FABSCO SHELL & TUBE, LLC

MANUFACTURING RECORD BOOK INDEX SHEET

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KBR

ACCEPTANCE
FOR ENGINEERING USE

THIS DOCUMENT IS:

ACCEPTED	(Code 1)	
ACCEPTED WITH COMMENTS	(Code 2)	
NOT ACCEPTED	(Code 3)	
NOT REVIEWED	(Code 4)	X

ACCEPTANCE DOES NOT RELIEVE SUPPLIER FROM FURNISHING MATERIAL IN CONFORMANCE WITH ORDER. REFER TO SDR-1 FOR FULL DEFINITION OF ACCEPTANCE CONDITIONS.

DISCIPLINE EXCH BY MW
DATE 29NOV12

HX2065 AGR FLASH GAS COOLER

Southern Company Generation **Kemper County**
MM233798 0 Unit 1

FABSCO SHELL & TUBE PO: MPC17901-0001
S11-10279-8 HX2065 DATA BOOK Rev: 0
IGCC - GASIFIER - MULTIPAGE - SELEXOL AREA MISC HEAT EXCHANGER -

FORM U-1 MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
As Required by the Provisions of the ASME Code Rules, Section VIII, Division 1

1. Manufactured and certified by **FABSCO SHELL & TUBE, LLC., 2410 INDUSTRIAL ROAD, SAPULPA, OK 74066** (Name and address of Manufacturer)
2. Manufactured for **SOUTHERN COMPANY GENERATION** (Name and address of Purchaser)
3. Location of installation **KEMPER COUNTY, MS** (Name and address)
4. Type: **HORIZ.** (Horiz., vert., or sphere) **HEAT EXCHANGER** (Tank, separator, jkt. vessel, heat exh., etc.) **S11-10279-8** (Mfg's serial No.)
   N/A (CRN) **S11-10279-8-1** (Drawing No.) **7539** (Nat'l Bd. No.) **2012** (Year built)
5. ASME Code, Section VIII, Div. 1 **2010 ED.** [Edition and Addenda (date)] **N/A** (Code Case No.) **N/A** [Special Service per UG-120(d)]

Items 6-11 incl. to be completed for single wall vessels, jackets of jacketed vessels, shell of heat exchangers, or chamber of multichamber vessels.

6. Shell (a) No. of course(s): **1/1** (b) Overall length (ft & in.): **16'-5 3/8" / 1'-4 1/4"**

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B, & C)			Heat Treatment	
No.	Diameter, in.	Length (ft & in.)	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
1	18" O.D.	16'-5 3/8"	SA-312TP304L	1/4"	0"	S	NONE	0.85	1	FULL(RT-4)	1.0	N/A	N/A
1*	24" O.D.	1'-4 1/4"	SA-312TP304L	1/4"	0"	S	NONE	0.85	1	FULL(RT-4)	1.0	N/A	N/A
	* ANNULAR DISTRIBUTOR												

7. Heads: (a) **SA-240-304L** (Mat'l Spec. No., Grade or Type) (H.T. - Time & Temp.) (b) **NA** (Mat'l Spec. No., Grade or Type) (H.T. - Time & Temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	END	3/16	0"	NA	NA	2:1	NA	NA	NA	NA	X	S	NONE	1.00
(b)														

If removable, bolts used (describe other fastening) **NA** (Mat'l Spec. No., Grade, size, No.)

8. Type of jacket **NA** Jacket closure **NA** (Describe as ogee & weld, bar, etc.)
   If bar, give dimensions **NA** If bolted, describe or sketch.
9. MAWP **180** (internal) **NA** (external) psi at max. temp. **290** (internal) **NA** (external) °F Min. design metal temp. **10** °F at **180** psi.
10. Impact test **NO,Exempt Per ug-20(f), ucs-66(a)(c), Fig ucs-66 Note(c) & ucs-67** [Indicate *yes* or *no* and the component(s) impact tested] at test temperature of **NA** °F.
11. Hydro. Test press. **234** Proof test **NA**

Items 12 and 13 to be completed for tube sections.

12. Tubesheet: **SA-240-304L** [Stationary (Mat'l Spec. No.)] **19 1/8"** [Dia., In. (subject to press.)] **1 3/8"** (Nom. thk., in.) **0.1875"** (Corr. Allow., in.) **Bolted** [Attachment (welded or bolted)]
    NA [Floating (Mat'l Spec. No.)] **NA** (Dia., in.) **NA** (Nom. thk., in.) **NA** (Corr. Allow., in.) **NA** (Attachment)
13. Tubes: **SA-213TP304L** (Mat'l Spec. No., Grade or Type) **1"** (O.D., in.) **0.0910 THK avg** (Nom. thk., in. or gauge) **51** (Number) **"U"** [Type (Strait or U)]

Items 14-18 incl. to be completed for inner chambers of jacketed vessels or channels of heat exchangers.

14. Shell (a) No. of course(s): **1** (b) Overall length (ft & in.): **1'-10"**

Course(s)			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B, & C)			Heat Treatment	
No.	Diameter, in.	Length (ft & in.)	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff.	Temp.	Time
1	18" O.D.	1'-10"	SA-312TP304L	1/4"	0"	S	NONE	0.85	1	FULL	1.00	N/A	N/A

15. Heads: (a) **SA-240-304L** (Mat'l Spec. No., Grade or Type) (H.T. - Time & Temp.) (b) **NA** (Mat'l Spec. No., Grade or Type) (H.T. - Time & Temp.)

	Location (Top, Bottom, Ends)	Thickness		Radius		Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure		Category A		
		Min.	Corr.	Crown	Knuckle					Convex	Concave	Type	Full, Spot, None	Eff.
(a)	END	1 3/4"	0"	NA	NA	NA	NA	NA	22 5/8"	NA	NA	S	NONE	1.00
(b)														

If removable, bolts used (describe other fastening) **(20)7/8"Dia.&(20)7/8"Dia.SA-193B7 Studs W/SA-194-2H Heavy Hex Nuts** (Mat'l Spec. No., Grade, size, No.)

FORM U-1 (Back)

16. MAWP 150 (internal) NA (external) psi at max. temp. 200 (internal) NA (external) °F Min. design metal temp 10 °F at 150 psi.

17. Impact test NO,Exempt Per ucs-66, ucs-67 & ucs-68 [Indicate yes or no and the component(s) impact tested] NA °F.

18. Hydro., pneu., or comb. Test pres: 195 Proof te: NA

19. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc.)	No.	Diameter or Size	Flange Type	Material		Nozzle Thickness		Reinforcement Material	How Attached		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
INLET	1	6"-300#	RF-WN	SA-312TP304L	SA-182F304L	0.4320"	0"	NA	UW16.1	NONE,0.7(	NA
OUTLET	1	8"-300#	RF-WN	SA-312TP304L	SA-182F304L	0.5000"	0"	NA	UW16.1	NONE,0.7(	NA
INLET/OU	1	4"-150#	RF-WN	SA-312TP304L	SA-182F304L	0.2370"	0"	NA	UW16.1	NONE,0.7(	NA
INLET	1	4"-150#	RF-WN	SA-312TP304L	SA-182F304L	0.2370"	0"	NA	UW16.1	NONE,0.7(	NA
VENT	1	2"-150#	RF-WN	SA-312TP304L	SA-182F304L	0.2180"	0"	NA	UW16.1	NONE,0.7(	NA
DRAIN	1	2"-150#	RF-WN	SA-312TP304L	SA-182F304L	0.2180"	0"	NA	UW16.1	NONE,0.7(	NA
VENT	1	3/4"-6000#	CPLG	SA-182F304L	NA	6000#	0"	NA	UW16.1	NA	NA
DRAIN	1	3/4"-6000#	CPLG	SA-182F304L	NA	6000#	0"	NA	UW16.1	NA	NA

20. Supports: Skirt NO (Yes or no) Lugs NONE (No.) Legs NONE (No.) Others (2)Saddles (Describe) Attached Welded to Shell (Where and how)

21. Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: (List the name of part, item number, mfg's. name and identifying number)
SHELL, CHANNEL & NOZZLES, ITEM #6, #7, #14, #15, #19, J & M WELDING, LLC., SN: 93057.3, 93057.4

22. Remarks: SERVICE: AGR FLASH GAS COOLER ITEM NO.: HX2065

STRAIGHT TUBE LENGTH = 16'-0"

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Pressure Cessels, Section VIII, Division 1.

U Certificate Authorization No 30112 Expires December 30 ,20 12

Date 9/27/12 Name FABSCO SHELL & TUBE, LLC. (Manufacturer) Signed Anthony Cardwell (Representative)

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commision issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of Oklahoma and employed by ONEBEACON AMERICA INSURANCE of LYNN, MA have inspected the pressure vessel described in this Manufacturer's Data Report on 9/19/12, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his 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 9/27/12 Signed Mark Faught (Authorized Inspector) Commission NB 7935 A OK 657 (Nat'l Board incl. endorsements, State, Province, and No.)

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the statements on this report are correct and that field assembly construction of all parts of this vessel conforms with the requirements of ASME Code, Section VIII, Division 1. U Certificate of Authorization No.

U Certificate of Authorization Nc Expires ,20

Date Name (Assembler) Signed (Representative)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commision issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of and employed by of , have compared the statements in this Manufacturer's Data Report with the described pressure vessel and state that parts referred to as data item included in the certificate of shop inspection, have been inspected by me and to the best of my knowledge and belief, the Manufacturer has constructed and assembled this pressure vessel in accordance with ASME Code, Section VIII, Division 1. The described vessel was inspected and subjected to hydrostatic test of psi.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his 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 Signed (Authorized Inspector) Commission (Nat'l Board incl. endorsements, State, Province, and No.)

FORM U-2 MANUFACTURER'S PARTIAL DATA REPORT

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 J&M Welding, LLC 7862 South Regency Drive, Tulsa, OK 74131
(Name and address of Manufacturer)
2. Manufactured for Fabsco, LLC P.O. Box 988, Sapulpa, OK 74067
(Name and address of Purchaser)
3. Location of installation "unknown"
(Name and address)
4. Type: HORIZONTAL SHELL, CHANNEL & NOZZLES [Description of vessel part (shell, two piece head, tube bundle)] 93057.3,.4 (Mfg's serial No.) (CRN)
(National Board number) S11-10279-7/8-1 REV.4 (Drawing number) FABSCO, LLC (Drawing prepared by) 2012 (Year built)
5. ASME Code Section VIII Div 1 2010 [Edition and Addenda (date)] (Code Case number) [Special Service per UG-120(d)]

Items 6-11 incl. to be completed for single wall vessels, jackets of jacketed vessels, shell of heat exchangers, or chamber of multi-chamber vessels.

6. Shell (a) Number of course (s): 1 (b) Overall Length : 16' 5-3/8"

Course(s)			Material	Thickness		Long. Joint (Cat A)			Circum. Joint (Cat. A, B, & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff	Temp.	Time
1	1' 6" Od	16' 5-3/8"	SA312TP304L	.25"	0"	S	NONE	0	1	FULL	100		

7. Heads: (a) SA-965-F304L (Material spec. number, grade or type) (H.T. – time & temp) (b) SA-240-304L (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)	L.END	3.9375"	0						22.625"			S	NONE	100
(b)	R.END	.1875"	0			2:1					X	S	NONE	100

If removable, bolts used (describe other fastenings) N/A (Material spec. number, grade, size, number)

8.Type of jacket Jacket closure (Describe as ogee & weld bar, etc.)

If bar, give dimensions If bolted, describe or sketch

9. MAWP 180PSI (Internal) (External) at max temp. 290°F (Internal) (External) Min. design metal temp. 10°F at 180 psi

10. Impact Test NONE [Indicate yes or no and the component(s) impact tested] : test temperature of

11. Hydro., pneu., or comb. test press. NONE Proof Test

Items 12 and 13 to be completed for tube sections.

12. Tubesheet - [Stationary (material spec. no.)] - [Diameter, (subject to pressure)] - (Nominal thickness) - (Corr. Allow,) - [Attachment (welded or bolted)]
N/A Floating (material spec. no.)] (Diameter) (Nominal thickness) (Corr. Allow.) (Attachment)

13. Tubes - (Material spec. no., grade or type) - (O.D.) - (Nominal thickness) - (Number) - [Type (straight or U)]

Items 14-18 incl. To be completed for inner chambers of jacketed vessels or channels of heat exchangers.

14. Shell (a) No. of course(s): 1 (b) Overall length: 1' 10"

Courses			Material	Thickness		Long. Joint (Cat. A)			Circum. Joint (Cat. A, B, & C)			Heat Treatment	
No.	Diameter	Length	Spec./Grade or Type	Nom.	Corr.	Type	Full, Spot, None	Eff.	Type	Full, Spot, None	Eff	Temp.	Time
1	1' 6" Od	1' 10"	SA312TP304L	.25"	0"	S	NONE	100	1	FULL	100	-	-

Form U-2 (Back)

15. Heads: (a) SA965-F304L (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)	(2) ENDS	3.9375"	0"						22.625"			S	NONE	100

If removable, bolts used (describe other fastenings) N/A
(Material spec. number grade, size, number)

16. MAWP 150 psi _____ at max temp. 200°F _____ Min. design metal temp. 10°F at 150 psi
(Internal) (External) (Internal) (External)

17. Impact test NONE at test temperature of _____
[Indicate yes or no and the component(s) impact tested]

18. Hydro., pneu., or comb. test press. _____ Proof Test _____

19. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain, etc)	No.	Diameter or Size	Flange Type	Material		Nozzle Thickness		Reinforcemer Material	How Attached		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr		Nozzle	Flange	
INLET	1	6"-300#	RFWN	SA-312TP304L	SA182F304L	.4320"	0"		UW16.1(c)	TYPE 1	SHELL
OUTLET	1	8"-300#	RFWN	SA-312TP304L	SA182F304L	.5"	0"		UW16.1(c)	TYPE 1	SHELL
INLET	1	4"-150#	RFWN	SA-312TP304L	SA182F304L	.237"	0"		UW16.1(c)	TYPE 1	CHNL
OUTLET	1	4"150#	RFWN	SA-312TP304L	SA182F304L	.237"	0"		UW16.1(c)	TYPE1	CHNL
Vent/drain	2	2"-300#	RFLWN		SA182F304L		0"		UW16.1(c)	FLT	CHNL

20. Identification of Parts:

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

21. Supports: Skirt NO Lugs - Legs - Others - Attached -
(Yes or No) (No.) (No.) (Describe) (Where and how)

22. Remarks
AGR FLASH COOLER. PO# MPC17901. ITEM # HX1065/2065.
SAFETY VALVE(S) SUPPLIED BY OTHERS PER UG-125(a).
NO DESIGN BY J&M WELDING, LLC
WPS QUALIFIED WITH AND WITHOUT PWHT.

