/304L (b)
(Material spec. number, grade or type) (H.T. - time & temp.) (Material spec. number, grade or type) (H.T. - time & temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)		0.313				2:1						1	FULL	UNK.
(b)														

Body Flanges on Heads

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

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

9. Impact test NO at test temperature of
[indicate *yes* or *no* and the component(s) impact tested]

10. Hydro., pneu., or comb. test pressure NONE Proof test

11. 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.)

12. Identification of part(s)

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

13. Supports: Skirt NO (Yes or no) Lugs (Number) Legs (Number) Others (Describe) Attached (Where and how)

14. Remarks: NO DESIGN FUNCTION BY BRIGHTON TRU-EDGE HEADS. NO HYDRO TEST PERFORMED.

FORM U-2A

Manufactured By BRIGHTON TRU-EDGE HEADS, 11861 MOSTELLER ROAD, CINCINNATI, OH 45241

Manufacturer's Serial No. 1073801-1 CRN - National Board No. -

CERTIFICATE OF SHOP/FIELD COMPLIANCE

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

U or PRT VIII-1 Certificate of Authorization nun 51,949 Expires 11/25/2024

Date 8-14-2024 Name BRIGHTON TRU-EDGE HEADS (Manufacturer) Signed (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by The Hartford Steam Boiler Inspection and Insurance Company of Hartford, CT have inspected the pressure vessel part described in this Manufacturer's Data Report on 8-14-24, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 8-14-24 Signed (Authorized Inspector) Commissions NB10904 (National Board Authorized Inspector Commission number)

FORM U-2A MANUFACTURER'S PARTIAL DATA REPORT (ALTERNATIVE FORM)
A Part of a Pressure Vessel Fabricated by One Manufacturer for Another Manufacturer
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by BRIGHTON TRU-EDGE HEADS, 11861 MOSTELLER ROAD, CINCINNATI, OH 45241
(Name and address of Manufacturer)

2. Manufactured for TATE METAL WORKS INC, PO BOX 171, SPARTANBURG SC 29304
(Name and address of Purchaser)

3. Location of installation Unknown
(Name and address)

4. Type ELLIP HEAD 96" ID X 0.375" THK
[Description of vessel part (shell, two-piece head, tube bundle)]
1073802-1
(Manufacturer's serial number)
(CRN)

(National Board number)
PO # 24018-00001
(Drawing number)
(Drawing prepared by)
2024
(Year built)

5. ASME Code, Section VIII, Div. 1 2023 Edition
[Edition and Addenda, if applicable (date)]
(Code Case number)
[Special service per UG-120(d)]

6. Shell (a) Number of course(s): (b) Overall length

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

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

7. Heads: (a) SA240-304/304L (b)
(Material spec. number, grade or type) (H.T. - time & temp.) (Material spec. number, grade or type) (H.T. - time & temp.)

	Location (Top, Bottom , Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)		0.313				2:1						1	SPOT	UNK.
(b)														

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

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

9. Impact test NO at test temperature of .
[indicate *yes* or *no* and the component(s) impact tested]

10. Hydro., pneu., or comb. test pressure NONE Proof test

11. Nozzles, inspection, and safety valve openings:

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

12. Identification of part(s)

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

13. Supports: Skirt NO (Yes or no) Lugs (Number) Legs (Number) Others (Describe) Attached (Where and how)

14. Remarks: NO DESIGN FUNCTION BY BRIGHTON TRU-EDGE HEADS. NO HYDRO TEST PERFORMED.

FORM U-2A

Manufactured By BRIGHTON TRU-EDGE HEADS, 11861 MOSTELLER ROAD, CINCINNATI, OH 45241

Manufacturer's Serial No. 1073802-1 CRN - National Board No. -

CERTIFICATE OF SHOP/FIELD COMPLIANCE

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

U or PRT VIII-1 Certificate of Authorization nun 51,949 Expires 11/25/2024

Date 8-14-2024 Name BRIGHTON TRU-EDGE HEADS (Manufacturer) Signed Richard Parton (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by The Hartford Steam Boiler Inspection and Insurance Company of Hartford, CT have inspected the pressure vessel part described in this Manufacturer's Data Report on 8-14-24, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 8-14-24 Signed (Authorized Inspector) Commissions NB10904 (National Board Authorized Inspector Commission number)

5/23/2024	
# of Pls.	4

PLATE INSPECTION REPORT

Purchase Order #24018-00002 **Job:** 24018.01

Vendor: Phoenix Metals

Material Size 0.313" X 60" X 305" Specification SA240-304/304L

Date ID#SD4L-4053

ID Suffix	Pcs.	Heat#	Slab/Lot#	MTR Accepted By	Material Accepted B		UT-Thk.	Notes
A	4	BB9D		[illegible] 5/29/24	MLF	5-29-24	0.313	

NAS NORTH AMERICAN STAINLESS
An Acerinox Group Company

METALLURGICAL TEST REPORT

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

Certificate: 915899 01
Customer: 0305 408

Mail To:
PHOENIX METALS COMPANY
12420 MEANS COURT
CHARLOTTE, NC 28278

Ship To:
PHOENIX METALS COMPANY
12420 MEANS COURT
CHARLOTTE, NC 28278

Date: 4/23/2024 Page: 1
Steel: 304/304L
Finish: HRAP

Your Order: 306419 NAS Order: AN 1053821 01 Corrosion: ASTM A262/21;180Bend-OK

PRODUCT DESCRIPTION:

STAINLESS STEEL COIL, HRAP; UNS 30400/30403
ASTM A240/23,A480/23,A666/23;ASME SA240/23,SA480/23,SA666/19
CHEM ONLY ON FOLLOWING ASTM: A276/17,A479/23,A484/23,A312/22a
CHEM ONLY ON FOLLOWING ASME: SA312/23,SA479/23

AMS 5511K/5513J XMRK; MIL-5059D AMD3(X CRN MEAS); MIL-4043B
NACE MR0175/ISO 15156-3:2015 A, MR0103/07;QQS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; RoHS 1, 2 & 3 Compliant
Material is Free of Radioactive Contamination
Steel Making Process: EAF, AOD, & Cont. Casting
Product Mfg.by a Quality Mgt.Sys. in Conf. w/ISO 9001
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

Product ID #	Coil #	Thickness	Width	Weight	--------Length-------	Mark	Pieces	COMMODITY CODE
04BB9D A	* 04BB9D A	.3125	60.0000	15,580	COIL 239.30	2	1	270342

ANAB, ISO/IEC 17025, Certificate# L2323

CHEMICAL ANALYSIS CM(Country of Melt) ES(Spain) US(United States) ZA(South Africa) JP(Japan) Chemical Analysis per ASTM A751/20

HEAT	CM	C %	CR %	CU %	MN %	MO %	N %	NI %	P %	S %
BB9D	US	.0199	18.2270	.5130	1.7815	.3645	.0779	8.1025	.0310	.0027
		SI %								
		.3160								

MECHANICAL PROPERTIES

Product ID #	Coil #	loc	dir	UTS KSI	20C .2% YS KSI	20C ELONG %-2"	Hard RB	Tail Hard
04BB9D A	04BB9D A	F	T	93.28	47.26	52.61	86.00	89.00

P.O. No. 24018.0002
Job No. 24018.01
ID No. 504L-4253A
2nd (23)

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

Technical Dept. Mgr. D. Hargett
DANIEL HARGETT 4/24/2024

5/23/2024	
# of Pls.	1

PLATE INSPECTION REPORT

Purchase Order #24018-00002 **Job: 24018.01**

Vendor: Phoenix Metals

Material Size 0.313" X 48" X 305" Specification SA240-304/304L

Date ID#SD4L-4052

ID Suffix	Pcs.	Heat#	Slab/Lot#	MTR Accepted By	Material Accepted B		UT-Thk.	Notes
A	1	BC4X		JWB 6/10/24	MLE	6-10-24	0.405	

NAS NORTH AMERICAN STAINLESS
An Acerinox Group Company

METALLURGICAL TEST REPORT

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

Certificate: 914992 01
Customer: 0305 408

Mail To:
PHOENIX METALS COMPANY
12420 MEANS COURT
CHARLOTTE, NC 28278

Ship To:
PHOENIX METALS COMPANY
12420 MEANS COURT
CHARLOTTE, NC 28278

Date: 4/19/2024 Page: 1
Steel: 304L
Finish: HRAP

Your Order: 306177
NAS Order: AN 1053687 01
Corrosion: ASTM A262/21 A;180Bend-O

PRODUCT DESCRIPTION:

STAINLESS STEEL COIL, HRAP; UNS 30403
ASTM A240/23,A480/23,A666/23;ASME SA240/23,SA480/23,SA666/19
CHEM ONLY ON FOLLOWING ASTM: A276/17,A479/23,A484/23,A312/22a
CHEM ONLY ON FOLLOWING ASME: SA312/23,SA479/23
AMS 5511K XMRK; MIL-5059D AMD3(X CRN MEAS); MIL-4043B
NACE MR0175/ISO 15156-3:2015 A, MR0103/07;QQS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; RoHS 1, 2 & 3 Compliant
Material is Free of Radioactive Contamination
Steel Making Process: EAF, AOD, & Cont. Casting
Product Mfg.by a Quality Mgt.Sys. in Conf. w/ISO 9001
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

Product ID #	Coil #	Thickness	Width	Weight	--------Length-------	Mark	Pieces	COMMODITY CODE
02BC4X A	* 02BC4X A	.3125	48.0000	15,480	COIL 297.20	1	1	907758

ANAB, ISO/IEC 17025, Certificate# L2323

CHEMICAL ANALYSIS

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

Chemical Analysis per ASTM A751/20

HEAT	CM	C %	CR %	CU %	MN %	MO %	N %	NI %	P %	S %
BC4X	US	.0144	18.3215	.4095	1.7280	.4325	.0724	8.0800	.0300	.0010

SI %
.3965

MECHANICAL PROPERTIES

Product ID #	Coil #	loc	dir	UTS KSI	20C .2% YS KSI	20C ELONG %-2"	% Hard RB	Tail Hard
02BC4X A	02BC4X A	F	T	94.08	47.77	52.04	86.00	87.00

P.O. No. 24018-00002
Job No. 24018
ID No. SD4L-4052 A
JMB (23)

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

Technical Dept. Mgr. Daniel Hargett
DANIEL HARGETT 4/22/2024

24018 3" 150# R.F.S.O.

MATERIAL TEST CERTIFICATE (EN10204 3.1)

FELIX TECH
Felix Metal Tech Co., Ltd.
Bac Hamlet, Luu Kiem Commune,
Thuy Nguyen Dist, Hai Phong ,Vietram
TEL : +84 225 3692 194 (REP.)

CUSTOMER : ALLIED STAINLESS GROUP, INC.
PO. NO. : PO60821
MPS. NO. : N/A
PROJECT NAME : N/A

FELIX MR NO.: FO2308-008 Rev.0
SPECIFICATION : ASTM A182 F304/F304L-22
ASME SA182 F304/F304L-2021ED

CERTIFICATE NO. : FV231020-030
PAGE : 1 OF 1
DATE : 2023-10-20

Description	Q'ty (EA)	Lot No.	*2	Size of Specimen D (mm)	Size of Specimen G.L. (mm)	Tension Test *1 Y.S. (MPa)	T.S. (MPa)	E.L. (%)	R.A. (%)	Hardness Test (HBW)	Impact Test Temp. : °C, Notch : mmV (J) Min.	Avg.
		Spec. Min.		12.5	50	205	515	30	50			
		Spec. Max.								237		
10 #150 SO RF 3" 4L1SR3	561	A6803 CM42	T	12.5	50	337.2	589.2	56.4	74.6	159, 159		
		3973					<< BLANK >>					
TOTAL	561											

Heat Treatment *4
S : 1050°C x 2.0 hrs, WC

Heat No.		C	Si	Mn	P	S	Ni	Cr	Mo	Cu	V	Nb	Al	N			
Spec. Min.							8.00	18.00									
Spec. Max.		0.03	1.00	2.00	0.045	0.030	13.00	20.00						0.10			
A6803	H	0.027	0.34	1.54	0.040	0.021	8.05	18.31						0.09			

Chemical Composition(%) *3

Remark
- NACE MR0175/ISO15156-3 -2015 : HRC22 Max(=HB237)
- NACE MR0103-2015
- Country of Forging: VIET NAM
- IGC Test : ASTM A262 Method E -> Passed
- No weld repair was performed.
- Free of Mercury contamination and no mercury bearing equipment was used during manufacturing.

Dimension & Visual	PMI	UT	MT	PT
Accepted (ASME B16.5-2020)	Accepted	N/A	N/A	N/A

Abbreviation
*1. Tension Test : Y.S. = Yield Strength, T.S. = Tensile Strength, E.L. = Elongation, R.A. = Reduction of Area, G.L. = Gauge Length(mm), D. = Diameter(Ø)
*2. Location : L = Longitudinal, Tr = Transverse, T = Tangential, R = Radial
*3. Chemical Composition : H = Heat Analysis, P = Product Analysis
*4. Heat Treatment : N = Normalized, A = Annealed, Q = Quenched, T = Tempered, S = Solution Treated, S.R. = Stress Relieved, A.C. = Air Cooled, W.C. = Water Cooled, F.C. = Furnace Cooled
*5. CE : C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15

FELIX METAL TECH CO.,LTD · FELIX TECH · QUALITY MANAGEMENT

Surveyor

We hereby certify that the material herein has been tested, inspected and satisfied in accordance with the above specification.

Nguyễn Tiến Bình
Manager / Q M. Team

MTR heat attachments

SALES ID : C651890 PACKING SLIP : PAC-0409151 ITEM ID : A45140L-32 LINE NUM : 16

24 of 8, 2" 150 # R.F.W.N.

CHANDAN STEEL LIMITED

(GOVT. OF INDIA RECOGNISED EXPORT HOUSE)

ADM. OFFICE: [illegible] SAGAR, N. S. PATKAR MARG, Chowpatty MUMBAI-400007, INDIA
Tel: 91-22-[illegible]
Website : www.chandansteel.net
Email : [illegible]@chandansteel.net
L/c. No. : —
L/c. Date: —

Works : Plot # 31 to 34, 45 to 49/2, 142 (Exp. Area), G.I.D.C. Umbergaon, Survey No. [illegible], Village - Dehri, Dist. - Valsad, Gujarat - 396171 India.
Tel: [illegible]
Email : info@chandansteel.net
GSTIN - [illegible]

INSPECTION CERTIFICATE 3.1
ACCORDING TO EN 10204

Merit Brass Company One Merit Drive PO Box 43127 Cleveland - OH 44143 USA	Test Certificate No : EXP/23-24/01446 -01 Date of Issue : 30.12.2023 P.O. No. : P1014010-HOUSTON Invoice No. & Date : EXP/23-24/01446 Dtd.30.12.2023

ITEM DESCRIPTION
STAINLESS STEEL FORGED & FULLY MACHINED FLANGES

40 of 8

SR. NO.	ARTICLE NO.	Heat No.	Pcs	Box No.	Wt.Kgs	Grade	Item	Process Route
5	A45140L-32	CH-20226	100	2	262.50	F304/304L	2" WNRF 150 LBS 40	Electric Induction Melting, A.O.D. Refining Continuous Casting & Hot Forging.
7	A45140L-48	CH-20377	100	3	519.96	F304/304L	3" WNRF 150 LBS 40	
8	A452L-128	CH-20416	15	3	195.15	F304/304L	8" LJFF 150 LBS	
13	A453L-48	CH-20847	60	3 & 4	244.98	F304/304L	3" SWRF 150 LBS STD	
9	A452L-16	CH-19412	20	4	18.65	F304/304L	1" LJFF 150 LBS	

CHEMICAL COMPOSITION (Weight %)

SR. NO.	ARTICLE NO.	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Ti	N	OTHERS
5	A45140L-32	0.026	0.44	1.83	0.040	0.008	18.50	-	8.06	-	-	0.073	-
7	A45140L-48	0.019	0.42	1.63	0.044	0.014	18.20	-	8.04	-	-	0.076	-
8	A452L-128	0.024	0.49	1.79	0.039	0.006	18.40	-	8.07	-	-	0.068	-
13	A453L-48	0.024	0.44	1.67	0.041	0.005	18.25	-	8.05	-	-	0.070	-
9	A452L-16	0.024	0.45	1.74	0.039	0.007	18.40	-	8.12	-	-	0.073	-

MECHANICAL PROPERTIES

SR. NO.	ARTICLE NO	0.2% Yield Strength N/mm^2 ($R_{p0.2}$)	Tensile Strength N/mm^2 (R_m)	Elongation %	Reduction of Area %	Hardness (H.B.W.)
5	A45140L-32	260	570	62	78	165-168
7	A45140L-48	264	574	61	79	162-164
8	A452L-128	264	562	61	75	155-159
13	A453L-48	262	563	59	77	161-165
9	A452L-16	273	564	59	76	171-173

Remarks:

1. The material is solution annealed at minimum 1050 °C and water quenched.
2. Material is free from mercury and radio-active contamination and is found within the limits of the background radiation
3. PMI test 100% satisfactory.
4. Inter-Granular Corrosion Test as per ASTM A262-15(2021) (Pr.E):- Satisfactory.
5. The material conforms to ASTM A 182 - 22, ASME SA 182 - 21 & Dimension confirms to ASME B16.5 - 20 Specification.
6. Visual and Dimensions inspection done and found satisfactory.
7. The material conforms to NACE MR0175/ISO 15156-3:2015 & NACE MR0103-2015
8. Marking Details - MATERIAL SPECIFICATION, SIZE, GRADE, HEAT NO., CHANDAN
9. Country of Melt - INDIA.

We hereby certify that, the material described herein, and supplied are in compliance with the requirements of the order.

V.Y. NARAYANAN
SR. MANAGER Q. A.

Q. A.

F/QA/18, Rev 00, 11 01 2018

24018
3" 150# R.F.W.N.

4079.

CHANDAN STEEL LIMITED

(GOVT. OF INDIA RECOGNISED EXPORT HOUSE)

ISO 9001 : 2015 CERTIFICATE No. 04 100 011022

ADM. OFFICE: 504, SUKH SAGAR, N. S. PATKAR MARG, MUMBAI 400 007, INDIA
Tel: 91-22-66290600. Fax: 91-22-66290633/34
Website : www.chandansteel.net
Email : csl@chandansteel.net

WORKS: Plot No. 35, Survey No.102/2 & 3 G. I. D. C., Umbergaon. Village : Dehari, Tal- Umbergaon. Dist Valsad, Gujarat - 396 171. INDIA.
Tel.: 91-260-256 2066 / 4367 / 1166. Fax: 91-260-256 2157
E-mail : exports@chandansteel.net

L/c. No. : —
L/c. Date: —

INSPECTION CERTIFICATE 3.1
ACCORDING TO EN 10204

ALLIED STAINLESS GROUP	Test Certificate No. : EXP/23-24/00534 -05
7200 Mykawa Road	Date of Issue : 13.07.2023
Houston, Texas 77033	P. O. No. : PO53405
Phone: 800-969-5565	Invoice No. & Date : EXP/23-24/00534 Dtd 13.07.2023

ITEM DESCRIPTION
STAINLESS STEEL FORGED & FULLY MACHINED FLANGES

Sr.No.	ARTICLE NO.	Heat No.	Pcs	Box No.	Wt.Kgs	Grade	Item	Process Route
4	4L1WRS4	CH-19385	110	2 & 3	794.93	F304/304L	4" WNRF 150 LBS 40S	Electric Induction Melting, A.O.D. Refining, Continuous Casting & Hot Forging
5	4L1WRS3	CH-19205	175	4 & 27	909.28	F304/304L	3" WNRF 150 LBS 40S	
6	4L1WFS3	CH-19205	28	2	149.31	F304/304L	3" WNFF 150 LBS 40S	
12	4L1SR5	CH-19283	27	2 & 73	174.09	F304/304L	5" SORF 150 LBS	
3	4L1WRA5	CH-19304	16	4	133.57	F304/304L	5" WNRF 150 LBS 10S	

CHEMICAL COMPOSITION (Weight %)

Sr.No.	ARTICLE NO.	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Ti	N	OTHERS
4	4L1WRS4	0.022	0.50	1.61	0.035	0.013	18.06	-	8.00	-	-	0.073	-
5	4L1WRS3	0.026	0.49	1.79	0.040	0.028	18.18	-	8.00	-	-	0.075	-
6	4L1WFS3	0.026	0.49	1.79	0.040	0.028	18.18	-	8.00	-	-	0.075	-
12	4L1SR5	0.020	0.43	1.64	0.038	0.014	18.40	-	8.05	-	-	0.084	-
3	4L1WRA5	0.023	0.42	1.75	0.039	0.015	18.39	-	8.05	-	-	0.092	-

MECHANICAL PROPERTIES

Sr.No.	ARTICLE NO	0.2% Yield Strength N/mm² ($R_{p0.2}$)	Tensile Strength N/mm² (R_m)	Elongation %	Reduction of Area %	Hardness (H.B.W.)
4	4L1WRS4	266	571	59	72	165-167
5	4L1WRS3	274	574	62	74	170-174
6	4L1WFS3	274	574	62	74	170-174
12	4L1SR5	264	573	61	78	161-165
3	4L1WRA5	268	574	60	76	162-165

Remarks:

1. The material is solution annealed at minimum 1050°C and water quenched.
2. Material is free from mercury and radio-active contamination and is found within the limits of the background radiation.
3. PMI test 100% satisfactory.
4. Inter-Granular Corrosion Test as per ASTM A262-15(2021) (Pr.E).- Satisfactory.
5. The material conforms to ASTM A 182 - 22, ASME SA 182 - 21 & Dimension confirms to ASME B16.5 - 20 Specification.
6. Visual and Dimensions inspection done and found satisfactory.
7. The material conforms to NACE MR0175/ISO 15156-3:2015 & NACE MR0103-2015.
8. The steel making is by Chandan Steel Limited, India.
9. Country of Melt - INDIA.

Q.A.

We hereby certify that, the material described herein and supplied are in compliance with the requirements of the order.

V. Y. NARAYANAN
SR. MANAGER Q. A.

F/QA/18. Rev.00,11.01.2018

24018 24" 150# R.F.W.N.

CHANDAN STEEL LIMITED

(GOVT. OF INDIA RECOGNISED EXPORT HOUSE)
ISO 9001 : 2015 CERTIFICATE No. 04 100 011022

ADM. OFFICE: 504, SUKH SAGAR, N. S. PATKAR MARG, Chowpatty MUMBAI 400 007, INDIA
Tel.: 91-22- 66290600. Fax.: 91-22-66290633/34
Website : www.chandansteel.net
Email : csl@chandansteel.net
L/c. No. : —
L/c. Date: —

Works : Plot # 31 to 36, 45 to 49/2, 142 (Exp. Area), G.I.D.C. Umbergaon, Survey No. 102/2 & 102/3, Village - Dehri, Dist. - Valsad, Gujarat - 396171 India.
Tel. : (+91) 260 7128999/800/802 .
Email : info@chandansteel.com
GSTIN - 24AAACC4713B1ZG

INSPECTION CERTIFICATE 3.1

ACCORDING TO EN 10204

ALLIED STAINLESS GROUP	Test Certificate No. : EXP/24-25/00076 -01
7200 Mykawa Road	Date of Issue : 20.04.2024
Houston, Texas 77033	P. O. No. : PO67003
Phone: 800-969-5565	Invoice No. & Date : EXP/24-25/00076 Dtd.20.04.2024

ITEM DESCRIPTION
STAINLESS STEEL FORGED & FULLY MACHINED FLANGES

Sr.No.	ARTICLE NO.	Heat No.	Pcs	Box No.	Wt.Kgs	Grade	Item	Process Route
17	4L1BR12	245050	14	47	629.00	F304/304L	12" BLRF 150 LBS	Electric Induction Melting, A.O.D. Refining, Continuous Casting & Hot Forging
39	4L3WRS12	CH-21765	28	79,80, 81, 82 & 126	1760.00	F304/304L	12" WNRF 300 LBS 40S	
44	4L1WRS24	245023	29	61,62, 63, 64, 65, 66, 67 & 68	3437.00	F304/304L	24" WNRF 150 LBS 40S	
48	4L1SR24	CH-20964	9	59 & 129	785.00	F304/304L	24" SORF 150 LBS	
49	4L1SR20	CH-21336	8	71	496.00	F304/304L	20" SORF 150 LBS	

CHEMICAL COMPOSITION (Weight %)

Sr.No.	ARTICLE NO.	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Ti	N	OTHERS
17	4L1BR12	0.016	0.37	1.73	0.037	0.006	18.22	-	8.07	-	-	0.082	-
39	4L3WRS12	0.025	0.55	1.65	0.043	0.010	18.05	-	8.07	-	-	0.078	-
44	4L1WRS24	0.020	0.28	1.65	0.037	0.007	18.50	-	8.09	-	-	0.085	-
48	4L1SR24	0.022	0.48	1.85	0.040	0.012	18.65	-	8.05	-	-	0.077	-
49	4L1SR20	0.025	0.47	1.79	0.042	0.006	18.31	-	8.04	-	-	0.075	-

MECHANICAL PROPERTIES

Sr.No.	ARTICLE NO.	0.2% Yield Strength N/mm^2 ($R_{p0.2}$)	Tensile Strength N/mm^2 (R_m)	Elongation %	Reduction of Area %	Hardness (H.B.W.)
17	4L1BR12	264	571	62	76	156-158
39	4L3WRS12	268	571	61	76	160-163
44	4L1WRS24	264	559	62	75	160-162
48	4L1SR24	274	572	61	74	162-166
49	4L1SR20	264	568	60	77	152-155

Remarks:

1. The material is solution annealed at minimum 1050°C and water quenched.
2. Material is free from mercury and radio-active contamination and is found within the limits of the background radiation.
3. PMI test 100% satisfactory.
4. Inter-Granular Corrosion Test as per ASTM A262-15(2021) (Pr.E):- Satisfactory.
5. The material conforms to ASTM A 182 – 23, ASME SA 182 - 23 & Dimension confirms to ASME B16.5 - 20 Specification.
6. Visual and Dimensions inspection done and found satisfactory.
7. The material conforms to NACE MR0175/ISO 15156-3:2015 & NACE MR0103-2015.
8. The steel making is by Chandan Steel Limited, India.
9. Country of Melt - INDIA.

We hereby certify that, the material described herein, and supplied are in compliance with the requirements of the order.

Q.A.

V. Y. NARAYANA
SR. MANAGER Q. A.

F/QA/18, Rev.00,11.01.2018

24018
24" 150# R.F. Bl.

CHANDAN STEEL LIMITED

(GOVT. OF INDIA RECOGNISED EXPORT HOUSE)

ISO 9001 : 2015 CERTIFICATE No. 04 100 011022

ADM. OFFICE: 504, SUKH SAGAR, N. S. PATKAR MARG,
Chowpatty MUMBAI 400 007, INDIA
Tel: 91-22- 66290600. Fax: 91-22-66290633/34
Website : www.chandansteel.net
Email : csl@chandansteel.net

Works : Plot # 31 to 36, 45 to 49/2, 142 (Exp. Area), G.I.D.C. Umbergaon,
Survey No. 102/2 & 102/3, Village - Dehri, Dist. - Valsad, Gujarat - 396171 India.
Tel. : (+91) 260 7128999/800/802.
Email : info@chandansteel.com
GSTIN - 24AAACC4713B1ZG

L/c. No. : ----
L/c. Date: ---

INSPECTION CERTIFICATE 3.1
ACCORDING TO EN 10204

ALLIED STAINLESS GROUP	Test Certificate No. : EXP/23-24/01728 -04
7200 Mykawa Road	Date of Issue : 07.02.2024
Houston, Texas 77033	P. O. No. : PO60791
Phone: 800-969-5565	Invoice No. & Date : EXP/23-24/01728 Dtd.07.02.2024

ITEM DESCRIPTION
STAINLESS STEEL FORGED & FULLY MACHINED FLANGES

Sr.No.	ARTICLE NO.	Heat No.	Pcs	Box No.	Wt.Kgs	Grade	Item	Process Route
100	4L1SR16	CH-20974	15	107	692.00	F304/304L	16" SORF 150 LBS	Electric Induction Melting, A.O.D. Refining, Continuous Casting & Hot Forging
101	4L1BR24	CH-20658	16	85,86 & 87	3061.00	F304/304L	24" BLRF 150 LBS	
106	4L1WRM18	CH-20967	11	95,96 & 97	691.00	F304/304L	18" WNRF 150 LBS 10s	
46	4L1L4	CH-20846	64	110	352.00	F304/304L	4" LJFF 150 LBS	
18	4L1BR12	245050	28	61 & 62	1254.20	F304/304L	12" BLRF 150 LBS	

CHEMICAL COMPOSITION (Weight %)

Sr.No.	ARTICLE NO.	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Ti	N	OTHERS
100	4L1SR16	0.025	0.42	1.65	0.038	0.005	18.50	-	8.02	-	-	0.067	-
101	4L1BR24	0.028	0.44	1.78	0.040	0.010	18.40	-	8.06	-	-	0.075	-
106	4L1WRM18	0.020	0.48	1.70	0.038	0.004	18.57	-	8.08	-	-	0.070	-
46	4L1L4	0.022	0.46	1.70	0.040	0.013	18.42	-	8.02	-	-	0.076	-
18	4L1BR12	0.016	0.37	1.73	0.037	0.006	18.22	-	8.07	-	-	0.082	-

MECHANICAL PROPERTIES

Sr.No.	ARTICLE NO.	0.2% Yield Strength N/mm^2 ($R_{p0.2}$)	Tensile Strength N/mm^2 (R_m)	Elongation %	Reduction of Area %	Hardness (H.B.W.)
100	4L1SR16	264	572	61	78	162-164
101	4L1BR24	272	562	58	73	168-171
106	4L1WRM18	272	574	64	76	162-164
46	4L1L4	264	562	64	75	162-164
18	4L1BR12	273	565	63	75	161-165

Remarks:

1. The material is solution annealed at minimum 1050°C and water quenched.
2. Material is free from mercury and radio-active contamination and is found within the limits of the background radiation.
3. PMI test 100% satisfactory.
4. Inter-Granular Corrosion Test as per ASTM A262-15(2021) (Pr.E):- Satisfactory.
5. The material conforms to ASTM A 182 – 22, ASME SA 182 - 23 & Dimension confirms to ASME B16.5 - 20 Specification.
6. Visual and Dimensions inspection done and found satisfactory.
7. The material conforms to NACE MR0175/ISO 15156-3:2015 & NACE MR0103-2015.
8. The steel making is by Chandan Steel Limited, India.
9. Country of Melt - INDIA.

We hereby certify that, the material described herein, and supplied are in compliance with the requirements of the order.

Q.A.

V. Y. NARAYANAN
SR. MANAGER Q. A.

F/QA/18, Rev.00,11.01.2018

24018 1/2" 3000# L.C.

PURCHASER:	Norca Industrial Company LLC C/O GPVF, LLC- IMPORT OF RECORD	**TBC INSPECTION CERTIFICATE** (MILL TEST REPORT) TBC STEEL INDUSTRY SDN. BHD.	DATE: July.26,2023 ORDER NO: 870/005018 WORK NO: NK2304113
STANDARD:	ASTM A182 F304/L-2018	No 5, Lorong IKS, Simpang Empat K,Taman IKS Simpang Empat, 14100 Simpang Ampat, Penang, Malaysia.	MTR NO: TBCIC-113 PAGE: 5/8
DIMENSION :	ASME B16.11		
ACCORDING:	EN10204-2004 Type 3.1	Tel:+04-582 9266 Fax:+04-582 8266	

PRODUCT	SPECIFICATION FOR MATERIAL	SPECIFICATION FOR PIPE FITTINGS
CARBON STEEL FORGED FITTINGS	ASTM A182 F304/L	ASME B16.11

Pos.	DESCRIPTION	Q'TY (PCS)	HEAT NO.	C	Si	Mn	P	S	Ni	Cr	N		
				CHEMICAL COMPOSITION%									
				0.030	1.00	2.00	0.045	0.030	8.0	18.0	0.10		
				MAX	MAX	MAX	MAX	MAX	13.0	20.0	MAX		
25)	1 CAP 3M S/W 304/L 6354	50	S221205AA11	0.012	0.258	1.39	0.037	0.0127	8.03	18.40	--		
26)	1 X 3/4 RED COUPLING 3M S/W 304/L 2115	100	S221205AA11	0.012	0.258	1.39	0.037	0.0127	8.03	18.40	--		
27)	1 X 3/4 RED TEE 3M S/W 304/L 2168	75	S221205AA11	0.012	0.258	1.39	0.037	0.0127	8.03	18.40	--		
28)	3/4 90 ELBOW 3M THREADED 304/L [illegible]	100	S221205AA11	0.012	0.258	1.39	0.037	0.0127	8.03	18.40	--		
29)	1/4 COUPLING 3M THREADED 304/L 6446	100	S221223AA19	0.020	0.289	1.40	0.039	0.0078	8.04	18.05	--		
30)	1/2 COUPLING 3M THREADED 304/L 6448	100	S221223AA19	0.020	0.289	1.40	0.039	0.0078	8.04	18.05	--		

Pos.	STANDARD / HEAT NO.	YIELD STRENGTH Mpa	TENSILE STRENGTH Mpa	ELONGATION %	REDUCTION OF AREA %	HARDNESS HB	DIMENSION INSPECTION	SURFACE TREATMENT	SURFACE INSPECTION
		170 MIN	485 MIN	30 MIN	50 MIN	--			
25)	S221205AA11	241	535	46	63	--	GOOD	ACID PICKLING	GOOD
26)	S221205AA11	241	535	46	63	--	GOOD	ACID PICKLING	GOOD
27)	S221205AA11	241	535	46	63	--	GOOD	ACID PICKLING	GOOD
28)	S221205AA11	241	535	46	63	--	GOOD	ACID PICKLING	GOOD
29)	S221223AA19	250	541	42	60	--	GOOD	ACID PICKLING	GOOD
30)	S221223AA19	250	541	42	60	--	GOOD	ACID PICKLING	GOOD

(NOTE):

1.HEAT TREATMENT: SOLUTION TREAT,TEMPERATURE 1040°C,WATER COOLED.

WE HEREBY CERTIFY THAT THE PRODUCT DESCRIBED HEREIN HAS BEEN MANUFACTURED IN ACCORDANCE WITH THE SPECIFICATIONS CONCERNED AND ALSO WITH THE PURCHASER'S REQUIREMENTS AND THAT THE TEST RESULTS SHOWN HEREIN ARE CORRECT .

TBC STEEL INDUSTRY SDN. BHD. QUALITY ASSURANCE DEPT.

MILL TEST REPORT

TA CHEN INTERNATIONAL, INC.
www.tachen.com

This MTR contains:2 pages (Page:1)

24018
3/4" 3000# F.C.

Cust# AMEWAL Company: AMERICAN STAINLESS & SUPPLY, LLC.
MTR# MEKA/MEKA20184-4.pdf PO# S1621892 SO# LNCNC7
Item: P4LTC00E

MEKA20184-4

M.E.G.A.

INSPECTION CERTIFICATE
Certificato d'Ispezione

COMPANY WITH QUALITY SYSTEM CERTIFIED BY DNV GL = ISO 9001:2015 =

REPORT N. / Rapporto N.: TC-028620-22-0002	Issued on: 07/10/2022 / Revised on	Customer / Cliente: TA CHEN INTERNATIONAL INC, 9525 WALLISVILLE RD., HOUSTON TX 77013 - U.S.A.	Job n. / Com. n.: 28620 — Page n./Pagina n.: 4 of 9
Revision / Revisione: 0	According to / In accordo a: EN 10204:2004, UNI EN 10204:2005 — Type / Tipo: 3.1		Purchase order and project/Ordine e progetto: LA4290

DESCRIPTION / DESCRIZIONE

Test / Prova	Item / Pos.	Qty / Q.tà	Customer code / Codice cliente	Material / Materiale	Heat / Colata	Product / Prodotto
AZHP	45	460	P4LTC00E/MG	ASTM A182-22 F304/304L	1KBA	COUPLING S.3000 NPT A/SA182 F304/L 3/4
AHSP	46	65	P4LTC01B/MG	ASTM A182-22 F304/304L	456400	COUPLING S.3000 NPT A/SA182 F304/L 1.1/4
AWSB	47	36	P4LTCP008/MG	ASTM A182-22 F304/304L	0EAJ	CAP S.3000 NPT A/SA182 F304/L 1/4
AXTJ	50	8	P4LTCP030/MG	ASTM A182-22 F304/304L	283884	CAP S.3000 NPT A/SA182 F304/L 3
AZHP	54	140	P4LTHC00E/MG	ASTM A182-22 F304/304L	1KBA	HALF COUPLING S.3000 NPT A/SA182 F304/L 3/4

Test / Prova	STEEL MELTING AND HEAT TREATMENT DATA / Dettagli di produzione e trattamento termico	CTY of melt	RAW AND FORGING MATERIAL CERTIFICATES / Certificati di acciaieria/forgia	Ref. to MEGA-LAB Mechanical Test
AZHP	ELECT.FURN.-SOLUT.ANNEALED at 1050 C-WATER QUENCHED CERT 2021/036178 ROLDAN	ES	2021/036178 by ROLDAN by ACERINOX ITALIA srl	MC-000000-22-0176
AHSP	ELECT.FURN.-SOLUT.ANNEALED at 1050 C-WATER QUENCHED CERT 353578 OLARRA	ES	353578 by OLARRA	
AWSB	ELECT.FURN.-SOLUT.ANNEALED at 1050 C-WATER QUENCHED CERT 2021/002431 ROLDAN	ES	2021/002431 by ROLDAN by ACERINOX ITALIA srl	MC-000000-21-0165
AXTJ	ELECT.FURN.-SOLUT.ANNEALED at 1070^C-WATER QUENCHED CERT MEST760806/21/ VALBRUNA	IT	MEST760806/21/ by VALBRUNA by ACCIAIERIE VALBRUNA s.p.a.	MC-000000-21-0730
AZHP	ELECT.FURN.-SOLUT.ANNEALED at 1050 C-WATER QUENCHED CERT 2021/036178 ROLDAN	ES	2021/036178 by ROLDAN by ACERINOX ITALIA srl	MC-000000-22-0176

Test / Prova	Test loc. / Preso a	Orient. / Direz.	TENSILE TEST AT ROOM TEMPERATURE / Trazione a temperatura ambiente — Specimen / Provino: Shape / Forma	A Sez.[mm²]	Gage Length Lungh.[mm]	Yield strength Sner. [Mpa] Min:	Tensile strength Rottura [Mpa] Min:	Elongation Allung. [%] Min:	Red. Of Area Contraz. [%] Min:	CVN IMPACT TEST (KV) / Prova di resilienza — Dimens. Dimens. [mm]	T Temp. [°C]	Abs. Energy Energia ass. [J]	Shear A Area d [%]	Lat Exp Esp. Lat. [mm]	Bend [B] Flatt. [F] Piega Schiacc.	Hardness Durezza [HBW2.5/187.5]	Grain Size Dimens. grano
AZHP	T/2	LONG	Round	127.100	50.000	306.200	558.900	52.400	76.100	10X10X55	20	84-92-104	–	–		160-163	
AHSP	T/2	TRANS	Round	30.200	25.000	298.100	596.500	53.700	72.500	10x10x55	0	172-174-194	–	–		172-173	
AWSB	T/2	LONG	Round	122.600	50.000	348.600	651.200	48.800	69.200	10x10x55	20	212-216-228	–	–		170-172	
AXTJ	T/2	TRANS	Round	30.200	25.000	272.800	588.600	53.900	71.900	10x10x55	0	186-194-212	–	–		168-172	
AZHP	T/2	LONG	Round	127.100	50.000	306.200	558.900	52.400	76.100	10X10X55	20	84-92-104	–	–		160-163	

Test / Prova	C [%]	Si [%]	Mn [%]	S [%]	P [%]	Cr [%]	Ni [%]	Mo [%]	Ti [%]	Cu [%]	V [%]	Al [%]	H [%]	Nb [%]	N [%]	Sn [%]	O [%]	B [%]	Fe [%]	Zr [%]	CE[A] [%]	PREN[B] [%]	CEs[E] [%]	J fact.[D] [%]
AZHP	0.0230	0.4500	1.5200	0.0270	0.0310	18.2650	8.0100	0.4560	0.0040	0.4170					0.0860							21.1458		
AHSP	0.0170	0.3200	1.4900	0.0260	0.0370	18.1000	8.1000								0.0905							19.5480		
AWSB	0.0280	0.3670	1.4520	0.0270	0.0290	18.2900	8.0550	0.3330	0.0020	0.4120					0.0910							20.8449		
AXTJ	0.0140	0.5600	1.7600	0.0250	0.0300	18.1400	8.0100								0.0880							19.5480		
AZHP	0.0230	0.4500	1.5200	0.0270	0.0310	18.2650	8.0100	0.4560	0.0040	0.4170					0.0860							21.1458		

REMARKS / Note

1: MATERIAL ACCORDING TO NACE MR0175/ISO 15156-1-2-3 Ed.2020, NACE MR0103 Ed.2015.
2: MATERIAL ACCORDING TO ASME Sect. II Part A 2021 Edition.

A: CE = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 | B: PREN = Cr + 3.3Mo + 16N
C: X factor = (10P + 5Sb+4Sn+As)/100 - elements expressed in ppm
D: J factor = ((Mn + Si)(P + Sn)) x 10E4 | E: CEs = C + Mn/6

Additional elements: 'AZHP': Co 0.1900 | 'AHSP': Co 0.1400 | 'AWSB': Co 0.2730 |

Quality Control Inspector
Certification department
Ispettore controllo qualità

Emmanuel Centemeri

Form QC-01-01 Rev. 0 2013-03-15

MILL TEST REPORT **TA CHEN INTERNATIONAL, INC.**
www.tachen.com

Cust# AMEWAL Company: AMERICAN STAINLESS & SUPPLY, LLC.
MTR# MEKA/MEKA20184-4.pdf PO# S1621892 SO# LNCNC7
Item: P4LTC00E

M.E.G.A.

INSPECTION CERTIFICATE
Certificato d'ispezione

COMPANY WITH QUALITY SYSTEM CERTIFIED BY DNV GL = ISO 9001:2015 =

REPORT N. / Rapporto N.	TC-028620-22-0002	Issued on / Revised on	07/10/2022	Customer / Cliente	TA CHEN INTERNATIONAL INC	Job n. / Com. n. 28620	Page n./ Pagina n. 9 of 9
Revision / Revisione	0	According to / In accordo a	EN 10204:2004 / UNI EN 10204:2005 — Type / Tipo 3.1		9525 WALLISVILLE RD. HOUSTON TX 77013 - U.S.A.	Purchase order and project/Ordine e progetto: LA4290	

We hereby certify that all items supplied for the above purchase orders meet all the requirements of the applicable specification of manufacture, the purchase item descriptions, purchase specifications and purchase order requirements. Visual, dimensional and marking check of items supplied has been carried out by our internal inspectors with satisfactory results.
The chemical and mechanical values shown on this EN 10204 certificate are true copy of the mill test certificate issued by the steel mill, or by the laboratory that determined them.
All material is certified to be mercury free and free from radioactivity contamination. No weld repair was performed. Marking was performed by low stress stamps in accordance with MSS SP25 Ed. 2018.

Manufacturing standards:
- 45° and 90° elbows, tees, crosses, full and half couplings, caps, square, hexagonal and round plugs, hexagonal and flush bushings, welding bosses are manufactured in accordance with ASMEB.16.11 Ed. 2016; threads in accordance with ANSI/ASME B1.20.1 Ed. 2013
- Outlet branches are manufactured in accordance with: ASME B.31.1 Ed. 2020, B.31.3 Ed. 2020 and MSS SP 97 Ed. 2019
- Seamless swage nipples are manufactured in accordance with: BS 3799-74 or MSS SP 95 Ed. 2018
- Seamless pipe nipples are manufactured in accordance with: B36.10 Ed. 2018 or B36.19 Ed. 2018
- Flanged outlet branches are manufactured in accordance with: ASME B.31.1 Ed. 2020, B.31.3 Ed. 2020 and B.16.5 Ed. 2020
- Unions are manufactured in accordance with: BS 3799-74 or MSS SP 83 Ed. 2018

When the length of flanged nipolet is not specified in the description, it is 150 mm.
The material is according to ASTM and ASME Boiler and Pressure Vessel Code Section II.
When the Edition/Revision of the listed standards is not mentioned, it is the latest.
Austenitic, duplex stainless steels and nickel alloy have been pickled and passivated. Machined surfaces do not require pickling and passivation.
M.E.G.A. is approved with certificate DGR-0036-QS-W 75/2002/MUC by T.U.V. (certification Body N.0036) to issue certificate of specific product control in accordance with the Pressure Equipment Directive 2014/68/EU (PED) Annex 1, Section 4.3.

Test results are relevant only to the specimens belonging to the indicated heat, batch and material.
- Tensile test: ASTM A370 paragraph 6. Elongation determined after fracture, Yield strength determined by 0.2% off-set method
- Impact test: ASTM A370 Paragraph 20 / ASTM E23
- Hardness test: ASTM E10 (HBW); ASTM E92 (HV10); ASTM E18 (HRC)
- Chemical analysis: ASTM E415 and E1086
- Grain size determined according to ASTM E112

The product are manufactured in Italy.

Quality Control Inspector Certification department Ispettore controllo qualità	Emmanuel Centemeri

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trademark M.E.G.A. is printed in green color.

Form QC-01-01 Rev. 0 2013-03-15

M.E.G.A. S.p.A. - Via Dalla Chiesa, 3 - 24020 Scanzorosciate (Bergamo) - Italy - VAT IT 00210060166 - Ph. +39 035 661280 / 661199 - Fax +39 035 665535 - E-mail inspection@mega-fittings.com

MILL TEST REPORT — **TA CHEN INTERNATIONAL, INC.** www.tachen.com

This MTR contains:2 pages (Page:1)

24018
3" 3000# F.C.

Cust# AMEWAL Company: AMERICAN STAINLESS & SUPPLY, LLC.
MTR# MEKA/MEKA20194-5.pdf PO# S1621892 SO# LNCNC7
Item: P4LTC030

MEKA20194-5

M.E.G.A.

INSPECTION CERTIFICATE
Certificato d'Ispezione

COMPANY WITH QUALITY SYSTEM CERTIFIED BY DNV GL = ISO 9001:2015 =

REPORT N. / Rapporto N. TC-029724-23-0001	Issued on 01/02/2023 / Revised on	Customer / Cliente: TA CHEN INTERNATIONAL INC, 9525 WALLISVILLE RD. HOUSTON TX 77013 - U.S.A.	Job n. / Com. n. 29724 — Page n. / Pagina n. 5 of 19
Revision / Revisione 0	According to / In accordo a: EN 10204:2004, UNI EN 10204:2005 — Type / Tipo 3.1		Purchase order and project/Ordine e progetto LA8192

DESCRIPTION / DESCRIZIONE

Test Prova	Item Pos.	Qty Q.tà	Customer code Codice cliente	Material Materiale	Heat Colata	Product Prodotto
AXTJ	30	1	P4LTC030/MG	ASTM A182-22a F304/304L	283884	COUPLING S.3000 NPT A/SA182 F304/L 3
BBYE	30	24	P4LTC030/MG	ASTM A182-22a F304/304L	287500	COUPLING S.3000 NPT A/SA182 F304/L 3
AWSB	31	100	P4LTCP00B/MG	ASTM A182-22a F304/304L	0EAJ	CAP S.3000 NPT A/SA182 F304/L 1/4
BDHT	35	300	P4LTHC010/MG	ASTM A182-22a F304/304L	543348	HALF COUPLING S.3000 NPT A/SA182 F304/L 1
AYRN	36	300	P4LTHP00B/MG	ASTM A182-22a F304/304L	1BEX	HEX. HEAD PLUG NPT A/SA182 F304/L 1/4

Test Prova	STEEL MELTING AND HEAT TREATMENT DATA / Dettagli di produzione e trattamento termico	CTY of melt	RAW AND FORGING MATERIAL CERTIFICATES / Certificati di acciaieria/forgia	Ref. to MEGA-LAB Mechanical Test
AXTJ	ELECT.FURN.-SOLUT.ANNEALED at 1070^C-WATER QUENCHED CERT MEST760806/21/ VALBRUNA	IT	MEST760806/21/ by VALBRUNA by ACCIAIERIE VALBRUNA s.p.a.	MC-000000-21-0730
BBYE	ELECT.FURN.-SOLUT.ANNEALED at 1080 C-WATER QUENCHED CERT MEST064343/2022/ VALBRUNA	IT	MEST064343/2022/ by VALBRUNA by ACCIAIERIE VALBRUNA s.p.a.	MC-000000-22-0789
AWSB	ELECT.FURN.-SOLUT.ANNEALED at 1050 C-WATER QUENCHED CERT 2021/002431 ROLDAN	ES	2021/002431 by ROLDAN by ACERINOX ITALIA srl	MC-000000-21-0165
BDHT	ELECT.FURN.-SOLUT.ANNEALED at 1050°C WATER QUENCHED CERT 501344 OLARRA	ES	501344 by OLARRA by ACEROS INOXIDABLE OLARRA	MC-000000-22-1269
AYRN	ELECT.FURN.-SOLUT.ANNEALED at 1050 C WATER QUENCHED CERT 171393 RODACCIAI	IT	171393 by RODACCIAI by RODACCIAI S.p.A.	MC-000000-21-0825

Test Prova	Test loc. Preso a	Orient. Direz.	TENSILE TEST AT ROOM TEMPERATURE / Trazione a temperatura ambiente — Specimen / Provino: Shape Forma	A Sez.[mm²]	Gage Length Lungh.[mm]	Yield strength Sner. [Mpa] Min:	Tensile strength Rottura [Mpa] Min:	Elongation Allung. [%] Min:	Red. Of Area Contraz. [%] Min:	CVN IMPACT TEST (KV) / Prova di resilienza — Dimens. Dimens. [mm]	T Temp. [°C]	Abs. Energy Energia ass. [J]	Shear A Area d [%]	Lat Exp Esp. Lat. [mm]	Bend [B] Flatt. [F] Piega Schiacc.	Hardness Durezza [HBW2.5/187.5]	Grain Size Dimens. grano
AXTJ	T/2	TRANS	Round	30.200	25.000	272.800	588.600	53.900	71.900	10x10x55	0	186-194-212	–	–		168-172	
BBYE	T/2	TRANS	Round	121.500	50.000	316.200	575.600	51.400	67.200				–	–		207-221	
AWSB	T/2	LONG	Round	122.600	50.000	348.600	651.200	48.800	69.200	10x10x55	20	212-216-228	–	–		170-172	
BDHT	T/2	LONG	Round	31.400	25.000	484.300	618.100	50.200	72.200				–	–		187-191	
AYRN	T/2	LONG	Round	122.600	50.000	436.600	588.400	52.200	66.000	10x10x55	0	226-228-242	–	–		166-166	

Test Prova	C [%]	Si [%]	Mn [%]	S [%]	P [%]	Cr [%]	Ni [%]	Mo [%]	Ti [%]	Cu [%]	V [%]	Al [%]	H [%]	Nb [%]	N [%]	Sn [%]	O [%]	B [%]	Fe [%]	Zr [%]	CE[A] [%]	PREN[B] [%]	CEs[E] [%]	J fact.[D] [%]
AXTJ	0.0140	0.5600	1.7600	0.0250	0.0300	18.1400	8.0100								0.0880							19.5480		
BBYE	0.0160	0.6100	1.7700	0.0270	0.0290	18.2400	8.1000	0.6300		0.5500					0.0870							21.7110		
AWSB	0.0280	0.3670	1.4520	0.0270	0.0290	18.2900	8.0550	0.3330	0.0020	0.4120					0.0910							20.8449		
BDHT	0.0240	0.3400	1.4600	0.0260	0.0360	18.1100	8.0000								0.0960							19.6460		
AYRN	0.0240	0.4330	1.4650	0.0250	0.0330	18.3600	8.0450	0.3950		0.4680					0.0850							21.0235		

REMARKS / Note

1: MATERIAL ACCORDING TO NACE MR0175/ISO 15156-1-2-3 Ed.2020, NACE MR0103 Ed.2015.
2: MATERIAL ACCORDING TO ASME Sect. II Part A 2021 Edition.

A: CE = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 | B: PREN = Cr + 3.3Mo + 16N
C: X factor = (10P + 5Sb+4Sn+As)/100 - elements expressed in ppm
D: J factor = ((Mn + Si)(P + Sn)) x 10E4 | E: CEs = C + Mn/6

Additional elements: 'BBYE': Co 0.1460 | 'AWSB': Co 0.2730 | 'BDHT': Co 0.1400 | 'AYRN': Co 0.1640 |

Quality Control Inspector
Certification department
Ispettore controllo qualità
Emmanuel Centemeri

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trademark M.E.G.A. is printed in green color.

Form QC-01-01 Rev. 0 2013-03-15

MILL TEST REPORT TA CHEN INTERNATIONAL, INC.
www.tachen.com

Cust# AMEWAL Company: AMERICAN STAINLESS & SUPPLY, LLC.
MTR# MEKA/MEKA20194-5.pdf PO# S1621892 SO# LNCNC7
Item: P4LTC030

M.E.G.A.

INSPECTION CERTIFICATE
Certificato d'ispezione

COMPANY WITH QUALITY SYSTEM CERTIFIED BY DNV GL • ISO 9001:2015 •

REPORT N. / Rapporto N.	TC-029724-23-0001	Issued on / Revised on	01/02/2023	Customer / Cliente	TA CHEN INTERNATIONAL INC	Job n. / Com. n. 29724	Page n./ Pagina n. 19 of 19
Revision / Revisione	0	According to / In accordo a	EN 10204:2004 / UNI EN 10204:2005 — Type / Tipo 3.1		9525 WALLISVILLE RD. HOUSTON TX 77013 - U.S.A.	Purchase order and project/Ordine e progetto	LA8192

We hereby certify that all items supplied for the above purchase orders meet all the requirements of the applicable specification of manufacture, the purchase item descriptions, purchase specifications and purchase order requirements. Visual, dimensional and marking check of items supplied has been carried out by our internal inspectors with satisfactory results.
The chemical and mechanical values shown on this EN 10204 certificate are true copy of the mill test certificate issued by the steel mill, or by the laboratory that determined them.
All material is certified to be mercury free and free from radioactivity contamination. No weld repair was performed. Marking was performed by low stress stamps in accordance with MSS SP25 Ed. 2018.

Manufacturing standards:
- 45° and 90° elbows, tees, crosses, full and half couplings, caps, square, hexagonal and round plugs, hexagonal and flush bushings, welding bosses are manufactured in accordance with ASMEB.16.11 Ed. 2021; threads in accordance with ANSI/ASME B1.20.1 Ed. 2013 (R 2018)
- Outlet branches are manufactured in accordance with: ASME B.31.1 Ed. 2022, B.31.3 Ed. 2022 and MSS SP 97 Ed. 2019 and ASME B.31.8 Ed. 2022
- Seamless swage nipples are manufactured in accordance with: BS 3799-74 or MSS SP 95 Ed. 2018
- Seamless pipe nipples are manufactured in accordance with: B36.10 Ed. 2022 or B36.19 Ed. 2022
- Flanged outlet branches are manufactured in accordance with: ASME B.31.1 Ed. 2022, B.31.3 Ed. 2022 and B.16.5 Ed. 2020
- Unions are manufactured in accordance with: BS 3799-74 or MSS SP 83 Ed. 2018

When the length of flanged nipolet is not specified in the description, it is 150 mm.
The material is according to ASTM and ASME Boiler and Pressure Vessel Code Section II.
When the Edition/Revision of the listed standards is not mentioned, it is the latest.
Austenitic, duplex stainless steels and nickel alloy have been pickled and passivated. Machined surfaces do not require pickling and passivation.
M.E.G.A. is approved with certificate DGR-0036-QS-W 75/2002/MUC by T.U.V. (certification Body N.0036) to issue certificate of specific product control in accordance with the Pressure Equipment Directive 2014/68/EU (PED) Annex 1, Section 4.3.

Test results are relevant only to the specimens belonging to the indicated heat, batch and material.
- Tensile test: ASTM A370 paragraph 6. Elongation determined after fracture, Yield strength determined by 0.2% off-set method
- Impact test: ASTM A370 Paragraph 20 / ASTM E23
- Hardness test: ASTM E10 (HBW); ASTM E92 (HV10); ASTM E18 (HRC)
- Chemical analysis: ASTM E415 and E1086
- Grain size determined according to ASTM E112

The product are manufactured in Italy.

Quality Control Inspector Certification department Ispettore controllo qualità	Emmanuel Centemeri

This certificate is issued by a computerized system and it is valid with electronic signature. On the original certificate the trademark M.E.G.A. is printed in green color.

Form QC-01-01 Rev. 0 2013-03-15

24018 3/4" 3000# PLUG

This MTR contains 1 pages (Page 1)

MILL TEST REPORT

TA CHEN INTERNATIONAL, INC.
www.tachen.com

Cust# AMEWAL Company: AMERICAN STAINLESS & SUPPLY, LLC.
MTR# OCKA/OCKA00004-14.pdf PO# S1621892 SO# LNCNC7
Item: P4LTHP00E Bundle: 47R Heatno: 47R

OCKA00004-14

OMC Raccordi s.r.l.
Via Piacenza 30/32 - 29010 Calendasco - PC - ITALY
Tel. +39 0523 760841 - Fax +39 0523 768880 - E-mail sales@omcitaly.com
QUALITY CONTROL DEPARTMENT

A01

COMPANY WITH QUALITY SYSTEM ISO 9001: 2015 CERTIFIED BY RINA CERT. N° 9679/03/S

INSPECTION CERTIFICATE EN 10204:2004 / 3.1 A02

Nr A03 2023-C_OMC-00415 Date 29.09.2023 Z02

A06
TA CHEN INTERNATIONAL, INC.
5855 Obispo Ave.
90805 Long Beach, CA US

Ordine / PO	LB0668/B	A07
Item	26	
DDT / Delivery note	2023-1E310-0000342	
Packing List	2023-1E310-0000342	
Fattura / Invoice	2023-1E423-0000120	A08
Ns. rif. / Our ref.	2023-1E201-0000117-0018	

Dest. TA CHEN INTERNATIONAL, INC. - GLOBAL CARBON A09
8900 RAILWOOD DRIVE
HOUSTON, TX 77078 US

Cod. colata B07 Heat Code	Nr. colata B07 Heat Nr	Quantità B08 Quantity	Descrizione Description B01 - (B09 - B11)
47R	541607	200,00	HEX.H.PLUG 3/6M THRD NPT 3/4" F304/F304L - TCI Item no. P4LTHP00E

Mat. in acc. a / Mat. in acc. to B02
ASTM A182/A182M-21 Gr. F304/F304L
ASME SA182/SA182M Gr. F304/F304L, ASME II PART A Ed.2021
ANSI/NACE MR-0175/2021 ISO 15156 :2020
ANSI/NACE MR 0103 - ISO 17945 Ed. 2015
P.E.D. 2014/68/EU ANNEX 1 PAR. 4.3

Ann. mat. / Mat. remarks B02
MATERIAL DESCALED & PICKLED
PMI TEST 100%: SATISFACTORY
INTERGRANULAR CORROSION TEST ACCORDING TO ASTM A262 PRACTICE "E" SATISFACTORY

Elementi / Elements (C71 - C92)	C	Si	Mn	S	P	Cr	Ni	Mo	Ti	Cu	V	Nb	N
LADLE ANALYSIS	0,019	0,390	1,460	0,026	0,037	18,190	8,110	0,000	0,000	0,470	0,000	0,000	0,087
	Al	B							CE LF	CE SF	F1	F2	PREN
LADLE ANALYSIS	0,000	0,000							-	-	-	-	19,582

CE LF=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE SF=C+(Mn/6) F1=Cu+Ni+Cr+Mo+V F2=Cr+Mo

Provetta Test specimen Sez/Sect mm2	L. mm	Forma C10 Shape 1=O - 2=□	°C C03	Snervamento>0,2% C11 Yield Strength>0,2% MPa	Snervamento>1,0% C11 Yield Strength>1,0% MPa	Rottura C12 Tensile MPa	Allungamento C13 Elongation %	Contrazione C15 Reduction of area %
122,65	50,00	1		460,0	--	744,0	38,5	51,0

DUREZZA / HARDNESS C22 HBW	Tipo/Type C40	Provetta / Test Specimen	°C C03	1-Joule C42	2-Joule C42	3-Joule C42	Media/Average C43
220,0 - 225,0	KV	10x10mm	-10	220	227	229	225,3

RESILIENZA / IMPACT TEST

Tratt. Term. / Heat treatment C70	Solution Treated at 1050°C / Water Cool	ELECTRIC FURNACE
Dim in acc. a / Dim. acc. to B14	ASME B16.11 Ed.2021 - ASME B1.20.1 Ed.2013	

Marcatura in acc. B06 Marking in acc. to	MSS SP25 Ed. 2018	Vis. & Dim.	SATISFACTORY	Origine Origin of Steel	ITALY

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

UFFICIO CONTROLLO QUALITA' QUALITY CONTROL DEPARTMENT A05	ENTE UFFICIALE DI COLLAUDO INSPECTION AUTHORITY Z03	MARCHIO PRODUZIONE MANUFACTURER'S SYMBOL A04
Eugenio Stefanoni		OMC

BRIGHTON TRU-EDGE HEADS
11861 MOSTELLER RD * CINCINNATI OH 45241 * (513)-771-2300
MTR COVER LETTER

TATE METALWORKS INC
P.O. BOX 171
SPARTANBURG SC 29304

ATTN : QC MANAGER
CUSTOMER P/O: 24018-00001
BRIGHTON S/O: 55018 It: 10
PRODUCTION ORDER: **1073801**

TO WHOM IT MAY CONCERN:

ATTACHED ARE COPIES OF MILL TEST REPORTS FOR THE FOLLOWING MATERIALS PROVIDED ON YOUR REFERENCED PURCHASE ORDER.

LABOR AND MATL

1.00 - SA240-304/304L - SS 2:1 ELLIPTICAL 96" ID 0.313" MIN. THK. WITH 2" SF

HEAT NUMBER(S)
544323 (out)

CERTIFICATE OF COMPLIANCE

NO HEAT TREATMENT WAS PERFORMED BY BRIGHTON.

ALL HEADS WERE COLD FORMED. ALL HEADS ARE IN COMPLIANCE WITH REGULATION UG - 81 AND UG - 79 AS STATED IN SECTION VIII DIVISION I OF THE ASME BOILER AND PRESSURE VESSEL CODE. HEADS WERE FORMED WITHOUT COMING IN CONTACT WITH MERCURY OR ANY OF ITS COMPOUNDS.

IF YOU HAVE ANY FURTHER QUESTIONS CONCERNING MILL TEST REPORTS ONLY, PLEASE CONTACT ME IN CINCINNATI, OHIO AT 1-800-543-1644.

VERY TRULY YOURS,
Richard W Seiter
BRIGHTON TRU-EDGE HEADS

MILL TEST REPORTS TO GO WITH SHIPMENT.

BRIGHTON TRU-EDGE HEADS
11861 MOSTELLER RD * CINCINNATI OH 45241 * (513)-771-2300
MTR COVER LETTER

TATE METALWORKS INC
P.O. BOX 171
SPARTANBURG SC 29304

ATTN : QC MANAGER
CUSTOMER P/O: 24018-00001
BRIGHTON S/O: 55018 lt: 20
PRODUCTION ORDER: **1073802**

TO WHOM IT MAY CONCERN:

ATTACHED ARE COPIES OF MILL TEST REPORTS FOR THE FOLLOWING MATERIALS PROVIDED ON YOUR REFERENCED PURCHASE ORDER.

LABOR AND MATL

1.00 - SA240-304/304L - SS 2:1 ELLIPTICAL 96" ID 0.313" MIN. THK. WITH 2" SF

HEAT NUMBER(S)
544323 (out)

CERTIFICATE OF COMPLIANCE

NO HEAT TREATMENT WAS PERFORMED BY BRIGHTON.

ALL HEADS WERE COLD FORMED. ALL HEADS ARE IN COMPLIANCE WITH REGULATION UG - 81 AND UG - 79 AS STATED IN SECTION VIII DIVISION I OF THE ASME BOILER AND PRESSURE VESSEL CODE. HEADS WERE FORMED WITHOUT COMING IN CONTACT WITH MERCURY OR ANY OF ITS COMPOUNDS.

IF YOU HAVE ANY FURTHER QUESTIONS CONCERNING MILL TEST REPORTS ONLY, PLEASE CONTACT ME IN CINCINNATI, OHIO AT 1-800-543-1644.

VERY TRULY YOURS,
Richard W Seiter
BRIGHTON TRU-EDGE HEADS

MILL TEST REPORTS TO GO WITH SHIPMENT.

Manufacturer / Fabricante

outokumpu

Type of document / Tipo de documento

INSPECTION CERTIFICATE

CERTIFICADO DE INSPECCION

according to / de acuerdo con

EN 10204-3.1

Document number / Nº de certificado. 12/27/2023

0000637828 /

Page / Pagina: 1 / 2

1 Steel Drive; P.O. Box 13000; Calvert, AL 36513-1300

SPECIALTY ROLLED METALS, LLC
423 SAINT PAUL BLVD.
CAROL STREAM IL 60188
USA

Customer/Ship to / Cliente: SPECIALTY ROLLED METALS, LLC,CAROL STREAM

Customer's order number / Nº de Pedido Cliente: 03311187

Manufacturer's works order no. / Nº de Pedido Manufactura: 901331554 / 001

Delivery note no. / Nº de Entrega: 85842665 / 010

Product / Producto: Stainless Steel Hot Rolled Coil/Bobina

Terms of delivery / Condiciones de entrega

ASTM A240/A240M-23a, ASME SA-240 Sec. II part A Ed.2021
ASTM A480/A480M-23b, ASME SA-480 Sec. II part A Ed.2019
ASTM A666-23
NACE MR0103 / ISO 17945: 2015
ASTM A276-23, A312-22a, A479-23, A484-23a Chemical only
NACE MR0175 / ISO 15156-3: 2020
ASME SA312-22a, SA479-23 for Chemical Composition
EN 10028-7: 2016
EN 10088-2: 2014

Steel Grade and Quality / Acero

TYPE 304L/304
UNS S30400
UNS S30403
1.4307
1.4301

P.O. No. 24018-00001
Job No. 24018.01
ID No. SH4L-237
JMB 12/23

Customer's material no./ Nº de material del cliente	Product dimensions (Thickness / Width / Length) / Dimensiones (Espesor / Ancho / Largo)	Steelmaking procedure/ Proceso de manufact.	Finish/ Acabado
21243	9.53 mm x 1,524.00 mm 0.3750 inch x 60.0000 inch	AOD	IIa / 1D / No.1

Packing-No./ Nº de Empaque	No.of pieces/ Piezas	Actual weight/ Peso actual	Actual length/ Longitud actual	Coil-No./ Bobina No.	Heat No./ Colada	Inspection lot/ Lote de inspeccion	Inspection lot/ Lote de inspeccion
3559924	1	47,598 lb / 21,590 kg	604 ft / 184 m	917157	544323	1000895760	1000895761
Sum / Suma	1	47,598 lb / 21,590 kg					

Chemical composition / Composicion Quimica — Chemical analysis per ASTM A751-21

Heat / Colada	Country of Melt / Pais de colada	% C	% Si	% Mn	% P	% S	% Cr	% Mo	% Ni	% N	% Cu
544323	USA	0.026	0.44	1.31	0.032	0.0012	18.15	0.37	8.03	0.068	0.51

Sample Position/ Localiz.de la muestra: TRANSVERSE — Mechanical testing per ASTM A370-23

Inspection lot/ Lote de inspección	YS0.2% PSI / MPa	YS1,0 PSI / MPa	TS PSI / MPa	El. A80 %	El. 2" %	HRB
1000895760	44,960 / 310	55,982 / 386	92,966 / 641	52	56	91
1000895761	45,685 / 315	57,578 / 397	93,111 / 642	51	56	91

Resistant to Intergranular corrosion / Resistente contra corrosióninter-granular: ASTM A 262-15, PRACTICE E - Sample Acceptable

Dimensions-surface / Dimensiones-Superficie: OK

Positive Material Identification (PMI) / Control de Identidad (análisis espectográfico): OK

Heat Treat: Solution anneal 1900°F/1040°C Min, Air and water quench
Bending test per ASTM E290-14 OK
No welding or weld repairs were performed on this material
Grain Size as per ASTM E112-13, comparison procedure
DFARS 225.872-1 Compliant
No intentional additions of Mercury compounds were made or used

APPROVED

Q.C. DEPT

Originator of the document / Originador del documento /

Outokumpu Stainless USA, LLC
An ISO 9001:2015 certified company
ISO 17025:2017 accredited testing lab by ANAB
EU PED 2014/68/EU, Anex I, 4.3 certified

Certificate is generated automatically / Certificado es generado automaticamente

The information provided is a true copy of data on file / Los valores mostrados corresponden a los datos archivados

Arturo Hernandez Rubio

Name of expert / Nombre del experto

Date of issue and validation / Fecha de emisión y validación

12/27/2023

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Manufacturer / Fabricante

outokumpu

Type of document / Tipo de documento

INSPECTION CERTIFICATE

CERTIFICADO DE INSPECCION

according to / de acuerdo con

EN 10204-3.1

Document number / N° de certificado. 12/27/2023

0000637828 /

Free of radioactive contamination

EU RoHS Directive 2011/65/EU Compliant

Product manufactured in the USA

Country of Melt as per ISO 3166-1

Originator of the document / Originador del documento /	The information provided is a true copy of data on file / Los valores mostrados corresponden a los datos archivados	Date of issue and validation Fecha de emisión y validación	
Outokumpu Stainless USA, LLC An ISO 9001:2015 certified company ISO 17025:2017 accredited testing lab by ANAB EU PED 2014/68/EU, Anex I, 4.3 certified Certificate is generated automatically / Certificado es generado automaticamente	Arturo Hernandez Rubio Name of expert / Nombre del experto	12/27/2023 This document shall not be altered or reproduced, except in full. Fraudulent, fictitious, or false statements or entries may be prosecuted by law.	

FORM U-2A MANUFACTURER'S PARTIAL DATA REPORT (ALTERNATIVE FORM)
A Part of a Pressure Vessel Fabricated by One Manufacturer for Another Manufacturer
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by BRIGHTON TRU-EDGE HEADS, 11861 MOSTELLER ROAD, CINCINNATI, OH 45241
(Name and address of Manufacturer)

2. Manufactured for TATE METAL WORKS INC, PO BOX 171, SPARTANBURG SC 29304
(Name and address of Purchaser)

3. Location of installation Unknown
(Name and address)

4. Type ELLIP HEAD 96" ID X 0.375" THK (Description of vessel part (shell, two-piece head, tube bundle)) 1073802-1 (Manufacturer's serial number) (CRN)

(National Board number) PO # 24018-00001 (Drawing number) (Drawing prepared by) 2024 (Year built)

5. ASME Code, Section VIII, Div. 1 2023 Edition (Edition and Addenda, if applicable (date)) (Code Case number) [Special service per UG-120(d)]

6. Shell (a) Number of course(s): (b) Overall length

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

Body Flanges on Shells

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

7. Heads: (a) SA240-304/304L (Material spec. number, grade or type) (H.T. - time & temp.) (b) (Material spec. number, grade or type) (H.T. - time & temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)		0.313				2:1						1	SPOT	UNK
(b)														

Body Flanges on Heads

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

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

9. Impact test NO [Indicate *yes* or *no* and the component(s) impact tested] at test temperature of

10. Hydro., pneu., or comb. test pressure NONE Proof test

11. 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.)