CERTIFICATE OF SHOP/FIELD COMPLIANCE

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

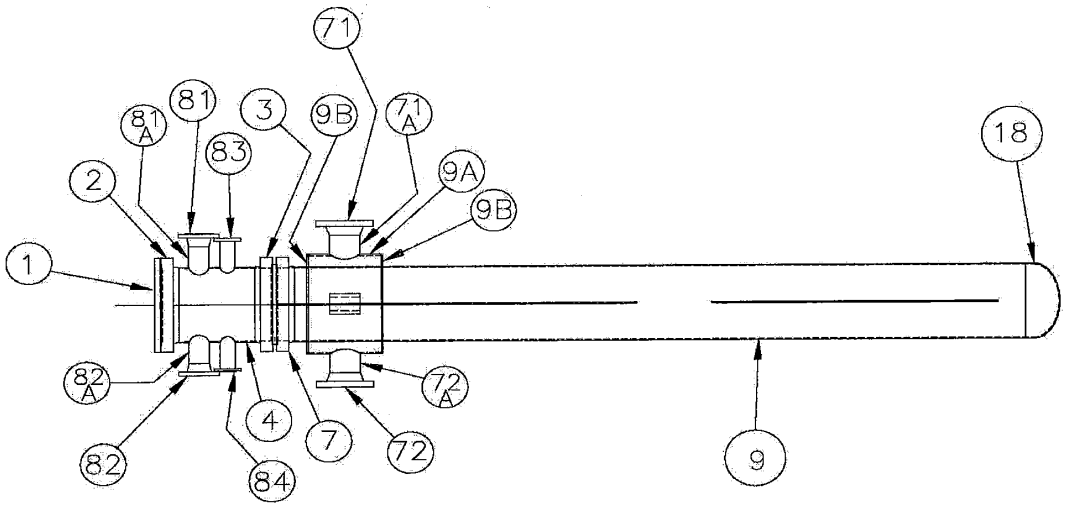
U Certificate of Authorization Number 41,929 Expires 07/18/2014

Date 8/30/12 Name J&M Welding, LLC Signed _____
(Manufacturer) (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/or the State or Province of OKLAHOMA and employed by OneBeacon America Insurance Company of Lynn, Ma. have inspected the pressure vessel part described in this Manufacturer's Data Report on 8/30/12 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 8/30/12 Signed Michael R. Pope Commissions NB9265-A
(Authorized Inspector) [National Board(incl endorsements) State, Province and number]



Mark No	MATERIAL DESCRIPTION		
	SUPPLIERS	HEAT No.	MATERIAL
1	NAS	8PK1	SA-240-304L
2	OKLAHOMA FORGE	50079	SA-965-F304L
3	OKLAHOMA FORGE	50079	SA-965-F304L
4	OUTO KUMPU	401095	SA-312TP304L
7	OKLAHOMA FORGE	50079	SA-965-F304L
9	OUTO KUMPU	401095	SA-312TP304L
9A	BRISMET	742096	SA-312TP304L
9B	ATI	837131	SA-240-304L
18	UNIFORM COMPONENTS	2C890	SA-240-304L
19	NAS	9WT6	SA-240-304L
21	HEAT TRANSFER TUBULAR	1" O.D. x 0.091	SA-213TP304L
71	BEBITZ	82564	SA-182F304L
71A	SUMITOMO METALS	F126013	SA-312TP304L
72	BEBITZ	83171	SA-182F304L
72A	BRISMET	402507	SA-312TP304L
81	BEBITZ	87396	SA-182F304L
81A	BRISMET	400023	SA-312TP304L
82	BEBITZ	87396	SA-182F304L
82A	BRISMET	400023	SA-312TP304L
83	FCI	M359	SA-182F304L
84	FCI	M359	SA-182F304L

CUSTOMER: SOUTHERN COMPANY SERVICES

FABSCO SHELL & TUBE, LLC

		DATE	DWG No	REV
PO NO:	MPC 17901	9/26/2012		
ITEM NO:	HX2065	AC	S11-10279-8-HS	

METALLURGICAL TEST REPORT

NORTH AMERICAN STAINLESS
6870 HIGHWAY 42 EAST
GHENT, KY 41045

6870 HIGHWAY 42 EAST

Certificate: 660875 9

Customer: 002830 021

Mail To:
ROLLED ALLOYS
CUSTOMER PICKUP
289 MIFFLIN DRIVE
WRIGHTSVILLE, PA 17368

Ship To:
ROLLED ALLOYS
CUSTOMER PICKUP
289 MIFFLIN DRIVE
WRIGHTSVILLE, PA 17368

Date: 8/04/2011 Page: 1

Steel: 304/304L

Finish: HRAP

Your Order: S05692

NAS Order: IN 0126036 03

Corrosion: ASTM A262/02aE;180Bend-OK

PRODUCT DESCRIPTION:

STAINLESS STEEL PLATE, HRAP; UNS 30400/30403
ASTM A240/10,A480/10,A666/10; ASME SA240/10,SA480/10,SA666/10
CHEM ONLY ON FOLLOWING ASTM: A276/10,A479/10a,A484/10,A312/09
CHEM ONLY ON FOLLOWING ASME: SA312/10,SA479/10
AMS5511H/5513J XMRK; MIL-S-5059D AMD3(X CRN MEAS); MIL-S-4043B
NACE MR0175/01, MR0103/07; QQS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED
SAE AMS QQ-S-763

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; QQS763F Cond A; RoHS Compliant
Material is Free of Radioactive Contamination
NAS 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	Plate#	Skid #	Thickness	Width	Weight	-------Length------	Mark	Pieces	Commodity Code
028PK1 BB	028PK1 BB		2.0213	60.0000	8,550	PLATE 240.00	13	1	

CHEMICAL ANALYSIS

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

HEAT	CM	C	CR	CU	MN	MO	N	NI	P	S
8PK1	US	.0225	18.2410	.3670	1.8445	.2800	.0772	8.0535	.0325	.0021
		SI								
		.2380								

Tony Cardwell

JAN 03 2012

MECHANICAL PROPERTIES

Product Id#	Plate#	loc	dir	UTS KSI	.2% YS KSI	ELONG %-2"	Hard RB	A 262 Pr A	R of A %
028PK1 BB	028PK1 BB	F	T	90.55	40.65	67.88	78.00	1.00	71.66

HEAT# 8PK1
TRACER# 242100

ROLLED ALLOYS QUALITY ASSURANCE
APPROVED
DATE 8-15-11

NAS hereby certifies that the analysis on this certification is correct and the materi[illegible]eets the specifications stated.

QC ENGINEER
ERIC HESS

8/04/2011

Kemper County MM233798

NAS NORTH AMERICAN STAINLESS

METALLURGICAL TEST REPORT

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

Certificate: 667331 01
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: 8/26/2011 Page: 1
Steel: 304/304L
Finish: HRAP
Corrosion: ASTM A262/02aE;180Bend-OK

Your Order: S05523
NAS Order: AN 0485050 02

PRODUCT DESCRIPTION:

STAINLESS STEEL PLATE, HRAP; UNS 30400/30403
ASTM A240/11,A480/11,A666/10; ASME SA240/10,SA480/10,SA666/10
CHEM ONLY ON FOLLOWING ASTM: A276/10,A479/10a,A484/10,A312/09
CHEM ONLY ON FOLLOWING ASME: SA312/10,SA479/10
AMS5511H/5513J XMRK; MIL-S-5059D AMD3(X CRN MEAS); MIL-S-4043B
NACE MR0175/01, 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; QQS763F Cond A; RoHS Compliant
Material is Free of Radioactive Contamination
NAS 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
039WT6 CA	* 039WT6 CA	2.0000	60.0000	8,225	PLATE	240.00	3	1

CHEMICAL ANALYSIS

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

HEAT	CM	C	CO	CR	CU	MN	MO	N	NI	P
9WT6	US	.0215	.1455	18.0945	.4545	1.7385	.2865	.0784	8.0155	.0305
		S	SI							
		.0013	.2895							

Tony Cardwell
JAN 03 2012

MECHANICAL PROPERTIES

Product ID #	Coil #	loc	dir	UTS KSI	.2% YS KSI	ELONG %-2"	Hard RB	A 262 Pr A	R of A %
039WT6 CA	039WT6 CA	F	T	86.62	40.53	66.45	78.00	OK	71.08

HEAT# 9WT6
TRACER# 243385

ROLLED ALLOYS QUALITY ASSURANCE
APPROVED Harold Sykes
DATE 8/31/11

NAS hereby certifies that the analysis on this certification is correct and the material meets the specifications stated.

QC ENGINEER _____ 8/26/2011
ERIC HESS

2 3 7

OKLAHOMA FORGE, INC.

Certification of Analysis and Tests

INVOICE NUMBER 111-69864

Date: 12/13/11

Toll Free (866)909-5553
Local(918)446-5553 FAX (918)446-4150
e:Mail ~ sales@oklahomaforge.com
Web Site ~ www.oklahomaforge.com
P.O. Box 701500
Tulsa, Oklahoma 74170-1500

Sold To	Your Purchase Order	Sales Order
FABSCO INC P. O. BOX 988 SAPULPA, OK 74066 USA	Number T11-10251-FG By TRACI STAMPS Dated 10/24/2011	Number 111-53769 Shipped Via DELIVERY Ship Date 12/13/2011

PART DESCRIPTION

Item# | Your Part Number | Shop Order Number | Shape | Dimensions | Supplier | Heat Number | Material Specifications | Chemical Analysis | Physical Properties | Charpy Impact (Ft. Lbs.) | Quantity

28 | 10279-1&2-27 | 111-53769-28 | RING | 44.937"OD x 34.500"ID x 5.125"TH | ELECTRALLOY | 50531 | SA965-11 F304/304L SOL. ANNEAL | Qty: 2

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.016	1.79	.025	.002	.51	8.34	18.41		.22						N-.074

Yield Lb/Sqln	Tensile Strength Lb/Sqln	Elong%in 2In	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
0	0	0	0										

29 | 10279-1&2-28 | 111-53769-29 | RING | 44.937"OD x 34.500"ID x 5.250"TH | ELECTRALLOY | 50531 | SA965-11 F304/304L SOL. ANNEAL | Qty: 2

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.016	1.79	.025	.002	.51	8.34	18.41		.22						N-.074

Yield Lb/Sqln	Tensile Strength Lb/Sqln	Elong%in 2In	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
0	0	0	0										

31 | 10279-7&8-2,3,7 | 111-53769-31 | RING | 22.625"OD x 17.500"ID x 3.937"TH | ELECTRALLOY | 50079 | SA965-11 F304/304L SOL. ANNEAL | Qty: 6

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.015	1.78	.028	.022	.54	8.21	18.36		.36						N-.076

Yield Lb/Sqln	Tensile Strength Lb/Sqln	Elong%in 2In	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
41,100	86,000	60	77	152									

Tony Cardwell
DEC 21 2011

Notes: UT REPORT ATTACHED

I CERTIFY THAT THERE IS A TRUE COPY OF THE ORIGINAL TEST SHEET NOW ON FILE AT THE OFFICE OF OKLAHOMA FORGE, INC. AND THAT THIS MATERIAL WAS MELTED AND MANUFACTURED IN THE USA.

Anneal by heating to 1450-1550 degrees F for one hour/inch of thinnest section. Slow cool furnace to 700 degrees F then air cool by opening door.
Normalize by heating to 1650 degrees F, Hold at 1650 degrees F for one hour/inch of thinnest section and air cool.
Solution Anneal by heating to 1900-2050 degrees F and Water Quenching.

F040-9/2011

4 9

OUTOKUMPU

****
* CERTIFICATION *
****

08/15/11
HEAT 401095 ORDER 0025894/003 BO0020711

SHIP TO:
SHAW ALLOY PIPING PRODUCTS, INC.
626 w. 41th Street

TULSA OK 74107

---------- YOUR ORDER & DATE ----------
46732 8/15/11 CUST# ALLPIP01

---------- ITEM DESCRIPTION ----------
18" SCH10 TP304/TP304L A312

Country of Melt : SWE
Country of Mfg. : USA

---------- SPECIFICATIONS ----------

ASTM A312-11/ASME SA312-10
WELDED
MECHANICAL TESTING: ASTM A370
YIELD STRENGTH:0.2% OFFSET
COLD FINISHED
ELECTRIC FUSION WELDED (EFW)
IM EINVERNEHMEN MIT DEM TUV
SUD INDUSTRIE SERVICE GMBH
WIRD AUF EINE GEGENZEICHNUNG
LAUT SCHREIBEN VOM 05.AUGUST
2008 DURCH TUV SUD INDUSTRIE
SERVICE GMBH VERZICHTET

2011 ADDENDA
QUALITY SYSTEM CERTIFIED TO:
PED 97/23/EC ANNEX 1, § 4.3
BY TUV SUD INDUSTRIE SERVICE
GMBH, NOTIFIED BODY 0036
TOLERANCE: ASTM A999
LONGITUDINAL WELDED
RANDOM LENGTHS
PLAIN ENDS
DESCALED, PICKLED, AND
PASSIVATED: ASTM A380

Certificate in conformance with EN10204-95 3.1.B / EN10204-2004 3.1

---------- MECHANICAL & OTHER TESTS ----------

Tensile strength,KSI (MPa)	83.7 (577)
Yield strength,KSI (MPa)	41.1 (283)
Elongation % in 2	50.0
Guided Bend Face	OK
Bend Test	
Hydrotest PSI (MPa)	500 (3.45)

NACE MR0175/ISO 15156:09
HRB-87
NACE MR0103-10

Tony Cardwell
FEB 0 8 2012

---------- CHEMICAL COMPOSITION ----------

Carbon	(C)	.024	Manganese	(Mn)	1.560
Phosphorus	(P)	.027	Sulphur	(S)	.001
Silicon	(Si)	.380	Chromium	(Cr)	18.230
Nickel	(Ni)	8.110	Nitrogen	(N)	.070

CAUTION: Processing that produces fumes and dust may cause respiratory disease: Especially alloys containing Chromium and Nickel.

CERTIFICATION: We certify that the analysis figures are correct as contained in the records of the company and that the material is free of known mercury, asbestos, and low melting alloy contamination. No weld repair unless otherwise noted.

HEAT TREATMENT: Solution annealed at a minimum of 1900 F and water quenched to below 800F within 3 minutes.

Knowingly & willfully falsifying or concealing a material act on this form, or making false, fictitious or fraudulent statements or representations herein could constitute a felony punishable under federal statutes.

We hereby certify that the chemical analysis and/or test results shown in this report are correct as contained in the records of the company.

Martha James

Quality Representative
Martha James

Outokumpu Stainless Pipe, Inc.
ADDRESS
1101 North Main Street
Wildwood, Florida 34785-9601
TELEPHONE
(352) 748-1313
TELEFAX
Administration (352) 748-2751
Purchasing (352) 748-6576
Production Control (352)748-0533
Quality Assurance (352) 748-0533

Pipe/Tube Manufactured by

Brismet

BRISTOL METALS, LLC
IN BRISTOL, TN, USA

MILL TEST REPORT

9A

RM ID NUMBER
101185

SALES ORDER / RLS
002076 / 3

CERT ID / REV
00011284 / 01

SOLD TO

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

CUSTOMER P.O. CUSTOMER PART
TP180003

HEAT NO.
742096

DESCRIPTION:**324001003120200**
24" WELDED PIPE SCHED 10S TP304/TP304L (UNS# S30400/S30403) A312 DOUBLE RANDOM LENGTHS

CERTIFICATION REQUIREMENTS

ENGINEERING
ASTM A312-07 ASME SA312-07, No ADD.

HYDRO PRESSURE
300 PSI

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

Chemical

C	Cr	Mn	Ni	N	P	Si	S
.024	18.12	1.49	8.10	.070	.025	.39	.005

Mechanical

TEST	UNITS	RESULTS
Tensile PSI	**PSI**	**91000**
Yield PSI	**PSI**	**46000**
Elong %		**60**

Hardness

RB83

TEST	RESULT
TG Bend	**Pass**

This test report represents the actual attributes of the items furnished and all items were manufactured, sampled, inspected, and tested in full compliance with applicable specifications and your purchase order.
Certification is in accordance with EN10204:2004 type 3.1.
Chemical content is % by weight. Mechanical test results are in English units (inches and pounds).
No weld repairs have been performed on the base material.
Hardness in accordance with NACE MR0175 and MR0103 and material is free of cold work to enhance mechanical properties.
Pipe is Pickled and Passivated in accordance with ASTM A380.
Bristol Metals has a Quality Management System in place that is in compliance with ISO 9001:2000.
Bristol Metals does not add mercury during any manufacturing process.
NAFTA country of orgin: USA

Tony Cardwell

FEB 0 8 2012

Rick Duncan

Rick Duncan - Quality Assurance Mgr

9B

ATI Allegheny Ludlum

Certificate of Test

Stephen Wolff - Director, Corporate Quality Assurance

500 Green Street
Washington, PA 15301

Mill Information

Cert Number 0103733-00
Sales Order 50-032-356
Cert Date Apr-24-2012

Customer Information

Name ROLLED ALLOYS INC
PO S07762
PO Date Mar-19-2012

Sold to: ROLLED ALLOYS INC
PO BOX 310
TEMPERANCE, MI 48182

Ship to: ROLLED ALLOYS LP
6555 SOUTH 57TH W AVE
TULSA, OK 74131

Material Information

"ATI 304/304L" STAINLESS STEEL
PMP HOT ROLLED PLATE ANNEALED* PICKLED COMMERCIAL CUT EDGE

ASTM-A-240-11B
ASTM-A-262-10 PRACTICE E
AMS 5511H
UNS S30400

ASME-SA-240 ED 2010
AMS 5513J
UNS S30403

Piece Information

Pcs	Gauge (in)	Width (in)	Length (in)	Heat #	Piece ID	Section Id	Lot #	Total Wt (lbs)
Item: 001 Cust-Id: 728033499001 Cust-Job:				Govt-Contract-#: ScheduleB:			Govt-DO-Rating:	
1	.7500	96.0000	272.0000	837131	AA45391	---	410386	5825

Chemistry Testing

Element	Requirements Min	Requirements Max	Final Heat Analysis 837131	Loc
C	---	.030	.019	BN
MN	---	2.00	1.65	BN
P	---	.040	.030	BN
S	---	.030	< .001	BN
SI	---	.75	.36	BN
CR	18.00	19.50	18.07	BN
NI	8.00	10.50	8.02	BN
MO	---	.75	.38	BN
CU	---	.75	.37	BN
N	---	.10	.09	BN

Tony Cardwell
JUL 27 2012

HEAT# 837131
TRACER# 262240
ROLLED ALLOYS QUALITY ASSURANCE
APPROVED
DATE 5/1/12

ALC620 04/25/2012 09:27:47

9B

ATI Allegheny Ludlum

Certificate of Test

Stephen Wolff - Director, Corporate Quality Assurance

500 Green Street
Washington, PA 15301

Mill Information		Customer Information	
Cert Number	0103733-00	Name	ROLLED ALLOYS INC
Sales Order	50-032-356	PO	S07762
Cert Date	Apr-24-2012	PO Date	Mar-19-2012

Chemistry Testing

Allegheny Ludlum performs chemical analysis by the following techniques:
C, S by combustion/infrared; N, O, H by inert fusion/thermal conductivity;
Mn, P, Si, Cr, Ni, Mo, Cu, Cb, Co, V, by WDXRF; Pb, Bi, Ag by GFAA;
B by OES; Al and Ti (>=0.10%) by WDXRF, otherwise by OES.