12. Identification of part(s)

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

13. Supports: Skirt NO (Yes or no) Lugs (Number) Legs (Number) Others (Describe) Attached (Where and how)

14. Remarks: NO DESIGN FUNCTION BY BRIGHTON TRU-EDGE HEADS. NO HYDRO TEST PERFORMED.

Manufactured By	BRIGHTON TRU-EDGE HEADS, 11861 MOSTELLER ROAD, CINCINNATI, OH 45241		
Manufacturer's Serial No.	1073802-1	CRN -	National Board No. -

CERTIFICATE OF SHOP/FIELD COMPLIANCE

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

U or PRT VIII-1 Certificate of Authorization nun 51,949 Expires 11/25/2024

Date 8-14-2024 Name BRIGHTON TRU-EDGE HEADS (Manufacturer) Signed Richard Barton (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by The Hartford Steam Boiler Inspection and Insurance Company of Hartford, CT have inspected the pressure vessel part described in this Manufacturer's Data Report on 8-14-24 and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 8-14-24 Signed (Authorized Inspector) Commissions NB11904 (National Board Authorized Inspector Commission number)

FORM U-2A MANUFACTURER'S PARTIAL DATA REPORT (ALTERNATIVE FORM)
A Part of a Pressure Vessel Fabricated by One Manufacturer for Another Manufacturer
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by BRIGHTON TRU-EDGE HEADS, 11861 MOSTELLER ROAD, CINCINNATI, OH 45241
(Name and address of Manufacturer)

2. Manufactured for TATE METAL WORKS, PO BOX 171, SPARTANBURG SC 29304
(Name and address of Purchaser)

3. Location of installation Unknown
(Name and address)

4. Type ELLIP HEAD 96" ID X 0.375" THK [Description of vessel part (shell, two-piece head, tube bundle)] 1073801-1 (Manufacturer's serial number) ________ (CRN)

________ (National Board number) PO # 24018-00001 (Drawing number) ________ (Drawing prepared by) 2024 (Year built)

5. ASME Code, Section VIII, Div. 1 2023 Edition [Edition and Addenda, if applicable (date)] ________ (Code Case number) ________ [Special service per UG-120(d)]

6. Shell (a) Number of course(s): ________ (b) Overall length ________

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

Body Flanges on Shells

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

7. Heads: (a) SA240-304/304L (Material spec. number, grade or type) (H.T. - time & temp.) (b) ________ (Material spec. number, grade or type) (H.T. - time & temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)		0.313				2:1						1	FULL	UNK.
(b)														

Body Flanges on Heads

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

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

9. Impact test NO [Indicate *yes* or *no* and the component(s) impact tested] at test temperature of ________

10. Hydro., pneu., or comb. test pressure NONE Proof test ________

11. Nozzles, inspection, and safety valve openings:

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

12. Identification of part(s)

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

13. Supports: Skirt NO (Yes or no) Lugs ________ (Number) Legs ________ (Number) Others ________ (Describe) Attached ________ (Where and how)

14. Remarks: NO DESIGN FUNCTION BY BRIGHTON TRU-EDGE HEADS. NO HYDRO TEST PERFORMED.

Manufactured By BRIGHTON TRU-EDGE HEADS, 11861 MOSTELLER ROAD, CINCINNATI, OH 45241

Manufacturer's Serial No. 1073801-1 CRN - National Board No. -

CERTIFICATE OF SHOP/FIELD COMPLIANCE

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

U or PRT VIII-1 Certificate of Authorization nun 51,949 Expires 11/25/2024

Date 8-14-2024 Name BRIGHTON TRU-EDGE HEADS (Manufacturer) Signed (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

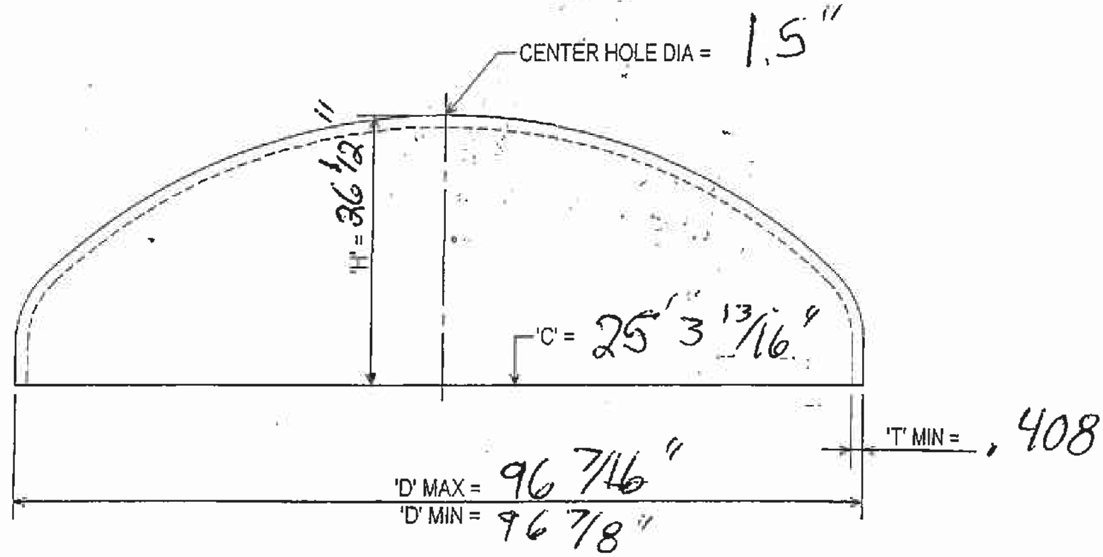
I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by The Hartford Steam Boiler Inspection and Insurance Company of Hartford, CT have inspected the pressure vessel part described in this Manufacturer's Data Report on 8-14-24, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel part in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his/her employer makes any warranty, expressed or implied, concerning the pressure vessel part described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his/her employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 8-14-24 Signed (Authorized Inspector) Commissions NB10904 (National Board Authorized Inspector Commission number)

SHOP ORDER NUMBER 24018.01

PURCHASE ORDER NUMBER 24018-00001

I.D. NUMBER SH42-237A



1. NUMBER OF WELD SEAMS IN HEAD 1

2. NAMEPLATE ATTACHED (WELDED HEAD ONLY)? Yes

3. SERIAL NUMBER 1073801-1

4. HEAT NUMBERS (MUST BE ON EACH PIECE OF WELDED HEAD) 544323

5. FORMING OK? OK

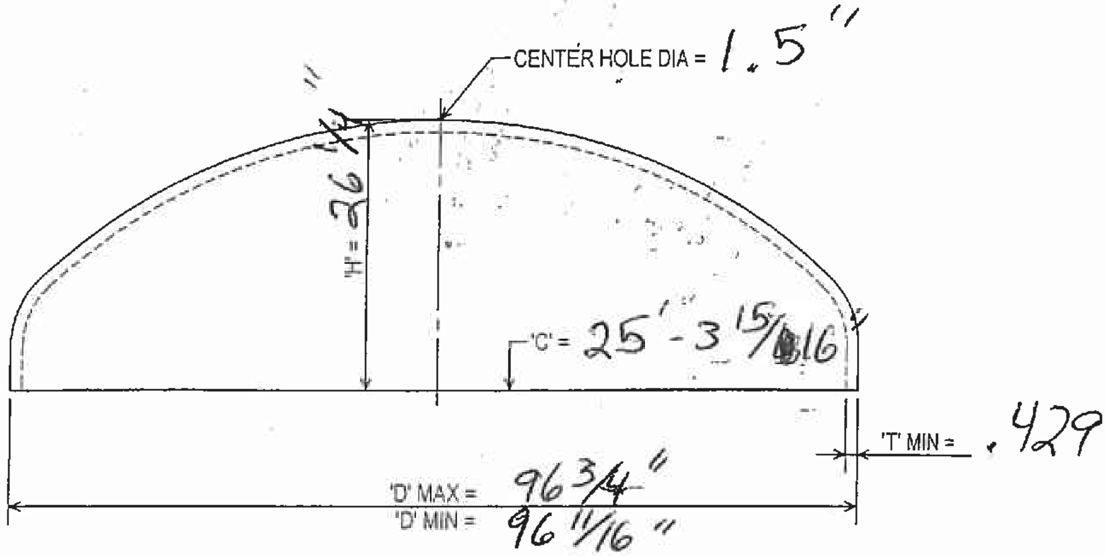
6. EDGE PREPARATION OK? OK

7. DEFECTS NOTED N/A

SHOP ORDER NUMBER 24018.01

PURCHASE ORDER NUMBER 24018-00001

I.D. NUMBER SH4L-237B



1. NUMBER OF WELD SEAMS IN HEAD 1

2. NAMEPLATE ATTACHED (WELDED HEAD ONLY)? Yes

3. SERIAL NUMBER 1073802-1

4. HEAT NUM BERS (MUST BE ON EACH PIECE OF WELDED HEAD) /544323

5. FORMING OK? OK

6. EDGE PREPARATION OK? OK

7. DEFECTS NOTED N/A

Tate METALWORKS, INC. P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540	TITLE	TATE METALWORKS STANDARD DETAILS FORMED HEAD
ISSUED: -/-/- REVISED: -/-/-	THIS DOCUMENT IS THE PROPERTY OF TATE METALWORKS, INC. AND MUST ONLY BE USED IN CONNECTION WITH WORK DONE FOR THIS COMPANY.	DRAWING NUMBER

7/30/2024	
# of Pls.	1

PLATE INSPECTION REPORT

Purchase Order #24018-00008 **Job: 24018.01**

Vendor: Rolled Alloys

Material Size 0.313" X 48" X 160" Specification SA240-304/304L

Plate ID#SD4L-4076

ID Suffix	Pcs.	Heat#	Slab/Lot#	MTR Accepted By	Material Accepted B		UT-Thk.	Notes
A	1	~~[illegible]~~ AC8V		[illegible] 8/13/24	BLZ	08-13-24	~~[illegible]~~ .334	

NAS NORTH AMERICAN STAINLESS
An Acerinox Group Company

METALLURGICAL TEST REPORT

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

Certificate: 877546 01
Customer: 2830 001

Mail To:
ROLLED ALLOYS
125 W. STERNS RD.
TEMPERANCE, MI 48182

Ship To:
ROLLED ALLOYS
125 W. STERNS RD.
TEMPERANCE, MI 48182

Date: 10/11/2023
Steel: 304/304L
Finish: HRAP

Your Order: 0220267-TEM
NAS Order: AN 1030894 03
Corrosion: ASTM A262/21;180Bend-OK

PRODUCT DESCRIPTION:

STAINLESS STEEL COIL, HRAP; UNS 30400/30403
ASTM A240/23,A480/23,A666/23;ASME SA240/19,SA480/19,SA666/19
CHEM ONLY ON FOLLOWING ASTM: A276/17,A479/23,A484/23,A312/22a
CHEM ONLY ON FOLLOWING ASME: SA312/19,SA479/19
AMS 5511K/5513J XMRK; MIL-S-5059D AMD3(X CRN MEAS); MIL-4043B
NACE MR0175/ISO 15156-3:2015 A, MR0103/07;QQS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; RoHS 1, 2 & 3 Compliant
Material is Free of Radioactive Contamination
Steel Making Process: EAF, AOD, & Cont. Casting
Product Mfg.by a Quality Mgt.Sys. in Conf. w/ISO 9001
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

P.O. No. 24018-00008
Job No. 24018.01
ID No. 5042-7076 A
JW-MB

Product ID #	Coil #	Thickness	Width	Weight	--------Length--------	Mark	Pieces	COMMODITY CODE
03AC8V B	* 03AC8V B	.3125	48.0000	14,160	COIL 271.90	3	1	0003813

ANAB, ISO/IEC 17025, Certificate# L2323

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

Chemical Analysis per ASTM A751/20

HEAT	CM	C %	CO %	CR %	CU %	MN %	MO %	N %	NI %	P %
AC8V	US	.0101	.2235	18.0010	.5145	1.7635	.4235	.0739	8.4195	.0310

S %	SI %
.0010	.2660

HEAT # AC8V
TRACER # 0690032US

MECHANICAL PROPERTIES

Product ID #	Coil #	l o c	d i r	UTS KSI	20C .2% YS KSI	20C ELONG %-2"	% Hard RB	Tail Hard	A 262 'E' Pr E
03AC8V B	03AC8V B	F	T	89.23	46.86	51.10	88.00	89.50	OK

ROLLED ALLOYS
Receiving Inspection
By:
Date: 10-13-23

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

Technical Dept. Mgr.

7/30/2024	
# of Pls.	1

PLATE INSPECTION REPORT

Purchase Order #24018-00008 **Job: 24018.01**

Vendor: Rolled Alloys

Material Size 0.625" X 72" X 240" Specification SA240-304/304L

Plate ID#SD4L-4077

ID Suffix	Pcs.	Heat#	Slab/Lot#	MTR Accepted By	Material Accepted B		UT-Thk.	Notes
A	1	39061		[illegible] 8/13/24	[illegible]	08-13-24	.693	

MILL TEST REPORT **TA CHEN INTERNATIONAL, INC.** This MTR contains:5 pages (Page:1)

www.tachen.com

Cust#: ROLHOU Company#: ROLLED ALLOYS- HOUSTON Vendor: INDUSTEEL BELGIUM
MTR#: USCL/USCL2024-102729.pdf PO#: 0229012-HOU SO#: LMZFJ0 Vendor#:USINOR

Item:.62572240304L#1 Bundle:599327003 Heatno:38061 Item:.62572240304L#1 Bundle:599327002 Heatno:38061

CERTIFICAT DE RECEPTION 3.1 / EN 10204:2004
Inspection Certificate 3.1 / EN 10204:2004

Numéro de document Rev. 01 — 2024-102729

Page 001 / 005

USCL2024-102729

ArcelorMittal

Client: Ta Chen International (CA) Corp

Référence client: LB2816

Projet:

Industeel Belgium
Site: Rue de Châtelet 266 6030 Marchienne-au-Pont

Produit: Standardized product

Commande / Poste: 200009264 / 000010

Bordereau de livraison: 80137371

#010 - PRODUITS LIVRES - DELIVERED PRODUCTS

Nuance - Grade	Selon norme - According to
UNS S30400 (304)	ASTM A 240/M ED 2023a
UNS S30403 (304L)	ASTM A 240/M ED 2023a
UNS S30400 (304)	ASME IIA ED 2023 SA 240/M
UNS S30403 (304L)	ASME IIA ED 2023 SA 240/M
UNS S30400 (304)	AMS 5513
UNS S30403 (304L)	AMS 5511K

Epaisseur: 0.625" Largeur: 72" Longueur: 240"

Spécification

In accordance with ASTM A262 Practice A

https://... industeel.be

Etat thermique de livraison - Heat treatment condition
Hypertrempe à l'air (1050 °C - 1 min/mm) – Solution annealed and air quenched

Procédé d'élaboration - Melting process
Electric arc furnace - VOD - Finish n°1 - 1D - HRAP

Nbre	N° produit	N° de coulee	N° de lot de controle	Nbre	N° produit	N° de coulee	N° de lot de contrôle
01	599318002	38061	599327.5001	01	599327002	38061	599327.5001
01	599327003	38061	599327.5001				

Total: 003

ASTM/ASME A/SA480/480M
NO WELD REPAIR - MERCURY FREE
COUNTRY OF MELT AND MANUFACTURING: BELGIUM
Acc to A 262 practice A

P.O. No. 24018-00008
Job No. 24018.01
ID No. S04L-407714
ZnB 23

Nous certifions que les produits ci-dessus sont conformes aux prescriptions de la commande
We hereby certify that the above mentioned products are complying with the order requirements

MONIQUE BORGNIET
05/02/2024

HEAT # 38061
TRACER # 0710823US

HEAT # 38061
TRACER # 0710824US

ROLLED ALLOYS
Receiving Inspection
By: [signature]
Date: 8/9/24

www.tachen.com

Cust#: ROLHOU Company#: ROLLED ALLOYS- HOUSTON Vendor: INDUSTEEL BELGIUM
MTR#: USCL/USCL2024-102729.pdf PO#: 0229012-HOU SO#: LMZFJ0 Vendor#:USINOR

Item:.62572240304L#1 Bundle:599327003 Heatno:38061 Item:.62572240304L#1 Bundle:599327002 Heatno 38061

CERTIFICAT DE RECEPTION 3.1 / EN 10204 2004	Numéro de document Rev. 01 2024-102729	Page 002 / 005	ArcelorMittal
Client	Ta Chen International (CA) Corp		
Référence client	LB2816		
Projet			
Industeel Belgium Site : Rue de Châtelet 266 6030 Marchienne-au-Pont			
Produit	Standardized product		
Commande / Poste	200009264 / 000010		
Bordereau de livraison	80437321		

#020 - ANALYSE CHIMIQUE DE COULEE - HEAT CHEMICAL COMPOSITION - SCHMELZE CHEMISCHE ZUSAMMENSETZUNG

	C	Mn	P	S	Si	Cu	Ni	Cr	Mo
	%	%	%	%	%	%	%	%	%
Min.							8.000	18.000	
38061	0.022	1.899	0.0266	0.0014	0.345	0.205	8.056	18.090	0.241
Max	0.030	2.000	0.0400	0.0300	0.750	0.750	10.500	19.500	0.750
	Co	N	Fe	Nb	Ti				
	%	%	%	%	%				
Min.									
38061	0.114	0.1000	70.791	0.008	0.002				
Max		0.1000		0.100	0.100				

#041 - PMI - POSITIVE MATERIAL IDENTIFICATION - VERWECHSLUNGSPRÜFUNG

Non confusion de matière	PMI Conform

Résultat du contrôle

Conforme aux spécifications précitées

Nous certifions que les produits ci-dessus sont conformes aux prescriptions de la commande
We hereby certify that the above mentioned products are complying with the order requirements
Wir bestätigen hiermit, dass die obengenannten Erzeugnisse den Bestellungsvorschriften entsprechen

MONIQUE BORGNET
05/07/2024

MILL TEST REPORT | **TA CHEN INTERNATIONAL, INC.** | This MTR contains:5 pages (Page:3)

www.tachen.com

Cust#: ROLHOU Company#: ROLLED ALLOYS- HOUSTON Vendor: INDUSTEEL BELGIUM
MTR#: USCL/USCL2024-102729.pdf PO#: 0229012-HOU SO#: LMZFJ0 Vendor#:USINOR

Item:.62572240304L#1 Bundle:599327003 Heatno:38061 Item:.62572240304L#1 Bundle:599327002 Heatno:38061

CERTIFICAT DE RECEPTION 3.1 / EN 10204 2004	Numéro de document Rev. 01 2024-102729	Page 003 / 005	ArcelorMittal
Client	Ta Chen International (CA) Corp		
Référence client	LB2816		
Projet			
Industeel Belgium Site Rue de Châtelet 266 6030 Marchienne-au-Pont			
Produit	Standardized product		
Commande / Poste	200009264 / 000010		
Bordereau de livraison	80437321		

P072 ESSAIS MECANIQUES - MECHANICAL TESTS

DURETE SUR COUPON - HARDNESS ON SAMPLE

Brinell HB

N° lot QM	Etat	Loc	Epr	T°	Uni	Mac	Uni	HB	HB	HB	HB
							Min				
							Max	201	201	201	201
599327 5001	000	T3/4	PSS	68	°F			176	182	183	180

DURETE SUR COUPON - HARDNESS ON SAMPLE

NACE MR0175 / ISO 15156-3

N° lot QM	Etat	Loc	Epr	T°	Uni	Mac
599327 5001	000	T3/4	PSS	68	°F	

Test result HRC < 22

DURETE SUR COUPON - HARDNESS ON SAMPLE

NACE MR0103 / ISO 17945

N° lot QM	Etat	Loc	Epr	T°	Uni	Mac	Uni
							Min
							Max
599327 5001	000	T3/4	PSS	68	°F		

Test result HRC < 22

TRACTION A L' AMBIANTE - ROOM TEMPERATURE TENSILE TEST

Traction

N° lot QM	Etat	Loc	Epr	T°	Uni	Mac	Uni	Rp 0.2%	Rm	A
							Uni	ksi	ksi	%
							Min	30.0	75.0	40
							Max		100.0	
599327 5001	000	T3/4	PST	68	°F			43.6	87.0	62

Nous certifions que les produits ci-dessus sont conformes aux prescriptions de la commande.
We hereby certify that the above mentioned products are complying with the order requirements.

MONIQUE BORDINET
05/02/2024
3.1 Inspector

MILL TEST REPORT **TA CHEN INTERNATIONAL, INC.** This MTR contains:5 pages (Page 4)

www.tachen.com

Cust#: ROLHOU Company#: ROLLED ALLOYS- HOUSTON Vendor: INDUSTEEL BELGIUM
MTR#: USCL/USCL2024-102729.pdf PO#: 0229012-HOU SO#: LMZFJ0 Vendor#:USINOR

Item:.62572240304L#1 Bundle:599327003 Heatno:38061 Item:.62572240304L#1 Bundle:599327002 Heatno:38061

CERTIFICAT DE RECEPTION 3.1 / EN 10204:2004	Numéro de document Rev. 01 2024-102729	Page 004 005	ArcelorMittal
Client	Ta Chen International (CA) Corp		
Référence client	82816		
Projet			
Industeel Belgium Site Rue de Châtelet 266 6030 Marchienne-au-Pont			
Produit	Standard product		
Commande / Poste	200009204 / 000010		
Bordereau de livraison	80437321		

PLIAGE

PLIAGE LONGITUDINAL MANDRIN RAYON 1XEP 90°

N° lot QM	Etat	Loc	Epr	T°	Uni	Mac	Uni
							Min
							Max
599327S401	000	T3/4	PSL	68	°F		

Test result Satisfactory as per specification

Loc	3/4	Trois-Quart - 3/4 Width
Loc	T	Tête - Top
Epr. Epaisseur	P	Peau - Rolled Surface
Epr. Face	S	Supérieure - Upper face
Epr. Sens	L	Long - Longitudinal
Epr. Sens	S	Standard - Standard
Epr. Sens	T	Travers - Transverse
Etat	000	Etat thermique de livraison
Epr.Ep./Face/Sens	PSL	Peau / Supérieure / Long
Epr.Ep./Face/Sens	PSS	Peau / Supérieure / Standard
Epr.Ep./Face/Sens	PST	Peau / Supérieure / Travers
T°	RT	Température ambiante

Nous certifions que les produits ci-dessus sont conformes aux prescriptions de la commande

		MONIQUE BORGNIET 05/02/2024

MILL TEST REPORT **TA CHEN INTERNATIONAL, INC.** This MTR contains:5 pages (Page:5)

www.tachen.com

Cust#: ROLHOU Company#: ROLLED ALLOYS- HOUSTON Vendor: INDUSTEEL BELGIUM
MTR#: USCL/USCL2024-102729.pdf PO#: 0229012-HOU SO#: LMZFJ0 Vendor#:USINOR

Item:.62572240304L#1 Bundle:599327003 Heatno:38061 Item:.62572240304L#1 Bundle:599327007 Heatno:38061

CERTIFICAT DE RECEPTION 3.1 / EN 10204:2004	Numero de document Rev. 01 2024-102729	Page 005 / 005	ArcelorMittal
Client	Ta Chen International (CA) Corp.		
Référence client	L82616		
Projet			
Industeel Belgium Site : Rue de Châtelet 266 6030 Marchienne-au-Pont			
Produit	Standardized product		
Commande / Poste	200009264 / 000010		
Bordereau de livraison	80437321		

#082 ESSAIS TECHNOLOGIQUES - TECHNOLOGICAL TESTS - TECHNOLOGISCHE PRÜFUNGEN

CORROSION

ASTM A262 E

N° lot QM	Etat	Loc	Epr.	T°	Uni	Mac
599327/5cc	000	T3/4	SSS	66	°F	

Test result: Satisfactory as per specification

Loc	3/4	Trois-Quart
Loc	T	Tête
Epr. Epaisseur	S	Standard
Epr. Face	S	Supérieure
Epr. Sens	S	Standard
Etat	000	Etat thermique de livraison
Epr Ep./Face/Sens	SSS	Standard / Supérieure / Standard
T°	RT	Température ambiante

Nous certifions que les produits ci-dessus sont conformes aux prescriptions de la commande

MONIQUE BORGNIET
05/07/2024

NSPS00009-2

NIPPON STEEL

NIPPON STEEL CORPORATION
KANSAI WORKS AMAGASAKI AREA
1 HIGASHIMUKOJIMA NISHINO-CHO, AMAGASAKI, JAPAN

INSPECTION CERTIFICATE

CERTIFICATE NO. :0YYE0979 PAGE : 1/2 DATE :2022-07-08

CUSTOMER :TA CHEN INTERNATIONAL, INC.
ORDER NO. :P.O.LA1536
SHIPPER :SANKYO & CO., LTD. 111 5246-AMZ1798A 2-848-N3-5-7-A874-02
COMMODITY :SEAMLESS COLD FINISHED STAINLESS STEEL PIPE
STANDARD :ASTM A312-21 / ASME 2021 EDITION SA-312 TP304
ASTM A312-21 / ASME 2021 EDITION SA-312 TP304L
ASTM A376-19 / ASME 2021 EDITION SA-376 TP304
SPECIFICATION :
MILL WORK NO. :0YYE0979 O.D.:NPS1/2 W.T.:SCH40S LENGTH:MIN.20feet MAX.24feet QUANTITY:130pcs.
TOTAL LENGTH:2818.24feet MASS:1099kg

HEAT NO. :F222031
PRODUCTS PCS. :130

HEAT TREATMENT :SOLUTION TREATED(1940 F X 2min. R.C.)

P.O. No. 24018-0006
Job No. 24018.01
ID No. SP4L-1794
JMB (23)

CHEMICAL COMPOSITION(%)

	*1	C *3	Si	Mn	P *3	S *3	Cr *2	Ni *2
SPEC. MIN.	L	-	-	-	-	-	180	80
MAX.	L	35	75	200	45	30	200	110
HEAT NO. F222031	L	22	31	172	28	0	183	82

*1 L:LADLE ANALYSIS *2:X10 *3:X1000 OTHER:X100

TENSILE TEST

	*1	*2	YS *3		TS *3		EL %
SPEC. MIN.	L	B	P	30.0	P	75.0	35
MAX.	L	B	P	-	P	-	-
HEAT NO. F222031	L	B	P	55.7	P	96.2	54

TYPE OF SPECIMEN:FULL SECTION *1 SAMPLING DIRECTION L:LONGITUDINAL *2 SAMPLING POSITION B:BASE METAL
*3 UNIT P:ksi GAUGE LENGTH:2.0in. KIND OF YS:0.2% OFFSET

CORROSION TEST(ASTM A262-E): ACCEPTABLE
CORROSION TEST(MIL-P-24691/3): GUARANTEED
CORROSION TEST(MIL-P-1144D): GUARANTEED
FLATTENING TEST: ACCEPTABLE
VISUAL & DIMENSIONS: ACCEPTABLE
EDDY CURRENT EXAMINATION STANDARD PRACTICE REFERENCE DISCONTINUITIES(ASME SA-999/ASTM E426 TRANSVERSE TANGENTIAL NOTCH): ACCEPTABLE
NO WELD REPAIR
MERCURY WOULD NOT BE DETECTED
NACE MR0175/ISO 15156, NACE MR0103/ISO 17945 HARDNESS: GUARANTEED
MELTED/CASTED/MANUFACTURED IN JAPAN
EN 10204 3.1

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MADE IN ACCORDANCE WITH THE RULES OF THE CONTRACT.

NOBUYUKI HISAMUNE
SENIOR MANAGER
QUALITY ASSURANCE DEPARTMENT

NO.353895A22

NIPPON STEEL
NIPPON STEEL CORPORATION
KANSAI WORKS AMAGASAKI AREA
1 HIGASHIMUKOJIMA NISHINO-CHO, AMAGASAKI, JAPAN

INSPECTION CERTIFICATE

CERTIFICATE NO. :0YYE0979 PAGE : 2/2 DATE :2022-07-08

WE HERE CERTIFY THAT, SPECIMENS FOR THE TESTS WERE SAMPLED FROM THE ORIGINAL LENGTH PRIOR TO CUTTING TO FINAL LENGTH AFTER THE PRODUCTS HAD BEEN MANUFACTURED AND HEAT TREATED, AND THE QUANTITY OF THE SPECIMENS WAS BASED ON THE NUMBER OF THE ORIGINAL LENGTH AT HEAT TREATMENT IN ACCORDANCE WITH THE REQUIREMENTS OF THE MATERIAL SPECIFICATION.

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MADE IN ACCORDANCE WITH THE RULES OF THE CONTRACT.

NOBUYUKI HISAMUNE
SENIOR MANAGER
QUALITY ASSURANCE DEPARTMENT

NO.353895A22

P50722C001 ~ 05

PEPS1961

PEXCO

Pennsylvania Extruded Tube Company

P.O. Box 1280 P.O. No. 24018.0001
Scranton Job No. 24018.01
PA USA 18501
570-585-7777 ID No. SP4L-1796

200814351

Page 1

23

Sold To: 90
SMI EXTRUDED TUBE INC.
CHICAGO, IL
Customer Order No: 991007
Pexco Order No: 963232/11

Work Order/Lot: 522281

Ship To:
TA CHEN INTERNATIONAL CORP.
HOUSTON, TX
Certification Date: 20080404

Quantity: 126 Pcs. @ 2685.42 FT
PO# L23043

ASTM A312-07, ASTM A376-06, ASME SA-312, ASME SA-376, ASME SECTION II
2007 Edition, NACE MR0175-2005, NACE MR0103-2005

Hot Finished Seamless Pipe
Type TP304/TP304L

Size: 2" SCH 40
Heat: 517709

Material Manufacturer: Pennsylvania Extruded Tube Co. USA

ANALYSIS %

	C	Si	Mn	P	S	Cr	Ni
Heat	.015	.30	1.61	.025	.006	18.39	10.12
Prod	.012	.31	1.64	.025	.005	18.38	10.20

	Mo	Co	Cu	N
Heat	.45	.071	.28	.030
Prod	.45	.073	.28	.026

Mechanical Tests:

Yield Strength 0.2% psi	Yield Strength 0.2% MPa	Yield Strength 1.0% psi	Yield Strength 1.0% MPa	Tensile Strength psi	Tensile Strength MPa	Elongation in % E2"	E10"	E4d	E5d	Reduction Of Area %
34800	240.0	N/A		83400	575.2	50	N/A	N/A	N/A	N/A

Hardness Test Results: 75HRB, 76HRB
Hydrostatic Test (psi): 2000

Hydro Pressure IAW ASTM A530/A999 (5 sec. hold), psi: 2000
Tensile Test sample width (1=Full-Size 2=1/2" Strip): 2
Flattening Test per MIL-P-24691/3 (meets A999), No. samples: 4
Result: Acceptable
Corrosion Test per Mil-P-24691/3 (A262 Pr E). No. of samples:
1 Result: Acceptable
Country Of Origin: United States
Inspection Certificate IAW EN 10204 3.1
Color-coding as agreed upon with customer (fax 3-26-02).
Hardness test meets NACE MR0175 & NACE MR0103 requirements.
Heat number is traceable to the original melt.
The grade 304L and 316L are not covered by ASTM A376 or ASME SA376 specifications. Therefore, these specifications do not apply to these grades.
All material subjected to a solution annealing heat treatment at a temperature of 1900 deg.F minimum followed by rapid air/water quenching to below 800 deg.F in less than three (3) minutes.
Material manufactured by Pennsylvania Extruded Tube Company (PEXCO), U.S.A. and meets the requirements of NAFTA Origin.
Material has not come in contact with Mercury or Mercury containing compounds. No weld repair or welding performed.
Material has been manufactured in accordance with PEXCO's

P50726001 v05
PEPS1962
200814351

Quality Manual R3 dated 9/16/07 (ISO 9001:2000 Certificate No. 109185, expiration date 3/31/09).
Melt Source: AB Sandvik MT, Sweden
Melt Method: Electric Arc Furnace-AOD Refining
This is to certify that the contents of this Certificate are correct and accurate as contained in PEXCO's records, and that all above test results and operations performed are in compliance with the requirements of the purchase order and the specifications as outlined above. Test results represent the actual attributes of the items purchased unless stated otherwise in this Certificate.

Gerard F. Dougherty, Qual. Mgr
10 (TA CHEN PIPE R19) (15) HF (US36252)

Authorized Representative

STOCK PIPE 24018 SP4L-1534 D

2" 540s Seamless

Tate Metalworks
20005-00009
KK1606
4/22

WSG
1921-16 Gijang-daero, Jangan-eup
Gijang-gun Busan, Korea 46028
TEL:+82-51-710-1700 FAX : +82-51-727-1636

CERTIFIED REPORT OF TESTS

per EN 10204 3.1
Notified Body TUV SUD Group ISO 9001: 2015 Cert No TUV100 01 2206
PED 2014/68/EU, Annex I, Section 4.3 and AD-W0 Cert No DGR-0036-QS-W 550/2012/MUC

CUSTOMER	Norca Industrial Company, LLC	CERTIFICATE NUMBER	WS 20020301-02
ORDER NUMBER	101-5021	ISSUE DATE	03-Feb-2020
PRODUCT TYPE	STAINLESS STEEL SEAMLESS PIPES, SOLUTION ANNEALED, PICKLED	MATERIAL GRADE	TP304L
PRODUCT SIZE	NPS2 X Sch 40S X 20 (FT, Length)	QUANTITY	1320 FT
SPECIFICATIONS	ASTM A312, ASME SA312, SA376	NUMBER OF LENGTHS	66
HEAT TREATMENT	SOLUTION ANNEALED TO MINIMUM OF 1900°F (1040°C)	REVISION	ASTM A312-18a, ASME SA312:2019 ASME SA376-2019
SURFACE FINISHES	ACID PICKLING	COUNTRY OF MANUFACTURE	KOREA

CHEMICAL COMPOSITION (according to mill certificate of stainless steel mill, %)

HEAT NUMBER	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	Co	N	Cb+Ta
S190821AA12	0.024	0.44	1.33	0.035	0.002	18.5	8.04	-	-	-	-	-

P.O. No. 20005-00009
Job No. 20005
ID No. SP4L-1534 SP4L-1534
JWB (17)

MECHANICAL TEST

YIELD STRENGTH (0.2% OFFSET)	TENSILE STRENGTH	ELONGATION (%)	HARDNESS
MPa 315	MPa 613	53	HRB 81
MPa 309	MPa 612	53	HRB 79

VISUAL INSPECTION	ACCEPTABLE	FLATTENING TEST	ACCEPTABLE	EDDY CURRENT TEST	ACCEPTABLE	DIMENSIONS CHECK	ACCEPTABLE
HYDROSTATIC TEST	ACCEPTABLE	ICT	ACCEPTABLE	NACE MR 0103 / ISO 17945-15	ACCEPTABLE	NACE MR 0175 / ISO 15156-15	ACCEPTABLE

ATTEST

The Material has not come in contact with mercury or/and low melting point elements. Weld repair was not used to manufacture this product.
The delivered products comply with the requirements of the order.
Eddy current test is conducted according to A999/A999M. Material is PMI-tested on all 100%.
Intergranular corrosion test(ICT) according to ASTM A262 Practice E
We hereby certify that the material herein has been made and tested in accordance with above specification and the results of all test are acceptable.

33-03 BPE-089

Ha, Jae min.
Quality Assurance Manager

JIN-JAE, JI
IN-HOUSE INSPECTOR

Stock Pipe
24018 3" S 40S Seamless
SP4L-1668

DIVINE
TUBES PRIVATE LIMITED

CIN NO. U27109GJ2004PTC043781

Manufacturer & Exporter of Stainless Steel Seamless | Welded Tube & Pipes

ISO 9001:2015, ISO 14001:2015, BS OHSAS 18001:2007, PED 2014/68/EU and AD 2000 MERKBLATT W0 CERTIFIED COMPANY

INSPECTION CERTIFICATE AS PER EN 10204:2004-3.1

F/DTPL/QAS/02

CUSTOMER :		
M/s. NORCA INDUSTRIAL COMPANY, LLC	Certificate No.	DTPL/SMLS/2021-22/188/2
1 HOLLOW LANE, SUITE 200	Date	13.10.2021
LAKE SUCCESS, NY 11042	PRODUCT	AUSTENITIC S.S SEAMLESS PIPE
USA	STANDARD	ASTM A 312 / ASME SA 312 - 18
	MATERIAL	TP 304/304L
	PO. NO. AND DATE	148/005005 DT. 16.06.2021

PO. SR. NO.	WORK ORDER NO.	DIMENSION	ENDS	QUANTITY NOS	QUANTITY FEET	HYDROSTATIC TEST TESTED PRESSURE (PSI)
[illegible]	SMLS/1[illegible]	3.0 INCH X SCH 40S X 18 TO 24 FEET LENGTH	[illegible]	48	366.[illegible]	[illegible]

SR NO.	HEAT NO.	ABBREV.	C	MN	P	S	SI	NI	CR
			CHEMICAL COMPOSITION %						
		S	0.035 MAX	2.00 MAX	0.045 MAX	0.030 MAX	1.00 MAX	8.00-11.00	18.00-20.00
		H	0.022	1.710	0.038	0.004	0.490	8.[illegible]	[illegible]
[illegible]	[illegible]-34405	P	0.021	1.653	0.039	0.001	0.515	8.[illegible]	[illegible]
		P	0.025	1.707	0.037	0.00[illegible]	[illegible]	8.5[illegible]	[illegible]

SR. NO	TENSILE STRENGTH (MPA)	YIELD STENGTH (MPA)	ELONGATION (%) G.L-50 MM	FLATTENING TEST	HARDNESS TEST (HRC)
	MECHANICAL TEST				
	515 MIN	205 MIN	35% MIN	(ASTM A 370)	[illegible] MAX
1	[illegible]	307.[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	30[illegible]	5[illegible]		[illegible]

HEAT TREATMENT : SOLUTION ANNEALED AT TEMP ABOVE 1040°C AND RAPID QUENCHED IN WATER

ALL PIPES ARE PICKLED AND PASSIVATED AS PER ASTM A 380 AND FOUND SATISFACTORY

100% VISUAL INSPECTION DONE AS PER ASTM A 312 / ASME SA 312 BY DTPL AND FOUND SATISFACTORY

100% DIMENSIONAL INSPECTION DONE AS PER ASTM A 312 / ASME SA 312 BY DTPL AND FOUND SATISFACTORY

100% HYDRO TEST DONE AS PER ASTM A 312 / ASME SA 312 BY DTPL AND FOUND SATISFACTORY

CHEMICAL ANALYSIS TEST AS PER ASTM A 312 / ASME SA 312 BY DTPL AND FOUND SATISFACTORY

MECHANICAL TEST AS PER ASTM A 312 / ASME SA 312 BY DTPL AND FOUND SATISFACTORY

100% PMI TEST AS PER ASTM A 312 / ASME SA 312 BY DTPL AND FOUND SATISFACTORY

IGC PRACTICE "E" TEST AS PER ASTM A 262 DONE BY DTPL AND FOUND SATISFACTORY

MARKING : DIVINE MAKE SIZE , PL , SEAMLESS PIPE , STANDARD , GRADE , HEAT NO., NACE MR 0175 & MR 0103 , PMI TESTED , [illegible]

[illegible] BY [illegible] BODY OF TUV NORD AND ALSO CONFIRM ACC [illegible]

[illegible] CONFIRM TO S.S SEAMLESS PIPE TP 304/304L GRADE AS PER ASTM A 312 , ASME SA 312 [illegible]

NOTE : S=SPECIFICATION, H=HEAT ANALYSIS, P=PRODUCT ANALYSIS, G.L=GAUGE LENGTH

REMARKS :- WE HEREBY CERTIFY THAT THE MATERIAL IS AS PER P.O. REQUIREMENT.

For, DIVINE TUBES PVT.LTD.