837131 - Material was produced by EF melting with AOD refining.

Mechanical Testing

	LOT 410386		
Condition:	ANNEALED		
Direction:	TRANSVERSE		
Temperature:	ROOM TEMP		
Spec:			
Test Limit	Units	Result	Loc
YIELD 0.2%	psi	45400.	TC
TENSILE	psi	92000.	TC
ELONGATION	%	58.	TC
RED OF AREA	%	79.	TC
HARDNESS	---	179. HBW	TC

Mechanical Property Requirements

Condition:	ANNEALED		
Direction:	TRANSVERSE		
Temperature:	ROOM TEMP		
Spec:			
Test Limit	Units	Min	Max
YIELD 0.2%	psi	30000.	---
TENSILE	psi	75000.	100000.
ELONGATION	%	40.	---
RED OF AREA	%	---	---
HARDNESS	---	---	201. HBW

Tony Cardwell

JUL 27 2012

HEAT# 837131

TRACER# 262240

ALC620 04/25/2012 09:27:47

9B

ATI Allegheny Ludlum

Certificate of Test

Stephen Wolff - Director, Corporate Quality Assurance

500 Green Street
Washington, PA 15301

Mill Information		Customer Information	
Cert Number	0103733-00	Name	ROLLED ALLOYS INC
Sales Order	50-032-356	PO	S07762
Cert Date	Apr-24-2012	PO Date	Mar-19-2012

Corrosion Testing

Test ID	Result Name	Test Result	Wt Loss	Units	Visual Exam	Pit Depth	Units	Bend	Loc	Requirements
LOT 410386	ASTM-A262 PR E	STEP	---	---	---	---	---	---	TC	---

Certification Statements

Material does not have a continuous carbide network.

Material was solution annealed at 1900F (1038C) minimum for a time commensurate with thickness and rapidly cooled with air or water.

Allegheny Ludlum does not use mercury in the testing or production of its products.

Material is of USA melt and manufacture.

No welds/weld repairs performed.

Knowingly and willfully recording any false, fictitious or fraudulent statement or entry on this document may be punished as a felony under Federal Statutes, including Federal Law, Title 18, Chapter 47.

DIN EN 10204:2005 3.1 Certificate

General Statements

TESTING WAS PERFORMED AT THE FOLLOWING LOCATIONS
BN = ATI-ALLEGHENY LUDLUM; 100 River Road; Brackenridge, PA 15014
TC = ATI-ALLEGHENY LUDLUM; 1300 Pacific Avenue; Natrona Heights, PA 15065
WARNING: Processing that makes fumes, dust, or solutions may cause lung disease. Please see MSDS for further information which has been supplied to your Purchasing Department. For an additional copy, please refer to our web site at www.alleghenyludlum.com/pages/assistance/MSDS.asp.

For access to online Certifications of Test, please register at www.alcextra.com.

The above is a true copy of the data on file. The material and test results conform to the sales contract and specification(s) as set forth in ATI Allegheny Ludlum's order acknowledgement. This certificate of Test may not be reproduced except in full without the written authorization of the company.

ATI Allegheny Ludlum's web site contains a listing of current quality and company accreditations, materials produced, general technical and contact information. Please visit us at www.alleghenyludlum.com.

TRACER # 262240

ALC620 04/25/2012 09:27:47

Tank Head Manufacturing Complex
10703 Sheldon Road
Houston, TX 77044

UNI-FORM COMPONENTS CO.

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

18

Packlist No.	Customer ID
PL-55850	FASHTU

MATERIAL CERTIFICATION

Customer PO No.	UCC Job No.	Date Cert. Originated
T11-10251-HD	100421	12/16/2011

Sold To:
FABSCO SHELL & TUBE INC
2410 INDUSTRIAL RD
SAPULPA OK 74066

Ship To:
FABSCO SHELL & TUBE INC
2410 INDUSTRIAL RD
SAPULPA OK 74066

Ln	Order Qty	Ship Qty	B/O Qty	Part Description
1	2	2	0	**HEAD 2:1 ELLIP,18 OD X 3/8 SA240-304L** 3/16" MIN **Unit of Measure: EA**

Code: 2C890 **HEAT/SLAB:70756/31A** **GRADE: SA240-304L** **Size: 3/8 X 25** **MILL: ATI**

Tony Cardwell
DEC 20 2011

MILL TEST REPORTS ATTACHED

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

1. We hereby certify that these heads were hot formed at 1950 degrees F. and air cooled in strict accordance with all applicable specifications.
2. We hereby certify that these heads comply with tolerances of UG-81 of ASME Section VIII, Div. 1.

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

Stephen Cobb

Quality Control

18

332088A-1 200

ATI Allegheny Ludlum
Allegheny Technologies

UCC QA CB APPROVED

500 Green Street
Washington, PA 15301

CERTIFIED MATERIAL TEST REPORT
CERTIFICATE OF CONFORMANCE

OUR ORDER NO.	MD1412981
YOUR ORDER NO.	6973655
MEMO NO.	074260-00 DUAL CERT
DATE	04/05/2011
SALESMAN NO.	373

Tracy McFarland
Tracy McFarland - Director, Corporate Quality Assurance

Ship To: SAMUEL SPECIALTY METALS
5022 ASHLEY COURT
HOUSTON TX 77041

SAMUEL SON & CO INC
5022 ASHLEY COURT
HOUSTON TX 77041

AL 304/304L HRAP
ASTM A240 10b ASME SA240 10
UNS S30400;
UNS S30403

Heat	Matl ID	Slip	Sid	Lot No	Size(Inches)	Pcs	Weight(lb)	
833650 From Slip 03029 AAB 5315032	05B	70483	AAB	241669	.3750 x 96.0000 x 240.0000	1	2620	253525
833701 From Slip 05051 ABB 5315032	01A	70752	ABB	242231	.3750 x 96.0000 x 240.0000	1	2620	253526
833792 From Slip 07086 ABA 5315032	01B	71008	ABA	242748	.3750 x 96.0000 x 240.0000	1	2620	253527
833792	01B	71009	ABB	242748	.3750 x 96.0000 x 240.0000	1	2620 5315032	253528
833793 From Slip 05112 ABB 5315032	31A	70754	ABB	242344	.3750 x 96.0000 x 240.0000	1	2620	253529
833793	31A	70755	ABA	242344	.3750 x 96.0000 x 240.0000	1	2620 5315032	253530
833793	31A	70756	AAB	242344	.3750 x 96.0000 x 240.0000	1	2620 5315032	253531
833793	31A	70757	AAA	242344	.3750 x 96.0000 x 240.0000	1	2620 5315032	253532
948973 From Slip 09275 AD 5315017	04	71122	AD	243194	.2500 x 96.0000 x 240.0000	1	1773	253519
948973	04	71123	AB	243194	.2500 x 96.0000 x 240.0000	1	1773 5315017	253520
948973	04	71124	AA	243194	.2500 x 96.0000 x 240.0000	1	1773 5315017	253521
948973	C4	71125	AC	243194	.2500 x 96.0000 x 240.0000	1	1773 5315017	253522
948973 From Slip 10127 AA 5315017	06	71279	AA	243442	.2500 x 96.0000 x 240.0000	1	1773	253523
948973 From Slip 10135 AB 5315017	08	71332	AB	243342	.2500 x 96.0000 x 240.0000	1	1773	253524

2080

Tony Cardwell
DEC 20 2011

PAGE 1 CONTINUE ON PAGE 2

Kemper County MM233798

NAS NORTH AMERICAN STAINLESS

METALLURGICAL TEST REPORT

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

Certificate: 667331 01

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: 8/26/2011 Page: 1

Steel: 304/304L

Finish: HRAP

Your Order: S05523 NAS Order: AN 0485050 02

Corrosion: ASTM A262/02aE;180Bend-OK

PRODUCT DESCRIPTION:

STAINLESS STEEL PLATE, HRAP; UNS 30400/30403
ASTM A240/11,A480/11,A666/10; ASME SA240/10,SA480/10,SA666/10
CHEM ONLY ON FOLLOWING ASTM: A276/10,A479/10a,A484/10,A312/09
CHEM ONLY ON FOLLOWING ASME: SA312/10,SA479/10
AMS5511H/5513J XMRK; MIL-S-5059D AMD3(X CRN MEAS); MIL-S-4043B
NACE MR0175/01, 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; QQS763F Cond A; RoHS Compliant
Material is Free of Radioactive Contamination
NAS 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

TAG - 10279-7+8 #19

Product ID #	Coil #	Thickness	Width	Weight	--------Length--------		Mark	Pieces
039WT6 CA	* 039WT6 CA	2.0000	60.0000	8,225	PLATE	240.00	3	1

CHEMICAL ANALYSIS

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

HEAT	CM	C	CO	CR	CU	MN	MO	N	NI	P
9WT6	US	.0215	.1455	18.0945	.4545	1.7385	.2865	.0784	8.0155	.0305
		S	SI							
		.0013	.2895							

Tony Cardwell
JAN 12 2012

MECHANICAL PROPERTIES

Product ID #	Coil #	loc	did r	UTS KSI	.2% YS KSI	ELONG %-2"	Hard RB	A 262 Pr A	R of A %
039WT6 CA	039WT6 CA	F	T	86.62	40.53	66.45	78.00	OK	71.08

HEAT# 9WT6

TRACER# 243385

ROLLED ALLOYS QUALITY ASSURANCE
APPROVED Harold Sykes
DATE 8/31/11

NAS hereby certifies that the analysis on this certification is correct and the material meets the specifications stated.

QC ENGINEER _____ 8/26/2011
ERIC HESS

NAS

6870 HIGHWAY 42 EAST

METALLURGICAL TEST REPORT

NORTH AMERICAN STAINLESS
6870 HIGHWAY 42 EAST
GHENT, KY 41045

Certificate: 660875 9

Customer: 002830 021

Mail To:
ROLLED ALLOYS
CUSTOMER PICKUP
289 MIFFLIN DRIVE
WRIGHTSVILLE, PA 17368

Ship To:
ROLLED ALLOYS
CUSTOMER PICKUP
289 MIFFLIN DRIVE
WRIGHTSVILLE, PA 17368

Date: 8/04/2011 Page: 1

Steel: 304/304L

Finish: HRAP

Your Order: S05692

NAS Order: IN 0126036 03

Corrosion: ASTM A262/02aE;180Bend-OK

PRODUCT DESCRIPTION:

STAINLESS STEEL PLATE, HRAP; UNS 30400/30403
ASTM A240/10,A480/10,A666/10; ASME SA240/10,SA480/10,SA666/10
CHEM ONLY ON FOLLOWING ASTM: A276/10,A479/10a,A484/10,A312/09
CHEM ONLY ON FOLLOWING ASME: SA312/10,SA479/10
AMS5511H/5513J XMRK; MIL-S-5059D AMD3(X CRN MEAS); MIL-S-4043B
NACE MR0175/01, MR0103/07; QQS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED
SAE AMS QQ-S-763

REMARKS:

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; QQS763F Cond A; RoHS Compliant
Material is Free of Radioactive Contamination
NAS 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

TAG-10279-7+8 #1

Product Id	Plate#	Skid #	Thickness	Width	Weight	-------Length------		Mark	Pieces	Commodity Code
028PK1 BB	028PK1 BB		2.0213	60.0000	8,550	PLATE	240.00	13	1	

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

HEAT	CM	C	CR	CU	MN	MO	N	NI	P	S
8PK1	US	.0225	18.2410	.3670	1.8445	.2800	.0772	8.0535	.0325	.0021
		SI								
		.2380								

Tony Cardwell
JAN 12 2012

MECHANICAL PROPERTIES

Product Id#	Plate#	loc	dir	UTS KSI	.2% YS KSI	ELONG %-2"	Hard RB	A 262 Pr A	R of A %
028PK1 BB	028PK1 BB	F	T	90.55	40.65	67.88	78.00	1.00	71.66

HEAT# 8PK1
TRACER# 242100

ROLLED ALLOYS QUALITY ASSURANCE
APPROVED
DATE 8-15-11

NAS hereby certifies that the analysis on this certification is correct and ma[illegible] meets the specifications stated.

QC ENGINEER _____ 8/0[illegible]11
ERIC HESS

Kemper County MM233798

Heat Transfer
Tubular Products L.L.C.

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MANUFACTURER'S CERTIFICATE OF COMPLIANCE

CUSTOMER: Fasbco

CUSTOMER ORDER NO: T11-10279-T

CUSTOMER JOB NO: 10279-7-21 TAG-10279-7+8 #21

OUR ORDER NO: 2296B

PRODUCT DESCRIPTION: 1" OD X .091" AW X SA213/304

DATE: 1/25/2012

ALL U-BENDS WERE SOLUTION ANNELED IN ACCORDANCE WITH SA-688.

Tony Cardwell

FEB 0 8 2012

WE CERTIFY THAT THIS MATERIAL HAS BEEN MANUFACTURED, INSPECTED, AND TESTED IN ACCORDANCE WITH THE SPECIFICATIONS TO WHICH IT WAS ORDERED, AND THAT THE ABOVE INFORMATION IS CORRECT AS CONTAINED IN THE RECORDS OF THIS CORPORATION.

12225 FM 529 Houston, Texas 77041 Tel: 281-531-8088 Fax: 281-531-8099 www.httproducts.com

SALZGITTER MANNESMANN STAINLESS TUBES
A Member of the Salzgitter Group

Salzgitter Mannesmann Stainless Tubes USA, Inc (A01)
12050 West Little York - Houston, TX 77041 - USA
www.smst-tubes.com

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INSPECTION CERTIFICATE
Abnahmeprüfzeugnis
Certificat de réception

EN 10204: 2004 TYPE 3.1 (A02)

No/Nr/N° (A03)

240447-1&2

Salzgitter Mannesmann Stainless Tubes USA, Inc - 12050 West Little York - Houston, TX 77041 - USA
HEAT TRANSFER TUBULAR PRODUCTS
12225 FM 529
77041 HOUSTON
USA

Purchaser/Besteller/Acheteur

Customer order no./Kunde Auftragsnr./N° Commande client (A07)
2296B
SMST-Tubes order no/Auftragsnr./N° Commande (A08)
0000240447

SMST-Tubes item	**Part number/Teilenummer/N° d'article (A09)**
0000240447-000001	58 PCS X 33'-0" Row A, B, C, D
0000240447-000002	48 PCS X 34'-0" Row E, F, G, H & Spares

Product Description/Produkt Beschreibung/Description du produit (B01) (B02) (B04)

Seamless Stainless Steel Cold Finished Tubes pickled Plain Ends Square Cut Deburred
Kaltgefertigte, nahtlose Edelstahlrohre pickled Enden Glatt Abgeschnitten
Tubes en Acier Inox Sans Soudure Finis à Froid pickled Coupés d'equerre, lisses, ébavuré

Specifications/Spezifikationen/Spécifications ASME SA 213 08 a / NACE MR0103 2007 / NACE MR0175/ISO 15156-3 2009

Grade/Werkstoff/Nuance TP 304 / TP 304L

Tolerances/Toleranzen/Tolérances SA 213 / A 1016 AW

Marking of the product/Kennzeichnung des Produktes/Marquage du produit (B06-D01)
DMV 1.000 X .091AW TP 304/ TP 304L SA-213 HT (XXX) SML CF 240447-(X) ET PHU(XXX) QL(XXX) USA

Quantity/Menge/Quantité

Heat no Schmelze Nr. N° de Coulée	Quality lot Qualitätslos Lot qualité	SMST item	Pieces Stück Pièces (B08)	Total weight Gesamtgewicht Masse totale (B13)	Total length Gesamtlänge Longueur totale	Dimensions Abmessungen OD (B09)	WT (B10)	Tube length Rohrlänge Longueur tube min (B11)	max
QL345	QL50000823	000001	58	1741 Lbs	1,914.00 Ft	1.000 "	0.091 "	33 Ft	33 Ft
QL347	QL50000829	000002	48	1491 Lbs	1,632.00 Ft	1.000 "	0.091 "	34 Ft	34 Ft
		Total	106	3232 Lbs	3,546.00 Ft				