Q.C.ENGINEER

P.O. No. 22005-00003
Job No. 22005.01
ID No. SP4L-1668
(21)

25

Office / Works :
114, Phase - I, G.I.D.C. [illegible]

+91 - 2764 - 232 402

24018 MTR SVK plate
3/16" 504L-3374

ATI Flat Rolled Products

500 Green Street
Washington, PA 15301

Certificate of Test

Noreen DeFerrari - Sr. Manager, Quality

Mill Information		Customer Information	
Cert Number	0215659-00	Name	ROLLED ALLOYS INC
Sales Order	50-011-362	PO	0192635-HOU
Cert Date	Mar-10-2021	PO Date	Jan-21-2021

Sold to: ROLLED ALLOYS INC
PO BOX 310
TEMPERANCE, MI 48182

Ship to: ROLLED ALLOYS INC.
9818 E. HARDY ROAD
HOUSTON, TX 77093

Material Information

"ATI 304/304L" STAINLESS STEEL
PMP HOT ROLLED PLATE ANNEALED PICKLED COMMERCIAL CUT EDGE

ASTM-A-240-20A
ASTM-A-262-15,PRACTICE E
AMS 5511K
UNS S30400
NACE MR0103/ISO 17945:2015
ASME-SA-240 ED 2019
AMS 5513J
UNS S30403
NACE MR0175/ISO 15156-3:2015

Piece Information

Pcs	Gauge (in)	Width (in)	Length (in)	Heat #	Piece ID	Section Id	Lot #	Total Wt (lbs)
Item: 001	Cust-Id: 0003839 Cust-Job:			Govt-Contract-#: ScheduleB:		Govt-DO-Rating:		
1	.1875	96.0000	240.0000	861959	CG06979	---	503207	1373

Chemistry Testing

Element (wt %)	Requirements Min	Max	Final Heat Analysis 861959	Loc
C	---	.030	.025	BN
MN	---	2.00	1.60	BN
P	---	.040	.031	BN
S	---	.030	< .001	BN
SI	---	.75	.38	BN
CR	18.00	19.50	18.20	BN
NI	8.00	10.50	8.11	BN
MO	---	.75	.49	BN
CU	---	.75	.45	BN
N	---	.10	.09	BN

ROLLED ALLOYS Receiving Inspection
By: [illegible]
Date: 3/24/21

P.O. No. [illegible]
Job No. [illegible]
ID No. 504L-3374A

HEAT # 861959
TRACER # 0616967US

ALC720 03/15/2021 11:45:32

ATI Flat Rolled Products	Certificate of Test	Noreen DeFerrari - Sr. Manager, Quality

500 Green Street
Washington, PA 15301

Mill Information		Customer Information	
Cert Number	0215659-00	Name	ROLLED ALLOYS INC
Sales Order	50-011-362	PO	0192635-HOU
Cert Date	Mar-10-2021	PO Date	Jan-21-2021

Chemistry Testing

ATI Flat Rolled Products performs chemical analysis by the following techniques for testing locations TC, BN, & LO: C & S by combustion/infrared absorption per ASTM E1019; N & O by inert fusion/thermal conductivity per ASTM E1019; Mn, P, Si, Cr, Ni, Mo, Cu, Cb(Nb), Co, V, W by WDXRF per ASTM E572; Pb, Bi, Ag by GFAA per ASTM E1184; Al and Ti (>=0.10%) by WDXRF per ASTM E572 otherwise by OES per ASTM E1086; Ta by ICP per ASTM E1479.

861959 - Material was produced by EF melting with AOD refining.
USA melt and manufacture
Material melted at ATI FRP Brackenridge (FRPB)

FRPB - ATI FRP BRACKENRIDGE 100 River Road Brackenridge, PA 15014

Mechanical Testing

		LOT 503207	
Condition:		ANNEALED	
Direction:		TRANSVERSE	
Temperature:		ROOM TEMP	
Spec:			
Test Limit	Units	Result	Loc
YS 0.2% OFFSET	psi	44900.	TC
TENSILE	psi	86200.	TC
ELONG. IN 2"	%	59.	TC
RED OF AREA	%	69.	TC
HARDNESS	---	152. HBW	TC

When hardness is measured using the Brinell scale, the indentation measuring device is Type A.

Bend test passed per periodic test requirement.

Mechanical Property Requirements

Condition:		ANNEALED	
Direction:		TRANSVERSE	
Temperature:		ROOM TEMP	
Spec:			
Test Limit	Units	Min	Max
YS 0.2% OFFSET	psi	30000.	----
TENSILE	psi	75000.	100000.

HEAT # 861959
TRACER # 0616967US

ALC720 03/15/2021 11:45:32

S+K 24018 M4R
5042-3445

NORTH AMERICAN STAINLESS

METALLURGICAL TEST REPORT

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

Certificate: 706219 02
Customer: 4660 013

Mail To:
SPECIALTY ROLLED METALS
423 ST. PAUL BLVD.
CAROL STREAM, IL 60188

Ship To:
SPECIALTY ROLLED METALS
423 ST. PAUL BLVD.
CAROL STREAM, IL 60188

Date: 7/12/2021 Page: 1
Steel: 304/304L
Finish: HRAP

Your Order: 03310787 NAS Order: AN 0947192 01 Corrosion: ASTM A262/15;180Bend-OK

PRODUCT DESCRIPTION:

STAINLESS STEEL COIL, HRAP; UNS 30400/30403
EN10028-7 & EN10088-2, 1.4301/1.4307
ASTM A240/20,A480/20a,A666/15;ASME SA240/19,SA480/19,SA666/19
AMS5511K/5513J XMRK; MIL-S-5059D AMD3(X CRN MEAS); MIL-S-4043B
NACE MR0175/ISO 15156-3:2009 A, MR0103/07;QQS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; RoHS 1, 2 & 3 Compliant
Material is Free of Radioactive Contamination
Steel Making Process: EAF, AOD, & Cont. Casting
Product Mfg.by a Quality Mgt.Sys. in Conf. w/ISO 9001
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

Product ID #	Coil #	Thickness	Width	Weight	--------Length-------	Mark	Pieces	COMMODITY CODE
05M92L B	* 05M92L B	.3750	60.0000	20,090	COIL 256.60	18	1	21243

ANAB, ISO/IEC 17025, Certificate# L2323

CHEMICAL ANALYSIS CM(Country of Melt) ES(Spain) US(United States) ZA(South Africa) JP(Japan) Chemical Analysis per ASTM A751/20

HEAT	CM	C %	CR %	CU %	MN %	MO %	N %	NI %	P %	S %
M92L	US	.0283	18.0410	.4460	1.7690	.4020	.0882	8.1070	.0310	.0027
		SI %								
		.3590								

P.O No. 21019-0026
Job No. 21019.01
ID No. 5042-3445 A
7/26(19)

MECHANICAL PROPERTIES

Product ID #	Coil #	loc	dir	UTS KSI	20C .2% YS KSI	20C 1% YS KSI	20C ELONG %-2"	% Hard RB	Tail Hard
05M92L B	05M92L B	F	T	96.67	56.43	67.34	50.04	88.50	92.00

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

Technical Dept. Mgr.
KRIS LARK 7/12/2021

24018 MTR SS PLATE
5046-4048

NORTH AMERICAN STAINLESS
An Acerinox Group Company

METALLURGICAL TEST REPORT

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

Certificate: 919741 06
Customer: 2830 023

Mail To:
ROLLED ALLOYS
6555 SOUTH 57TH WEST AVENUE
TULSA, OK 74131

Ship To:
ROLLED ALLOYS
6555 SOUTH 57TH WEST AVENUE
TULSA, OK 74131

Date: 5/10/2024 Page: 1
Steel: 304/304L
Finish: HRAP

Your Order: 0226409-TUL
NAS Order: AN 1053070 02
Corrosion: ASTM A262/21 A 180Bend-OK

PRODUCT DESCRIPTION

STAINLESS STEEL PLATE, HRAP; UNS S30400/30403
ASTM A240/23,A480/23,A666/23;ASME SA240/23 SA480/23,SA666/19
CHEM ONLY ON FOLLOWING ASTM: A276/17,A479/23,A484/23,A312/22a
CHEM ONLY ON FOLLOWING ASME: SA312/23,SA479/23

AMS 5511K/5513L XMRK; MIL-S-5059D AMD3(X CRN MEAS); MIL-S-4043B
NACE MR0175/ISO 15156-3:2015 A, MR0103/07;QQS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; RoHS 1, 2 & 3 Compliant
Material is Free of Radioactive Contamination
Steel Making Process: EAF, AOD, & Cont. Casting
Product Mfg.by a Quality Mgt.Sys. in Conf. w/ISO 9001
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

P.O. No. 24005-00023
Job No. 24005.02
ID No. 5046-4048

Skid #	Prod #	Thickness	Width	Weight	--------Length-------	Mark	Pieces	COMMODITY CODE
PX6419	* 04BE5V	.5000	48.0000	2,000	PLATE 144.00		2	0003864

ANAB, ISO/IEC 17025, Certificate# L2323

CHEMICAL ANALYSIS

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

Chemical Analysis per ASTM A751/20

HEAT	CM	C %	CO %	CR %	CU %	MN %	MO %	N %	NI %	P %
BE5V	US	.0148	.2080	18.1070	.4915	1.7655	.4015	.0849	8.0700	.0310

S %	SI %
.0010	.3385

MECHANICAL PROPERTIES

Skid #	Prod #	loc	dir	UTS KSI	20C .2% YS KSI	20C ELONG %-2"	% Hard RB	A 262 Pr A	R of A %
PX6419	04BE5V	F	T	80.84	31.32	69.48	78.00	OK	73.40

HEAT # BE5V
TRACER # 0705673US

ROLLED ALLOYS
Receiving Inspection
By: AB
Date: 5/14

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

Technical Dept. Mgr.
DANIEL HARGETT 5/10/2024

24018 MTR SD4L-3997A 3/8"

Manufacturer / Fabricante	Type of document / Tipo de documento	Document number / Nº de certificado. 10/19/2023
outokumpu	INSPECTION CERTIFICATE CERTIFICADO DE INSPECCION according to / de acuerdo con EN 10204-3.1	0000631027 / Page / Pagina: 1 / 2

1 Steel Drive; P.O. Box 13000; Calvert, AL 36513-1300

SPECIALTY ROLLED METALS, LLC
423 SAINT PAUL BLVD.
CAROL STREAM IL 60188
USA

Customer/Ship to / Cliente: SPECIALTY ROLLED METALS, LLC,CAROL STREAM

Customer's order number / Nº de Pedido Cliente .: 03311146

Manufacturer's works order no. / Nº de Pedido Manufactura .: 901328467 / 001

Delivery note no. / Nº de Entrega .: 85835870 / 010

Product / Producto: Stainless Steel Hot Rolled Coil/Bobina

Terms of delivery / Condiciones de entrega:
ASTM A240/A240M-23, ASME SA-240 Sec. II part A Ed.2021
ASTM A480/A480M-23a, ASME SA-480 Sec. II part A Ed.2019
ASTM A666-23
NACE MR0103 / ISO 17945: 2015
ASTM A276-23, A312-22a, A479-23, A484-23a Chemical only
NACE MR0175 / ISO 15156-3: 2020
ASME SA312-22a, SA479-23 for Chemical Composition
EN 10028-7: 2016
EN 10088-2: 2014

Steel Grade and Quality / Acero:
TYPE 304L/304
UNS S30400
UNS S30403
1.4307
1.4301

P.O. No. 24010-00001
Job No. 24010
ID No. SD4L-4000A
3997A
4005A
3998A

23

Customer's material no./ Nº de material del cliente	Product dimensions (Thickness / Width / Length) / Dimensiones (Espesor / Ancho / Largo)	Steelmaking procedure/ Proceso de manufact.	Finish/ Acabado
21243	9.53 mm x 1,524.00 mm 0.3750 inch x 60.0000 inch	AOD	IIa / 1D / No.1

Packing-No./ Nº de Empaque	No.of pieces/ Piezas	Actual weight/ Peso actual	Actual length/ Longitud actual	Coil-No./ Bobina No.	Heat No./ Colada	Inspection lot/ Lote de inspeccion	Inspection lot/ Lote de inspeccion
3545381	1	47,906 lb / 21,730 kg	617 ft / 188 m	909291	543627	1000883084	1000883085
Sum / Suma	1	47,906 lb / 21,730 kg					

Chemical composition / Composicion Quimica — Chemical analysis per ASTM A751-21

Heat / Colada	Country of Melt / País de colada	% C	% Si	% Mn	% P	% S	% Cr	% Mo	% Ni	% N	% Cu
543627	USA	0.027	0.35	1.27	0.032	0.0014	18.09	0.48	8.06	0.066	0.49

Sample Position/ Localiz.de la muestra: TRANSVERSE — Mechanical testing per ASTM A370-23

Inspection lot/ Lote de inspección	YS0.2% PSI / MPa	YS1,0 PSI / MPa	TS PSI / MPa	El. A80 %	El. 2" %	HRB
1000883084	45,685 / 315	57,433 / 396	92,675 / 639	51	56	88
1000883085	45,975 / 317	57,578 / 397	92,820 / 640	51	56	91

Resistant to intergranular corrosion / Resistente contra corrosióninter-granular: ASTM A 262-15, PRACTICE E - Sample Acceptable
Dimensions-surface / Dimensiones-Superficie: OK
Positive Material Identification (PMI) / Control de identidad (análisis espectográfico): OK

Heat Treat: Solution anneal 1900°F/1040°C Min, Air and water quench
Bending test per ASTM E290-14 OK
No welding or weld repairs were performed on this material
Grain Size as per ASTM E112-13, comparison procedure
DFARS 225.872-1 Compliant
No intentional additions of Mercury compounds were made or used

Originator of the document / Originador del documento /
Outokumpu Stainless USA, LLC
An ISO 9001:2015 certified company
ISO 17025:2017 accredited testing lab by ANAB
EU PED 2014/68/EU, Anex I, 4.3 certified
Certificate is generated automatically / Certificado es generado automaticamente

The information provided is a true copy of data on file / Los valores mostrados corresponden a los datos archivados
Arturo Hernandez Rubio
Name of expert / Nombre del experto

Date of issue and validation / Fecha de emisión y validación
10/19/2023
This document shall not be altered or reproduced, except in full. Fraudulent, fictitious, or false statements or entries may be prosecuted by law.

Manufacturer / Fabricante	Type of document / Tipo de documento	Document number / Nº de certificado. 10/19/2023
outokumpu	**INSPECTION CERTIFICATE** CERTIFICADO DE INSPECCION according to / de acuerdo con EN 10204-3.1	0000631027 / Page / Pagina: 2 / 2

Free of radioactive contamination

EU RoHS Directive 2011/65/EU Compliant

Product manufactured in the USA

Country of Melt as per ISO 3166-1

Originator of the document / Originador del documento /	The information provided is a true copy of data on file / Los valores mostrados corresponden a los datos archivados	Date of issue and validation Fecha de emisión y validación	
Outokumpu Stainless USA, LLC An ISO 9001:2015 certified company ISO 17025:2017 accredited testing lab by ANAB EU PED 2014/68/EU, Anex I, 4.3 certified Certificate is generated automatically / Certificado es generado automaticamente	Arturo Hernandez Rubio Name of expert / Nombre del experto	10/19/2023 This document shall not be altered or reproduced, except in full. Fraudulent, fictitious, or false statements or entries may be prosecuted by law.	

Tate
METALWORKS, INC.

PURCHASE ORDER

Tate Metalworks Incorporated
PO Box 171
Spartanburg SC 29304

864-576-3540

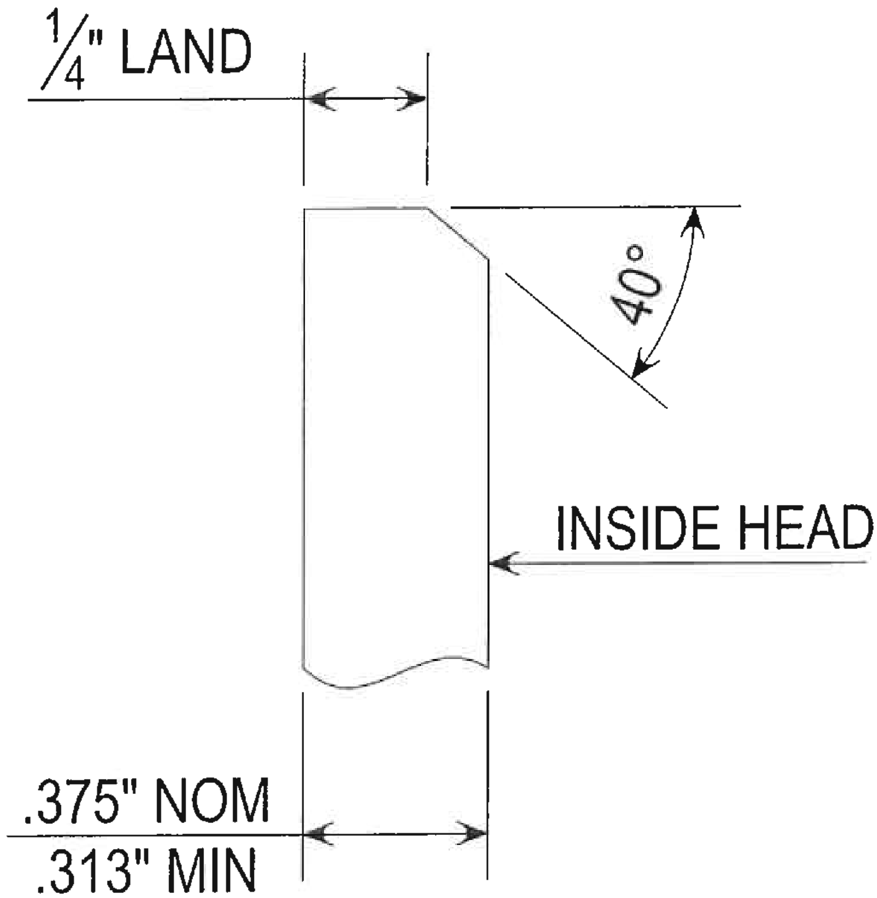
To: Brighton Tru-Edge Heads
11861 MOSTELLER RD.
Cincinnati OH 45241

Deliver to: 255 Happy Lane
Roebuck SC 29376

Order Number	24018-00001
Order Date	5/23/2024
Requisition No	
Delivery Date	8/1/2024
Purchaser	TWB
Terms, net 30	

Job	Phase	Cost Code	Cat	Description	Quantity	Rate	Amount	Tax
				ASME Head 2:1 Elliptical 96" I.D. X 313"min.(0.375"nom.) 2"SF, 26.313"max. OAH (+/- 0.375") Single Bevel: per Sketc attached SA516-70 ID#SH4L-237 Surcharge included in price Mark heat numbers on material Furnish matching Mtr's w/shipment No China/Taiwan Material Melted or Manufactured ASME Code Vessel All head's shall be cold formed and shall be in compliance with paragraph UG-81 and UCS-79(d) of ASME Section VIII, Div.1. All heads shall be seamless or 100% radiographed. If heads are welded, Original Form U-2 partial data reports are required. Frt. Included to Roebuck, SC 29376 Confirmed to: Amanda Suchko 513-672-4839 Quote#20242508 *Bevel (1) Head Only*	2.00 ea	6590.9500	13,181.90	
					Order Total		$13,181.90	$0.00

Approval Signature



HEAD BEVEL DETAIL

(1) Head Bevel
(1) Head square

24018

BRIGHTON

Brighton Tru-Edge Heads, LLC
11861 Mosteller Road
Sharonville OH 45241-1524

05/23/2024 14:59:47

This Proposal is issued subject to Brighton TruEdge Heads & Fabricated Products, Inc.'s Terms of Sale found at http://brightontruedge.com/terms-of-sale/; provided that if a Blanket Subcontract Agreement is in effect between the parties, this Proposal is issued subject to such Blanket Subcontract Agreement.

Proposal No. 20242508

To:
TIM BRADY
CREDIT TEAM
TATE METALWORKS INC
P.O. BOX 171
SPARTANBURG SC 29304

From:
Proposal Date 05/23/2024
Payment Terms Net 30 Days

Customer Information:
Inquiry No. 49251
Name TIM BRADY
Telephone 864-576-3540
Fax 864-574-6620
Email tim.brady@tatemetalworks.com

Sales Rep. Amanda Suchko
Telephone 513-672-4839
Fax 513-771-2404
amanda.suchko@brightontruedge.com

Line Item 10

Quantity	2.00	**Tag**	
Job Type	Labor and Matl	**Weld**	Yes
Material Type	SA240-304/304L	**X-Ray**	Spot X-Ray
Style	2:1 ELLIPTICAL	**U-2A Form**	Yes
Diameter	96" ID	**Finish Inside**	Mill Finish
Thickness	0.375" Nom 0.313" Min	**Finish Outside**	Mill Finish
SF	2"	**Circumference**	25' 1-9/16" IC
OAH	26.375"	**Weight Each**	1,167
Center Hole	2.375" Max	**Total Weight**	2,334
Bevel	40.0° Inside with 1/4" Land	**Volume**	564
		Form Code	Cold Formed & Pickled
		Inspection	ASME Code INSP w/ P. Dat Sht

Terms of Delivery: : FOB Cincinnati w/ freight allowed to ROEBUCK, SC

Notes:

Selling Price Each:....................................... **$6,590.95**
Shipment: 10 weeks **Price Includes June Surcharge**

Tate
METALWORKS, INC.

PURCHASE ORDER

Tate Metalworks Incorporated
PO Box 171
Spartanburg SC 29304

864-576-3540

To

Phoenix Metals
PO Box 932589
Atlanta GA 31193-2589

Deliver to

255 Happy Lane
Roebuck SC 29376

Order Number	24018-00002
Order Date	5/23/2024
Requisition No	
Delivery Date	6/6/2024
Purchaser	TWB

Terms, net 30

Job	Phase	Cost Code	Cat	Description	Quantity	Rate	Amount	Tax
				Plate 0.313" X 48" X 305" (1)pc. SA240-304/304L ID#SD4L-4052 SR-1	1,397.41 #	1.6800	2,347.65	
				Plate 0.313" X 60" X 305" (4)pcs. SA240-304/304L ID#SD4L-4053 SR-2,3,4,5	6,987.04 #	1.6800	11,738.23	
				Surcharge included in price Mark heat numbers on material Furnish matching Mtr's w/shipment				
				No China/Taiwan Material Melted or Manufactured				
				Frt. Included to Roebuck, SC 29376				
				Per Attached Tate Metalworks , Inc. "PURCHASE SPECIFICATION FOR STAINLESS STEEL WAREHOUSE CONTINUOUS MILL PLATES" Specification PS-CMP-001 (Revision Date: March 5, 2012)				
				Per Attached Tate Metalworks , Inc. "Purchase Order Terms and Conditions"				
				Exact piece count quantities required as listed				
				Confirmed to: Scott 800-521-6061 Quote#2488414				
				Fuel Surcharge	1.00 lot	29.5600	29.56	
						Order Total	$14,115.44	$0.00

Approval Signature

Phoenix Metals Company

CHARLOTTE - PHOENIX METALS
12420 MEANS CT.
P. O. BOX 7849
CHARLOTTE, NC 28278

Quote

No: 2488414
Date: 05/23/2024

Sold To: TATE METALWORKS, INC.
P. O. BOX 171
SPARTANBURG, SC 29304
Phone No. 864-576-3540 Fax No. 864-574-6620

Ship To: TATE METALWORKS, INC.
255 HAPPY LANE
ROEBUCK, SC 29376

Salesperson :SCOTT HUGGINS, email: SHUGGINS@PHOENIXMETALS.COM, Phone: 704-588-7075

Customer #	Contact	PO Number	Terms
TATMET	TIM-1		1/2% 10 NET 30
FOB	**Ship Via**	**Ship Date**	
DELIVERED	OUR TRUCK	06/06/2024	

	Product	Qty	UM	Description	Ord	UM	Bill Qty	Price	UM	Extension
1		1	PCS	T304L STAINLESS STEEL PLATE(.3125 X 48 X 305)	1397.41	LBS	1397.40	1.68	LBS	2,347.63
2		4	PCS	T304L STAINLESS STEEL PLATE(.3125 X 60 X 305)	6987.04	LBS	6987.04	1.68	LBS	11,738.22

Total Est Weight (LBS) 8384.45

SubTotal	14085.85
Est. Fuel Surcharge	29.56
Freight Charges	.00
Misc Charges	.00
Cutting/Labor	.00
Taxes	.00
Total	14,115.41

All quotes valid through the close of business today and are subject to final confirmation by a sales order acknowledgement
Phoenix Metals Terms and Conditions of Sale Apply. Please refer to www.phoenixmetals.com/terms-and-conditions

Tate

METALWORKS, INC.

P.O. Box 171, Spartanburg, SC 29304 : 255 Happy Lane, Roebuck, SC 29376
(P) 864-576-3540 (F) 864-574-6620

PURCHASE SPECIFICATION FOR STAINLESS STEEL WAREHOUSE CONTINUOUS MILL PLATES

Specification PS-CMP-001 (Revision Date: March 5, 2012)

1.0 GENERAL:

1.1 This specification applies to stainless steel continuous mill plates cut from coils, and purchased by Tate Metalworks, Inc. Material will be supplied in the form of plates. Plates will be furnished in accordance with ASME Specifications SA240, and SA 480, latest editions, and the following requirements.

1.2 The billing weight basis will be theoretical weight.

1.3 Additional requirements may be contained in the body of the purchase order or in other attachments. This specification and requirements contained in the purchase order take precedence over similar requirements listed SA240 and SA480.

1.4 Failure to comply with these specifications will result in rejection of material, or backcharges for corrective work.

2.0 CONDITION:

2.1 Plates shall be furnished as hot-rolled, annealed, and pickled unless otherwise specified in the purchase order.

2.2 The use of welding to repair imperfections must be approved in writing by Tate Metalworks prior to making such repairs. Any welding approved must meet the requirements noted in Section 20. of ASME Specification SA 480.

3.0 FINISH:

3.1 Plates shall have a No. 1 Mill Finish unless otherwise specified in the purchase order.

3.2 Plates shall be furnished with No. 3 slit edges.

3.3 All plates are to be delivered to our shop cleaned, undamaged, and suitable for resale without further cleaning or repair.

3.4 All of the following finish defects are cause for rejection of material:

Stains (Pickle stains, rust stains, & other stains)
Deep scratches (primarily from forklift handling and dragging)
Rust - including rust streaks from steel strapping.
Edge damage (from hooks and chains)
Marks from sources such as suction cups, forklift tires, and footprints.
Dimples from rolled in scale, shot, or other cause.

4.0 DIMENSIONS - PLATES:

4.1 Plates shall be furnished to the dimensions listed on the purchase order within the following tolerances:

Dimensional Tolerances

Dimension	
Width & Length	+1/8, -1/8"
Difference in Diagonals:	= 1/4" max.

4.2 Camber tolerance for plates is limited to 1/8" maximum deviation from a straight line in any 5 feet. Total camber not to exceed 3/8" along entire long edge.

5.0 PACKAGING AND LOADING - FLATBED TRAILER SHIPMENTS:

5.1 Plates are to be shipped on flatbed trailers for unloading at our shop by 25-ton overhead bridge crane.

5.2 Plates are to be loaded with the eye with wood dunnage between the plates and trailer bed.

5.3 Maximum lift weight is 25,000 lbs.

5.4 Loads are to be tarped.

5.5 If strapping is used, it shall be stainless steel .

6.0 PACKAGING AND LOADING - VAN TRAILER SHIPMENTS:

6.1 Plates shipped by van trailer are to be packaged for full protection from damage by forklift handling. This packaging shall include full length wood skids, and paper wrapping as a minimum.

6.2 If strapping is used, it shall be stainless steel .

7.0 MILL TEST REPORTS:

7.1 Certified mill test reports for all coils in the shipment shall be delivered with the material. A duplicate copy is to be mailed to this office.

8.0 MARKING:

8.1 Each plate is to be marked with the manufacturer's name, grade, and heat number. Each plate is to be marked in the vicinity of the heat number with our Shop Order Number, and the Tate Metalworks ID Number for that line item on the order.

10.0 PACKING LISTS:

A packing list shall accompany each shipment, and should list the following information:

In the header:

Our Purchase Order Number
Our Job Number
Your Mill Order Number
Date Shipped

In the body - for each ID Number:

ID Number
Heat Number
Number of plates
Thickness x Width x Weight
Specification and Grade

TATE METALWORKS, INC.

TERMS FOR PURCHASE

1. CONTRACT: This Purchase Order constitutes an offer by Buyer to purchase the goods and services specified upon the terms and conditions and at the price(s) and with the delivery date(s) stated herein and is not an acceptance of any offer by Seller to sell. Seller shall indicate its acceptance of this offer by verbal acceptance, by written acceptance on the face hereof or other written confirmation, by commencing work on the Purchase Order in any manner, or by delivering the goods or performing the services. This Purchase Order, together with the documents attached hereto or incorporated herein by reference, shall constitute the entire agreement of the parties and may not be modified except by a written change order issued by Buyer. No terms, stated by Seller in its proposal or in accepting or acknowledging this Purchase Order shall be binding; and Seller is hereby notified of Buyers objection to and rejection of any additional or different terms in Sellers quotation, acknowledgment, invoice or other forms. Buyers Purchase Order is expressly limited to acceptance upon the terms and conditions contained herein. If this Purchase Order is construed as an acceptance of an offer, this acceptance is expressly conditioned upon the offerer's assent to any different or additional terms contained on the front or reverse side hereof. If this Purchase Order is construed as a confirmation of an existing contract, the parties agree that this confirmation states the exclusive terms of any contract between the parties. Regardless of its construction, this Purchase Order incorporates by reference all terms of the Uniform Commercial Code providing any protection to Buyer, including, but not limited to, all warranty protection (express or implied) and all of Buyer's remedies under the UCC.

2. WARRANTY: Seller warrants title to goods sold hereunder to be free and clear of all liens and/or encumbrances and that all goods and services shall be of merchantable quality, free from defects in material, design and workmanship, shall conform to specifications, samples, drawings and plans, if any, shall be performed in a sound, professional and competent manner, and shall be fit for the particular purposes intended.

3. INDEMNITY: Seller agrees to defend, indemnify, and save harmless Buyer from any loss, cost, damage, claim or expense, including reasonable attorneys fees, or any nature including, but not limited to, any claim of death or injury to persons or damage to property, arising out of, or related in any way, directly or indirectly to, the goods and services supplied hereunder, including, without limitation, defects in design, materials, workmanship or manufacture, regardless of whose actions, omissions, or negligence may have caused the incident, except where such loss, cost, damage, claim or expense results from the sole negligence of Buyer.

4. INFRINGEMENT: Seller warrants that the use or sale of the goods and services shall not infringe any United States= patent claims, trademarks or other intellectual property rights. Seller shall indemnify and hold harmless, Buyer for all expenses, including attorneys fees, claims and liabilities arising out of a breach of the warranty.

5. REJECTION: Buyer shall have a reasonable opportunity to inspect goods and reject them if they fail to conform to the requirements of this Purchase Order. If goods are rejected, Buyer, at its option and a the expense and risk of Seller, may return rejected goods to Seller or store them until Seller provides instructions for disposal. Payment for goods without reasonable opportunity to inspect the same shall not constitute acceptance.

6. SHIPMENT: Seller's performance shall be in strict conformance with the delivery and other time provisions specified in this Purchase Order. Time is of the essence. If Seller fails to perform according to the terms of this order within the required time, Buyer may cancel this Purchase Order and purchase the goods and services elsewhere and hold Seller liable for any costs or damages incurred. Seller shall forward notice of shipment of goods to Buyer within twenty-four hours. The original Bill of Lading must accompany the invoice and be mailed in accordance with the instructions on the face of this Purchase Order. Complete packing lists must accompany each shipment. Separate invoices are required for each purchase order and for each shipment when partial deliveries are made.

7. FORCE MAJEURE: No liability shall result from delay in performance, or non-performance, caused by circumstances beyond the reasonable control of the party affected, such as Act of God, fire, flood, war, Government action, accident, labor trouble or shortage, inability to obtain material, equipment or transportation. At Buyer's option quantities so affected may be eliminated from this Purchase Order without liability, but this Purchase Order shall remain otherwise unaffected.

8. CONFIDENTIALITY: All drawings, plans, specifications or other documents, data or information furnished by Buyer to Seller, orally or in writing, shall be treated as confidential by Seller. Seller shall not make any commercial use thereof except in performance of this Purchase Order. Seller shall not disclose same to

anyone before or after performance of this Purchase Order without having obtained the written consent of Buyer. All such drawings, plans, specification or other documents, data or information shall be returned to Buyer upon request.

9. GOVERNMENTAL LAWS: Seller shall comply with the Fair Labor Standards Act. Seller shall not discriminate against any employee or applicant for employment because of age, race, color, creed, national origin or sex. Seller shall comply with all applicable federal, state and local fair employment practices laws, including all provisions of Executive Order 11246 of September 24, 1965, the Rehabilitation Act of 1973, and the Vietnam Era Veterans Readjustments Assistance Act of 1974 and any amendments thereto. Any clause required to be in a document of this type by any applicable law or administrative regulation having the effect of law shall be deemed to be incorporated herein. Seller warrants that the goods and services shall comply with all applicable laws, standards and regulations, whether governmental or industrial, in effect on the date of delivery or known in the industry to become effective after such date.

10. ASSIGNMENT: This Purchase Order shall not be assigned by Seller without Buyer's prior written consent.

11. APPLICABLE LAW: The validity, interpretation and performance of this Purchase Order shall be governed by the laws of the state of South Carolina.

12. CHANGES: Buyer may direct Seller to make changes in the goods or services ordered or in the requirements of the drawings, specifications or instructions. Seller shall promptly review such changes and within five (5) days inform Buyer of any change in Seller's cost of performance or delay in delivery. Upon mutual agreement as to any price or delivery change, Buyer shall issue a written change order. In the event Seller shall fail to comply with this procedure, Seller shall be deemed to have waived all claims for increased cost or extension of time of performance.

13. SUSPENSION OR TERMINATION: Buyer, for its convenience, shall have the right to suspend or terminate Seller's work hereunder, or any part thereof, including delivery, upon notice to Seller. Seller shall promptly comply with Buyer's instructions to minimize the cost to Buyer, In the event of suspension for convenience; Seller shall be entitled to recover only its uncompensated actual direct cost resulting from any suspension. In the event of termination for convenience, Seller shall be entitled to recover only its uncompensated actual direct costs incurred prior to the date of Buyer's termination plus those actual direct costs arising from Buyer's termination, provided that in no event shall the total price paid by the Buyer exceed the price(s) specified in this Purchase Order. Any cost claimed by Seller under this Article shall be subject to the audit and approval of Buyer. Upon termination, the goods shall become the property of Buyer in their then state of completion.

14. WAIVER: Buyer's waiver of any breach by Seller of any of the provisions of this Purchase Order shall not constitute a waiver of any other breach of the same or any other provision. Buyer's rights and remedies under any provision of this Purchase Order shall be in addition to and not in substitution or limitation of any other rights or remedies available to Buyer under applicable law.

15. LOST PROFIT: In no event shall Buyer be responsible for any consequential damages including, but not limited to, Seller's loss of actual or anticipated profits arising out of, or resulting from, this Purchase Order or from the performance, suspension, termination or breach hereof.

16. HEADINGS AND SEVERABILITY: Any headings preceding the several articles hereof are inserted solely for convenience of reference, shall not constitute a part of the Purchase Order and shall not otherwise affect the meanings, content, effect or construction of the Purchase Order. In the event that any provision contained herein is held to be invalid or unlawful, such provision shall be severable from the remaining provisions of this Purchase Order which shall remain in full force and effect.

J:\Purchase Specs\TMI Terms and Condtions.doc

4.0 Tate NDE Reports

Tate METALWORKS, INC.

Quality Control Inspection Record
Visual Examination

255 Happy Lane Roebuck, S.C. 29376 • (864) 576-3540 • www.tatemetalworks.com

Customer Name: Westrock Seminole
Project Location: Jacksonville, Fl
Project Name: Paper Machine Bulk Oil Storage Tank
Equipment Number: 303-150-00914
TMI Job Number: 24-018-01

Type of Surface: ☐ Base Metal ☐ Machined ☒ Weld Metal ☐ Other: ______
Condition of Surface: ☒ Satisfactory Method: ☒ Direct ☐ Remote

TMI Inspection Procedure: VT-2

Qty	*Item*	*Material*	*Accept*	*Comments*	*Technician*	*Date*
	020-1 to 007-1 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	020-1 to 007-1 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-1 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-1 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-1 to 007-2 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-1 to 007-2 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-2 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-2 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-2 to 007-3 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-2 to 007-3 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-3 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-3 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-3 to 007-4 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-3 to 007-4 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-4 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-4 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-4 to 007-5 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-4 to 007-5 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-5 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-5 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-5 to 030-1 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-5 to 030-1 outside	304/304L	✓	Satisfactory	LW	9/9/2024
4	Lifting Lugs	304/304L	✓	Satisfactory	LW	9/12/2024
3	Saddles	304/304L	✓	Satisfactory	LW	9/12/2024

Remarks: ______

Signature: Lonnie Womick Date: 9/12/2024

AWS Lonnie Womick CWI 11120271 QC1 EXP. 12/1/2026

Tate METALWORKS, INC.

Quality Control Inspection Record
Radiography

255 Happy Lane Roebuck, S.C. 29376 • (864) 576-3540 • www.tatemetalworks.com

Customer Name: Westrock Seminole

Project Location: Jacksonville, Fl

Project Name: Paper Machine Bulk Oil Storage Tank

Equipment Number: 303-150-00914

TMI Job Number: 24-018-01

X-Ray Coversheet

				Repair		*Tracer 1*		*Tracer 2*			
X-ray	*Welder*	*Accept*	*Reject*	*Accept*	*Reject*	*Accept*	*Reject*	*Accept*	*Reject*	*Technician*	*Date*
1	#30	✓								Andrew Martin	8/26/2024
2	#30	✓								Andrew Martin	8/26/2024
3	#30	✓								Andrew Martin	8/26/2024
4	#30	✓								Andrew Martin	8/26/2024
5	#3	✓								Andrew Martin	8/26/2024
6	#3	✓								Andrew Martin	8/26/2024

Remarks:

Signature: Lonnie Womick

AWS® Lonnie Womick CWI 11120271 QC1 EXP. 12/1/2026

Date: 8/26/2024

APPLIED TECHNICAL SERVICES

1049 Triad Court, Marietta, Georgia 30062 •(770) 423-1400 Fax (770) 514-3299 • www.atslab.com• FAA#HC4R227M

RADIOGRAPHIC INSPECTION REPORT

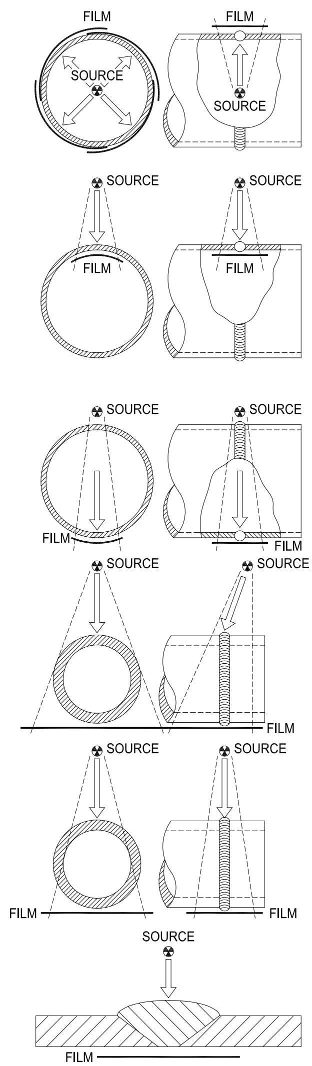
Job # P432040 PO # 24018-00013 WO # N/A Date 8/26/24 Page 1 of 1

CLIENT:	Tate Metal Works	PART NO.:	See Below
LOCATION:	255 Happy Ln	PART NAME:	See Below
	Roebuck, SC 29376	MATERIAL:	S/S
		THICKNESS:	Various
		TYPE WELD:	Full Pen.

RADIOGRAPHIC INSPECTION TECHNIQUE

Specification(s)	ATS 120.1 Rev. 32	Acceptance Criteria	ASME Section VIII Div. 1
Isotope	Ir-192	Film Mfg/Type	FujiFilm 80
Curies	50.4	Film Size	4.5" x 10"
KV	N/A	Sensitivity	ASTM E747 (7 Wire)
MA	N/A	Image Quality Indicator	ATSM B Pack S/S
Time	55 Seconds	Shim(s)	N/A
SFD	19.02"	Develop: Temp:	77 Time: 2.75 Minutes
SOD	18.5"	Screen(s)	Front + Back (0.010)
OFD	0.520"	Films Per Cassette	1
Source Size (Focal)	0.177"	Weld Reinforcement Thickness	Front(0.120")
Geometric Unsharpness	0.004	Welding Process	SAW

SETUP



SEE ATTACHED SKETCH

INTERPRETATION

(Acceptable indications are marked with a √ and rejected indications are marked with an "x".)

PART I.D./ FILM VIEW	Accept	Reject	Crack	Slag Inclusion	Tungsten Inclusion	Porosity	Undercut	Incomplete Fusion	Incomplete Penetration	Root Concavity	Root Convexity	DENSITY Image Quality Indicator IQI	DENSITY Area of Interest	REMARKS
18-1XR1														
View 0-1	√											2.5	2.5	
18-1XR2														
View 0-1	√											2.3	2.3	
18-1XR3														
View 0-1	√											2.6	2.5	Artifact
18-1XR4														
View 0-1	√											2.5	2.5	
18-1XR5														
View 0-1	√											2.4	2.4	
18-1XR6														
View 0-1	√											2.5	2.5	

RADIOGRAPHER(S):	Andrew Martin	Level II R.T.	DATE: 8/26/2024
INTERPRETER:	Andrew Martin *Andrew Martin*	Level II R.T.	DATE: 8/26/2024
CLIENT APPROVAL:			

Tate METALWORKS, INC.

Quality Control Inspection Record
Hydro Test

255 Happy Lane Roebuck, S.C. 29376 • (864) 576-3540 • www.tatemetalworks.com

Customer Name: Westrock Seminole

Project Location: Jacksonville, Fl

Project Name: Paper Machine Bulk Oil Storage Tank

Equipment Number: 303-150-00914

TMI Job Number: 24-018-01

Item	*Time of Completion*	*Gauge Reading*	*Date*	*Signature*
Vessel completely filled with water	2:30pm	n/a	9-12-24	L. Womack
Vessel verified to be leak free	3:30pm	n/a	9-12-24	L. Womack

Remarks:

Signature: Lonnie Womack Date: 9-12-24

Witness: [illegible] Date: 9-12-24

TATE METALWORKS INC.

(NAME OF MANUFACTURER)

32.78 PSI (kPa) AT 150 °F (°C)

MAX. ALLOWABLE WORKING PRESSURE

0 PSI (kPa) AT 150 °F (°C)

MAX. ALLOWABLE EXTERNAL WORKING PRESSURE
(IF SPECIFIED; SEE NOTE (1))

0 °F (°C) AT 32.78 PSI (kPa)

MIN. DESIGN METAL TEMPERATURE

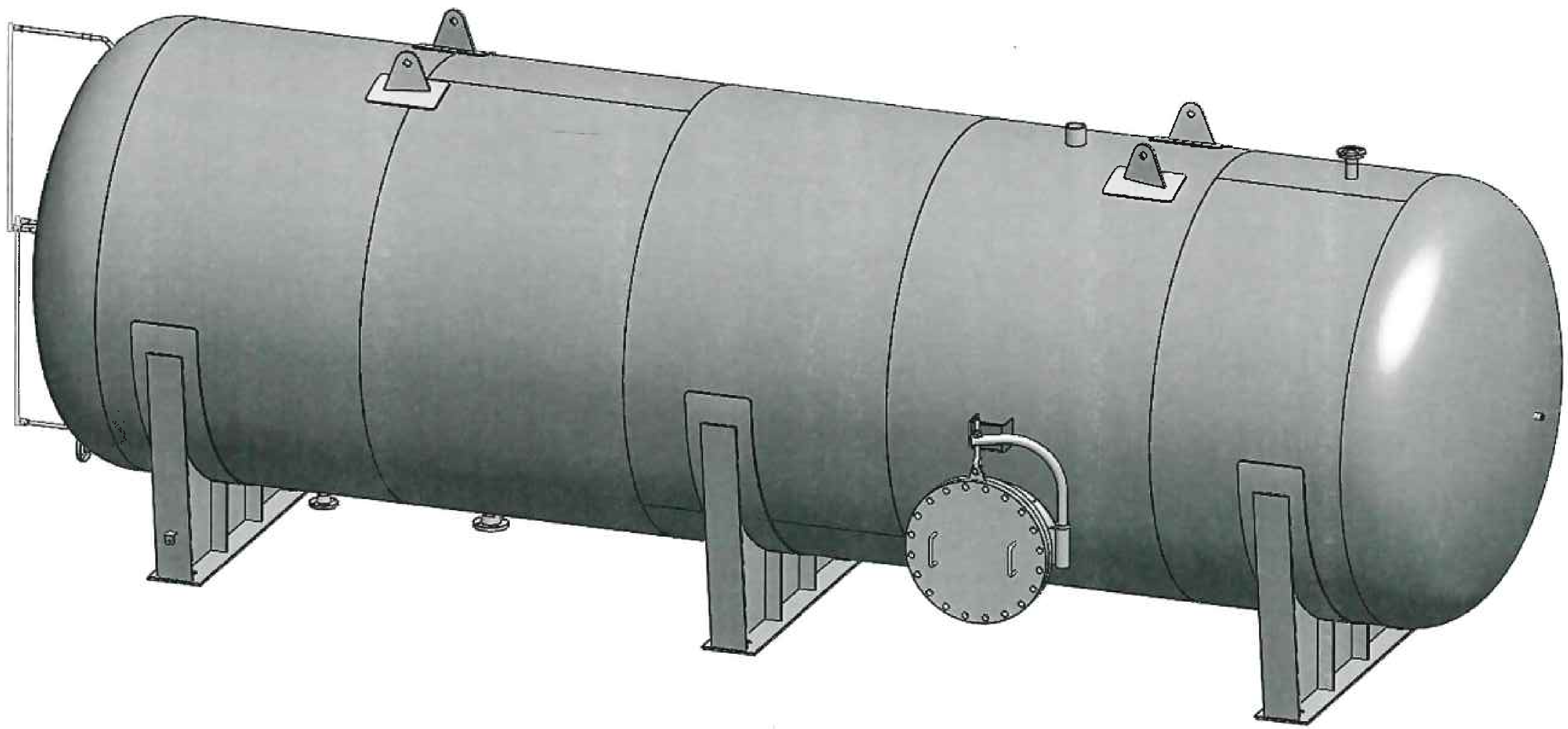
24-018-01

MANUFACTURER'S SERIAL NUMBER

2024

YEAR BUILT

QC
8/26/24



PAPER MACHINE BULK OIL STORAGE TANK ~ 303-150-00914 (2)

ISOMETRIC

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2	08/26/24	DWC	REVISED NOZZLE N5 TO 3" COUPLING. ADDED NOZZLES N11 & N12. ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate

METALWORKS, INC.

8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK

WESTROCK SEMINOLE ~ JACKSONVILLE, FL

TANK MODEL

SCALE 1:28

24-018-01-MOD-2

24-018-01-MOD

CKS

DRAWING SCHEDULE

TATE DWG. NO.	DESCRIPTION
24-018-01-000	SPECIFICATIONS, NOTES, & DRAWINGS
24-018-01-001	GENERAL ARRANGEMENT
24-018-01-002	ORIENTATION
24-018-01-003	NOZZLE SCHEDULE
24-018-01-004	NOZZLE STANDARD DETAILS
24-018-01-005	CROSS SECTION & JOINT DETAILS
24-018-01-007	SHELL WELD MAP
24-018-01-008	SHELL PLATE DETAILS
24-018-01-020	HEAD DETAILS
24-018-01-030	HEAD DETAILS
24-018-01-040	SHELL MANWAY DETAILS
24-018-01-041	SHELL MANWAY DETAILS
24-018-01-045	NOZZLE DETAILS
24-018-01-060	MISCELLANEOUS DETAILS
24-018-01-061	MISCELLANEOUS DETAILS
24-018-01-065	SADDLE DETAILS
24-018-01-066	SADDLE DETAILS
24-018-01-067	SADDLE DETAILS
24-018-01-070	FOUNDATION LOAD DETAILS
24-018-01-080	HYDROSTATIC TEST DETAILS
24-018-01-081	HYDROSTATIC TEST DETAILS
24-018-01-082	HYDROSTATIC TEST DETAILS
24-018-01-083	HYDROSTATIC TEST DETAILS
24-018-01-090	SHIPPING ENVELOPE

DESIGN NOTES:

CONSTRUCTION SHALL BE IN ACCORDANCE WITH: ASME SECTION VIII, DIV. 1 ~ NON-STAMPED

EQUIPMENT NO. 303-150-00914 MANUFACTURER SERIAL NO. 24-018-01

DESIGN CONDITIONS: 0 INTERNAL/ 0 EXTERNAL P.S.I.G. @ 150° F

MINIMUM DESIGN METAL TEMPERATURE (MDMT): 0 ° F @ 0 INTERNAL/ 0 EXTERNAL P.S.I.G.

CORROSION ALLOWANCE: 1/8" SHELL & HEADS SPECIFIC GRAVITY: 0.9

HYDRO-TEST CONDITIONS: SEE SHEET 080

INSPECTION BY: TATE & CUSTOMER SYMBOL APPLIED: NONE

EST. WEIGHT EMPTY: 13,906 LBS

TANK/VESSEL TO BE THOROUGHLY CLEANED OF ALL FOREIGN MATTER, INCLUDING DIRT, WELD FLUX/SPATTER, MILL SCALE, TRASH ETC. AFTER FABRICATION.

MATERIAL NOTES:

SHELL: SA240-304/304L HEADS/ROOF/BOTTOM: SA240-304/304L

SKIRT: N/A BASE RING: N/A

ANCHOR CHAIRS: N/A SUPPORT LEGS: N/A

INSULATION RINGS: N/A STIFFENING RINGS: N/A

TOP ANGLE: N/A REPADS: SA240-304/304L

FORGINGS/COUPLINGS: SA182-F304/304L BACKING FLANGES: N/A

STUB ENDS: N/A PLATE FLANGES: N/A

NOZZLE NECK (PIPE): SA312-TP304/304L SMLS NOZZLE NECK (PLATE): SA240-304/304L

FLANGE BOLTS: SA193-B8/ SA194-GR8 STRUCTURAL BOLTS: N/A

GASKETS: 1/8" THK GARLOCK 3000

GASKETS (HYDROSTATIC TEST): RED RUBBER

PLATFORM: N/A

LADDER/STAIRWAY: N/A HANDRAIL: N/A

OTHER: SADDLE: SA240-304/304L

1. TATE METALWORKS STANDARD WELD PROCEDURES:
   WPS 21: STAINLESS STEEL, SAW
   WPS 22: STAINLESS STEEL, FCAW
   WPS 50: STAINLESS STEEL, GTAW

2. TESTING PROCEDURES:
   A. VISUAL: VISUALLY INSPECT ALL WELDS.
   B. AIR TEST SHELL REPADS: TATE PROCEDURE: APT-001
   C. RADIOGRAPHY: X-RAY PER ASME, SECTION VIII, DIVISION 1
   D. HYDROSTATIC: HYDROSTATIC PRESSURE TEST PER TEST PROCEDURES

3. CLEANING:
   A. ALL WELDS WILL BE MECHANICALLY CLEANED. THE REMOVAL OF HEAT TINT IS INCLUDED
   B. AT THE COMPLETION OF FABRICATION, BUT PRIOR TO THE HYDROTEST, THE INTERIOR AND EXTERIOR OF THE TANK WILL BE PICKLED AND PASSIVATED PER TATE METALWORKS STANDARD STAINLESS STEEL CLEANING METHODS

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

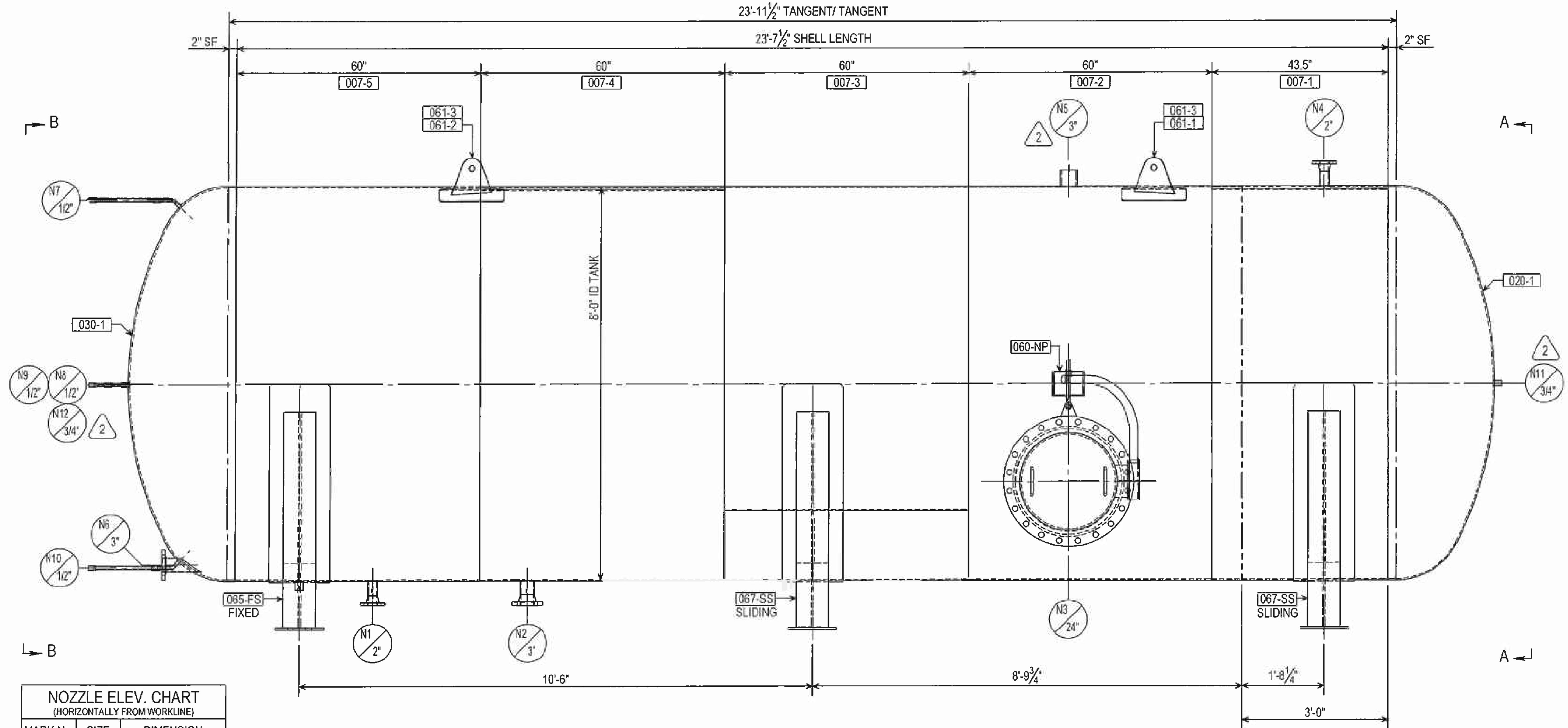
Tate METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE: 8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SPECIFICATIONS, NOTES, & DRAWINGS

SCALE: SCALE 1:4

DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-000-1

FILE NAME: 24-018-01-000
BY: CKS



ELEVATION

(REF DWG -002 FOR TRUE ORIENTATION)

WORKLINE

CENTER PUNCH OUTSIDE ONLY
FOR PERMANENT REFERENCE
ALL DIMENSIONS ARE TO THIS POINT

CERTIFIED CORRECT

NOZZLE ELEV. CHART
(HORIZONTALLY FROM WORKLINE)

	MARK No.	SIZE	DIMENSION
	N1	2"	17'-9 3/4"
	N2	3"	14'-7 3/4"
	N3	24"	3'-6 3/4"
	N4	2"	- 1'-8 1/4"
2	N5	3"	3'-6 3/4"
	N6	3"	HEAD
	N7	1/2"	HEAD
	N8	1/2"	HEAD
	N9	1/2"	HEAD
	N10	1/2"	HEAD
2	N11	3/4"	HEAD
2	N12	3/4"	HEAD

FILE NAME 24-018-01-001
BY CKS

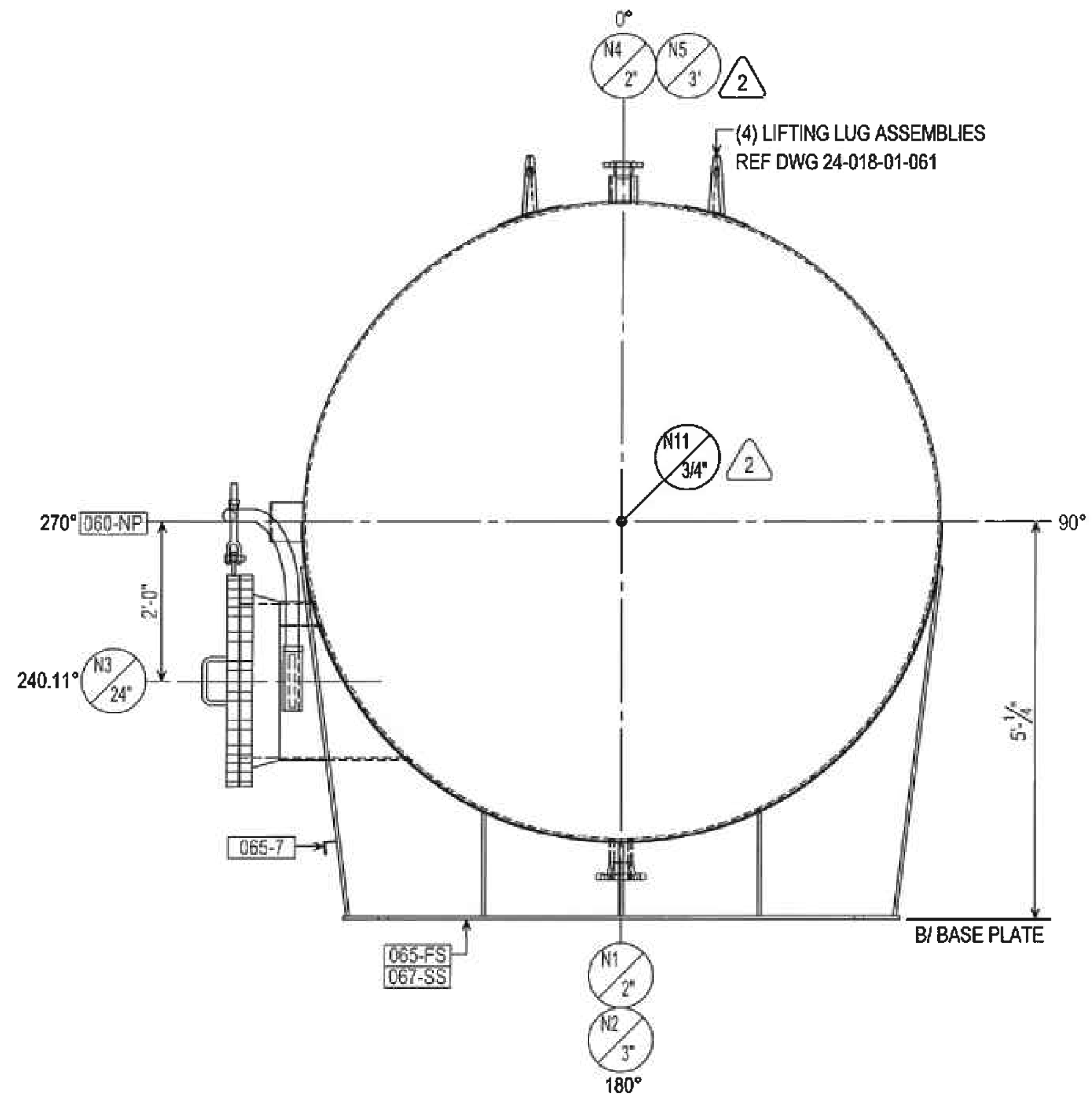
REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD
4					
3					
2	08/26/24	DWC	REVISE NOZZLE N5 TO 3" COUPLING. ADDED NOZZLES N11 & N12 ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

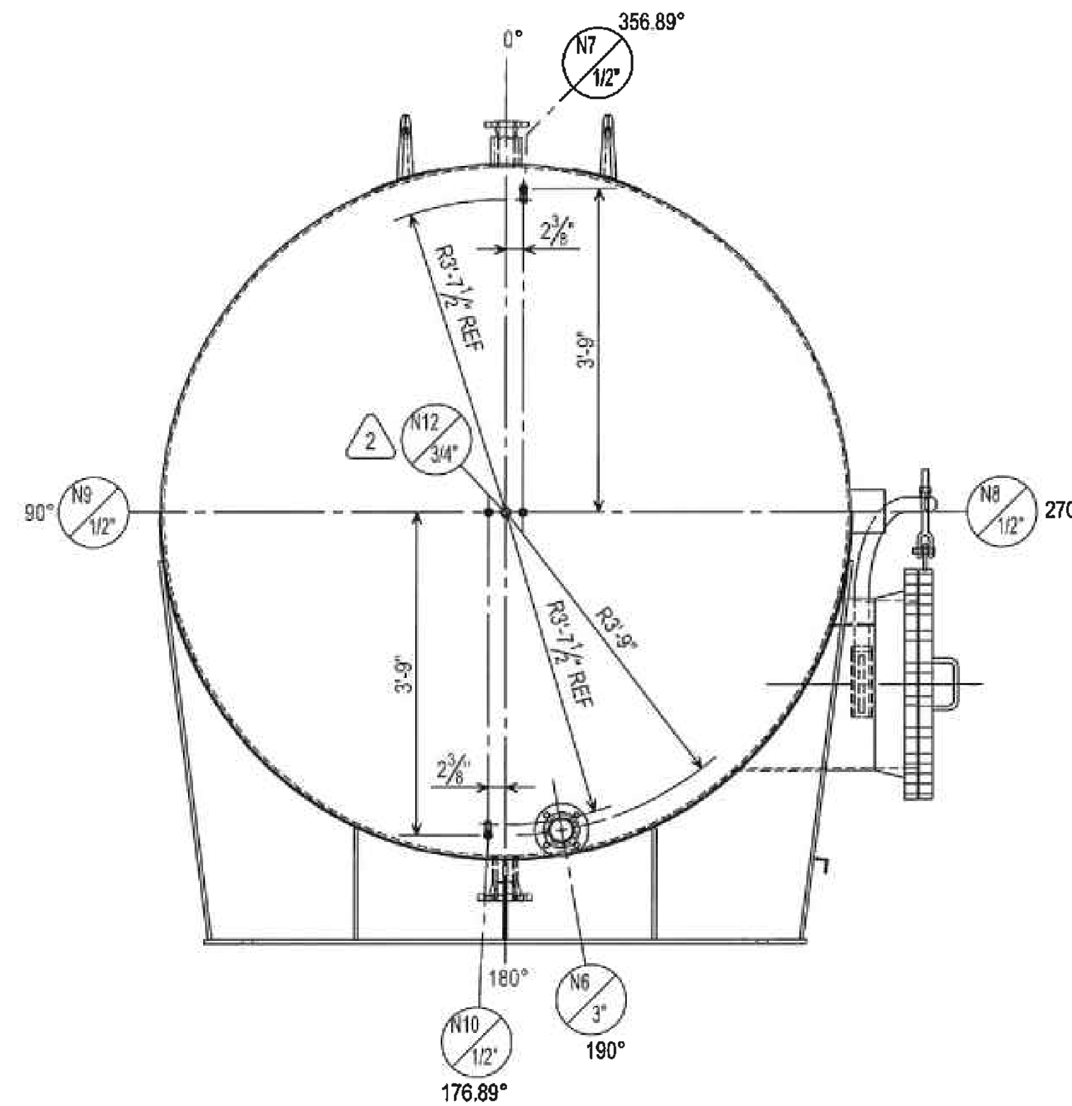
Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
GENERAL ARRANGEMENT

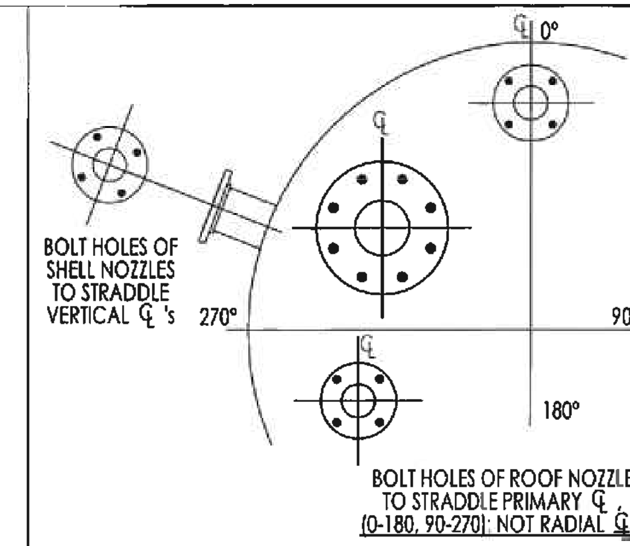
SCALE: SCALE 1:25
DRAWING NUMBER: 24-018-01-001-2 (Job / Ph / Sht / Rev)



SECTION A-A
HEAD NOZZLES NOT SHOWN FOR CLARITY



SECTION B-B



DETAIL FOR 2-HOLEING

MARK	DESCRIPTION	QTY	SHEET
067-SS	SLIDING SADDLE	2	067
065-7	GROUNDING LUG	1	065
065-FS	FIXED SADDLE	1	065
061-3	LIFTING LUG REPAD	4	061
061-2	LIFTING LUG	2	061
061-1	LIFTING LUG	2	061
060-NP	NAMEPLATE ASSEMBLY	1	060

ACCESSORY SCHEDULE

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2	08/26/24	DWC	REVISE NOZZLE N5 TO 3" COUPLING. ADDED NOZZLES N11 & N12. ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
ORIENTATION

SCALE: SCALE 1:26
DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-002-2

FILE NAME 24-018-01-002
BY CKS

NOZZLE AND MANWAY SCHEDULE

MARK	SIZE	NOZ-SE SCH/THICK	NOZ NECK CUT LGTH	FLANGE RATING	FLANGE TYPE	SE TYPE	FLANGE BOLTING	SERVICE	PROJECTION				MATERIAL			WELD DETAIL	WELD DIM & WPS						REPAD			REMARKS
									OS	IS	LG SIDE	SH SIDE	NOZZLE NECK	FLANGE	REPAD		a/WPS	b/WPS	c/WPS	d/WPS	e/WPS	f/WPS	THICK	O.D.	I.D.	
N1	2"	SCH 40S	4 13/16"	150#	RFWN	--	--	DRAIN	6"	FLUSH	--	--	SA312-TP304/304L SMLS	SA182-F304/304L	--	9	3/16:50	--	--	--	--	--	--	--	--	--
N2	3"	SCH 40S	4 5/8"	150#	RFWN	--	--	OUTLET	6"	FLUSH	--	--	SA312-TP304/304L SMLS	SA182-F304/304L	--	9	3/16:22	--	--	--	--	--	--	--	--	--
N3	24"							MANWAY																		REF DWG 24-018-01-040
N4	2"	SCH 40S	4 13/16"	150#	RFWN	--	--	FILL	6"	FLUSH	--	--	SA312-TP304/304L SMLS	SA182-F304/304L	--	9	3/16:50	--	--	--	--	--	--	--	--	--
2 N5	3"	FULL CPLG	--	3000#	THREADED	--	--	VENT	3 7/8"	FLUSH	--	--	--	SA182-F304/304L	--	10	3/16:22	--	--	1/4:22	--	--	--	--	--	--
N6	3"	SCH 40S	12 7/16"	150#	RFSO	--	--	LEVEL TRANSMITTER	--	FLUSH	8 7/8"	4"	SA312-TP304/304L SMLS	SA182-F304/304L	--	9	1/4:22	--	--	--	1/4:22	5/16:22	--	--	--	--
N7	1/2"							VISUAL LEVEL GAUGE																		REF DWG 24-018-01-045
N8	1/2"							VISUAL LEVEL GAUGE																		REF DWG 24-018-01-045
N9	1/2"							VISUAL LEVEL GAUGE																		REF DWG 24-018-01-045
N10	1/2"							VISUAL LEVEL GAUGE																		REF DWG 24-018-01-045
2 N11	3/4"	FULL CPLG	--	3000#	THREADED	--	--	SPIN HOLE PLUG	1 5/8"	FLUSH	--	--	--	SA182-F304/304L	--	10	3/16:50	--	--	1/4:50	--	--	--	--	--	w/ PLUG
2 N12	3/4"	FULL CPLG	--	3000#	THREADED	--	--	SPIN HOLE PLUG	1 5/8"	FLUSH	--	--	--	SA182-F304/304L	--	10	3/16:50	--	--	1/4:50	--	--	--	--	--	w/ PLUG

GENERAL NOTES:
1. ALL NOZZLES TO BE FLUSH WITH THE INSIDE OF THE TANK UNLESS NOTED OTHERWISE.

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2	08/26/24	DWC	REVISED NOZZLE N5 TO 3' COUPLING. ADDED NOZZLES N11 & N12. ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

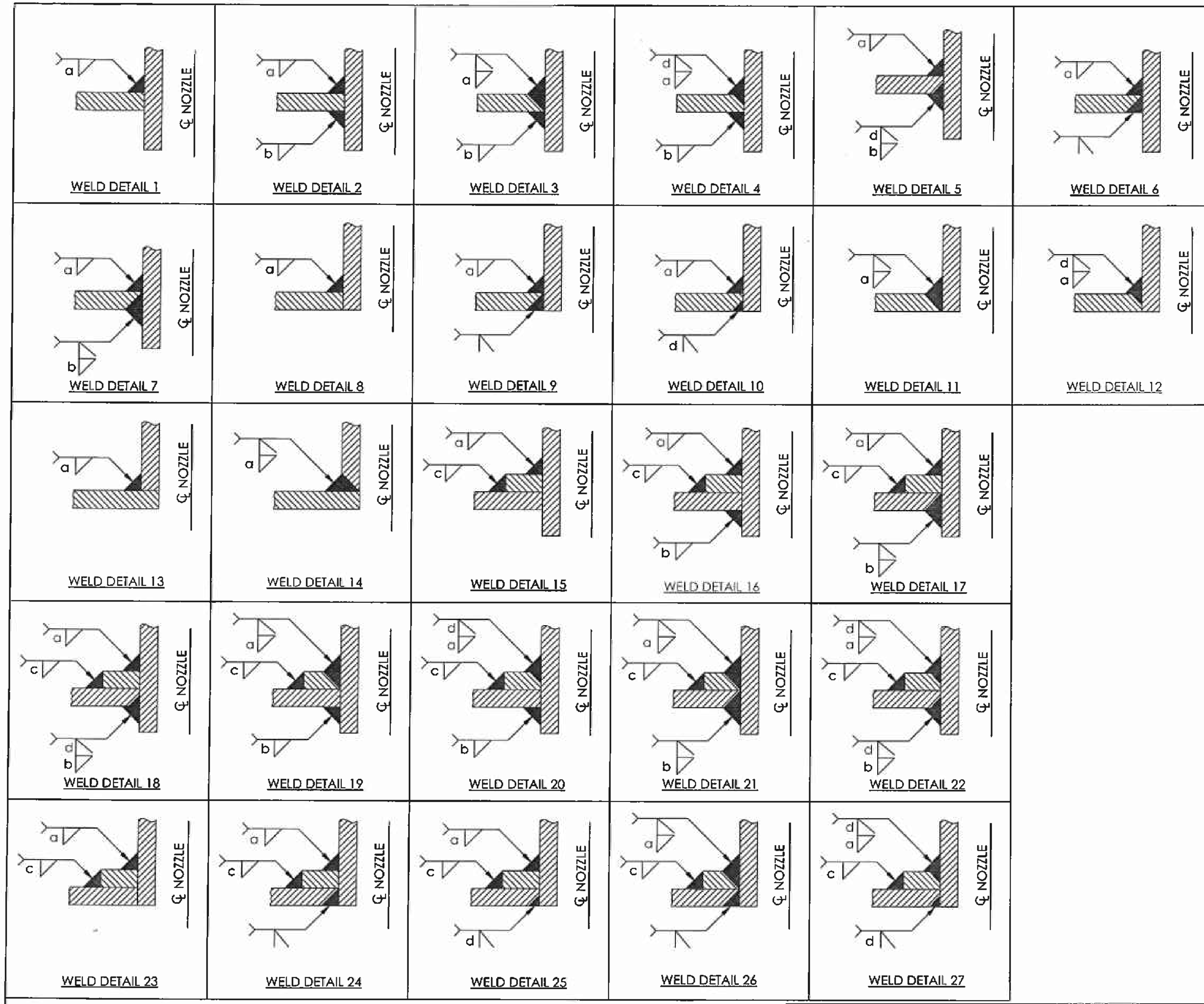
Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
NOZZLE SCHEDULE