Chemical Analysis / Chemische Zusammensetzung / Analyse chimique (C71 - C92)

Heat no/Schmelzen Nr./N° de coulée QL345

Melting Process/Erschmelzungsart/Élaboration (C70) E+AOD or VOD

Country of origin / Herstellungsland/Pays d'origine Germany

Heat Analysis / Analyse de coulée

	C	Si	Mn	P	S	Cr	Ni
Min	0.00	0.00	0.00	0.00	0.00	18.00	8.00
Max	0.035	1.00	2.00	0.045	0.0300	20.00	11.00
	0,017	0,35	1,91	0,023	0,008	18,13	10,10

Tony Cardwell
FEB 0 8 2012

Quality Lot : QL50000823

Product Analysis / Analyse du produit

ASME SA 213

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No/Nr/N° (A03)

240447-1&2

	C	Si	Mn	P	S	Cr	Ni
Min	0.000	0.00	0.00	0.000	0.0000	18.00	8.00
Max	0.035	1.00	2.00	0.045	0.0300	20.00	11.00
50003258	0.020	0,36	1,96	0,029	0,0079	18,12	10,28

Chemical Analysis / Chemische Zusammensetzung / Analyse chimique (C71 - C92)

Heat no/Schmelzen Nr./N° de coulée QL347

Melting Process/Erschmelzungsart/Élaboration (C70) E+AOD or VOD

Country of origin / Herstellungsland/Pays d'origine Germany

Heat Analysis / Analyse de coulée

	C	Si	Mn	P	S	Cr	Ni
Min	0.00	0.00	0.00	0.00	0.00	18.00	8.00
Max	0.035	1.00	2.00	0.045	0.0300	20.00	11.00
	0,019	0,25	1,91	0,023	0,010	18,28	10,15

Quality Lot : QL50000829

ASME SA 213

Product Analysis / Analyse du produit

	C	Si	Mn	P	S	Cr	Ni
Min	0.000	0.00	0.00	0.000	0.0000	18.00	8.00
Max	0.035	1.00	2.00	0.045	0.0300	20.00	11.00
50003280	0.023	0,27	1,95	0,028	0,0090	18,25	10,29

Tony Cardwell

FEB 0 8 2012

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EN 10204: 2004 TYPE 3.1 (A02)

No/Nr/N° (A03)

240447-1&2

Mechanical testing

Quality Lot : QL50000823

Tensile test at room temperature/Zugversuch bei Raumtemperatur/Essai de traction à température ambiante (C10)

ASTM A 370

Test no Proben Nr. N° d'échantillon (C00)	Direction Probenricht ung Direction (C02)	Yield strength/Dehngrenze/Limite d'élasticité (C11)			Tensile strength / Zugfestigkeit / Résistance à la traction (C12)	Elongation/Bruchdehnung/Allongement (C13)					Reduction of area Z%
		0.2 %	0.5 %	1 %		2 "	50 mm	5D	5,65 √So	4D	
		ksi	/	/	ksi	%	/	/	/	/	/
	Min	30	/	/	75	35	/	/	/	/	/
	Max	/	/	/	/	/	/	/	/	/	/
50003258	LONGITUDINAL	38,90	/	/	90,00	53.90	/	/	/	/	/
50003287	LONGITUDINAL	36,50	/	/	91,10	55.91	/	/	/	/	/

ırdness test/Härteprüfung/Essai de dureté (C30)

ASTM A 370 NACE MR0175/ISO 15156-3 NACE MR0103

Load /

Test no Proben Nr. N° d'échantillon	HB			HRC			HV			HRB			HR 15-T			HR 30-T		
Min	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Max	/	/	/	22	22	22	/	/	/	90	90	90	90	/	/	90	/	/
	min	max	avg	min	max	avg	min	max	avg	min	max	avg	min	max	avg	min	max	avg
50003257	0,0	0,0	0	0,0	0,0	0,00	0,0	0,0	0,00	65,0	68,0	66,50	/	/	/	/	/	/
50003258	0,0	0,0	0	0,0	0,0	0,00	0,0	0,0	0,00	68,0	70,0	69,00	/	/	/	/	/	/

Flattening test/Faltversuch/Essai d'aplatissement (C50)

ASTM A 1016

Test Number	Result
50003258	OK
50003258	OK

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FEB 0 8 2012

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No/Nr/N° (A03)

240447-1&2

Flaring test/Aufweiteversuch/Essai d'évasement (C51)

ASTM A 1016

Test Number	Result
50003258	OK
50003258	OK

Tony Cardwell

FEB 0 8 2012

Quality Lot : QL50000829

Tensile test at room temperature/Zugversuch bei Raumtemperatur/Essai de traction à température ambiante (C10)

ASTM A 370

Test no Proben Nr. N° d'échantillon (C00)	Direction Probenrichtung Direction (C02)	Yield strength/Dehngrenze/Limite d'élasticité (C11)			Tensile strength / Zugfestigkeit / Résistance à la traction (C12)	Elongation/Bruchdehnung/Allongement (C13)					Reduction of area Z%
		0.2 %	0.5 %	1 %		2 "	50 mm	5D	5,65 √So	4D	
		ksi	/	/	ksi	%	/	/	/	/	/
	Min	30	/	/	75	35	/	/	/	/	/
	Max	/	/	/	/	/	/	/	/	/	/
50003280	LONGITUDINAL	40,90	/	/	94,10	51.30	/	/	/	/	/
50003288	LONGITUDINAL	45,80	/	/	95,80	49.90	/	/	/	/	/

Hardness test/Härteprüfung/Essai de dureté (C30)

ASTM A 370 NACE MR0175/ISO 15156-3 NACE MR0103

Load /

Test no Proben Nr. N° d'échantillon	HB			HRC			HV			HRB			HR 15-T			HR 30-T		
Min	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Max	/	/	/	22	22	22	/	/	/	90	90	90	90	/	/	90	/	/
	min	max	avg	min	max	avg	min	max	avg	min	max	avg	min	max	avg	min	max	avg
50003279	0,0	0,0	0	0,0	0,0	0,00	0,0	0,0	0,00	67,0	68,0	67,50	/	/	/	/	/	/
50003280	0,0	0,0	0	0,0	0,0	0,00	0,0	0,0	0,00	69,0	71,0	70,00	/	/	/	/	/	/

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No/Nr/N° (A03)

240447-1&2

Flattening test/Faltversuch/Essai d'aplatissement (C50) **ASTM A 1016**

Test Number	Result
50003280	OK
50003280	OK

Flaring test/Aufweiteversuch/Essai d'évasement (C51) **ASTM A 1016**

Test Number	Result
50003280	OK
50003280	OK

Tony Cardwell

FEB 0 8 2012

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No/Nr/N° (A03)

240447-1&2

Other Tests and Declarations / Andere Prüfungen und Prüffeststellungen / Autres tests et déclarations

QL50000823

QL50000829

Heat treatment / Wärmebehandlung/Traitement thermique, 1950°F and water quenched

Eddy Current tested in accordance with ASTM E-426/ 12-1/2% Notch /Result - Satisfactory

No Weld repair / Keine Reparaturschweissung / Aucune réparation par soudure

The material is conforming to directive 2000/53/EC, 2002/95/EC and CD 2005/618/EC. / Das Material entspricht den Anforderungen der Richtlinien 2000/53/EC, 2002/95/EC und CD 2005/618/EC. / Le matériau est conforme aux directives 2000/53/EC, 2002/95/EC et CD 2005/618/EC.

Tubes are free from mercury contamination and from radioactive contamination / Die Rohre sind frei von Quecksilberverunreinigungen und frei vom radioaktiver Verunreinigung / Les tubes sont exempts de contamination par le mercure et de contamination radioactive

Confirmation with reference to Pressure Equipment Directive 97/23/EC:
The works operates a quality management system that has undergone a specific assessment for materials for pressure equipment and is certified by a competent body (ABS QE Cert. No. 30788)
Bestätigung in Bezug auf Druckgeräterichtlinie 97/23/EC:
Das Werk wendet ein Qualitätsmanagementsystem an, das in Bezug auf Werkstoffe für Druckgeräte einer spezifischen Bewertung unterzogen wurde und von einer zuständigen Stelle (ABS QE Cert. No. 30788) zertifiziert ist.
Confirmation concernant la Directive Equipements sous Pression 97/23/EC : L'usine applique un système de management de la qualité qui a fait l'objet d'une évaluation spécifique pour les matériaux pour équipements sous pression et qui est certifié par un organisme compétent (ABS QE Cert. No. 30788)

SOLUTION ANNEALED, PICKLED AND PASSIVATED.

SMST certify that the delivered products comply with the requirements stipulated in the order. / Die Erzeugnisse wurden bestellungsgemäß geprüft und für in Ordnung befunden. / SMST-Tubes atteste que les produits livrés sont conformes aux stipulations de la commande.

Validation by manufacturer's representative / Validierung durch Vertreter des Herstellers

Mill's Inspector
Werksachverständiger
Le contrôleur usine

Raynee Rangel - Quality Technical Analyst

Raynee Rangel

Date of edition
Ausgabedatum 06/07/2011
Date d'édition

Tony Cardwell

FEB 0 8 2012

Salzgitter Mannesmann Stainless Tubes USA, Inc

EN ISO 9001 : 2008
Zertifikat-Registrier-Nr. 44 100 071888

BEBITZ
Bereich Flansche

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

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Abnahmeprüfzeugnis 3.1 / Inspection certificate 3.1 / Certificat de reception 3.1

nach (A02) / acc. DIN EN 10204 : 2005 Nr. (A03) / No. 11-02624 **Datum (Z02) / Date** 31.01.2011

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

Stempel des Abnehmers (Z03) / Stamp of the testing engineer: TKO 7

Überprüft als Hersteller nach AD-Merkblatt W0 / TRD100 und VdTÜV Werkstoffblätter 350/3, 354, 399. / Approved as manufacturer acc. AD-Merkblatt W0 / TRD100 and VdTÜV Material Sheets 350/3, 354, 399.
Zertifiziert nach DGR 97/23/EG durch TÜV CERT Zertifzierungsst. für Druckgeräte der TÜV NORD GmbH Co KG, Benannte Stelle Nr. 0045. / Certified acc. to PED 97/23/EC, certifying body for pressure equipment TÜV NORD GmbH Co KG, registration no. 0045.

Besteller (A06) Customer
Industrial Piping Specialists, Inc.
P.O. Box 581270
TULSA, OK 74158-1270

Bestell-Nr (A07) / Order-No. TP276692
Auftrag (A08) / Order 3021809
Lieferschein / Delivery No. 3130566
Position (B07.1) / Item 055RB

Stck (B08) Quantity	Bezeichnung (B01; B09 - B11) Product	Schmelze/Prüflos (B07) Heat no./Test no.
6	6 inch Welding Neck Flange 300 lbs S80s raised face	82564/1

Material (B02; B05) F 304/F 304L - ASTM A 182M-09a / ASME SA-182M
austenitis. > 1040 °C and quenched in water

Anford. (B03) Require-ments
ASME B 16.5-2009
NACE MR0175-2002 / MR0103-2007 - DIN EN ISO 15156-3 : 2005
2010 ASME Boiler & Pressure Vessel Code - Section II Part A
PMI-tested 100%, IC-test acc. to DIN EN ISO 3651-2 Test A / ASTM A 262 practice E

Schmelzenanalyse (C71 - C92) / Ladle analysis **Erschmelzung (C70) / Melting process** E

C	Si	Mn	P	S	Cr	Ni	Ti	Mo	Nb	V	N	Cu	Al	PREN
0,023	0,47	1,75	0,036	0,005	18,34	8,04					0,079			19,60

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

Mechanische Prüfungen / Mechanical tests

Probenlage (C02): q/t / Position of Specimen: q/t
Zugversuch / Tensile Test - ASTM A 370 — $l_0 = 4\,d_0$
KBV / Charpy Impact Test DIN EN 10045-1
Härte (C32) Hardness ISO 6506

Temp (C03) °C	Streckgr. (C11) / Yield strength 0,2% MPa (N/mm²)	1,0% MPa (N/mm²)	Zugfestigk. (C12) Tensile strength MPa (N/mm²)	Dehng. (C13) Elongation %	Einschnürg. Red. of area %	Temp. (C03) °C	Einzelwerte (C42) Single values J	MW (C43) Average J	Härte (C32) HBW 2,5/187,5
20	min 205 max		515	30,0	50	20			
20	297	324	577	63,3	76	20	138 150 144	144,0	168

Tony Cardwell

TAG-10279-7+8 #71

FEB 0 8 2012

Besichtigung und Ausmessung ohne Beanstandungen. (D01) / Results of inspection and dimension without objections.
Die gestellten Anforderungen sind erfüllt. (Z01) / The product meets the requirements.

R. Sparing,
Abnahmebeauftragter des Herstellers (Z02)
Inspection Representative of the Manufacturer

APZ wurde mit EDV erstellt und ist ohne Unterschrift gültig. / This MTR was electronically generated and is valid without a signature

[FABSCO SHELL & | T12-10279-FL | | | F126013] T0254055-1 | SSU680S304/LSL [LN: 39] [KAH]

71A

SUMITOMO METAL INDUSTRIES, LTD.
STEEL TUBE WORKS
1, NISHINO-CHO, HIGASHI-MUKOJIMA, AMAGASAKI, JAPAN

SSU680S304/LSL

INSPECTION CERTIFICATE

CERTIFICATE NO. :0YYU5273 PAGE : 1/1 DATE : 2011-08-08

CUSTOMER :MARUBENI-ITOCHU TUBULARS AMERICA INC.
ORDER NO. :HR030934
SHIPPER :K AND I TUBULAR CORP. 194 JH2 LZD66108 1P13J001601
COMMODITY :HOT FINISHED STAINLESS PIPE
STANDARD :ASTM A312-09 / ASME 2010 SA-312 TP304 ASTM A312-09 / ASME 2010 SA-312 TP304L
ASTM A376-06 / ASME 2010 SA-376 TP304
SPECIFICATION :
MILL WORK NO. :0YYU5273 O.D.:NPS6 W.T.:SCH80S LENGTH:MIN. 20feet MAX. 24feet QUANTITY:14pcs.
TOTAL LENGTH:316.66feet MASS:4099kg

HEAT NO. :F123012 F124108 F126013
PRODUCTS PCS. :1 4 9

HEAT TREATMENT :SOLUTION TREATED(1940°F X 2min. W.Q.)

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.									
F123012		L	20	30	176	34	0	183	82
F124108		L	25	29	182	36	0	185	84
F126013		L	23	33	177	34	0	183	81

*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.								
F123012		L	B	P	40.3	P	88.8	62
F124108		L	B	P	41.7	P	89.1	62
F126013		L	B	P	40.8	P	89.4	62

TYPE OF SPECIMEN:STRIP 1in. WIDTH *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(MIL-P-1144D) : ACCEPTABLE
CORROSION TEST(MIL-P-24691/3) : GUARANTEED
FLATTENING TEST: ACCEPTABLE
VISUAL & DIMENSIONS: ACCEPTABLE
ULTRASONIC EXAMINATION(ASME SA-999/SE-213 U-SHAPED NOTCH) : ACCEPTABLE
NACE MR0175 HARDNESS: GUARANTEED
NO WELD REPAIR
MERCURY FREE
CERTIFIED ACCORDING TO PED97/23/EC, ANNEX I, PAR 4.3 BY TUEV RHEINLAND INDUSTRIE SERVICE GmbH
(NOTIFIED BODY, ID-No. 0035/CERTIFICATE NO. 01 202 J/Q-02 008)
NACE MR0103 HARDNESS: GUARANTEED
EN 10204 3.1

Tony Cardwell
FEB 08 2012

WE HEREBY CERTIFY THAT THE MATERIAL HEREIN DESCRIBED HAS BEEN MANUFACTURED, SAMPLED, TESTED, AND INSPECTED IN ACCORDANCE WITH ABOVE STANDARD AND SPECIFICATION AND SATISFIES THE REQUIREMENTS.

MANAGER, QUALITY ASSURANCE SECTION

NO. 025594A11

<An Important Message To Our Customers>
This certification is intended only for products listed. Modification to or unauthorized use of this certification is strictly prohibited. Offences may be regarded as forgery of documents and be subject to criminal prosecution.
If you have any questions on this certification, you can contact us by facsimile or e-mail as shown below;
Fax. No. : +81-3-4416-6789 E-mail:pipe-ipp@sumitomometals.co.jp

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BEBITZ

Bereich Flansche

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

EN ISO 9001 : 2008
Zertifikat-Registrier-Nr. 44 100 071888

Abnahmeprüfzeugnis 3.1 / Inspection certificate 3.1 / Certificat de reception 3.1

nach (A02) / acc. DIN EN 10204 : 2005 **Nr. (A03) / No.** 10-25464 **Datum (Z02) / Date** 01.12.2010

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

Stempel des Abnehmers (Z03) / Stamp of the testing engineer: TKO 7

Überprüft als Hersteller nach AD-Merkblatt W0 / TRD100 und VdTÜV Werkstoffblätter 350/3, 354, 399. / Approved as manufacturer acc. AD-Merkblatt W0 / TRD100 and VdTÜV Material Sheets 350/3, 354, 399.
Zertifiziert nach DGR 97/23/EG durch TÜV CERT Zertifizierungsst. für Druckgeräte der TÜV NORD GmbH Co KG, Benannte Stelle Nr. 0045. / Certified acc. to PED 97/23/EC, certifying body for pressure equipment TÜV NORD GmbH Co KG, registration no. 0045.

Besteller (A06) / Customer: Industrial Piping Specialists, Inc.
P.O. Box 581270
TULSA, OK 74158-1270

Bestell-Nr (A07) / Order-No. TP276692
Auftrag (A08) / Order 3021809
Lieferschein / Delivery No. 3035716
Position (B07.1) / Item 056RB
Schmelze/Prüflos (B07) / Heat no./Test no. 83171/1

Stck (B08) / Quantity	Bezeichnung (B01; B09 - B11) / Product
20	8 inch Welding Neck Flange 300 lbs S80s raised face

Material (B02; B05): F 304/F 304L - ASTM A 182M-09a / ASME SA-182M
austenitis. > 1040 °C and quenched in water

Anford. (B03) Require-ments: ASME B 16.5-2009
NACE MR0175-2002 / MR0103-2007 - DIN EN ISO 15156 (all parts, last editions)
2007 / 2008a ASME Boiler & Pressure Vessel Code - Section II Part A
PMI-tested 100%, IC-test acc. to DIN EN ISO 3651-2 Test A / ASTM A 262 practice E

Schmelzenanalyse (C71 - C92) / Ladle analysis — **Erschmelzung (C70) / Melting process** E

C	Si	Mn	P	S	Cr	Ni	Ti	Mo	Nb	V	N	Cu	Al	PREN
0,019	0,41	1,71	0,037	0,026	18,28	8,05					0,085			19,64

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

Mechanische Prüfungen / Mechanical tests

Probenlage (C02): q/t / Position of Specimen: q/t — $l_0 = 4\,d_0$

Zugversuch / Tensile Test - ASTM A 370						KBV / Charpy Impact Test DIN EN 10045-1				Härte (C32) Hardness ISO 6506
Temp (C03) °C	Streckgr. (C11) / Yield strength 0,2% MPa (N/mm²)	1,0% MPa (N/mm²)	Zugfestigk. (C12) Tensile strength MPa (N/mm²)	Dehng. (C13) Elongation %	Einschnürg. Red. of area %	Temp. (C03) °C	Einzelwerte (C42) Single values J		MW (C43) Average J	HBW 2,5/187,5
20	min 205 max		515	30,0	50	20				
20	285	311	591	60,2	77	20	148	136 152	145,3	169

Tony Cardwell

FEB 0 8 2012

Pipe/Tube Manufactured by

Brismet

BRISTOL METALS, LLC
IN BRISTOL, TN, USA

MILL TEST REPORT

72A

RM ID NUMBER
113248

SALES ORDER / RLS
005032 / 3

CERT ID / REV
00043755 / 01

SOLD TO

INDUSTRIAL PIPING SPECIALISTS
PO BOX 581270
TULSA, OK 74158-1270
USA

CUSTOMER P.O. **TP262782**

CUSTOMER PART

HEAT NO. **402507**

DESCRIPTION:**308008003121200**
8" WELDED PIPE SCHED 80S TP304/TP304L (UNS#S30400/S30403) A312 XRAY DOUBLE RANDOM LENGTH

CERTIFICATION REQUIREMENTS

ENGINEERING
ASTM A312-09 ASME SA312-10, No ADD.

HYDRO PRESSURE
1,700 PSI

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

Physical

'ountry of Origin
,weden

Chemical

C	Cr	Co	Cu	Mn	Mo	Ni	N	P	Si	S
.019	18.26	.140	.34	1.54	.004	8.11	.067	.029	.32	.001

Mechanical

TEST	UNITS	RESULTS
Tensile PSI	PSI	89000
Yield PSI	PSI	47000
Elong %		58

Hardness
HB174

TEST	RESULT
TG Bend	Pass

Tony Cardwell

FEB 0 8 2012

NDE

TEST	RESULT
100% Radiography	Pass

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

Rick Duncan

Rick Duncan - Quality Assurance Mgr

Pipe/Tube Manufactured by

Brismet

BRISTOL METALS, LLC
IN BRISTOL, TN, USA

MILL TEST REPORT

72A

RM ID NUMBER
113248

SALES ORDER / RLS
005032 / 3

CERT ID / REV
00043755 / 01

SOLD TO

INDUSTRIAL PIPING SPECIALISTS
PO BOX 581270
TULSA, OK 74158-1270
USA

CUSTOMER P.O.	CUSTOMER PART	HEAT NO.
TP262782		402507

Raw Material Melt Source Sweden
FAR BAA-Cannot certify compliance, DFARS BAA-Complies, FAA TAA-Complies

Tony Cardwell

FEB 0 8 2012

Rick Duncan

Rick Duncan - Quality Assurance Mgr

81

82

BEBITZ

Bereich Flansche

EN ISO 9001 : 2008
Zertifikat-Registrier-Nr. 44 100 071888

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

Abnahmeprüfzeugnis 3.1 / Inspection certificate 3.1 / Certificat de reception 3.1

nach (A02) / acc. DIN EN 10204 : 2005 Nr. (A03) / No. 11-29255 **Datum (Z02) / Date** 22.11.2011

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

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

Überprüft als Hersteller nach AD-Merkblatt W0 / TRD100 und VdTÜV Werkstoffblätter 350/3, 354, 399. / Approved as manufacturer acc. AD-Merkblatt W0 / TRD100 and VdTÜV Material Sheets 350/3, 354, 399.
Zertifiziert nach DGR 97/23/EG durch TÜV CERT Zertifzierungsst. für Druckgeräte der TÜV NORD GmbH Co KG, Benannte Stelle Nr. 0045. / Certified acc. to PED 97/23/EC, certifying body for pressure equipment TÜV NORD GmbH Co KG, registration no. 0045.

Besteller (A06) Customer: Industrial Piping Specialists, Inc.
P.O. Box 581270
TULSA, OK 74158-1270

Bestell-Nr (A07) / Order-No. TP309026
Auftrag (A08) / Order 3121678
Lieferschein / Delivery No. 3136208
Position (B07.1) / Item 020RB

Stck (B08) Quantity	Bezeichnung (B01; B09 - B11) Product	Schmelze/Prüflos (B07) Heat no./Test no.
35	4 inch Welding Neck Flange 150 lbs S40s raised face	87396/1

Material (B02; B05): F 304/F 304L - ASTM A 182M-10 / ASME SA-182M
austenitis. > 1040 °C and quenched in water

Anford. (B03) Requirements: ASME B 16.5-2009
NACE MR0175-2003 / MR0103-2007 - DIN EN ISO 15156-3 : 2005
2010 ASME Boiler & Pressure Vessel Code - Section II Part A
PMI-tested 100%, IC-test acc. to DIN EN ISO 3651-2 Test A / ASTM A 262 practice E

Schmelzenanalyse (C71 - C92) / Ladle analysis — **Erschmelzung (C70) / Melting process** E

C	Si	Mn	P	S	Cr	Ni	Ti	Mo	Nb	V	N	Cu	Al	PREN
0,017	0,46	1,74	0,035	0,013	18,21	8,13					0,070			19,33

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

Mechanische Prüfungen / Mechanical tests

Probenlage (C02): q/t / Position of Specimen: q/t
Zugversuch / Tensile Test - ASTM A 370 — $l_0 = 4\,d_0$

Temp (C03) °C	Streckgr. (C11) / Yield strength 0,2% MPa (N/mm²)	1,0% MPa (N/mm²)	Zugfestigk. (C12) Tensile strength MPa (N/mm²)	Dehng. (C13) Elongation %	Einschnürg. Red. of area %
20	min 205 max		515	30,0	50
20	282	317	575	59,3	72

KBV / Charpy Impact Test DIN EN ISO 148-1

Temp. (C03) °C	Einzelwerte (C42) Single values J			MW (C43) Average J
20				
20	166	160	172	166,0

Härte (C32) Hardness ISO 6506-1 HBW 2,5/187,5

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Besichtigung und Ausmessung ohne Beanstandungen. (D01) / Results of inspection and dimension without objections.
Die gestellten Anforderungen sind erfüllt. (Z01) / The product meets the requirements.

R. Sparing,
Abnahmebeauftragter des Herstellers (Z02)
Inspection Representative of the Manufacturer

APZ wurde mit EDV erstellt und ist ohne Unterschrift gültig. / This MTR was electronically generated and is valid without a signature.

Tony Cardwell

FEB 0 8 2012

Pipe/Tube Manufactured by

Arismet
BRISTOL METALS, LLC
IN BRISTOL, TN, USA

BR440S04/L

MILL TEST REPORT

RM ID NUMBER
110061

SALES ORDER / RLS
004732 / 5

CERT ID / REV
00033611 / 01

81A
82A

SOLD TO

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

CUSTOMER P.O. **TP255793**

CUSTOMER PART

HEAT NO. **400023**

DESCRIPTION **304004003120200**
4" WELDED PIPE SCHED 40S TP304/TP304L (UNS# S30400/S30403) A312 DOUBLE RANDOM LENGTHS

CERTIFICATION REQUIREMENTS
~~ENGINEERING~~
ASTM A312-09 ASME SA312-07, 09 ADD.

HYDRO PRESSURE
1,600 PSI

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

Chemical

C	Cr	Mn	Ni	N	P	Si	S
.021	18.12	1.366	8.10	.0440	.029	.458	.0120

Mechanical

TEST	UNITS	RESULTS
Tensile PSI	PSI	87300
Yield PSI	PSI	39600
Elong %		57.6

Hardness

RB81

TEST	RESULT
TG Bend	Pass

This test report represents the actual attributes of the items furnished and all items were manufactured, sampled, inspected, and tested in full compliance with applicable specifications and your purchase order.
Certification is in accordance with EN10204:2004 type 3.1.
Chemical content is % by weight. Mechanical test results are in English units (inches and pounds).
No weld repairs have been performed on the base material.
Hardness in accordance with NACE MR0175 and MR0103 and material is free of cold work to enhance mechanical properties.
Pipe is Pickled and Passivated in accordance with ASTM A380.
Bristol Metals has a Quality Management System in place that is in compliance with ISO 9001:2000.
Bristol Metals does not add mercury during any manufacturing process.
NAFTA country of orgin: USA
Raw Material Melt Source USA
FAR BAA - Complies, DFARS BAA - Complies, FAR TAA - Complies

Tony Cardwell

FEB 08 2012

Rick Duncan

Rick Duncan - Quality Assurance Mgr

[FABSCO SHELL & | T12-10279-FL | | | M359] T0254055-4 | TP330675 [LN: 1] [KAH]

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FCI FORGED COMPONENTS INC.

14527 Smith Rd.
Humble, Texas 7739
TEL: (281) 441-4088
FAX: (281) 441-8899

REPORT NUMBER 58984
DATE 2/10/2012
FCI ORDER NUMBER 55006
Processed I.A.W. EN10204 3.1

CUSTOMER ORDER NUMBER TP330675
SOLD/SHIPPED TO IPS (TULSA)
606 NORTH 145 EAST AVE
TULSA OK 74116 USA

Item	Quantity	Description
1	2	2" X 600 X 9" LG RF LWN
2	2	2" X 600 X 9" LG RF LWN
4	2	2" X 300 X 9" LG RF LWN
5	2	2" X 300 X 9" LG RF LWN

10279-728

HEAT NUMBER: M359
MATERIAL TYPE: SA182F304/L I.A.W. ASME 2010 ED.

HEMICAL ANALYSIS

C	.013
Mn	1.770
P	.0290
S	.0300
Si	.580
Cr	18.240
Mo	.500
Ni	8.250
N	.0900

PHYSICAL PROPERTIES

Yield PSI	59,700
Tensile PSI	91,600
Elongation	52
Reduction of Area	73.4
Hardness	201 HBW

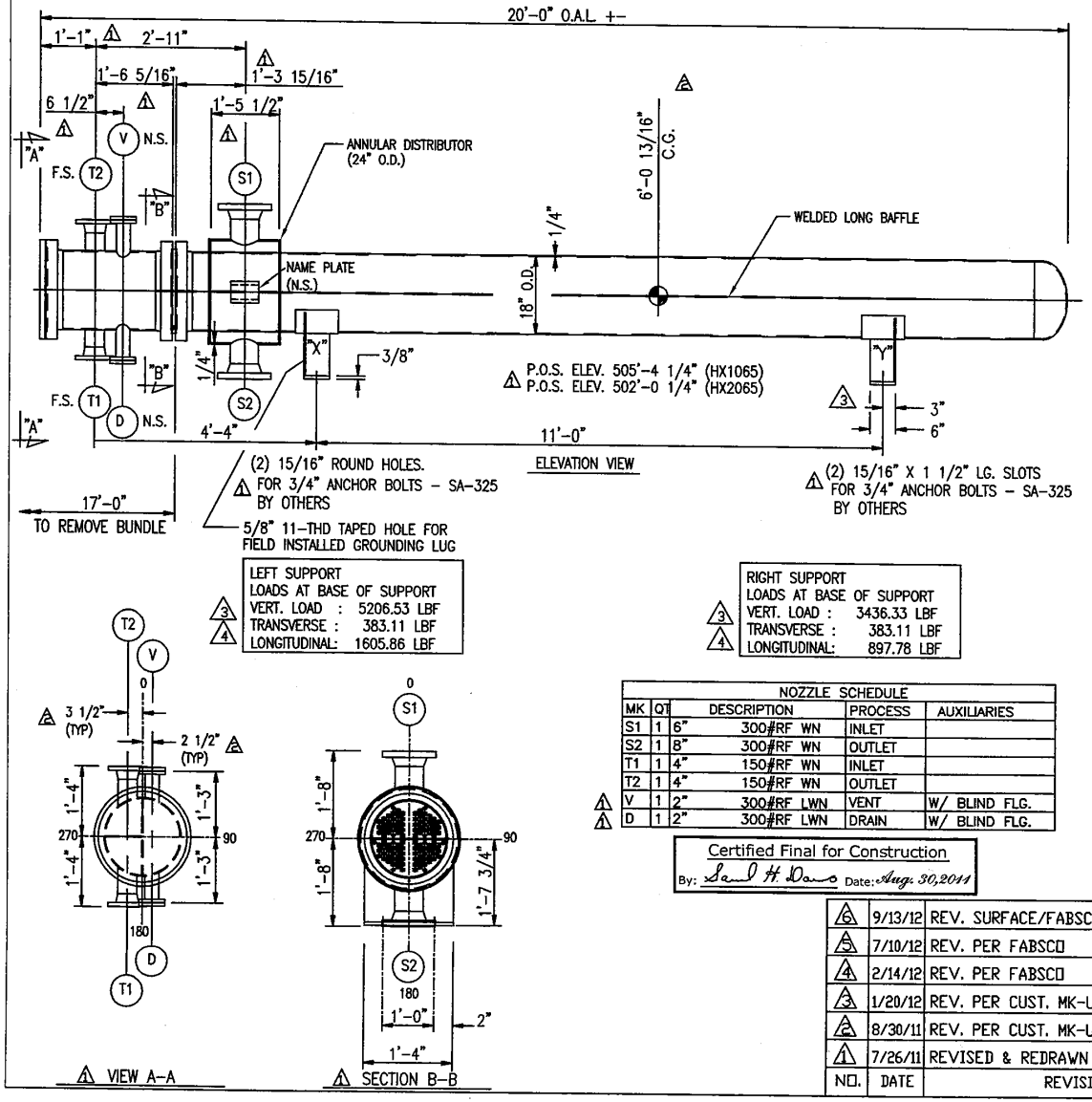
eat Treatment	SOLUTION ANNEALED
emperature	1900 °F
me at Temperature	
ooling Media	WATER

e hereby certify that all test results and process information contained herein are correct and true as contained in the cords of the company.

Prepared by Helen Fielder

Name: Helen Fielder Title: QA Representative

Date printed: 2/10/2012 2:54:48 PM



LEFT SUPPORT	
LOADS AT BASE OF SUPPORT	
VERT. LOAD :	5206.53 LBF
TRANSVERSE :	383.11 LBF
LONGITUDINAL:	1605.86 LBF

RIGHT SUPPORT	
LOADS AT BASE OF SUPPORT	
VERT. LOAD :	3436.33 LBF
TRANSVERSE :	383.11 LBF
LONGITUDINAL:	897.78 LBF

NOZZLE SCHEDULE					
MK	QT	DESCRIPTION		PROCESS	AUXILIARIES
S1	1	6"	300#RF WN	INLET	
S2	1	8"	300#RF WN	OUTLET	
T1	1	4"	150#RF WN	INLET	
T2	1	4"	150#RF WN	OUTLET	
V	1	2"	300#RF LWN	VENT	W/ BLIND FLG.
D	1	2"	300#RF LWN	DRAIN	W/ BLIND FLG.