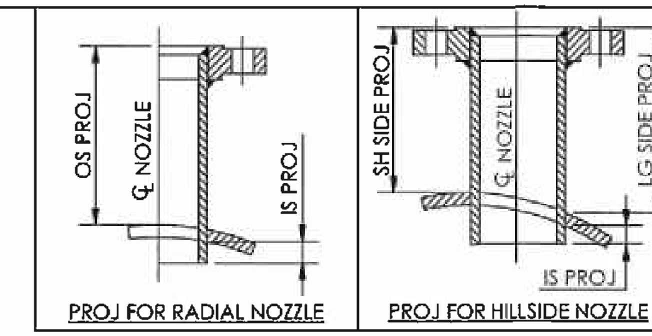
SCALE: SCALE 1:1

DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-003-2

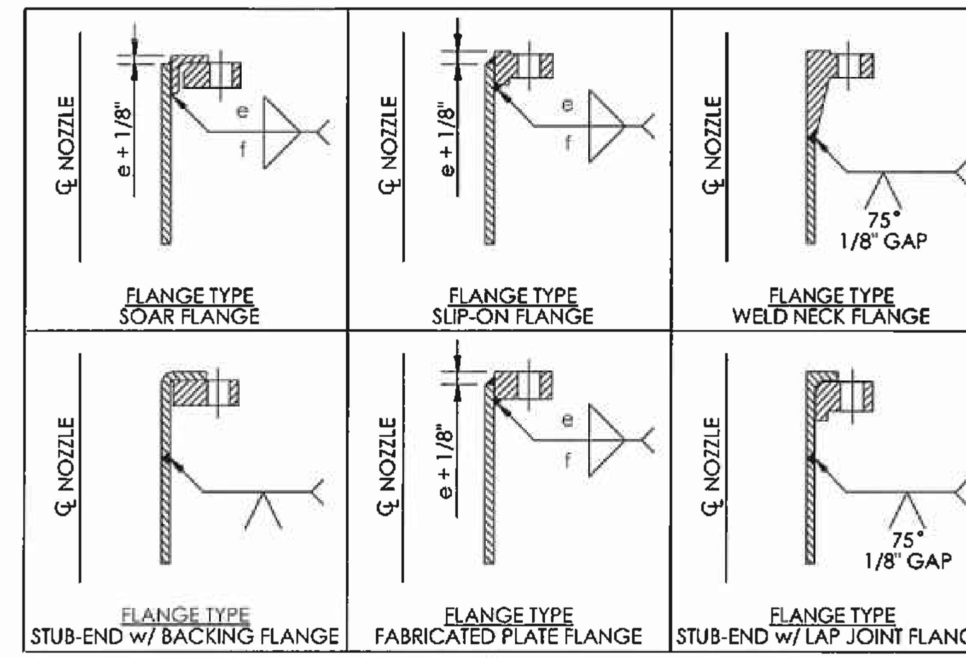
FILE NAME 24-018-01-003
BY CKS



WELD DETAIL



NOZZLE PROJECTION



FLANGE TYPE

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

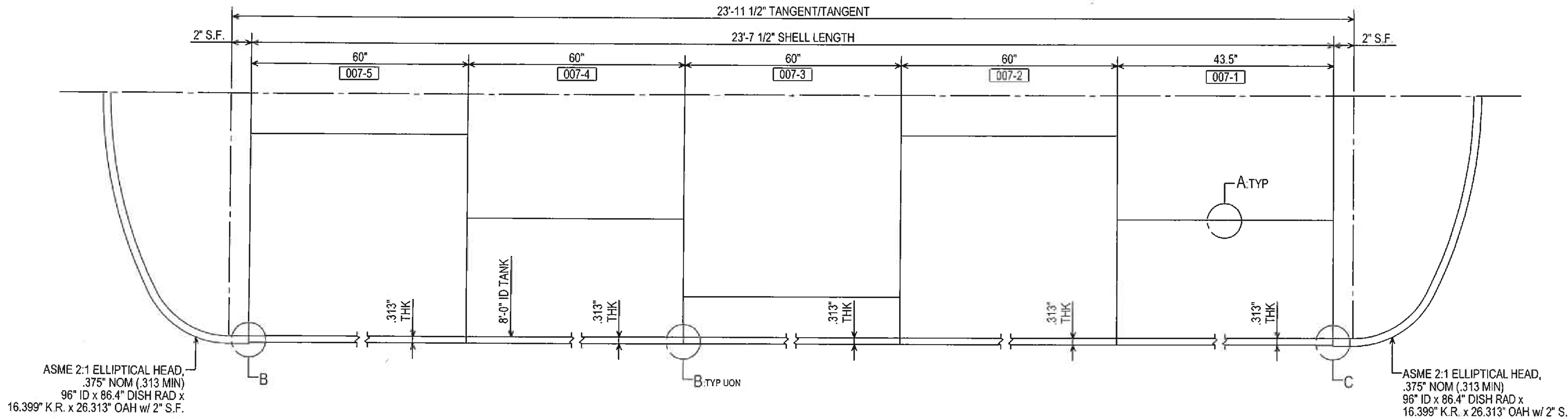
REVISIONS

FILE NAME 24-018-01-004
BY CKS

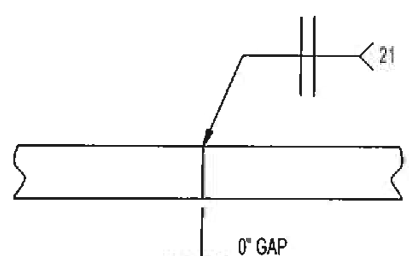
Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
NOZZLE STANDARD DETAILS

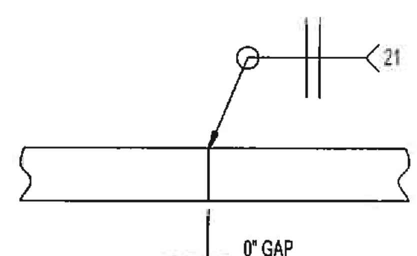
SCALE: SCALE 1:1
DRAWING NUMBER (Job / Ph / Sht / Rev): 24-018-01-004-1



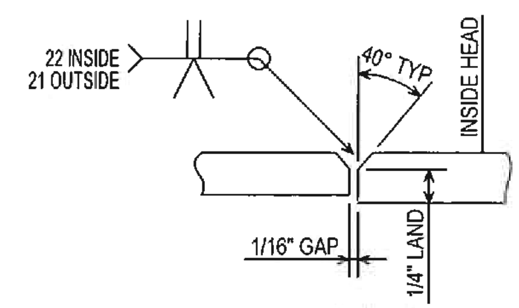
CROSS SECTION



DETAIL A



DETAIL B



DETAIL C

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

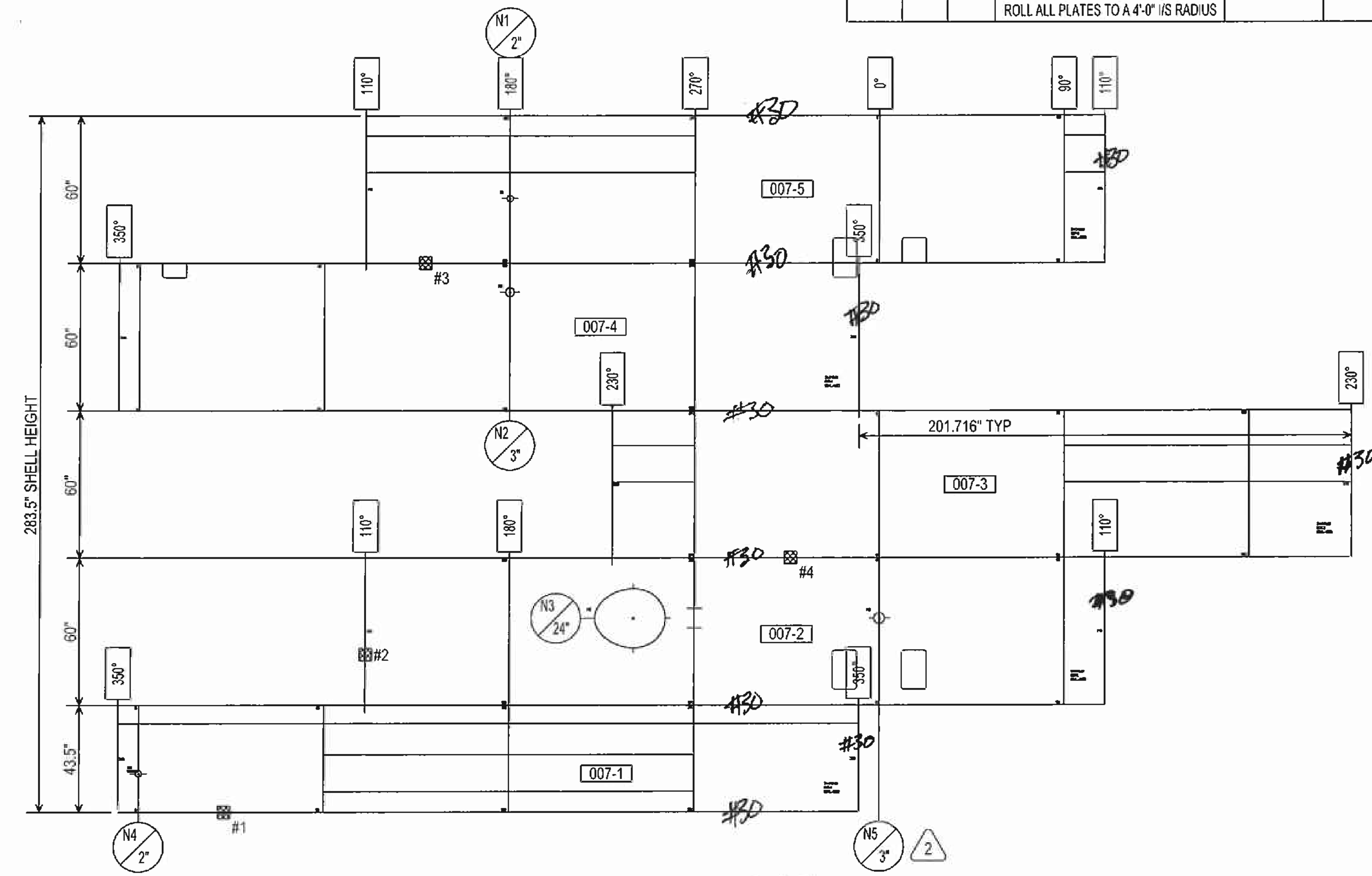
Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
CROSS SECTION & JOINT DETAILS

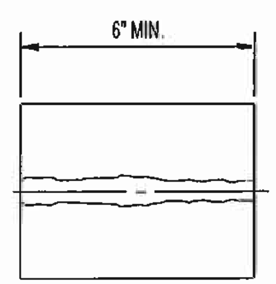
SCALE: SCALE 1:5
DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-005-1

FILE NAME 24-018-01-005
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
			SHELL ASSEMBLY PIECES					
007-1		1	PL, 0.313" x 43.5" x 302.575"		SA240-304/304L	2	1188	REF DWG 24-018-01-008
007-2		1	PL, 0.313" x 60" x 302.575"		SA240-304/304L	3	1589	REF DWG 24-018-01-008
007-3		1	PL, 0.313" x 60" x 302.575"		SA240-304/304L	3	1640	
007-4		1	PL, 0.313" x 60" x 302.575"		SA240-304/304L	3	1639	REF DWG 24-018-01-008
007-5		1	PL, 0.313" x 60" x 302.575"		SA240-304/304L	3	1639	REF DWG 24-018-01-008
			ROLL ALL PLATES TO A 4'-0" I/S RADIUS					



SHELL WELD MAP
VIEW FROM OUTSIDE



FILM DETAIL "A"
(4) REQUIRED

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2	08/26/24	DWC	REVISED NOZZLE N5 TO 3" COUPLING, ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

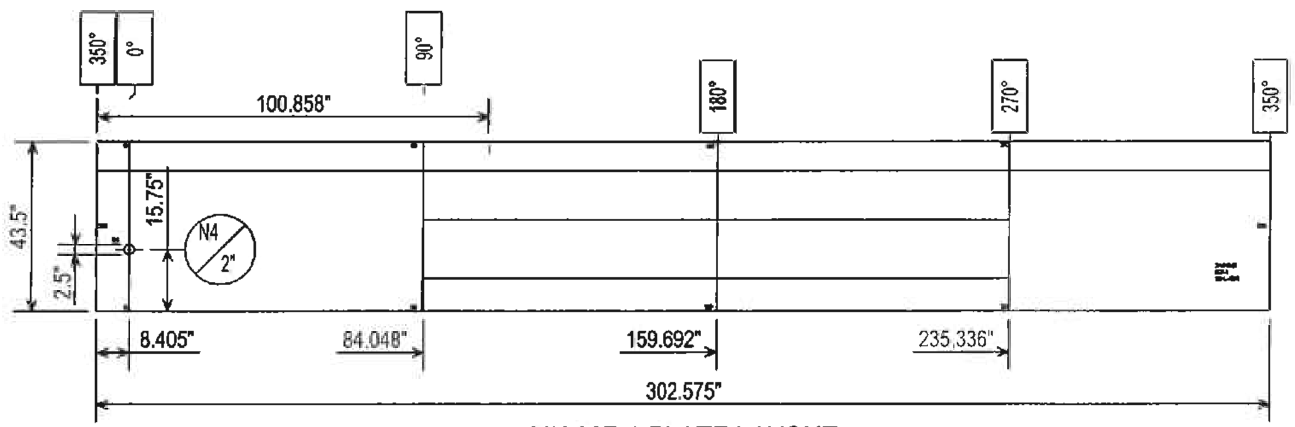
Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SHELL WELD MAP

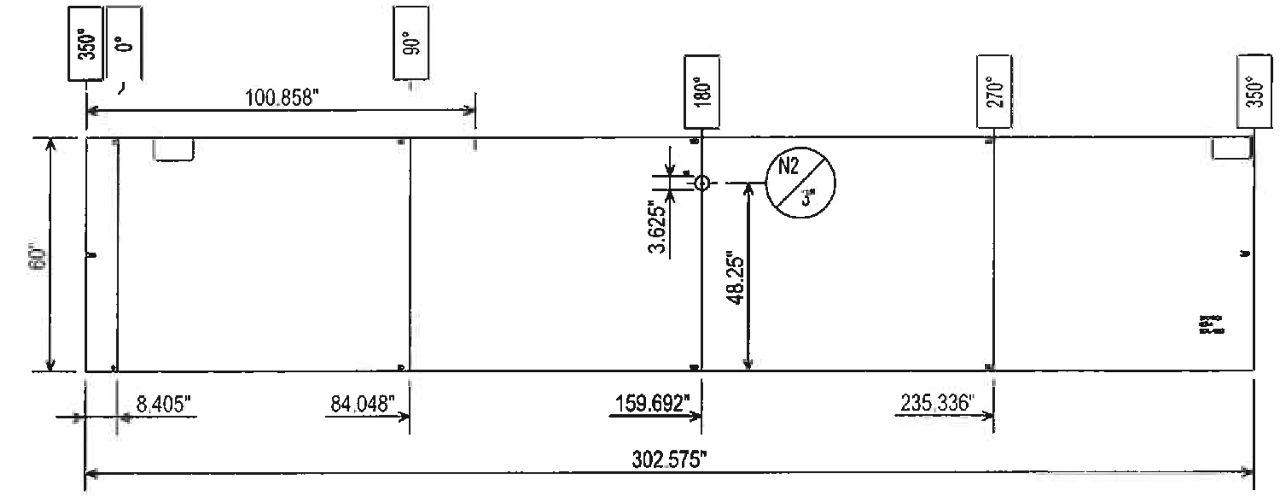
SCALE
SCALE 1:54

DRAWING NUMBER
Job Pc Sht Rev
24-018-01-007-2

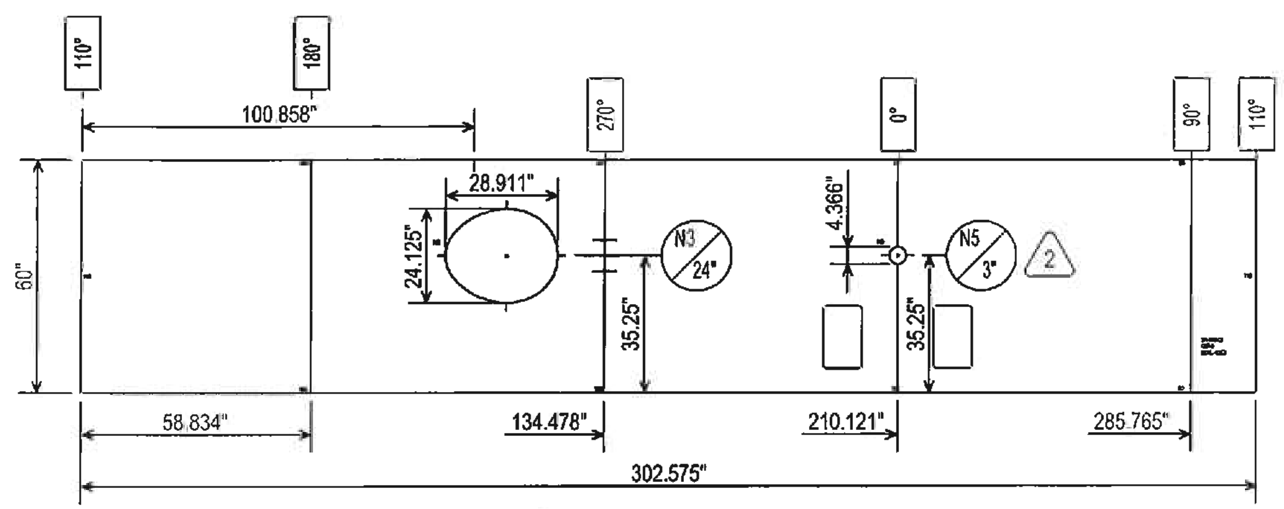
FILE NAME 24-018-01-007
BY CKS



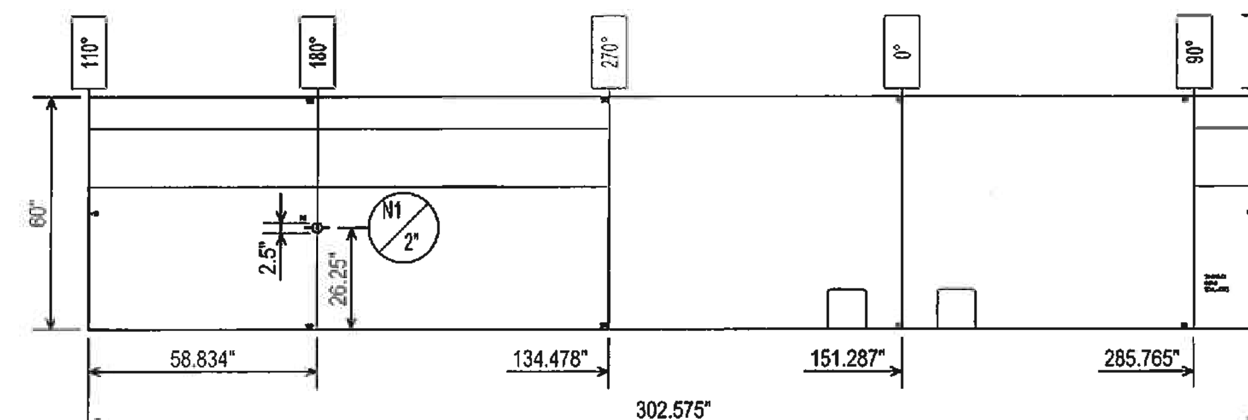
MK 007-1 PLATE LAYOUT
VIEW FROM OUTSIDE



MK 007-4 PLATE LAYOUT
VIEW FROM OUTSIDE



MK 007-2 PLATE LAYOUT
VIEW FROM OUTSIDE



MK 007-5 PLATE LAYOUT
VIEW FROM OUTSIDE

CERTIFIED CORRECT

REV.	DATE	DR BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2	08/26/24	DWC	REVISED NOZZLE N5 TO 3" COUPLING. ISSUED FOR CONSTRUCTION	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

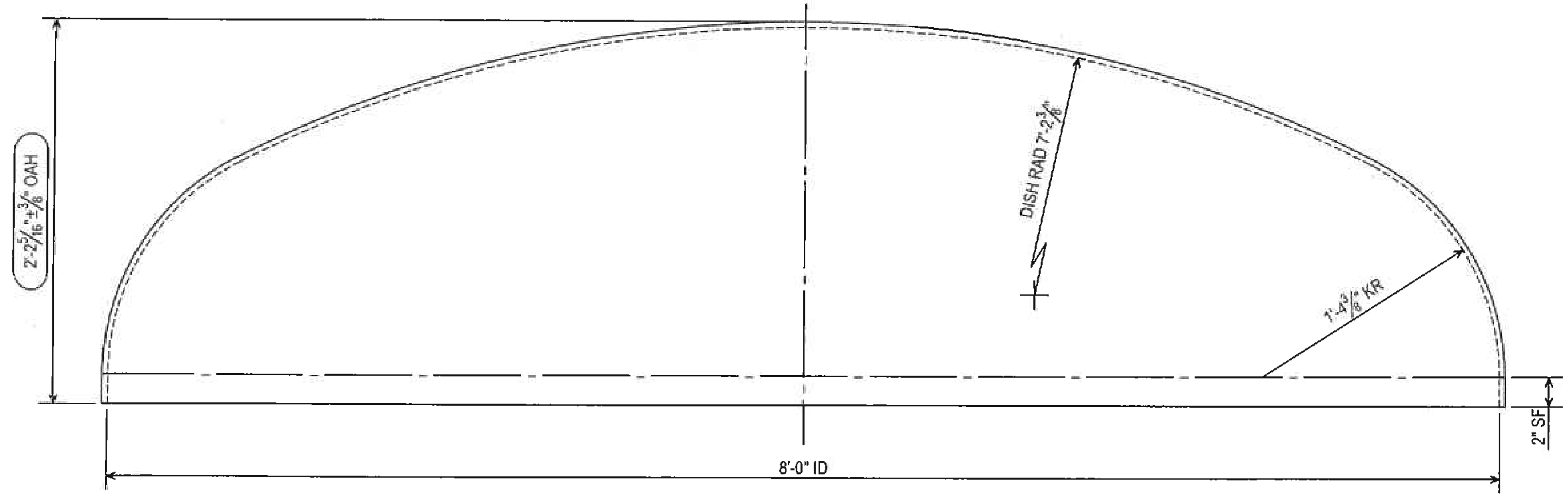
TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SHELL PLATE DETAILS

SCALE
SCALE 1:48

DRAWING NUMBER
Job Ph Sht Rev
24-018-01-008-2

FILE NAME 24-018-01-008
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
			ELLIPSOILDAL HEAD					
020-1		1	HD, .375" NOM THK (.313" MIN), 96" ID x 86.4" DISH RAD x 16.399" KR x 26.313" OAH w/ 2"SF		SA240-304/304L	1	1176	



HEAD ~ 020-1

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

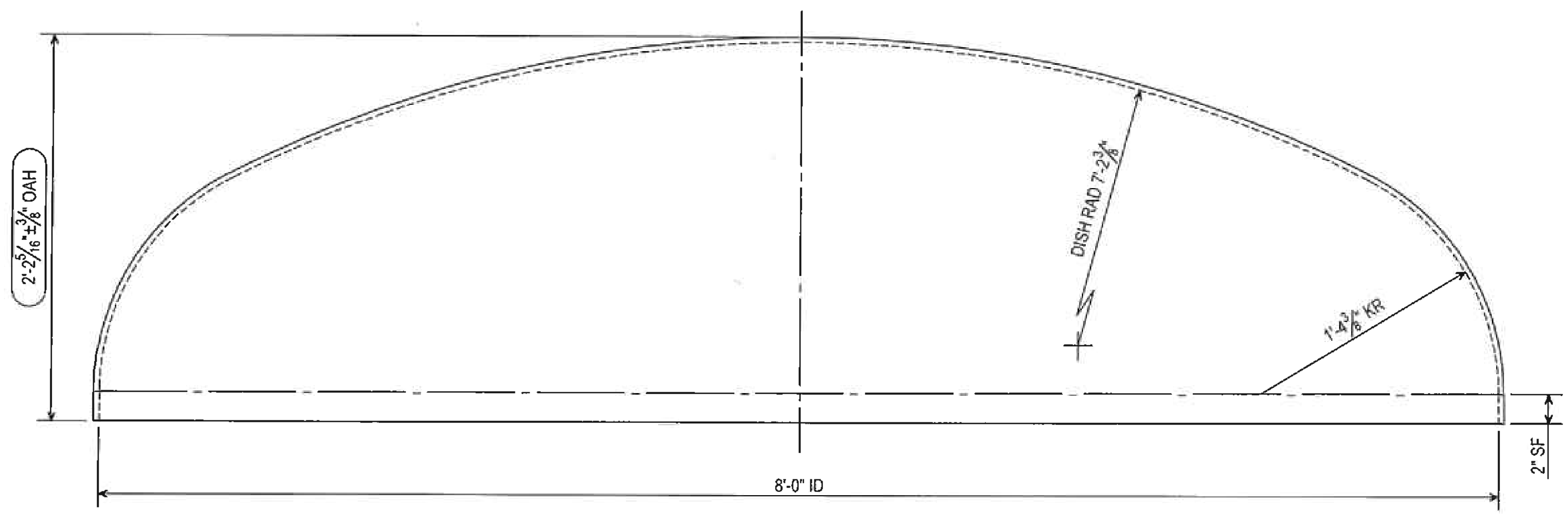
Tate METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HEAD DETAILS

SCALE: SCALE 1:10
DRAWING NUMBER: 24-018-01-020-1

FILE NAME 24-018-01-020
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
			ELLIPSOILDAL HEAD					
030-1		1	HD, .375" NOM THK (.313" MIN), 96" ID x 86.4" DISH RAD x 16.399" KR x 26.313" OAH w/ 2"SF		SA240-304/304L	1	1176	



HEAD ~ 030-1

CERTIFIED CORRECT

REV	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

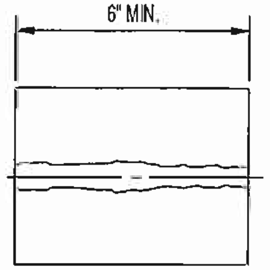
TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HEAD DETAILS

SCALE: SCALE 1:10

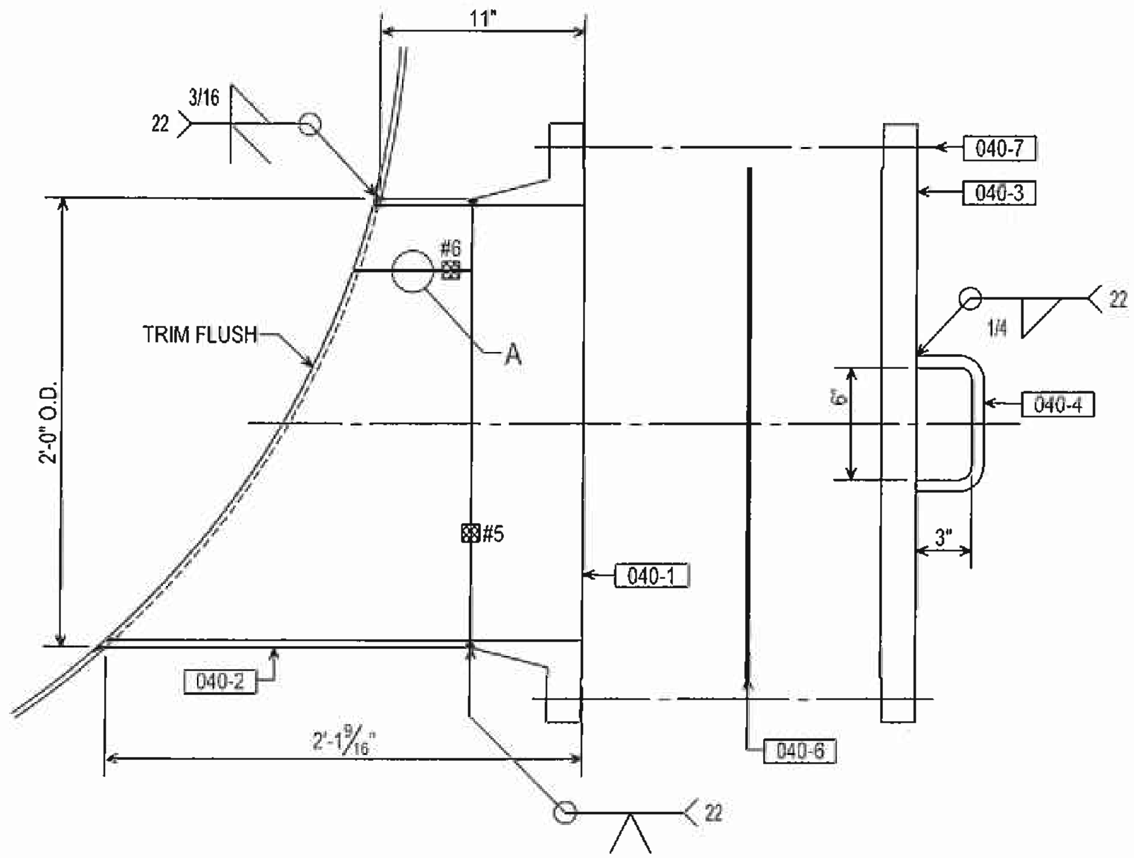
DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-030-1

FILE NAME 24-018-01-030
BY CKS

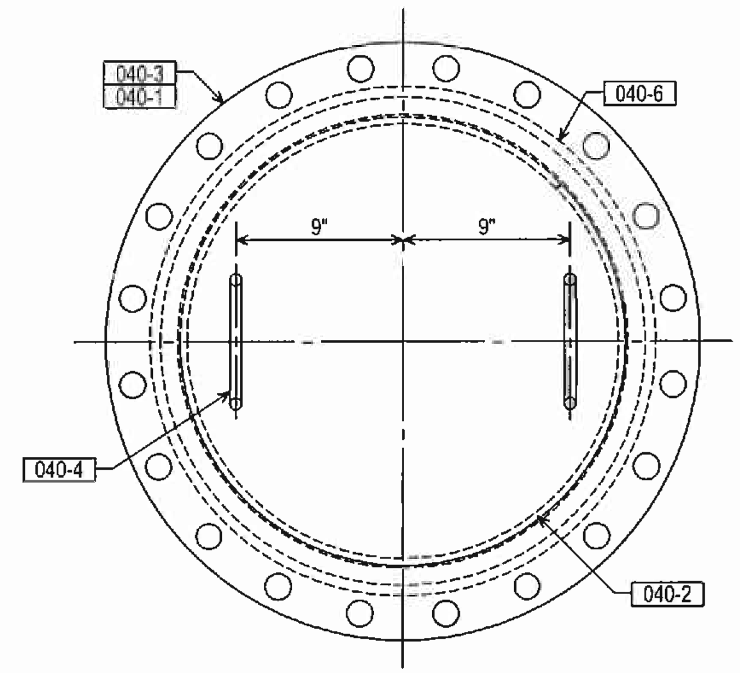
MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
040-N3		**1**	**MANWAY ~ 24"**				**445**	
040-1		1	FL, 24" 150# RF/WN SCH 40S BORE		SA182-F304/304L		269	
040-2		1	PL, .375" x 22.049" x 74.126"		SA240-304/304L		177	ROLL TO A 24" OD, SHOP TRIM
040-3		1	FL, 24" 150# RF BLD		SA182-F304/304L		417	
040-4		2	RB, 5/8" DIA	1'- 3/8"	SA479-304/304L		1	FORM PER DETAIL
040-6		1	G, 1/8" THK 24" 150# RING		GARLOCK 3000		1	
040-7		20	AT, 1 1/4" DIA x 7 1/2" LG. w/ (2) HN		SA193-B8/SA194-GR8		0	



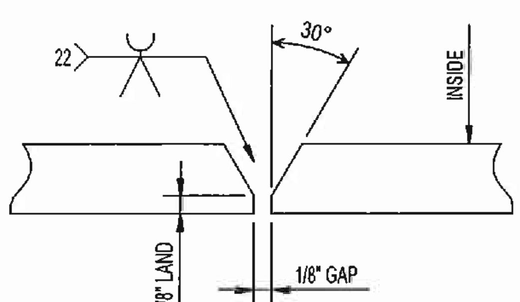
FILM DETAIL "A"
(2) REQUIRED



N3 ~ 24" MANWAY
ELEVATION - SIDE VIEW



N3 ~ 24" MANWAY
ELEVATION - FRONT VIEW



DETAIL A

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

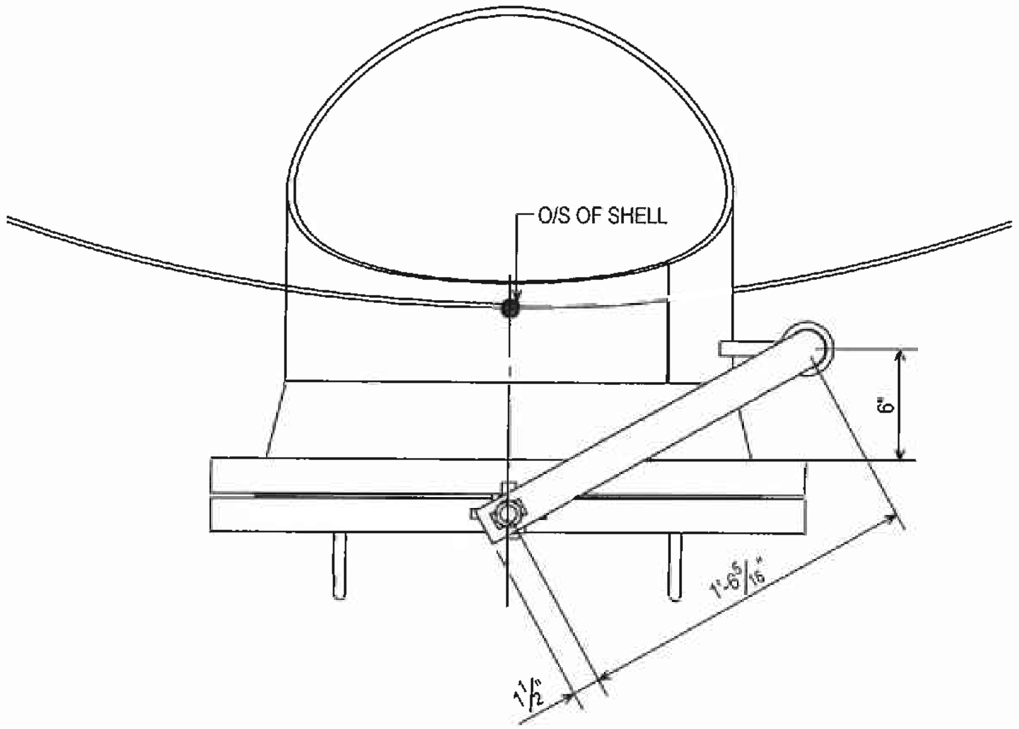
TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SHELL MANWAY DETAILS

SCALE: SCALE 1:10

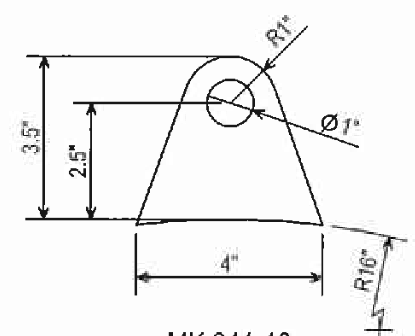
DRAWING NUMBER (Job / Ph / Sht / Rev): 24-018-01-040-1

FILE NAME: 24-018-01-040
BY: CKS

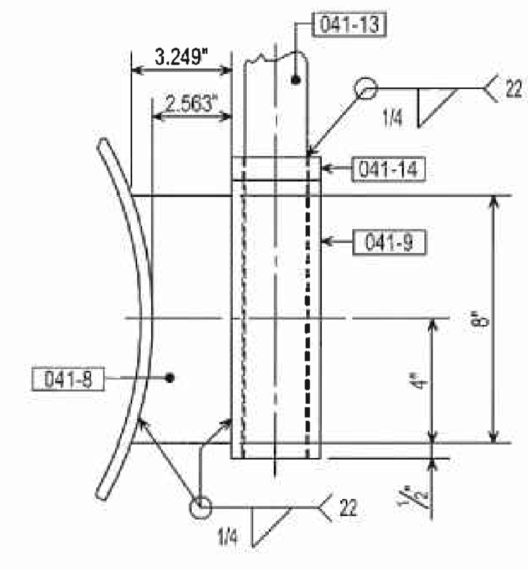
MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
040-N3		1	MANWAY ~ 24"				838	
041-8		1	PL, .75" x PATTERN		SA240-304/304L		5	
041-9		1	PI, 2 1/2" DIA SCH 160	9"	SA312-TP304/304L WLD		8	
041-10		1	PL, .5" x PATTERN		SA240-304/304L		1	
041-11		1	JAW END FITTING, 7/8"-9 x 12" LG., 1 1/8" OPENING WIDTH w/ 3/4" DIA PIN		GALVANIZED		3	McMASTER CARR P/N: 3001T26
041-12		2	HN, 7/8" DIA		SA194-2H HDG		0	
041-13		1	RB, 2" DIA	4'-6"	SA479-304/304L		39	SHOP TRIM
041-14		1	PI, 2 1/2" DIA SCH 160	3/4"	SA312-TP304/304L WLD		1	