Certified Final for Construction
By: Saul H. Davis Date: Aug. 30, 2011

DESIGN DATA	SHELL	TUBE
DESIGN PRESSURE P.S.I.G.	180	150
VACUUM PRESSURE P.S.I.G.	N/A	N/A
TEST PRESSURE P.S.I.G.	234	195
DESIGN TEMP. Deg.F.	290	200
MDMT Deg. F.	10	10
CORROSION ALLOWANCE	0"	0"
NUMBER OF PASSES	2	4
RADIOGRAPHY	100% (RT-4)	100%
HEAT TREAT REQUIRED	NO	NO

ESTIMATED WEIGHTS, LBS.

DRY: 4100 BUNDLE: 2200 WET: 5950 OPERATING: 4750

SPECIFICATIONS

ASME Code Section VIII, Div 1, 2010 Ed. (Stamp: Yes).
TEMA Class R; National Board Registration is required.
Design Reviewed For Compliance With The Requirements of UG-120(d).
Exempt From Impact Testing Per UG-20(f), UCS-66(a)(c), Fig. UCS-66 Note (c), and UCS-67.

MATERIAL

CHANNEL:	SA-312TP304L
SHELL:	SA-312TP304L
TUBESHEETS:	SA-240-304L
BAFFLES:	SA-240-304L
TUBES:	SA-213TP304L

(51 U's) 1" O.D.X 0.091" (AVG) X 16'-0" LG.
TUBE PITCH 1 1/4" ▷ SURFACE 437 SQ. FT.

GENERAL NOTES

ALL BOLT HOLES TO STRADDLE NATURAL CENTER LINES.
GASKETS: 1/8" THK 304L STN STL DBL JCKT'D GRAPHITE FILLED & GRAPHITE COATED (2-SETS SPARES REQ'D.)
INSULATION: SHELL SIDE 3" METAL GUARD (BY OTHERS)
STRENGTH WELD TUBES TO TUBESHEET PER UW-20 (c or d)
SHELL SIDE DESIGNED FOR WET H2S PER UOP 4.11 PARG 4.7
PAINT: SADDLE SUPPORT SURFACES TO BE SOLVENT CLEANED PER SSPC-SP1. SANDBLAST SADDLE SUPPORTS SURFACES PER SSPC-SP10 (PROFILE 1-2 MILS)
PRIMER: ONE (1) COAT CARBOLINE CARBOZINC 859 (2-3 MILS DFT)
INTERM.: ONE (1) COAT CARBOLINE CARBOGUARD 890 (4-6 MILS DFT)
FINISH: ONE (1) COAT CARBOLINE CARBOTHANE 134HG (2-3 MILS DFT)
(8-12 MILS TOTAL D.F.T.)(LIGHT GREY (RAL 7035)

CUSTOMER:	SOUTHERN COMPANY SERVICES
REQ. NO.:	MC213
P.O. NO.:	MPC17901
ITEM NO.:	HX1065/2065
SERVICE:	AGR FLASH GAS COOLER
SHIP TO:	KEMPER COUNTY, MS

NO.	DATE	REVISIONS
6	9/13/12	REV. SURFACE/FABSCO DD/
5	7/10/12	REV. PER FABSCO DD/SF
4	2/14/12	REV. PER FABSCO DD/SF
3	1/20/12	REV. PER CUST. MK-UP DD/SF
2	8/30/11	REV. PER CUST. MK-UP KS/DD
1	7/26/11	REVISED & REDRAWN AC/DGD

ASSEMBLY AND SPECIFICATIONS FOR
TWO 17-192 A F U

DWN. BY DS
DATE 3-23-11
CKD. BY SR

Fabsco
SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-1
REV. 6

Kemper County MM233798

CUSTOMER REQUIREMENTS

1) NOTIFY CUSTOMER AT LEAST 10 DAYS IN ADVANCE OF ANY SCHEDULED TEST, WITH VERBAL CONFIRMATION BEFORE THE HOLD POINT IS SCHEDULED TO OCCUR.

2) SUPPLIER IS REQUIRED TO PROVIDE A MINIMUM FIVE (5) DAY ADVANCE NOTICE PRIOR TO WHEN THE WITNESS POINT IS SCHEDULED TO OCCUR.

3) THE FLATNESS TOLERANCE (MAXIMUM DEVIATION FROM A PLANE) ON PERIPHERAL GASKET CONTACT SURFACES SHALL BE ±1/32". USE OF A STRAIGHT EDGE TO DETERMINE FLATNESS TOLERANCE IS ACCEPTABLE.

4) GIRTH FLANGE FLATNESS TOLERANCE SHALL BE MEASURED AFTER THE FLANGE FINAL WELDED. FLATNESS TOLERANCE ON TUBESHEET GASKET SURFACES SHALL BE MEASURED AFTER TUBE-TO-TUBESHEET JOINTS ARE ROLLED OR WELDED.

5) THE INTERPASS TEMPERATURE FOR AUST. STN. STL. SHALL NOT EXCEED 350°F.

6) TEMPORARY ATTACHMENTS AND ARC STRIKES SHALL BE REMOVED, AND THE AREA CONDITIONED, NONDESTRUCTIVELY EXAMINED MAGNETIC PARTICLE EXAMINATION (MT) OR DYE PENETRANT EXAMINATION (PT), IN ADDITION TO VISUAL EXAMINATION, TO ENSURE NO CRACKS HAVE BEEN GENERATED.

7) PLUG SHELL INSIDE DIAMETER WITH A METAL TEMPLATE CONSISTING OF TWO DISCS (EACH HAVING A DIAMETER EQUAL TO THE DIAMETER OF THE BAFFLES) RIGIDLY MOUNTED PERPENDICULAR TO A SHAFT, AND SPACED 18" APART.

8) WELD JOINT SURFACES AND A MINIMUM OF 1" ON THE INTERNAL AND EXTERNAL SURFACES OF THE ADJACENT BASE METAL SHALL BE CLEAN AND FREE OF PAINT, OIL, DIRT, SCALE, OXIDES, AND OTHER FOREIGN MATTER.

△1 9) ALL LIFTING LUG WELDS ARE TO BE M.T. OR P.T. OVER THE ENTIRE WELD SURFACE.

10) STAMPING TO BE DONE WITH "LOW STRESS" STAMPS.

11) SUPPORT PADS ARE TO BE AIR AND SOAP TESTED WITH 15 P.S.I.G. AIR PRESSURE. PLUG TEST HOLES WITH STIFF GREASE AFTER HYDROTEST.

12) THE P.O. No., ITEM No., SHIPPING WT., TO BE STENCILED ON THE SIDE OF THE SHELL IN 3" HIGH LETTERS.

13) SEAL WELD ALL ATTACHMENTS.

14) WHEN PREHEAT IS REQUIRED FOR WELDING, IT SHALL APPLY ALSO TO ELECTRIC ARC CUTTING, FLAME CUTTING, TACK WELDING, AND BACK GOUGING.

15) FOR CLEANING STN. STL., USE ALUMINUM OXIDE OR SILICON CARBIDE GRINDING WHEELS AND/OR STN. STL. BRUSHES NOT PREVIOUSLY USED ON CARBON OR LOW ALLOY STEEL.

16) PRECAUTION SHALL BE TAKEN TO AVOID CONTAMINATION ON STAINLESS STEEL. DURING FABRICATION.

17) NOZZLE WELDS SHALL BE SPOT X-RAYED OR U.T. WHEN POSSIBLE. NOZZLE WELD SHALL BE M.T. OR P.T. AS A MIN. REQUIREMENT.

18) CHEMICAL ANALYSIS OF ALL WELDS ON SHELL & CHANNEL SHALL BE TAKEN AS FOLLOWS TO REPRESENT BOTH MANUAL AND AUTOMATIC WELD:

- EACH COMPLETED CYLINDER, HEAD, NOZZLE WELD SHALL BE ANALYZED.
- TESTING TO BE DONE ON INSIDE SURFACE
- ANALYSIS SHALL INCLUDE EACH SOURCE OF DEPOSITED WELD MATERIAL (WIRE REEL, BOX OF WELD RODS)
- CHECK FOR Cr, Ni, C, Nb (Cb), Mo, V, WHERE APPLICABLE

19) FERRITE DETERMINATION OF STAINLESS STEEL PRESSURE PARTS ARE REQ'D AS FOLLOWS:

- FERRITED NUMBER TO BE BETWEEN 3.0 TO 8.
- READINGS SHALL BE TAKEN FROM AT LEAST TWO (2) LOCATIONS FROM EACH NOZZLE GIRTH WELD, VESSEL WELD SEAM & OTHER STRENGTH WELDS. AT LEAST SIX (6) READINGS SHALL BE TAKEN AT EACH LOCATION.

△1 20) P.M.I. IS TO BE IN ACCORDANCE WITH KBR SPECIFICATION 2-1TS-US-BO-M&U.

21) FLANGE BOLTING SHALL BE TIGHTENED WITH A TORQUE WRENCH TO A VALUE OF 50,000 P.S.I. STRESS IN STUDS.

22) BACK CHIPPED WELDS, WELDING GROOVE AND PLATE EDGES SHALL BE M.T. OR P.T. PRIOR TO WELDING ON THE REVERSE SIDE.

23) LIQUID PENETRANT MATERIALS SHALL BE FREE OF HALOGENS (CHLORIDES) ZINC, SULFUR AND OTHER MATERIALS DETREMENTAL TO AUSTENETIC STAINLESS STEEL.

24) MAXIMUM HORIZONTAL OR VERTICAL DEFLECTION OF MACHINED FACES OF NOZZLES FROM THE DESIGN PLANE SHALL BE 1/2 DEGREE OR 1/32", WHICHEVER IS GREATER.

△1 25) EXPOSED THREADS OF BOLTS SHALL BE COATED WITH RUST VETO 342 RUST PREVENTATIVE, TO PREVENT CORROSION DURING TESTING, SHIPPING, AND STORAGE.

NDT REQUIREMENTS

SHELL: 100% (RT-4) RADIOGRAPH.

△2 FRONT CHANNEL: 100% RADIOGRAPH.

△1 AFTER WELDING LONG BAFFLE TO SHELL, M.T. FULL LENGTH OF WELD.

△1 RADIOGRAPH FILM SHALL BE FINE GRAIN, HIGH DEFINITION, HIGH CONTRAST FILM (KODAK TYPE AA, EQUIVALENT OR BETTER). FILM DENSITY SHALL BE WITHIN A RANGE OF 2.0 TO 3.5 AS DETERMINED BY FILM DENSITY SPECIMENS OR BY CALIBRATED DENSITOMETER.

STANDARD SHOP PRACTICES

1) ALL BOLT HOLES TO STRADDLE NATURAL CENTER LINES.
2) GRIND INSIDE WELDS FLUSH IN BTM. 1/3 OF SHELL.
3) GRIND INSIDE WELDS SMOOTH WITH CHANNELS.
4) MATCH MARK ALL COMPONENTS FOR PROPER FIT UP.
5) INSTALL SHIPPING COVERS ON ALL NOZZLES FOR SHIPMENT.
7) VESSEL SHALL BE CLEANED INSIDE AND OUTSIDE OF WELD SPLATTER DIRT, WELD ROD, AND OTHER FOREIGN DEBRIS.

△1 8) MAIN DIMENSIONS ARE TO BE HELD WITHIN TEMA TOLERANCE.

STANDARD HYDROTEST REQUIREMENTS

1) HYDROTEST CHARTS REQUIRED.
2) HYDROTEST TO BE HELD FOR ONE (1) HOUR (MIN).
3) HYDROTEST WATER TEMPERATURE TO BE AT LEAST 50°F. (MIN)
4) HYDROTEST WATER TO HAVE A CHLORIDE CONTENT OF 50ppm (MAX.), AND THE pH CONTROLLED BETWEEN 6 AND 9.
5) AFTER HYDROTEST, THE EXCHANGER TO BE DRAINED AND DRIED ANY REMAINING WATER IS TO BE REMOVED BY BLOWING WARM AIR AT 120° F (MAX.)

SPECIAL PAINT REQUIREMENTS

1) ALL STAINLESS STEEL MATERIAL SHALL BE PROTECTED FROM BLASTING, OVERSPRAY, AND COATING.
2) ITEMS SUCH AS CHAINS, HOOKS, TONGS, METAL BARS, NARROW STRAPS, SHALL NOT BE ALLOWED TO COME IN CONTACT W/ PAINTED SURFACES.

P.O. NO.: MPC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

NO.	DATE	REVISIONS
△2	7/10/12	REV. PER FABSCO DGD/
△1	8/30/11	REV. PER CUST. MK-UP KS/DD

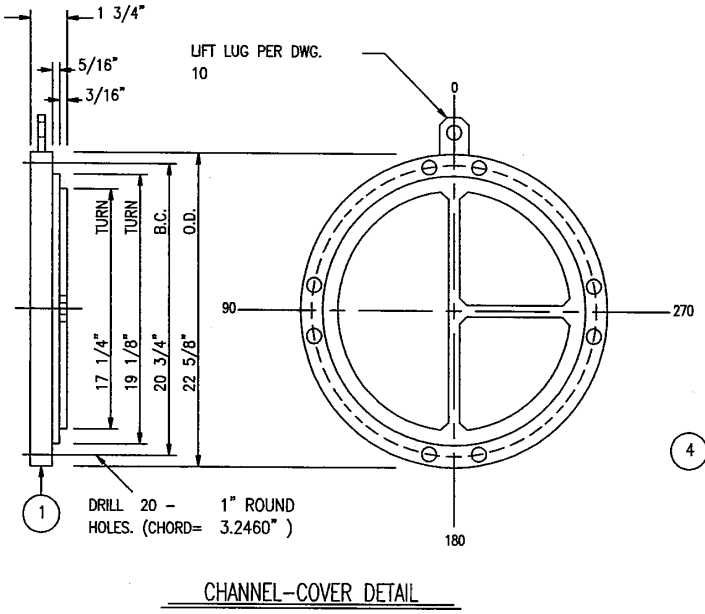
JOB NOTES

DWN. BY AC
DATE 4-7-11
CKD. BY DGD

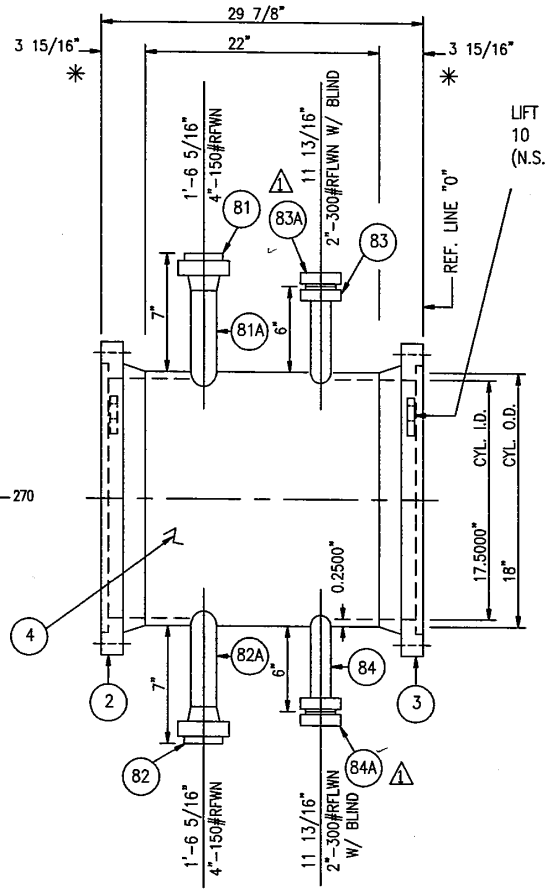
Fabsco SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-1A
REV. 2

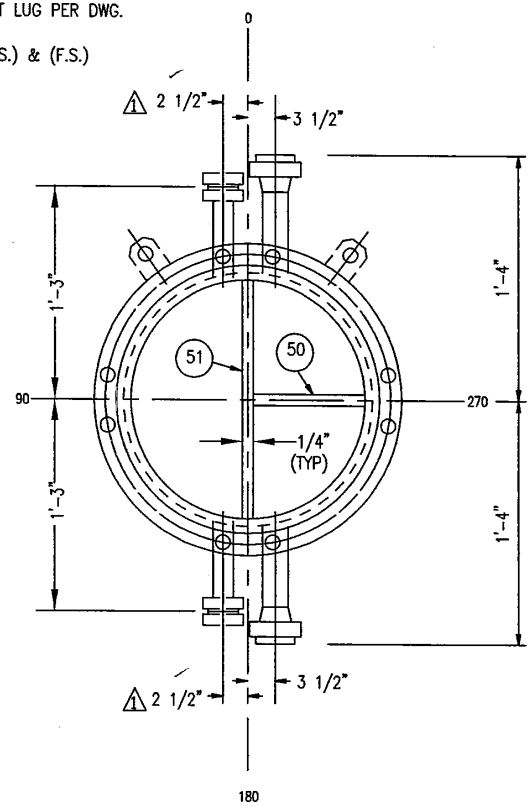
COVER NOTES:
1) MACHINE ALL COVER SURFACES TO 250 RMS EXCEPT GASKET SURFACES ARE 125 – 250u IN Ra.
2) ALL COVER PASS PLATE GROOVE WIDTHS TO BE 3/8" WIDE.
3) ALL COVER PASS PLATE GROOVE JUNCTIONS TO BE NOTCHED 3/8" AT 45 Deg.



CHANNEL–COVER DETAIL



CHANNEL SIDE VIEW



CHANNEL END VIEW

NOTES:
1) ALL WELDING TO BE IN ACCORDANCE W/ PROCEDURES ON DWG. -WM.
2) ALL BOLT HOLES TO STRADDLE CENTER LINES.
3) FOR WELD AND BEVEL DETAILS SEE DWG. 13
4) GRIND ALL INSIDE WELDS SMOOTH.
5) 100% RADIOGRAPHY.

P.O. NO.: MPC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

NO.	DATE	REVISIONS
1	8/30/11	REV. PER CUST. MK-UP KS/DD

TWO–REQ'D.

FRONT CHANNEL DETAILS

DWN. BY DS

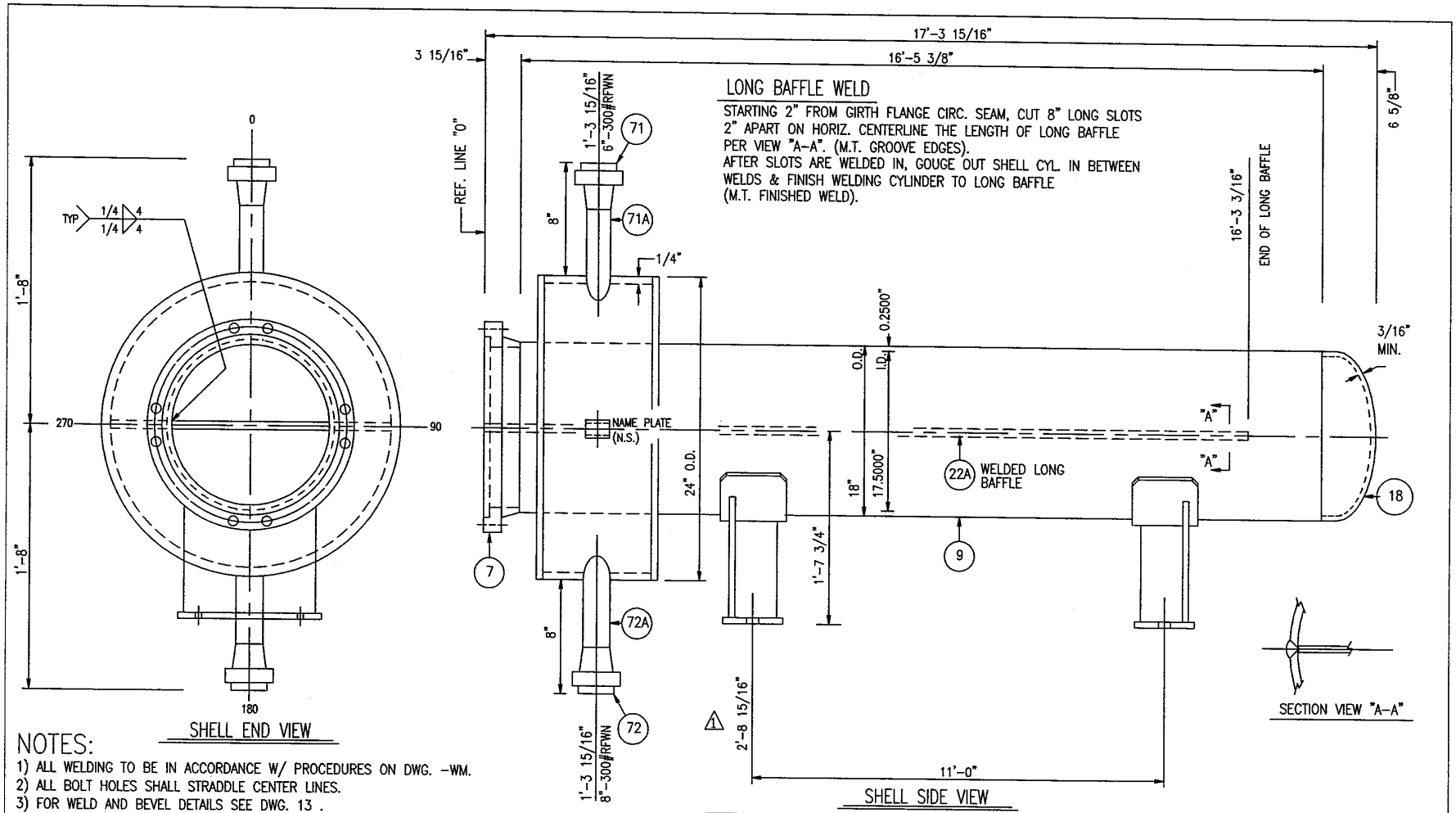
DATE 4– 7–11

CKD. BY DGD

Fabsco
SHELL & TUBE, LLC

DWG.NO. S11–10279–7/8–2

REV. 1



NOTES:

1) ALL WELDING TO BE IN ACCORDANCE W/ PROCEDURES ON DWG. -WM.
2) ALL BOLT HOLES SHALL STRADDLE CENTER LINES.
3) FOR WELD AND BEVEL DETAILS SEE DWG. 13 .
4) GRIND ALL INSIDE WELDS FLUSH, EXCEPT HEAD SEAMS SMOOTH.
5) 100% RADIOGRAPHY (RT-4). ⚠2
6) FOR VAPOR BELT DETAIL, SEE DWG. 3A.
7) FOR FLANGE DETAILS, SEE DWG. 12.

P.O. NO.: MPC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

NO.	DATE	REVISIONS
⚠2	7/10/12	REV. PER FABSCO DGD
⚠1	8/30/11	REV. PER CUST. MK-UP KS/DD

TWO-REQ'D.

SHELL DETAILS

DWN. BY DS

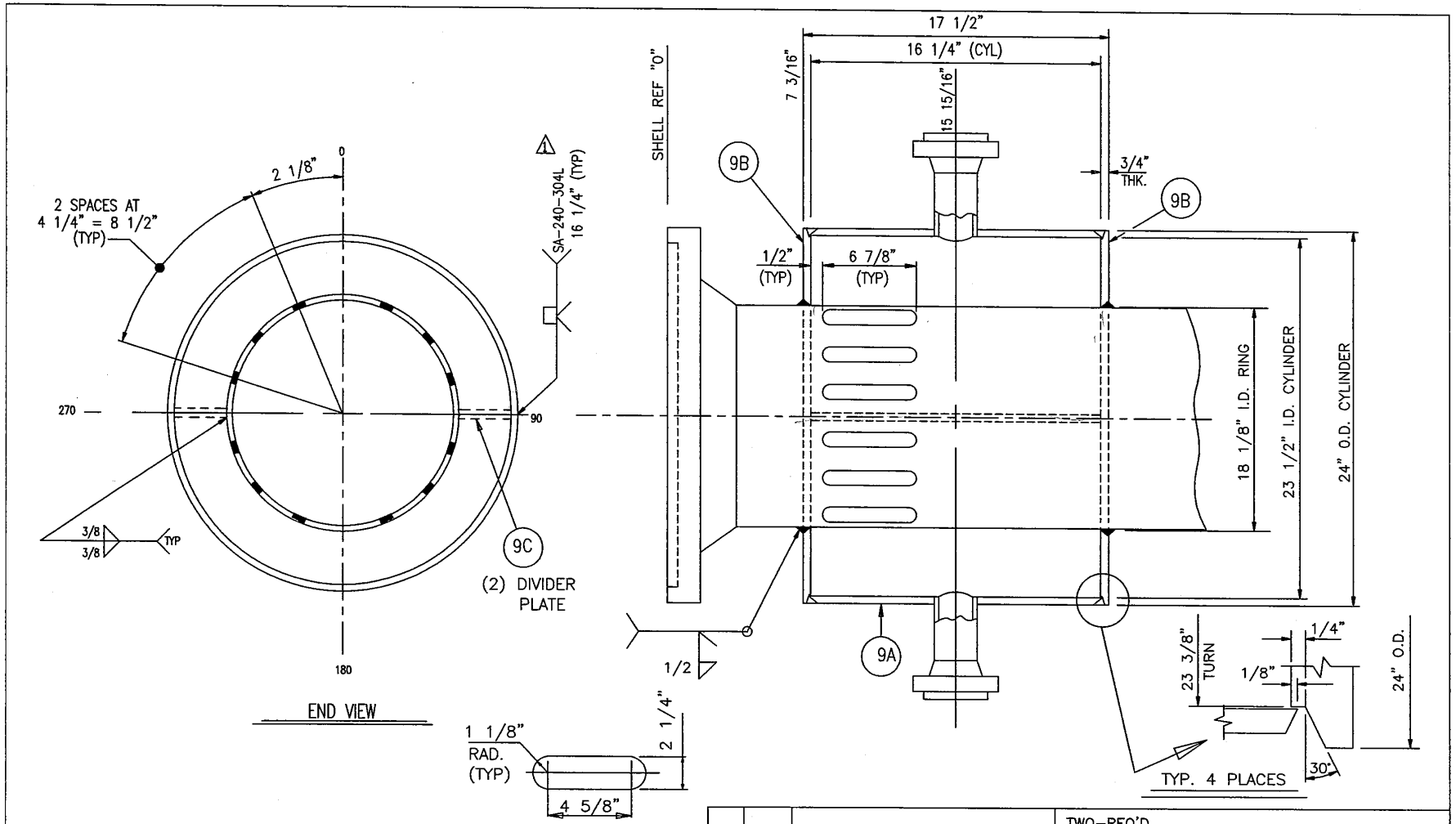
DATE 4- 7-11

CKD. BY DGD

Fabsco
SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-3

REV. 2



NOTES:

1) ALL WELDING SHALL BE IN ACCORDANCE WITH PROCEDURES: ON DWG -WM.
2) FOR WELD AND BEVEL DETAILS, SEE DWG. -13.
3) 100% RADIOGRAPHY.

P.O. NO.: MPC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

NO.	DATE	REVISIONS
1	8/30/11	REV. PER CUST. MK-UP KS/DD

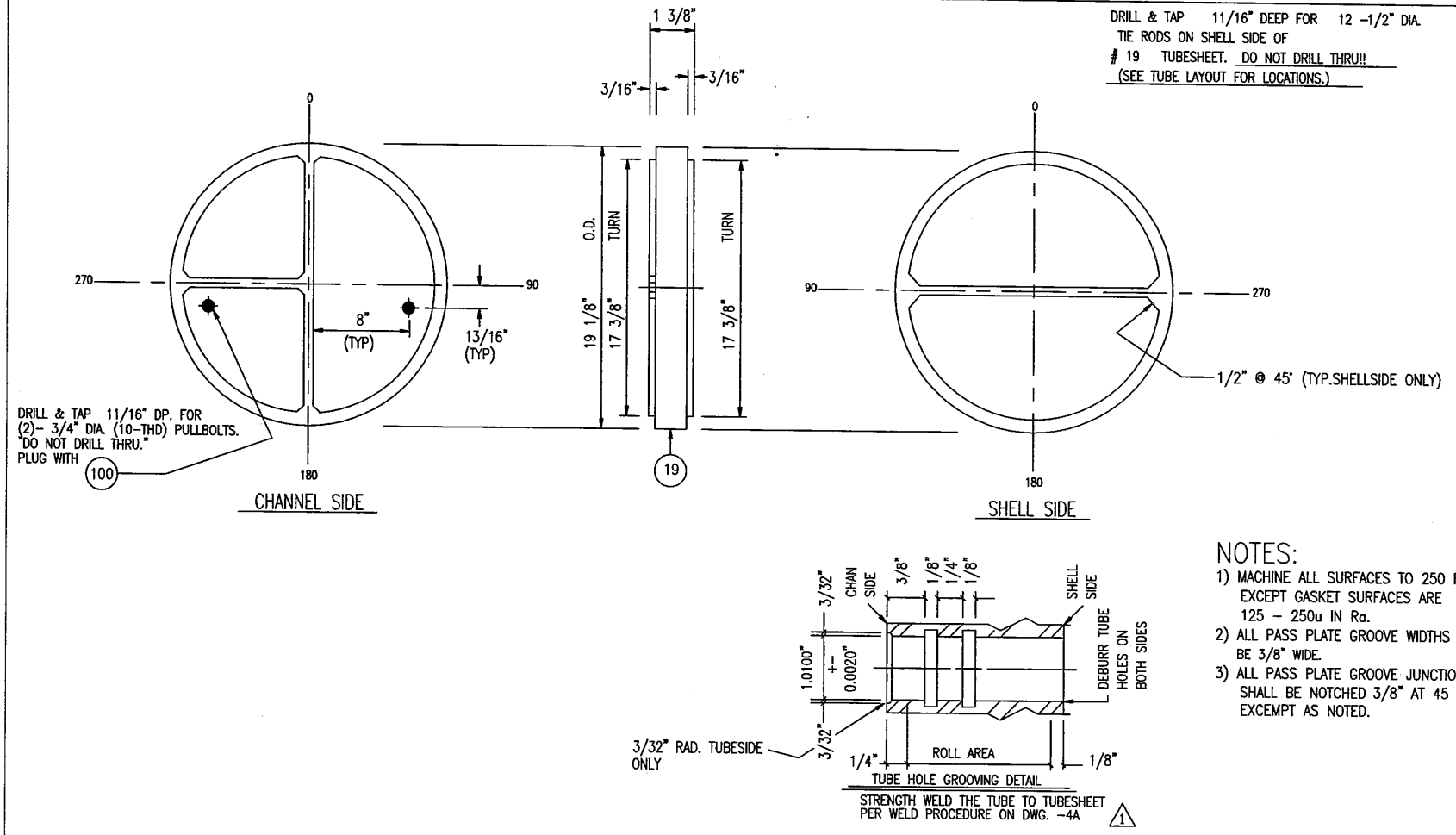
TWO-REQ'D.

VAPOR BELT DETAIL

DWN. BY DC
DATE 4/7/11
CKD. BY DGD

Fabsco SHELL & TUBE, LLC

DWG. NO. S11-10279-7/8-3A
REV. 1



NOTES:

1) MACHINE ALL SURFACES TO 250 RMS, EXCEPT GASKET SURFACES ARE 125 – 250u IN Ra.
2) ALL PASS PLATE GROOVE WIDTHS SHALL BE 3/8" WIDE.
3) ALL PASS PLATE GROOVE JUNCTIONS SHALL BE NOTCHED 3/8" AT 45 Deg. EXCEMPT AS NOTED.