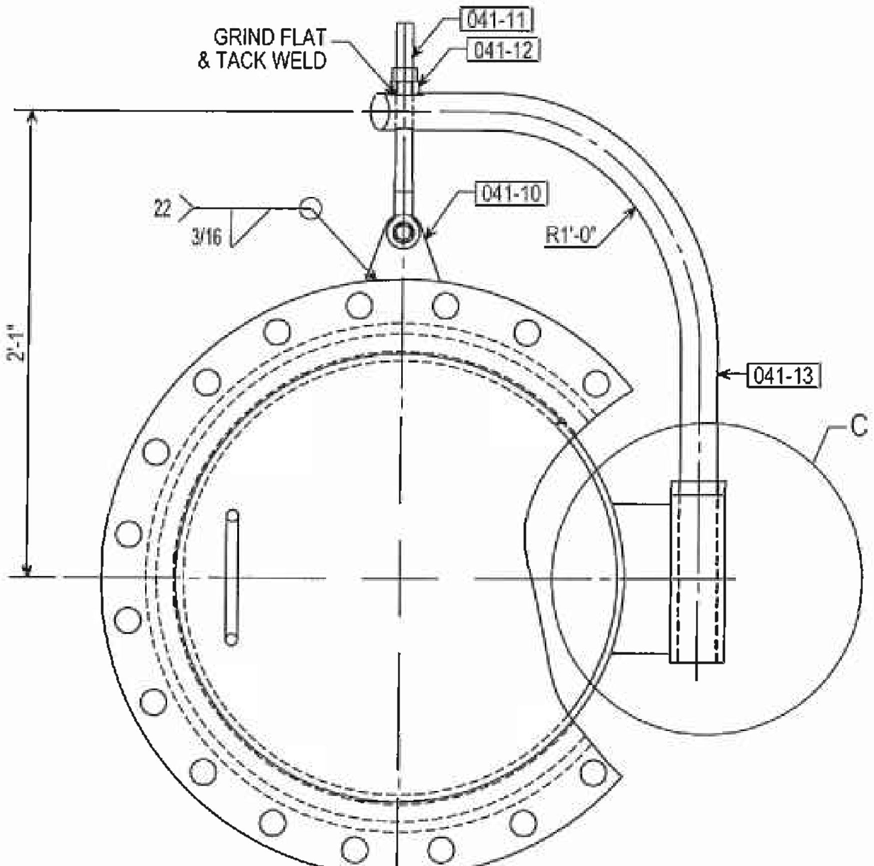
N3 ~ 24" MANWAY DAVIT
PLAN VIEW



MK 041-10
SCALE 1:4



DETAIL C
SCALE 1 : 6



N3 ~ 24" MANWAY DAVIT
ELEVATION - FRONT VIEW

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION.	NJB	DWC

REVISIONS

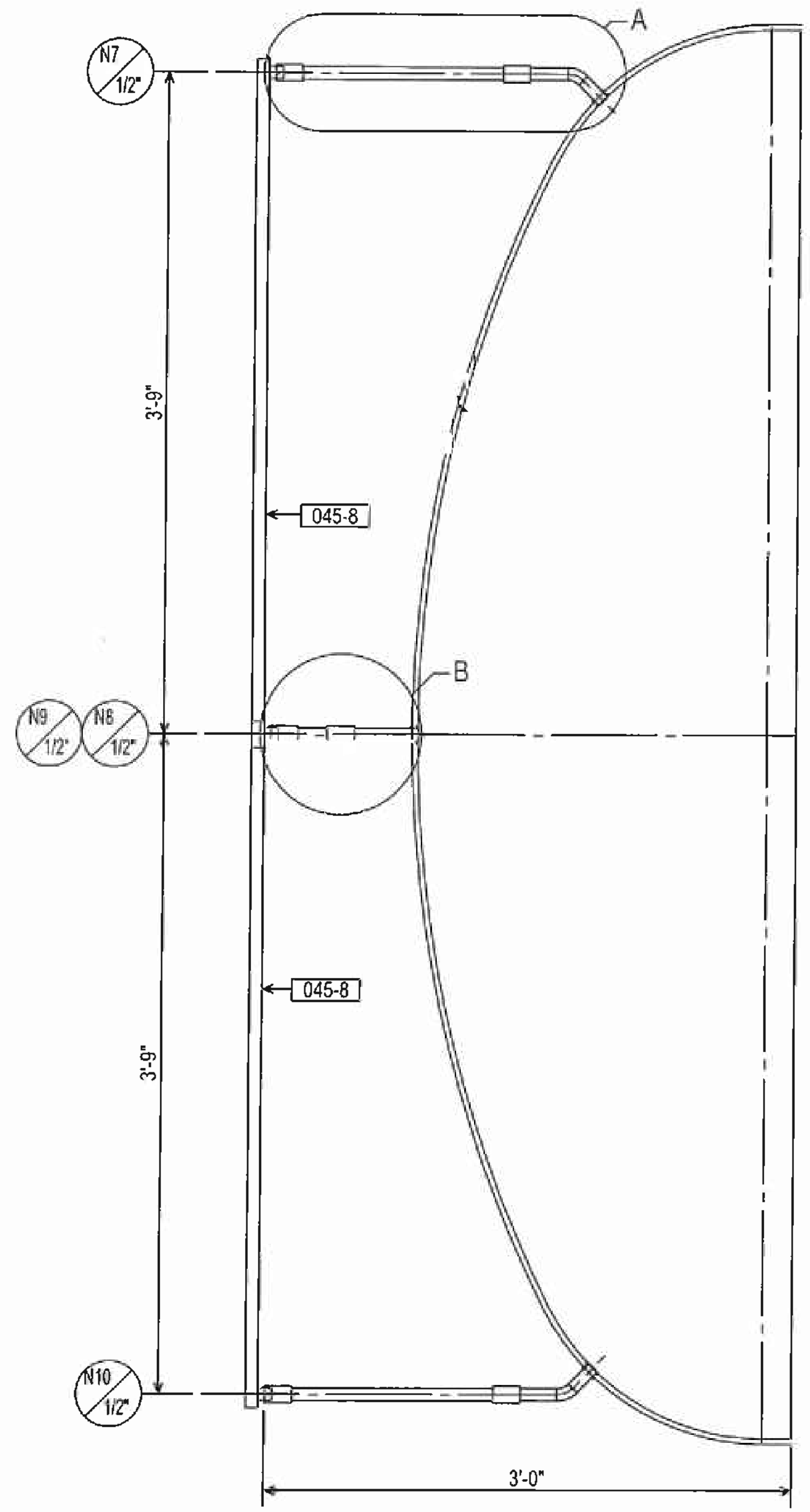
Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SHELL MANWAY DETAILS

SCALE: SCALE 1:10
DRAWING NUMBER: 24-018-01-041-1 (Job / Ph / Sht / Rev)

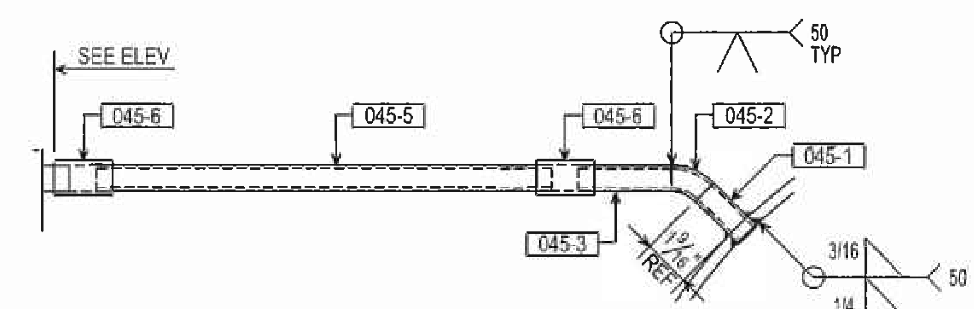
FILE NAME: 24-018-01-041
BY: CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
045-N7		1	**VISUAL LEVEL GAUGE ~ 1/2"**				1	
045-N10		1	**VISUAL LEVEL GAUGE ~ 1/2"**				1	
045-1		2	PI, 1/2" DIA SCH 40S	5"	SA312-TP304/304L SMLS		0	SHOP TRIM
045-2		2	EL, 1/2" DIA SCH 40S 45°		SA403-WP304/304L		0	
045-3		2	PI, 1/2" DIA SCH 40S	3"	SA312-TP304/304L SMLS		0	THREAD ONE END
			N8 & N9 TANK ASSY PIECES					
045-4		2	PI, 1/2" DIA SCH 40S	7 7/16"	SA312-TP304/304L SMLS		1	THREAD ONE END, SHOP TRIM
			LEVEL GAUGE SHIPPING PIECES					
045-5	2		PI, 1/2" DIA SCH 40S	1'-2 3/4"	SA312-TP304/304L SMLS		1	THREAD BOTH ENDS
045-6	8		FC, 1/2" DIA 3000# THREADED		SA182-F304/304L		0	
045-7	2		PI, 1/2" DIA SCH 40S	3"	SA312-TP304/304L SMLS		0	THREAD BOTH ENDS
045-8	2		KENNCO K9900 SERIES LEVEL GAUGE, 1/2" DIA MNPT x 45° CL TO CL		-		0	P/N: K99M50-45-ABH-GS-ATM-150-NS

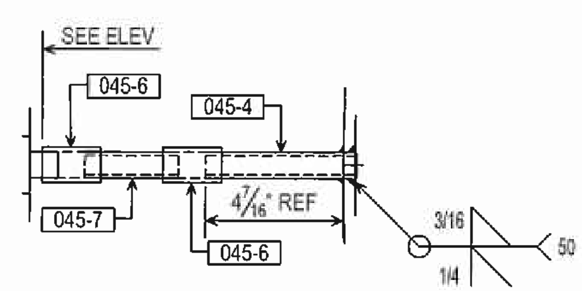


LEVEL GAUGE OVERALL ASSEMBLY

ELEVATION



DETAIL A
SCALE 1:6
SAME FOR N10, BUT MIRRORED



DETAIL B
SCALE 1:6

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION.	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL

NOZZLE DETAILS

SCALE: SCALE 1:12
DRAWING NUMBER: Job Ph Sht Rev 24-018-01-045-1

FILE NAME 24-018-01-045
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
060-NP		1	**NAMEPLATE ASSEMBLY**				6	
060-1		1	PL, .188" x PATTERN		SA240-304/304L	4	6	
060-2		1	TATE ASME STANDARD NAMEPLATE		ALUMINIUM	16	0	

TATE METALWORKS INC.
(NAME OF MANUFACTURER)

32.78 PSI (kPa) AT 150 °F (°C)
MAX. ALLOWABLE WORKING PRESSURE

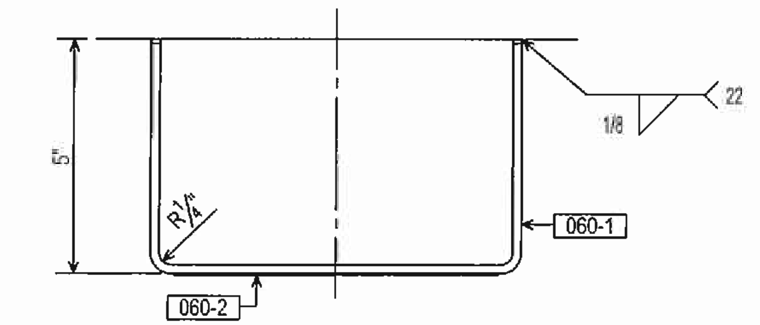
0 PSI (kPa) AT 150 °F (°C)
MAX. ALLOWABLE EXTERNAL WORKING PRESSURE
(IF SPECIFIED; SEE NOTE (1))

0 °F (°C) AT 32.78 PSI (kPa)
MIN. DESIGN METAL TEMPERATURE

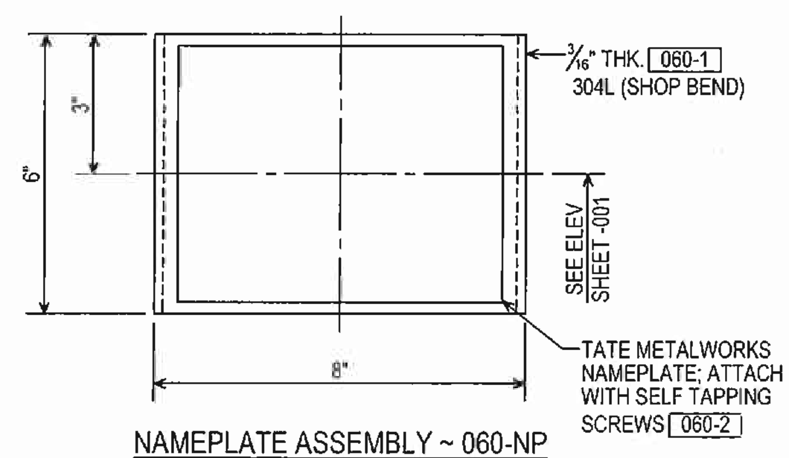
24-018-01
MANUFACTURER'S SERIAL NUMBER

2024
YEAR BUILT

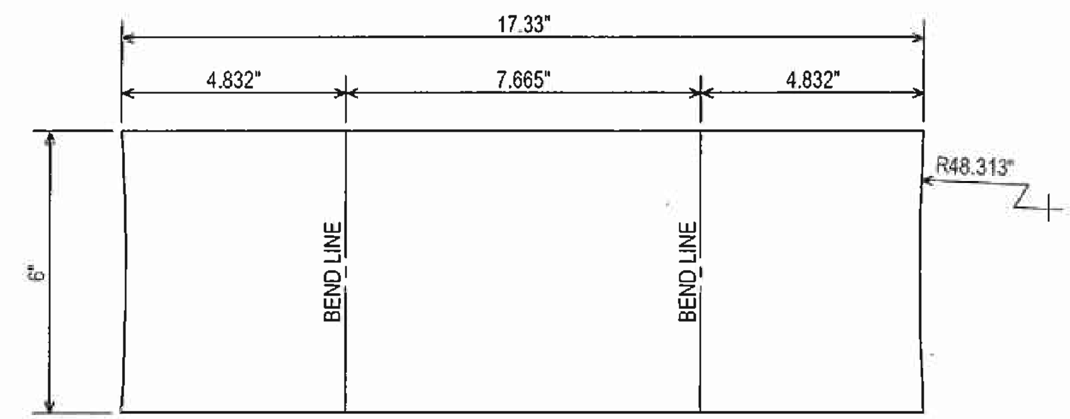
NAME PLATE FACSIMILE



NAMEPLATE ASSEMBLY ~ 060-NP
PLAN VIEW



NAMEPLATE ASSEMBLY ~ 060-NP
ELEVATION ~ FRONT



MK 060-1

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

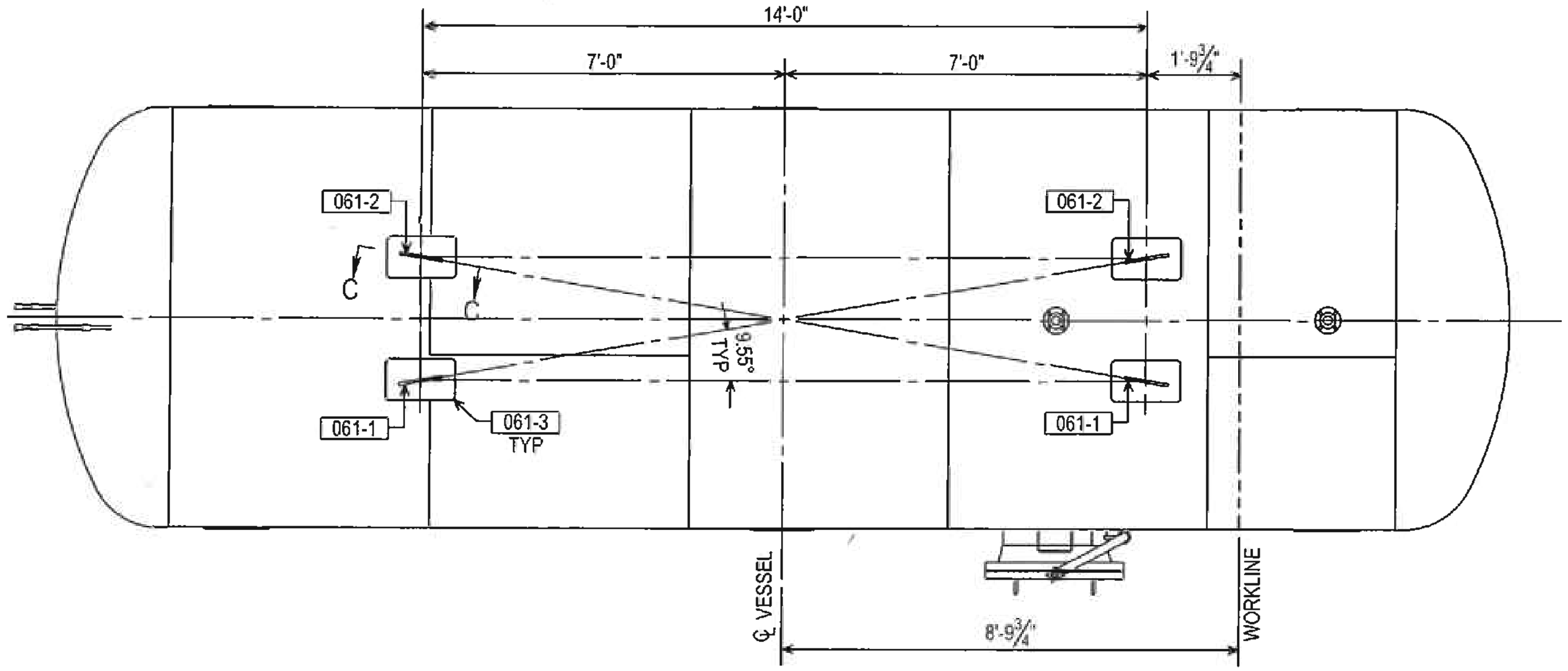
Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
MISCELLANEOUS DETAILS

SCALE: SCALE 1:4
DRAWING NUMBER: 24-018-01-060-1 (Job Ph Sht Rev)

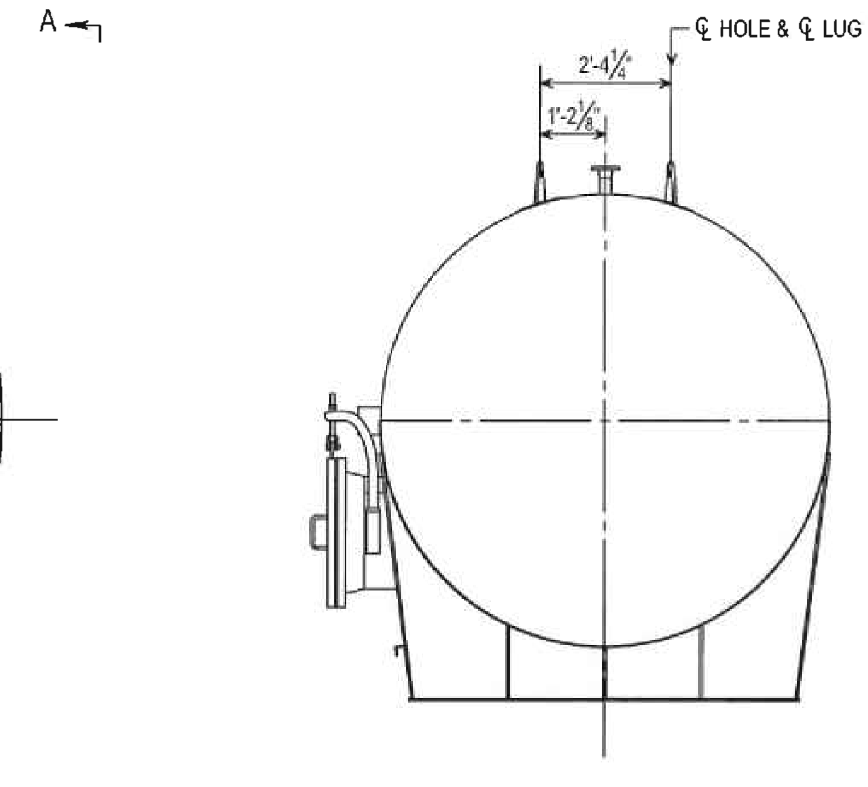
FILE NAME 24-018-01-060
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
			LIFTING LUG ASSEMBLY				**98**	
061-1		2	PL, .625" x PATTERN		SA240-304/304L		10	
061-2		2	PL, .625" x PATTERN		SA240-304/304L		10	
061-3		4	RP, .313" x 10" x 16"		SA240-304/304L		14	RADIUS CORNERS



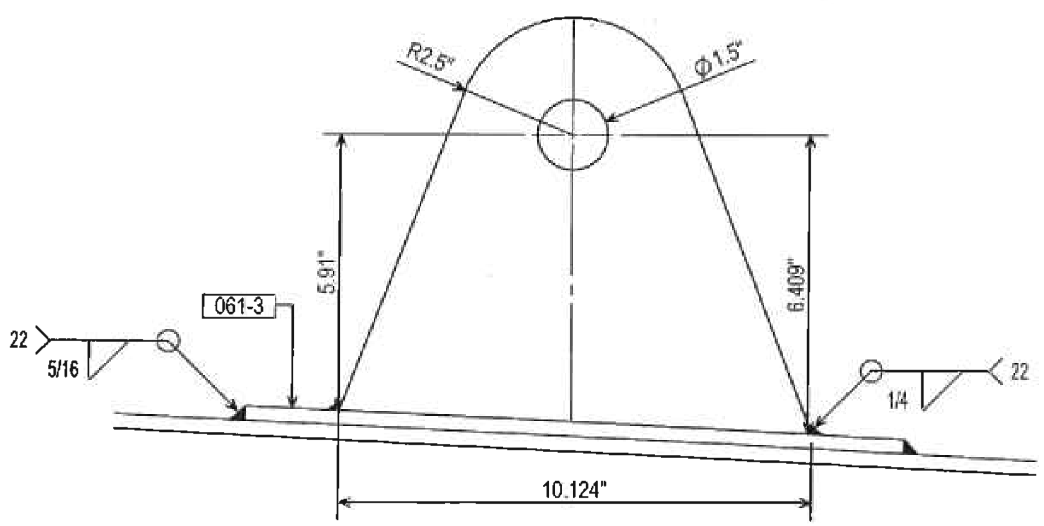
LIFTING LUG OVERALL ASSEMBLY

PLAN VIEW



SECTION A-A

EACH LUG REQUIRES A MINIMUM SHACKLE SIZE OF 4.75 TONS WITH A PIN SIZE OF 0.75 INCHES



MK 061-1 PATTERN

MK 061-2 PATTERN (OPP)

SCALE: 1:4

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

CERTIFIED CORRECT

Tate METALWORKS, INC.

P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE

8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK

WESTROCK SEMINOLE ~ JACKSONVILLE, FL

MISCELLANEOUS DETAILS

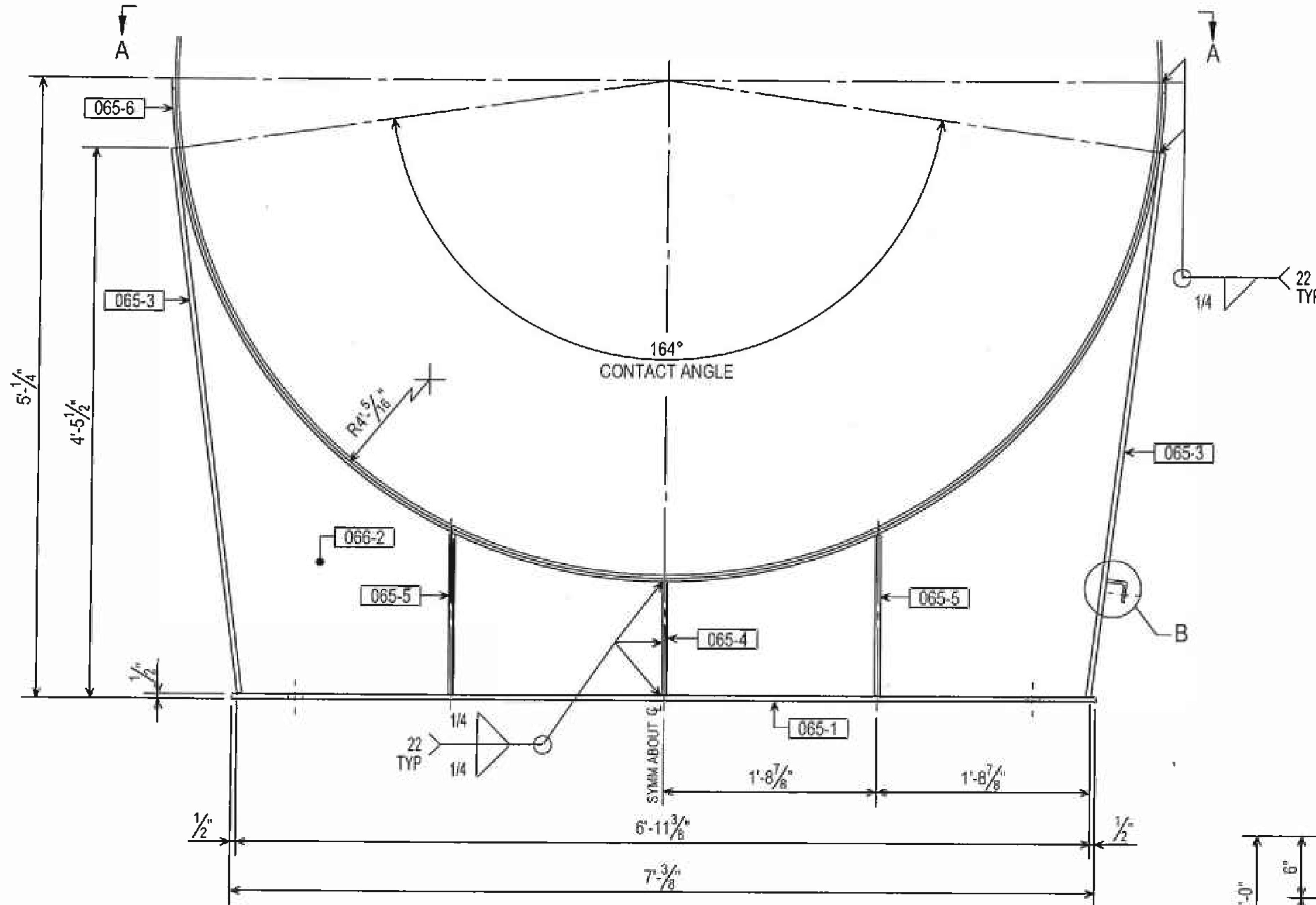
SCALE: SCALE 1:40

DRAWING NUMBER: 24-018-01-061-1

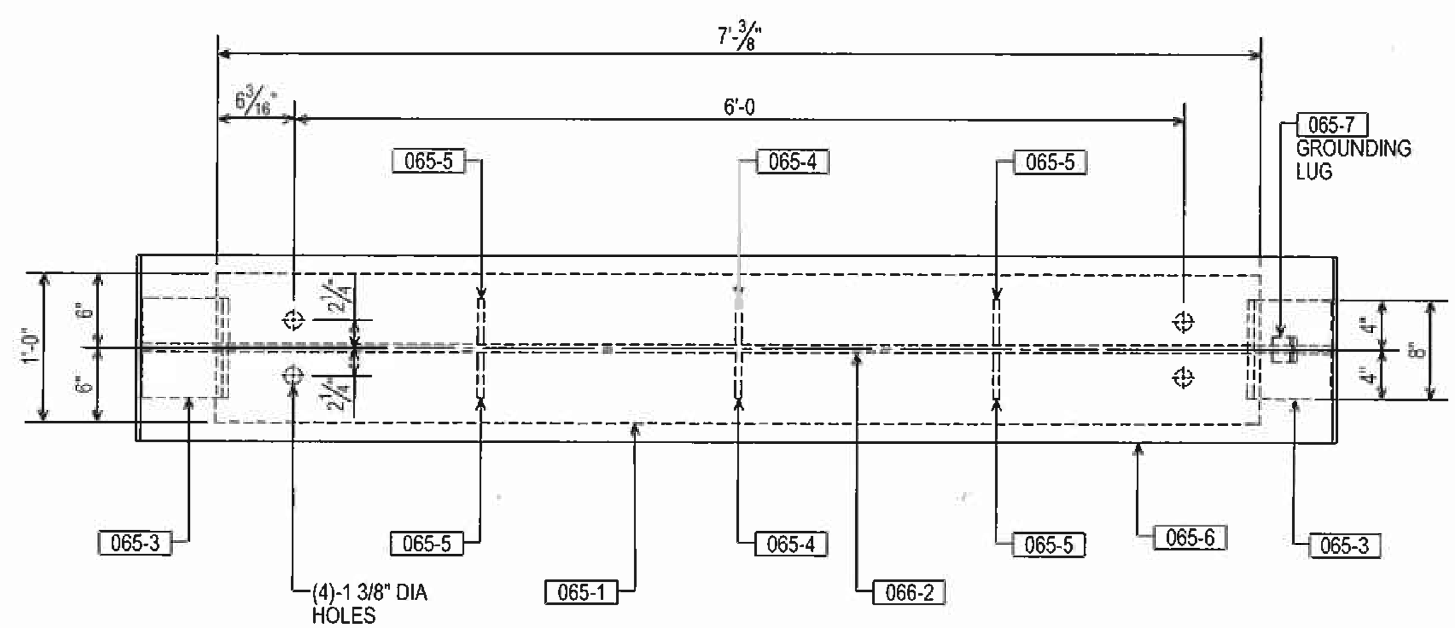
FILE NAME: 24-018-01-061

BY: CKS

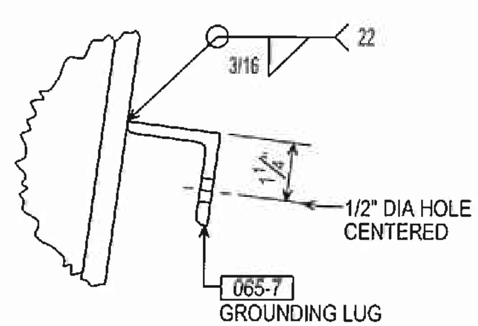
MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
065-FS		1	**FIXED SADDLE ASSEMBLY**				824	
065-1		1	PL, .5" x 12" x 84.4"		SA240-304/304L	6	146	w/ HOLES
066-2		1	PL, .625" x PATTERN		SA240-304/304L	10	303	
065-3		2	PL, .5" x 8" x 53.372"		SA240-304/304L	7	62	
065-4		2	PL, .5" x 3.688" x 11.125"		SA240-304/304L	8	6	
065-5		4	PL, .5" x 3.688" x 15.704"		SA240-304/304L	9	8	
065-6		1	RP, .313" x 15" x 152.269"		SA240-304/304L	5	206	ROLL TO 4'- 5/16" I/S RAD, RADIUS CORNERS
065-7		1	L, 2" x 2" x 1/4"	2"	SA479-304/304L	11	1	w/ HOLE



FIXED SADDLE ASSEMBLY ~ 065-FS
ELEVATION



SECTION A-A



DETAIL B
SCALE 1 : 4

REV	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

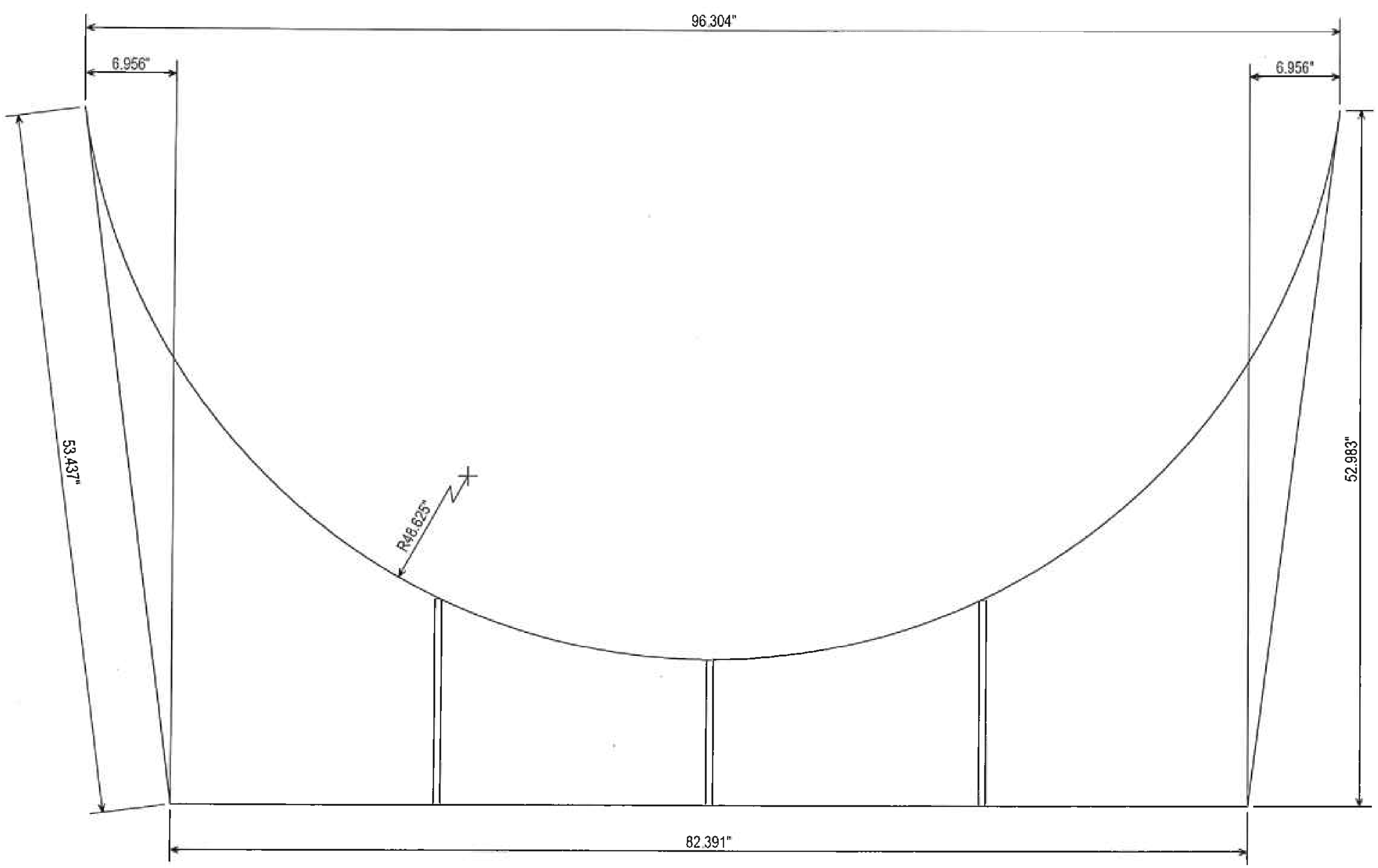
CERTIFIED CORRECT

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SADDLE DETAILS

SCALE: SCALE 1:15
DRAWING NUMBER (Job / Ph / Sht / Rev): 24-018-01-065-1

FILE NAME: 24-018-01-065
BY: CKS



MK 066-2

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

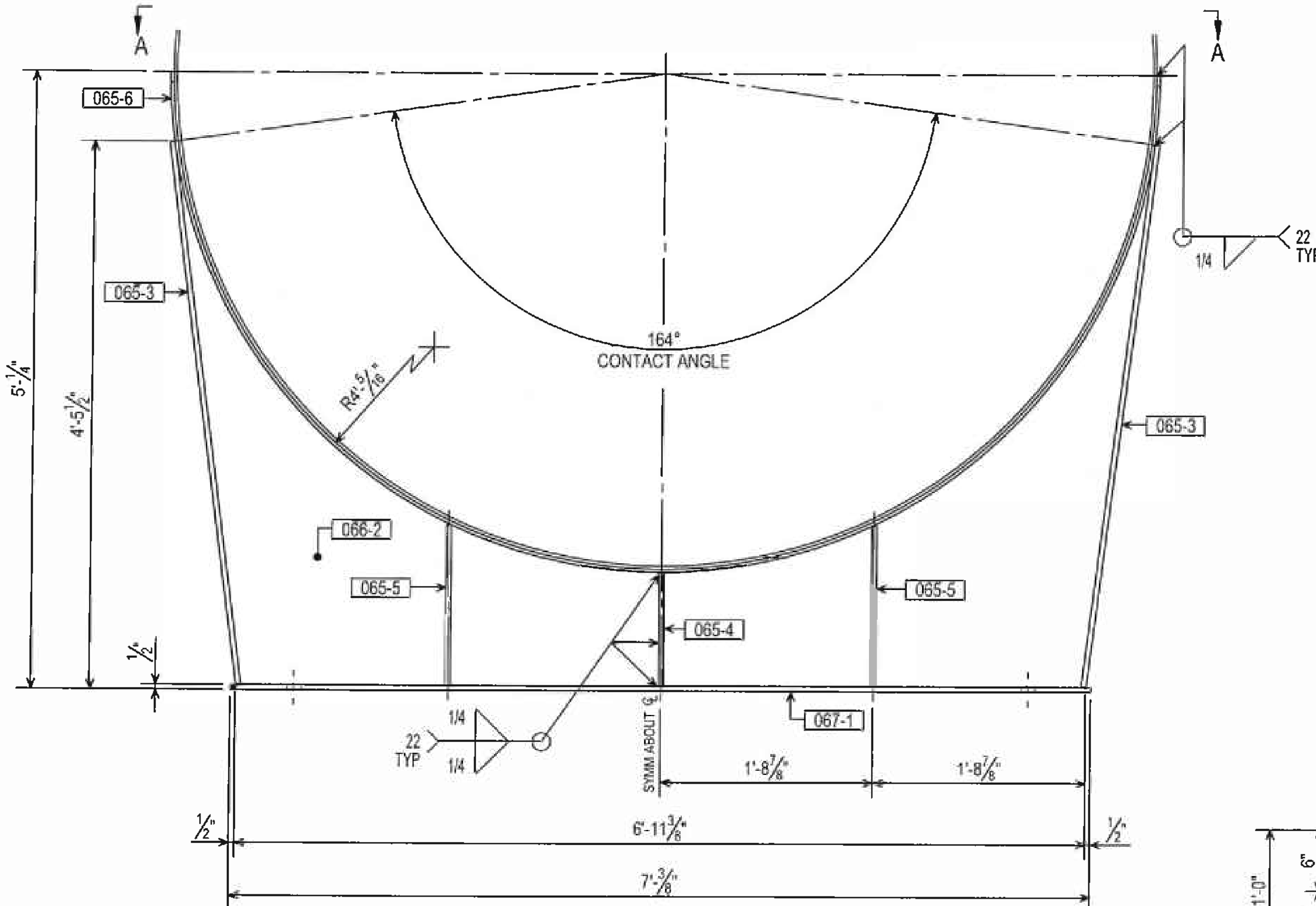
Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SADDLE DETAILS

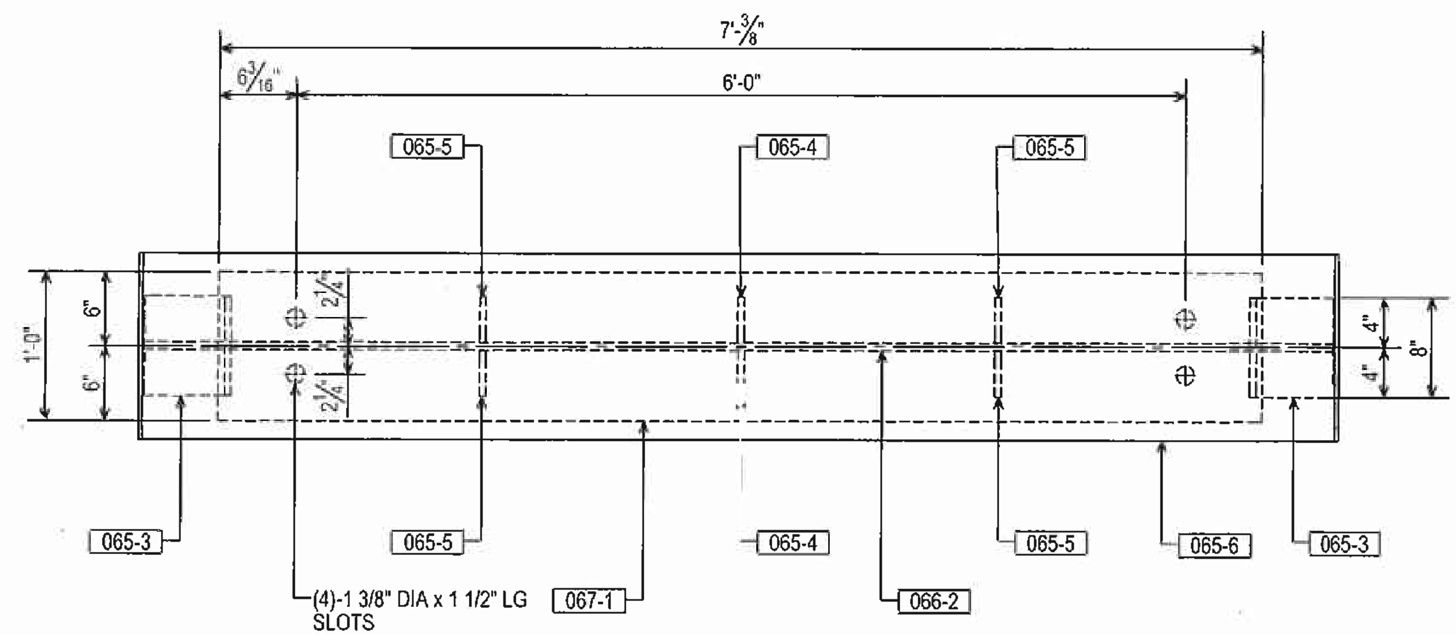
SCALE	DRAWING NUMBER (Job / Ph / Sht / Rev)
SCALE 1:10	24-018-01-066-1

FILE NAME	24-018-01-066
BY	CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
067-SS		**2**	**SLIDING SADDLE ASSEMBLY**				**823**	
067-1		2	PL, .5" x 12" x 84.4"		SA240-304/304L	6	145	w/ HOLES
066-2		2	PL, .625" x PATTERN		SA240-304/304L	10	303	
065-3		4	PL, .5" x 8" x 53.372"		SA240-304/304L	7	62	
065-4		4	PL, .5" x 3.688" x 11.125"		SA240-304/304L	8	6	
065-5		8	PL, .5" x 3.688" x 15.704"		SA240-304/304L	9	8	
065-6		2	RP, .313" x 15" x 152.269"		SA240-304/304L	5	206	ROLL TO 4'- 5/16" I/S RAD, RADIUS CORNERS



SLIDING SADDLE ASSEMBLY ~ 067-SS
ELEVATION
(2) REQUIRED



SECTION A-A

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate
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TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SADDLE DETAILS

SCALE: SCALE 1:15

DRAWING NUMBER: 24-018-01-067-1

FILE NAME 24-018-01-067
BY CKS

FOUNDATION LOAD SUMMARY

Saddle #1: Total Loading at Base (Right Sliding Saddle)				
Load	**Vessel Condition**	**Longitudinal Base Shear (lb_f)**	**Transverse Base Shear (lb_f)**	**Vertical Force (lb_f)**
Weight Only (D)	Operating, New	0	0	48,680
Weight Only (D)	Operating, Corroded	0	0	46,980
Thermal Expansion	Operating, New	21,906	0	0
Thermal Expansion	Operating, Corroded	21,141	0	0
Wind Only (0.6 * W)	Operating, New	567	657	0
Wind Only (0.6 * W)	Operating, Corroded	567	657	0
Seismic Only (0.7 * E)	Operating, New	2,670	1,340	2,582
Seismic Only (0.7 * E)	Operating, Corroded	2,574	1,293	2,490

Saddle #1: Total Loading at Base (Left Fixed Saddle)				
Load	**Vessel Condition**	**Longitudinal Base Shear (lb_f)**	**Transverse Base Shear (lb_f)**	**Vertical Force (lb_f)**
Weight Only (D)	Operating, New	0	0	48,274
Weight Only (D)	Operating, Corroded	0	0	46,564
Thermal Expansion	Operating, New	21,906	0	0
Thermal Expansion	Operating, Corroded	21,141	0	0
Wind Only (0.6 * W)	Operating, New	567	657	0
Wind Only (0.6 * W)	Operating, Corroded	567	657	0
Seismic Only (0.7 * E)	Operating, New	2,670	1,329	2,560
Seismic Only (0.7 * E)	Operating, Corroded	2,574	1,281	2,467

ALL VALUES REPORTED ARE SERVICE LOADS FOR ALLOWABLE STRESS DESIGN (ASD)

VERTICAL FORCE VALUES IN THE SEISMIC CASE INCLUDE THE 0.7 * 0.2 * S_{DS} DEAD LOAD FACTOR (COMPRESSIVE).
THE 0.7 TERM IS THE ASD LOAD COMBINATION FACTOR.

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC
A	06/07/24	CKS	ISSUED FOR CUSTOMER APPROVAL	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
FOUNDATION LOAD DETAILS

SCALE: SCALE 1:10
DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-070-1

FILE NAME 24-018-01-070
BY CKS

VESSEL HYDROTEST PROCEDURE:
TATE PROJECT NUMBER: 24-018, PHASE 01
CUSTOMER: WESTROCK JACKSONVILLE, FL
TANK NAME: PMO OIL TANK
TANK NUMBER: 303-150-00914
DESIGN CODE: ASME NON-STAMP

2 TEST:

1. COMPLETE ALL NDE REQUIREMENTS PER "TESTING PROCEDURES" AS OUTLINED ON DRAWING 24-018-01-000.
2. SET THE VESSEL IN THE SHOP, IN A HORIZONTAL POSITION WITH NOZZLE N5-3" AT THE TOP OF THE TANK AS A VENT.
3. INSTALL ALL BLIND FLANGES ON THE VESSEL, EXCLUDING NOZZLE N5-3" VENT. NOZZLE N5-3" VENT IS TO REMAIN OPEN THE ENTIRE TIME THE WATER SUPPLY IS CONNECTED TO THE VESSEL. THIS NOZZLE WILL ALSO BE USED TO OBSERVE THE FILLING OF THE VESSEL.
4. INSTALL THE VALVE AND TEST TREE ASSEMBLY ON NOZZLE N2-3".
5. CONNECT THE WATER SUPPLY/FIRE HOSE TO THE VALVE ASSEMBLY CONNECTED TO NOZZLE N2-3". DO NOT TURN ON THE WATER.
6. CONNECT THE PRESSURE HOSE TO NOZZLE N2-3" VALVE TREE (3/8" BALL VALVE CONNECTION)
7. WITH THE NOZZLE N5-3" VENT STILL OFF THE VESSEL, BEGIN FILLING THE VESSEL BY TURNING ON THE WATER SUPPLY, AND OPENING THE BALL VALVE CONNECTED TO NOZZLE N2-3".
8. FILL WITH WATER UNTIL THE VESSEL IS FULL. CLOSE BALL VALVE. DISCONNECT THE WATER SUPPLY.
9. INSTALL THE VENT ASSEMBLY ON NOZZLE N5-3" AND CLOSE BALL VALVE
10. THE VESSEL SHOULD BE COMPLETELY FULL OF WATER. THE PRESSURE GAUGE SHOULD READ 4.10 PSI.
11. THIS SHOULD BE HELD FOR ONE HOUR, WHILE INSPECTING THE VESSEL, VERIFYING THERE ARE NO LEAKS.
12. AFTER IT IS CONFIRMED THAT THERE ARE NO LEAKS, RELEASE THE PRESSURE BY SLOWLY OPENING THE BALL VALVE ON NOZZLE N5-3" VENT ASSEMBLY.
13. REMOVE THE VENT ASSEMBLY BLIND FLANGE FROM NOZZLE N5-3" VENT
14. CONNECT THE FILL/DRAIN HOSE TO NOZZLE N2-3", OPEN VALVE AND DRAIN THE VESSEL EMPTY.

GAUGE SIZE SHOULD BE BETWEEN 1.5 * TEST PRESSURE AND 4.0 * TEST PRESSURE PER ASME

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2	08/26/24	DWC	REVISED NOZZLE N5 FROM 2" TO 3". ISSUED FOR CONSTRUCTION	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

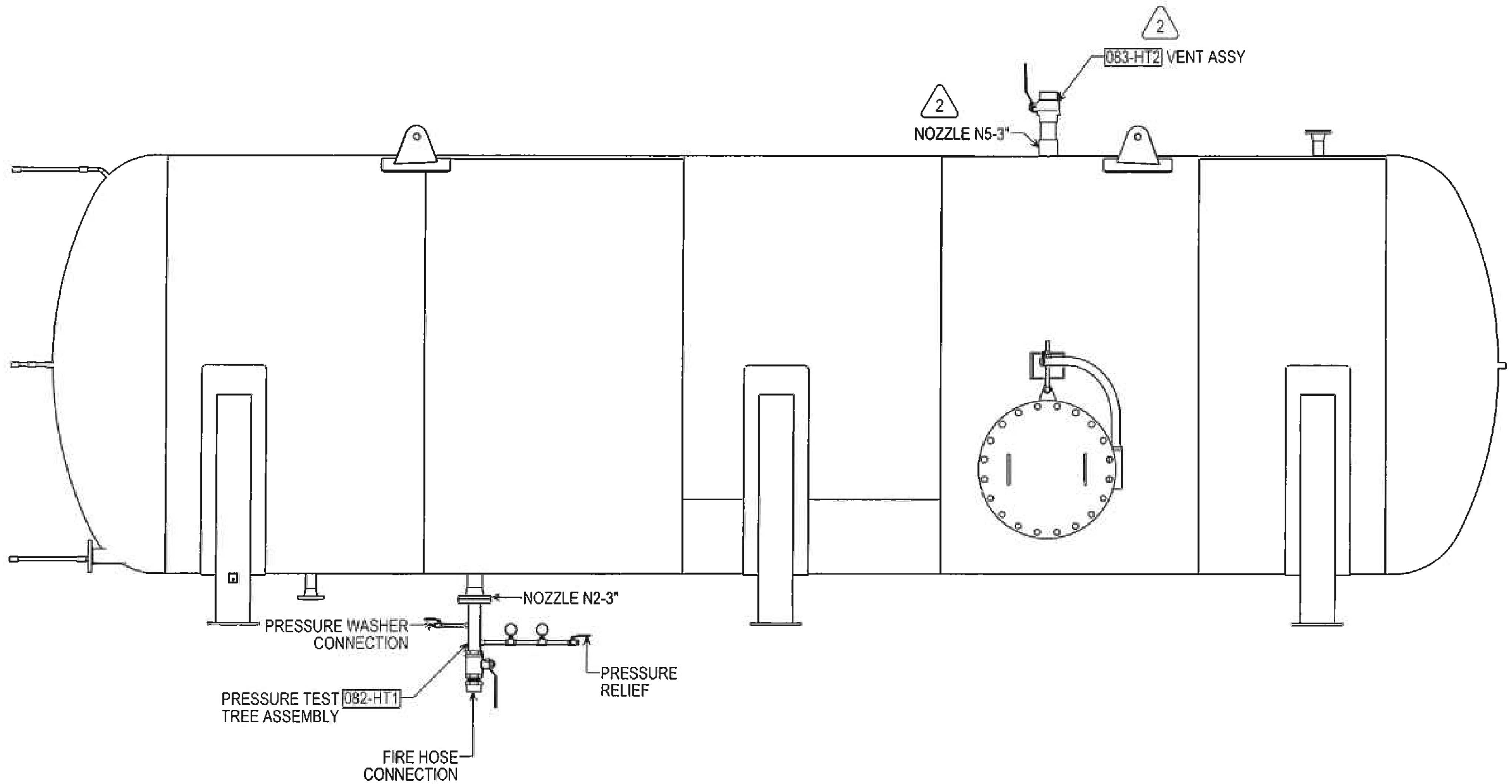
REVISIONS

Tate METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HYDROSTATIC TEST DETAILS

SCALE: SCALE 1:1
DRAWING NUMBER (Job Ph Sht Rev): 24-018-01-080-2

FILE NAME 24-018-01-080
BY CKS



VESSEL PRESSURE TEST CONFIGURATION

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2	08/26/24	DWC	REVISED NOZZLE N5 & 083-HT2 VENT ASSEMBLY. ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

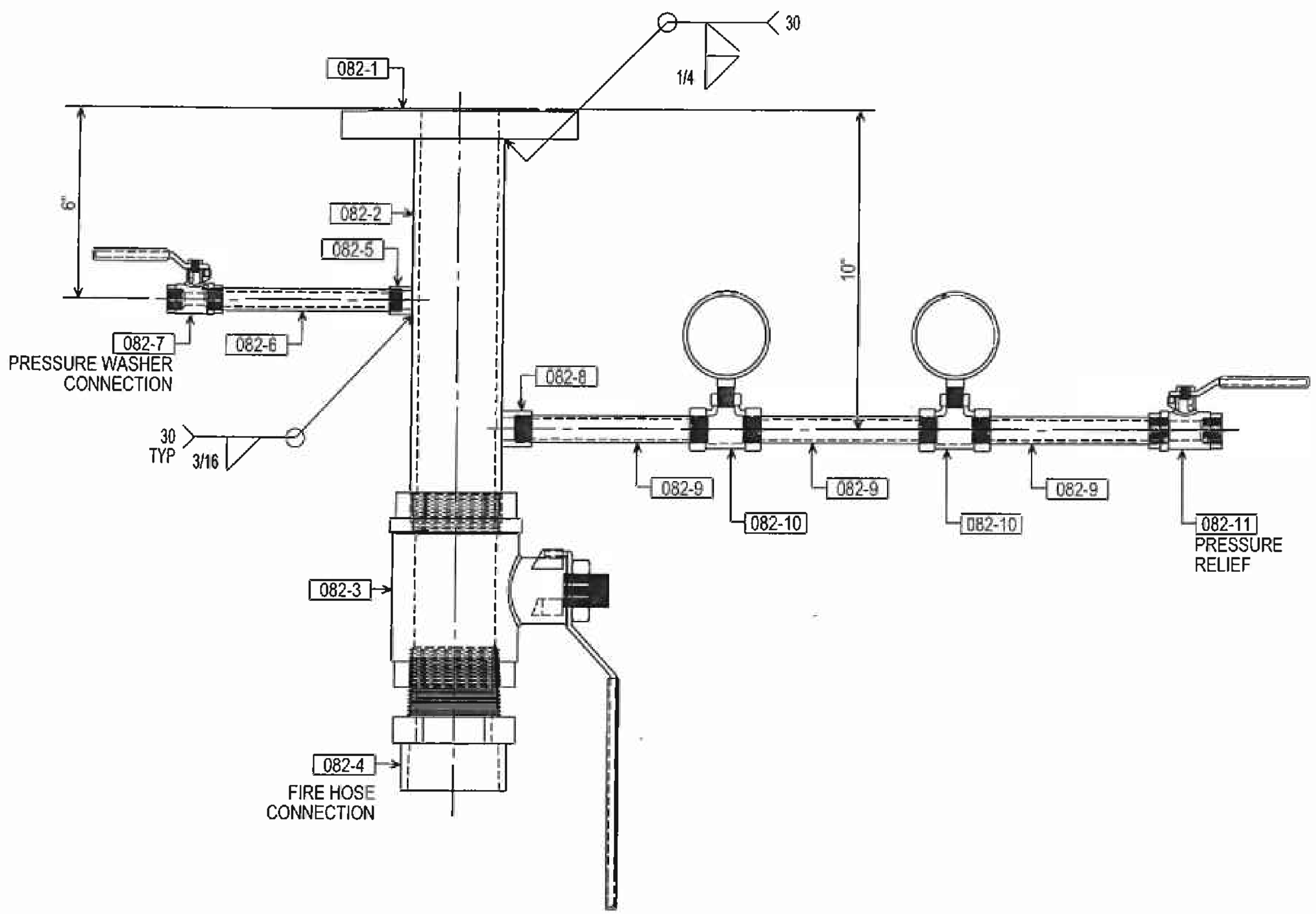
REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HYDROSTATIC TEST DETAILS

SCALE: SCALE 1:32
DRAWING NUMBER: Job Ph Sht Rev 24-018-01-081-2

FILE NAME 24-018-01-081
BY CKS



PRESSURE TEST TREE ASSEMBLY ~ 082-HT1
ELEVATION

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
082-HT1		**1**	**PRESSURE TEST ASSEMBLY TREE**				**40**	
082-1		1	FL, 3" 150# RF BLD		SA105		10	w/ 2 1/2" DIA HOLE
082-2		1	PI, 2 1/2" DIA STD WT	1'	SA53-B ERW		6	THREAD ONE END
082-3		1	BALL VALVE, 2 1/2" NPT FEMALE, MAX PRESSURE 450 PSI @ 100°F, MAX STEAM PRESSURE 150 PSI @ 366°F, TEMP RANGE -50° TO 400°F		BRASS		16	McMASTER CARR P/N: 47865K71
082-4		1	FIRE HOSE CONNECTION, MALE ADAPTOR x FEMALE SWIVEL 2 1/2" NPT x 2 1/2" NH/MST		BRASS		3	McMASTER CARR P/N: 6494T63
082-5		1	HALF COUPLING, 3/8" DIA 3000# THREADED		SA234-WPB		0	
082-6		1	PI, 3/8" DIA STD WT	6"	SA53-B ERW		0	THREAD BOTH ENDS
082-7		1	BALL VALVE, 3/8" NPT FEMALE, MAX PRESSURE 600 PSI @ 100°F, MAX STEAM PRESSURE 150 PSI @ 366°F, TEMP RANGE -50° TO 400°F		BRASS		0	McMASTER CARR P/N: 47865K22
082-8		1	HALF COUPLING, 1/2" DIA 3000# THREADED		SA234-WPB		0	
082-9		3	PI, 1/2" DIA STD WT	6"	SA53-B ERW		0	THREAD BOTH ENDS
082-10		2	INLINE 300# THREADED REDUCING TEE, 1/2" x 1/4" PIPE DIA		IRON		1	McMASTER CARR P/N: 4627K332
082-11		1	BALL VALVE, 1/2" NPT FEMALE, MAX PRESSURE 600 PSI @ 100°F, MAX STEAM PRESSURE 150 PSI @ 366°F, TEMP RANGE -50° TO 400°F		BRASS		1	McMASTER CARR P/N: 47865K23
082-12		2	PRESSURE GAUGE, 2 1/2" FACE x 1/4" BTM MOUNT w/ CERTS, PRESSURE RANGE 0-600 PSI, TEMP RANGE -40° TO 150°		--			McMASTER CARR P/N: 9796T31

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

REVISIONS

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

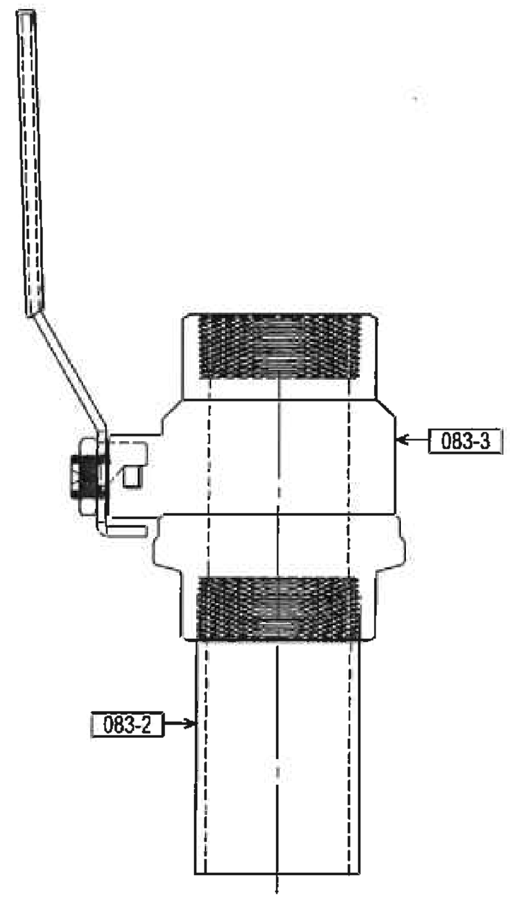
TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HYDROSTATIC TEST DETAILS

SCALE
SCALE 1:5

DRAWING NUMBER
Job Ph Sht Rev
24-018-01-082-1

FILE NAME 24-018-01-082
BY CKS

MARK	SHIP PC.	ASSEM PC.	DESCRIPTION	LENGTH	SPECIFICATION	SOURCE	WEIGHT/ EA.	NOTES
083-HT2		1	**VENT ASSEMBLY - 3"**				25	
2 083-2		1	PI, 3" STD WT PIPE NIPPLE	6"	SA53-B ERW		4	THREAD BOTH ENDS
2 083-3		1	BALL VALVE, 3" NPT FEMALE, MAX PRESSURE 450 PSI @ 100°F, MAX STEAM PRESSURE 150 PSI @ 366°F, TEMP RANGE -50° TO 400°F		BRASS		22	McMASTER CARR P/N: 47865K72



VENT ASSEMBLY ~ 083-HT2 2
ELEVATION

CERTIFIED CORRECT

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2	08/26/24	DWC	REVISED VENT ASSEMBLY TO 3". ISSUED FOR CONSTRUCTION.	NJB	CKS
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

REVISIONS

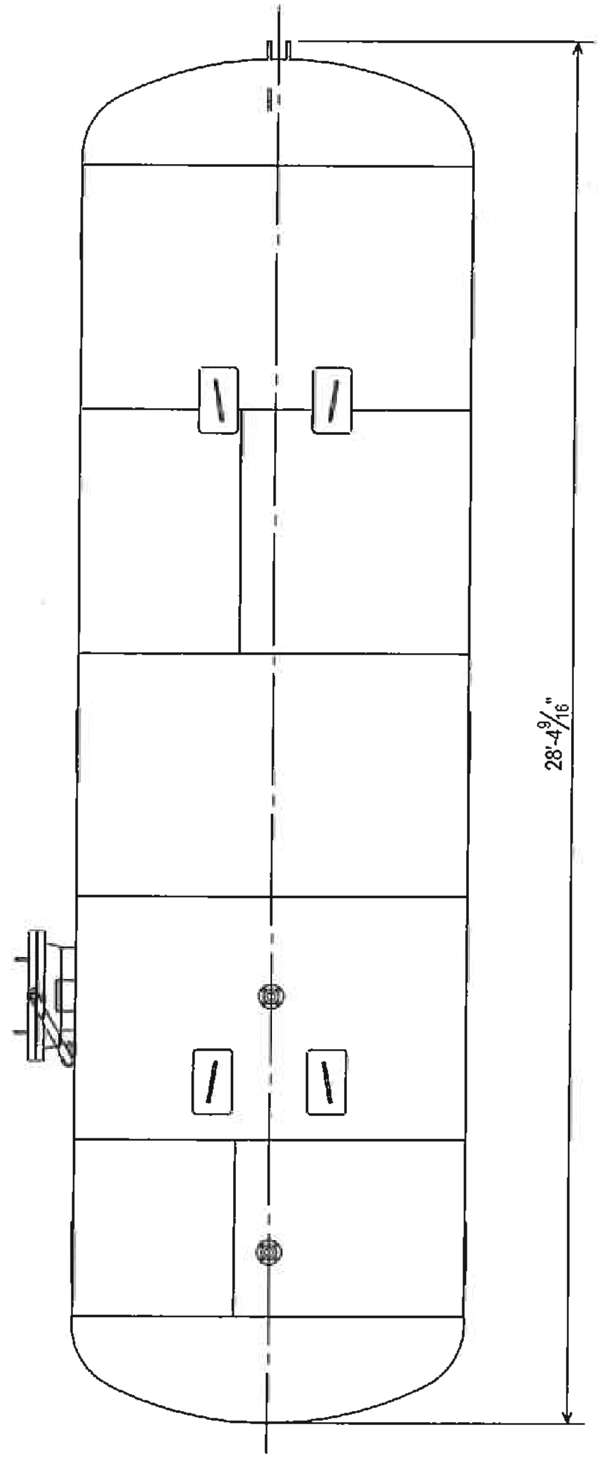
Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" ID x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
HYDROSTATIC TEST DETAILS

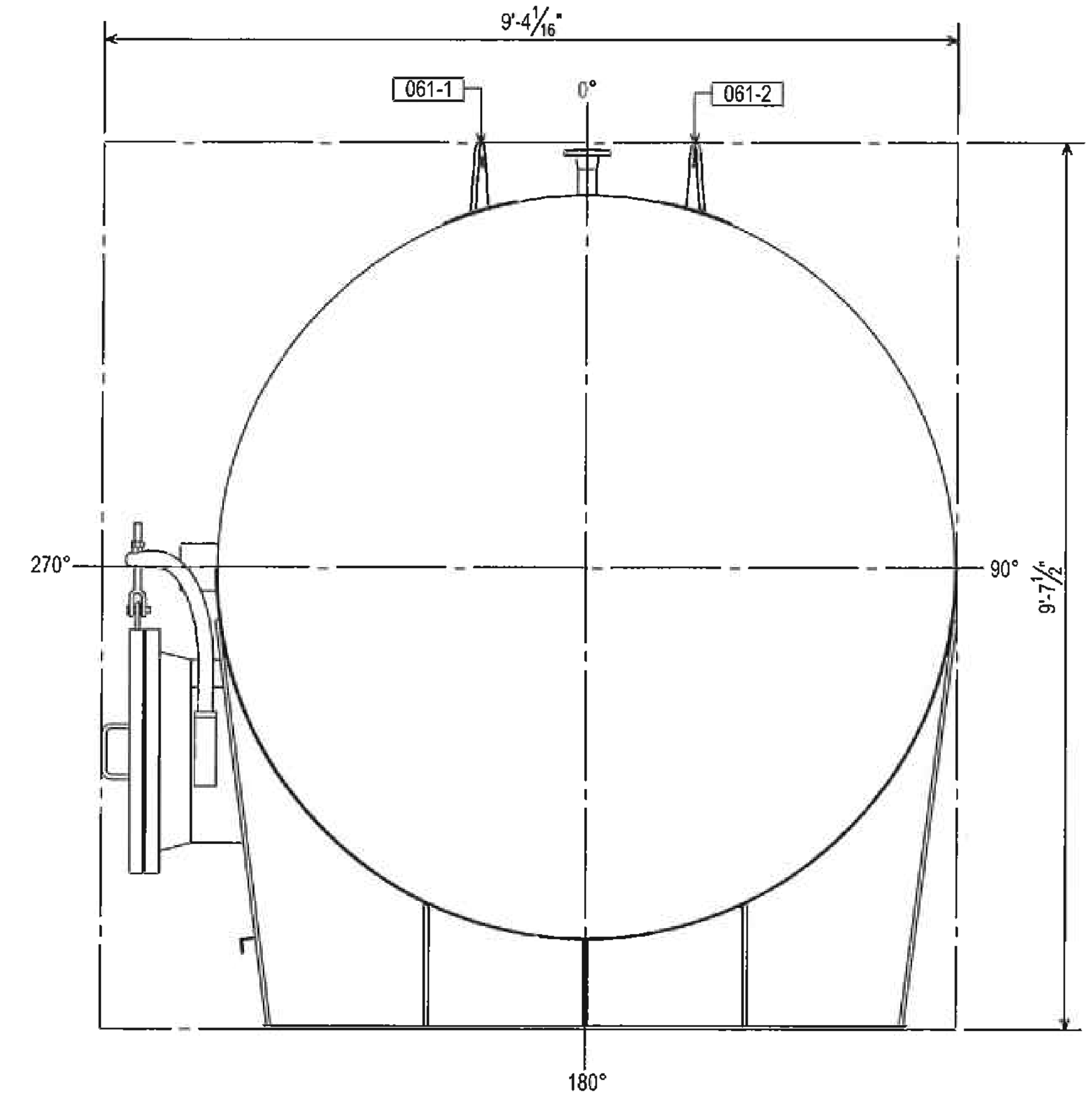
SCALE
SCALE 1:4

DRAWING NUMBER
Job Ph Sht Rev
24-018-01-083-2

FILE NAME 24-018-01-083
BY CKS



SHIPPING ENVELOPE
PLAN VIEW



SHIPPING ENVELOPE
ELEVATION
WEIGHT 13,906 LBS
SCALE: 1:24

REV.	DATE	DR. BY	REVISION DESCRIPTION	ENGRG	CHKD.
5					
4					
3					
2					
1	07/22/24	CKS	ISSUED FOR CONSTRUCTION	NJB	DWC

REVISIONS

CERTIFIED CORRECT

Tate
METALWORKS, INC.
P.O. BOX 171 255 HAPPY LANE SPARTANBURG, SC 29304-0171 (864) 576-3540

TITLE
8'-0" I.D. x 23'-11 1/2" T.L. TO T.L. ~ PAPER MACHINE BULK OIL STORAGE TANK
WESTROCK SEMINOLE ~ JACKSONVILLE, FL
SHIPPING ENVELOPE

SCALE: SCALE 1:46
DRAWING NUMBER: Job Ph Sht Rev
24-018-01-090-1

FILE NAME 24-018-01-090
BY CKS

Tate
METALWORKS, INC.

Quality Control Inspection Record
Visual Examination

255 Happy Lane Roebuck, S.C. 29376 • (864) 576-3540 • www.tatemetalworks.com

Customer Name: Westrock Seminole
Project Name: Paper Machine Bulk Oil Storage Tank
Project Location: Jacksonville, Fl
Equipment Number: 303-150-00914
TMI Job Number: 24-018-01

Type of Surface: ☐ Base Metal ☐ Machined ☒ Weld Metal ☐ Other: ____________
Condition of Surface: ☒ Satisfactory Method: ☒ Direct ☐ Remote

TMI Inspection Procedure: VT-2

Qty	*Item*	*Material*	*Accept*	*Comments*	*Technician*	*Date*
	020-1 to 007-1 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	020-1 to 007-1 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-1 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-1 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-1 to 007-2 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-1 to 007-2 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-2 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-2 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-2 to 007-3 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-2 to 007-3 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-3 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-3 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-3 to 007-4 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-3 to 007-4 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-4 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-4 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-4 to 007-5 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-4 to 007-5 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-5 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-5 outside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-5 to 030-1 inside	304/304L	✓	Satisfactory	LW	9/9/2024
	007-5 to 030-1 outside	304/304L	✓	Satisfactory	LW	9/9/2024
4	Lifting Lugs	304/304L	✓	Satisfactory	LW	9/12/2024
3	Saddles	304/304L	✓	Satisfactory	LW	9/12/2024

Remarks: ____________

Signature: Lonnie Womick Date: 9/12/2024

AWS®
Lonnie Womick
CWI 11120271
QC1 EXP. 12/1/2026

Tate METALWORKS, INC.	**Quality Control Inspection Record Radiography**

255 Happy Lane Roebuck, S.C. 29376 • (864) 576-3540 • www.tatemetalworks.com

Customer Name: Westrock Seminole

Project Location: Jacksonville, Fl

Project Name: Paper Machine Bulk Oil Storage Tank

Equipment Number: 303-150-00914

TMI Job Number: 24-018-01

X-Ray Coversheet

				Repair		*Tracer 1*		*Tracer 2*			
X-ray	*Welder*	*Accept*	*Reject*	*Accept*	*Reject*	*Accept*	*Reject*	*Accept*	*Reject*	*Technician*	*Date*
1	#30	✓								Andrew Martin	8/26/2024
2	#30	✓								Andrew Martin	8/26/2024
3	#30	✓								Andrew Martin	8/26/2024
4	#30	✓								Andrew Martin	8/26/2024
5	#3	✓								Andrew Martin	8/26/2024
6	#3	✓								Andrew Martin	8/26/2024

Remarks:

Signature: Lonnie Womick

AWS® Lonnie Womick
CWI 11120271
QC1 EXP. 12/1/2026

Date: 8/26/2024

APPLIED TECHNICAL SERVICES

1049 Triad Court, Marietta, Georgia 30062 •(770) 423-1400 Fax (770) 514-3299 • www.atslab.com• FAA#HC4R227M

RADIOGRAPHIC INSPECTION REPORT

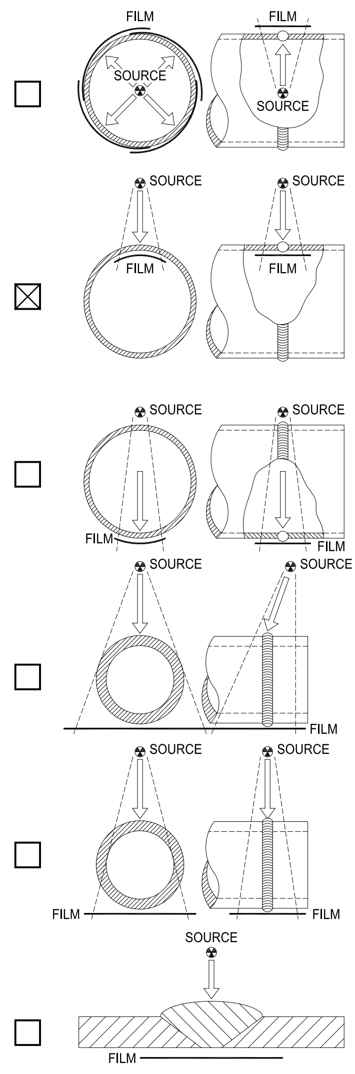
Job # P432040 PO # 24018-00013 WO # N/A Date 8/26/24 Page 1 of 1

CLIENT:	**Tate Metal Works**	PART NO.:	See Below
LOCATION:	**255 Happy Ln**	PART NAME:	See Below
	Roebuck, SC 29376	MATERIAL:	S/S
		THICKNESS:	Various
		TYPE WELD:	Full Pen.

RADIOGRAPHIC INSPECTION TECHNIQUE

Specification(s)	ATS 120.1 Rev. 32	Acceptance Criteria	ASME Section VIII Div. 1
Isotope	Ir-192	Film Mfg/Type	FujiFilm 80
Curies	50.4	Film Size	4.5" x 10"
KV	N/A	Sensitivity	ASTM E747 (7 Wire)
MA	N/A	Image Quality Indicator	ATSM B Pack S/S
Time	55 Seconds	Shim(s)	N/A
SFD	19.02"	Develop: Temp: 77 Time:	2.75 Minutes
SOD	18.5"	Screen(s)	Front + Back (0.010)
OFD	0.520"	Films Per Cassette	1
Source Size (Focal)	0.177"	Weld Reinforcement Thickness	Front(0.120")
Geometric Unsharpness	0.004	Welding Process	SAW

SETUP



☐ SEE ATTACHED SKETCH

INTERPRETATION

(Acceptable indications are marked with a √ and rejected indications are marked with an "x".)

PART I.D./ FILM VIEW	Accept	Reject	Crack	Slag Inclusion	Tungsten Inclusion	Porosity	Undercut	Incomplete Fusion	Incomplete Penetration	Root Concavity	Root Convexity	DENSITY Image Quality Indicator IQI	DENSITY Area of Interest	REMARKS
18-1XR1														
View 0-1	√											2.5	2.5	
18-1XR2														
View 0-1	√											2.3	2.3	
18-1XR3														
View 0-1	√											2.6	2.5	Artifact
18-1XR4														
View 0-1	√											2.5	2.5	
18-1XR5														
View 0-1	√											2.4	2.4	
18-1XR6														
View 0-1	√											2.5	2.5	

RADIOGRAPHER(S): Andrew Martin Level II R.T. DATE: 8/26/2024

INTERPRETER: Andrew Martin *Andrew Martin* Level II R.T. DATE: 8/26/2024

CLIENT APPROVAL: ______________________

TATE METALWORKS, INC.

Quality Control Inspection Record
Hydro Test

255 Happy Lane Roebuck, S.C. 29376 • (864) 576-3540 • www.tatemetalworks.com

Customer Name: Westrock Seminole

Project Location: Jacksonville, Fl

Project Name: Paper Machine Bulk Oil Storage Tank

Equipment Number: 303-150-00914

TMI Job Number: 24-018-01

Item	*Time of Completion*	*Gauge Reading*	*Date*	*Signature*
Vessel completely filled with water	2:30pm	n/a	9-12-24	L. Womick
Vessel verified to be leak free	3:30pm	n/a	9-12-24	L. Womick

Remarks:

Signature: [signature] Date: 9-12-24

Witness: [signature] Date: 9-12-24

TATE METALWORKS INC.

(NAME OF MANUFACTURER)

32.78 PSI (kPa) AT 150 °F (°C)

MAX. ALLOWABLE WORKING PRESSURE

0 PSI (kPa) AT 150 °F (°C)

MAX. ALLOWABLE EXTERNAL WORKING PRESSURE
(IF SPECIFIED; SEE NOTE (1))

0 °F (°C) AT 32.78 PSI (kPa)

MIN. DESIGN METAL TEMPERATURE

24-018-01

MANUFACTURER'S SERIAL NUMBER

2024

YEAR BUILT