P.O. NO.: MPC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

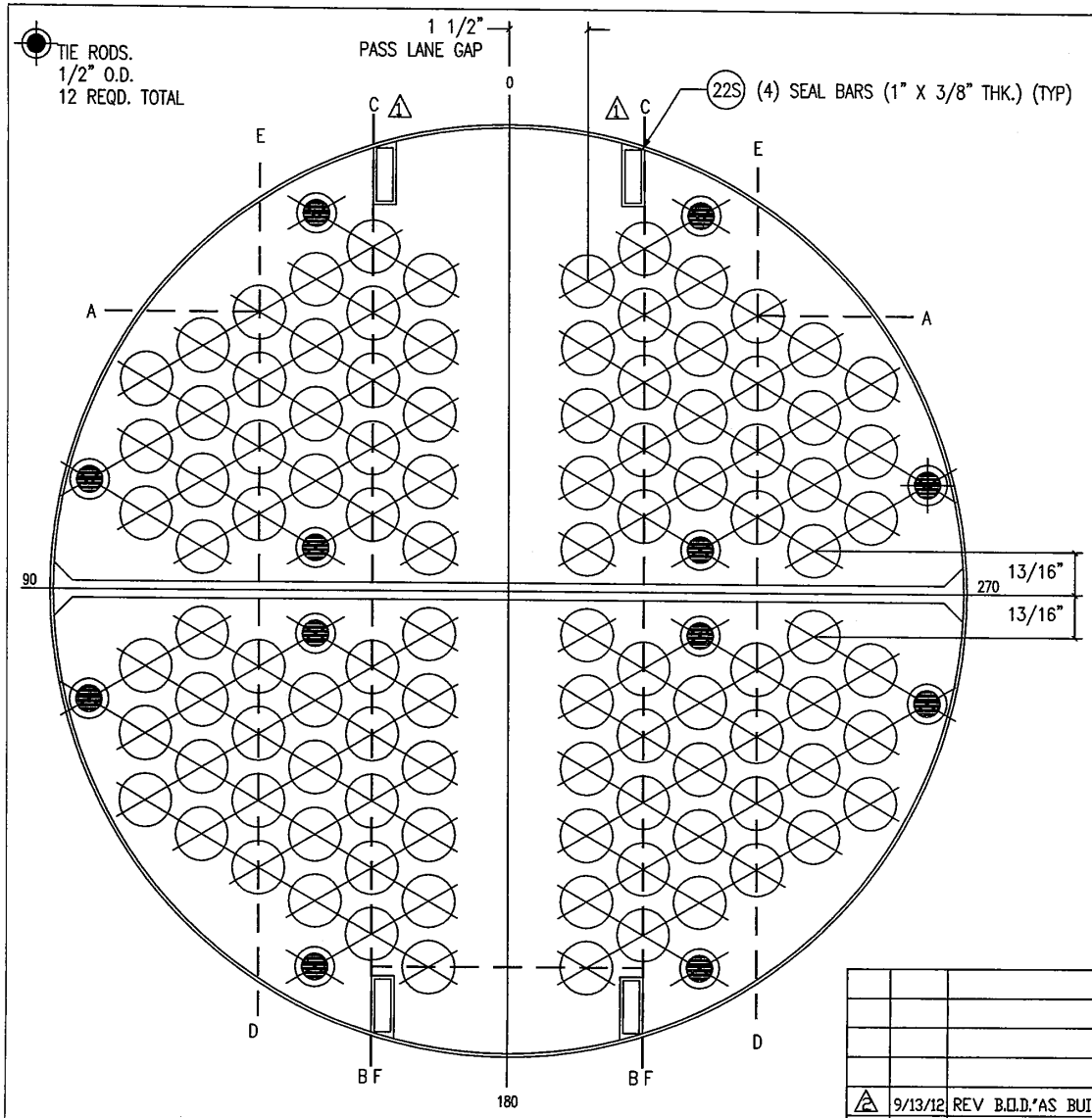
NO.	DATE	REVISIONS
1	8/30/11	REV. PER CUST. MK-UP KS/

TUBESHEET DETAILS

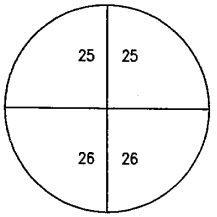
DWN. BY DS
DATE 4- 7-11
CKD. BY DGD

Fabsco SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-4
REV. 1



VIEW LOOKING AT SHELL SIDE OF NO. 19 TUBESHEET



TUBE DISTRIBUTION

NOTES:

1) DRILL AND REAM TUBE HOLES IN
   TUBESHEETS TO 1.0100" +- 0.0020" DIA.
   FOR 51 - 1" O.D. U-TUBES.
   TOTAL HOLES = 102
2) TUBE PITCH = 1 1/4" ROT. TRIANGLE. (30°)
3) NUMBER OF PASSES = 4
4) SEE DRAWING 4
   FOR TUBE GROOVING DETAILS.
5) BAFFLE O.D. = 17 3/16" (2)
6) O.T.L. = 16 15/16"

P.O. NO.: MOC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

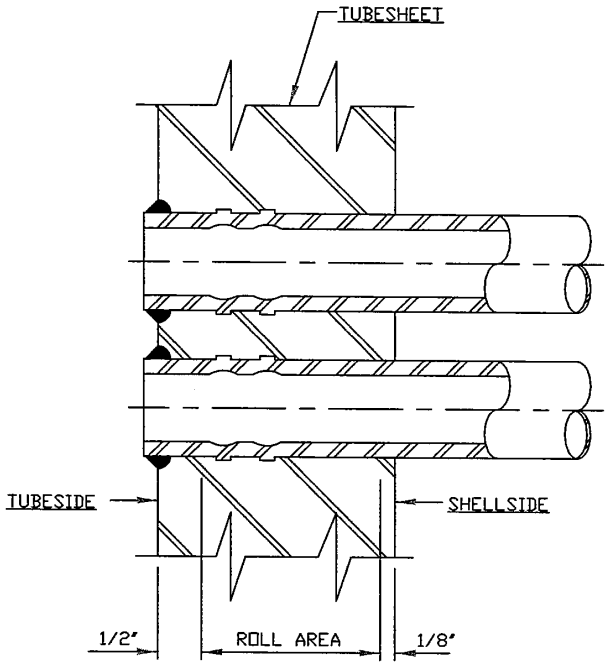
NO.	DATE	REVISIONS
2	9/13/12	REV B.O.D. 'AS BUILT'/FABSCO DD/
1	8/30/11	REV. PER CUST. MK-UP KS/

TUBE LAYOUT

DWN. BY DS
DATE 4-7-11
CKD. BY DGD

Fabsco
SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-5
REV. 2



NOTE: TUBES TO PROJECT 1/8" ± 1/16" PRIOR TO WELDING.

PROCEDURE FOR STRENGTH WELDING TUBES

1. CHAMFER ALL TUBE HOLES 3/32" RADIUS ON TUBESIDE.
2. CLEAN ALL TUBES AND TUBE HOLES WITH NAPHTHA.
3. LIGHTLY EXPAND TUBES TO METAL CONTACT.
4. WELD TUBES TO TUBESHEET WITH A TWO (2) PASS WELD USING: T-189
   DO NOT BURN END OF TUBES.
5. AFTER ALL TUBES HAVE BEEN WELDED AND PRIOR TO ROLLING, CHECK EACH TUBE WELD WITH DYE PENETRANT TEST.
7. AFTER STRENGTH WELD TEST, EXPAND TUBES TO PROPER AMOUNT STARTING 1/2" BEHIND STRENGTH WELD.
8. AFTER ALL TUBES HAVE BEEN ROLLED, CHECK EACH TUBE WELD WITH DYE PENETRANT TEST.
9. AIR AND SOAP TEST TUBE WELDS WITH 15 PSIG AIR PRESSURE ON SHELLSIDE.

△1

P.O. NO. : MPC17901
ITEM NO. : HX 1065/2065
SERVICE : AGR FLASH GAS COOLER
REQ'N NO. : MC213

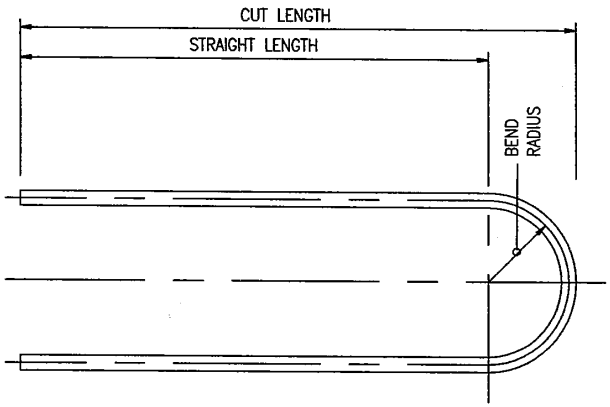
NO.	DATE	REVISIONS
△1	8/31/11	ADDED DETAIL DWG. KS

STRENGTH WELD DETAIL

DWN. BY	KS
DATE	8/31/2011
CKD. BY	
DWG. NO.	S11-10279-7/8-4A
REV.	1

Fabsco
SHELL & TUBE, LLC

ROW	NO.OF TUBES	BEND RADIUS	BEND DIAMETER	BEND LENGTH	STRAIGHT LENGTH	CUT LENGTH	DEVELOPED LENGTH
A	11	1 1/2"	3"	0'-4 3/4"	16'-0"	16'-2"	32'-4 3/4"
B	10	2 5/8"	5 1/4"	0'-8 1/4"	16'-0"	16'-3 1/8"	32'-8 1/4"
C	8	3 11/16"	7 3/8"	0'-11 5/8"	16'-0"	16'-4 3/16"	32'-11 5/8"
D	8	4 3/4"	9 1/2"	1'-2 15/16"	16'-0"	16'-5 1/4"	33'-2 15/16"
E	8	5 7/8"	11 3/4"	1'-6 1/2"	16'-0"	16'-6 3/8"	33'-6 1/2"
F	6	6 15/16"	13 7/8"	1'-9 13/16"	16'-0"	16'-7 7/16"	33'-9 13/16"



TOTAL NO. REQUIRED: 51
SIZE: 1" O.D. X .091" AVG
MATERIAL: SA-213TP304L

MAXIMUM OUT-OF-ROUNDNESS OF TUBES AT U-BENDS NOT TO EXCEED 10%.

QUANTITIES SHOWN ARE FOR ONE SET OF U-TUBES, 2 -SET REQ'D. TOTAL.

P.O. NO.: MPC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

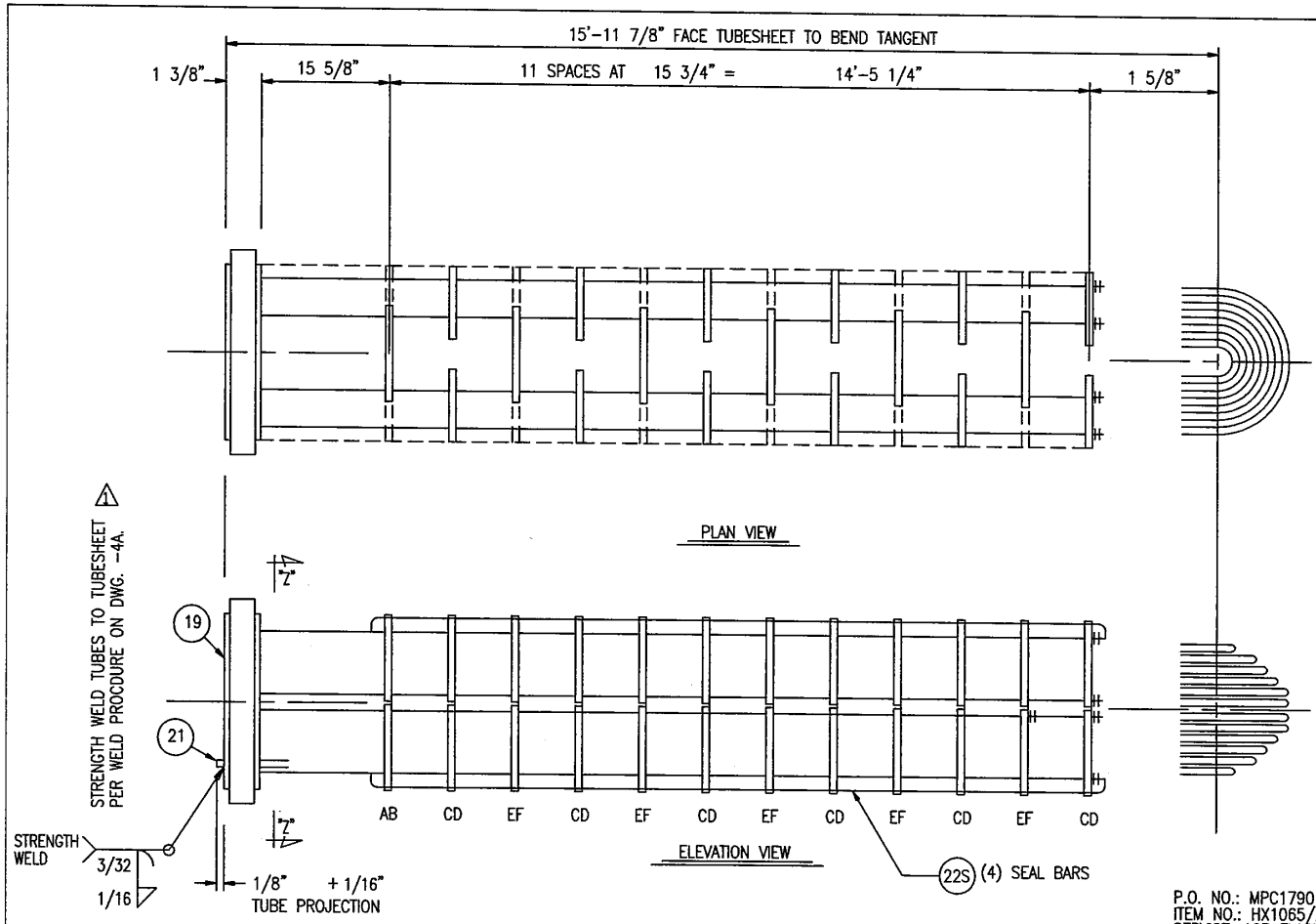
NO.	DATE	REVISIONS

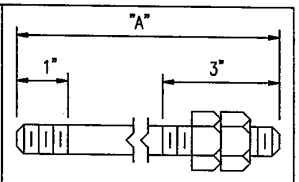
TUBE BENDING SCHEDULE

DWN. BY DS
DATE 4- 7-11
CKD. BY DCO

Fabsco
SHELL & TUBE, LLC

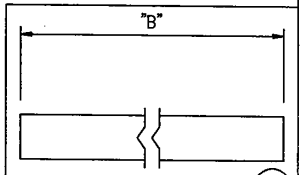
DWG.NO. S11-10279-7/8-6
REV. 0





1/2" O.D. TIE RODS (23)

	REQ'D.	"A"
A	10	15'-10 7/8"
B	2	14'-7 1/8"
C		
D		



3/4" O.D. SPACER TUBING

	REQ'D.	"B"
1	98	15 1/2"
2	22	31 1/4"
3		
4		
5		
6		
7		

P.O. NO.: MPC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

NOTES:
1) FOR SECTION AND VIEW DETAILS SEE DWG. -8
2) SEAL BARS TO PROJECT 1" PAST FIRST & LAST BAFFLES. ROUND OUTER CORNERS TO 1/2" RADIUS. WELD TO EACH BAFFLE.

NO.	DATE	REVISIONS
1	8/31/11	REV. PER FABSCO S&T KS/

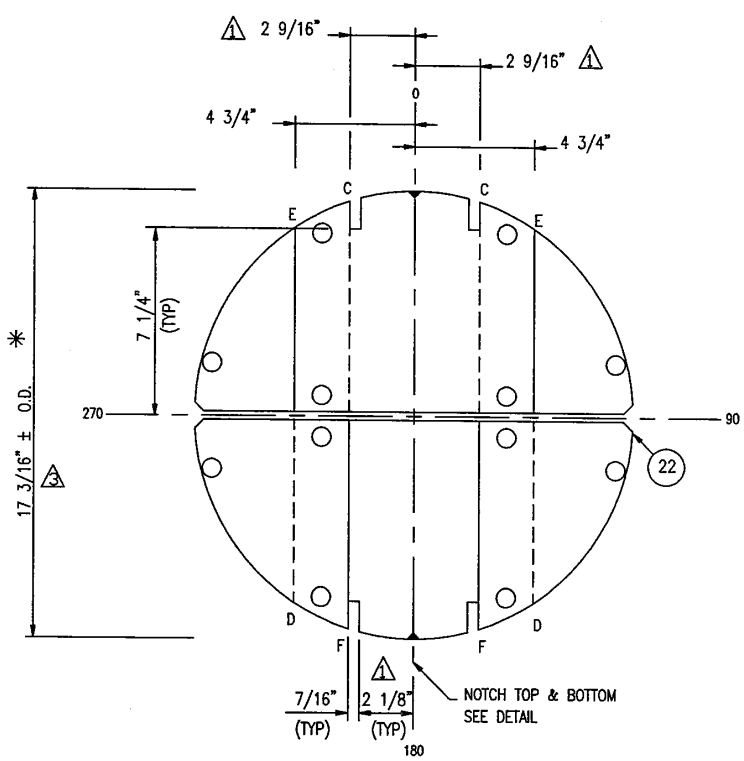
TWO – REQ'D.

BUNDLE DETAILS

DWN. BY DS
DATE 4- 7-11
CKD. BY DGD

Fabsco
SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-7
REV. 1

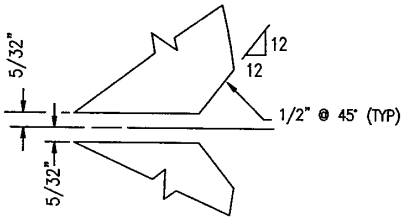


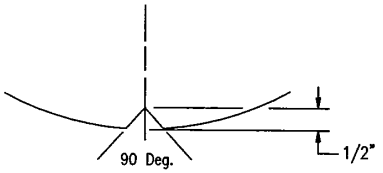
VIEW ZZ OF BAFFLES

1/4" THK.

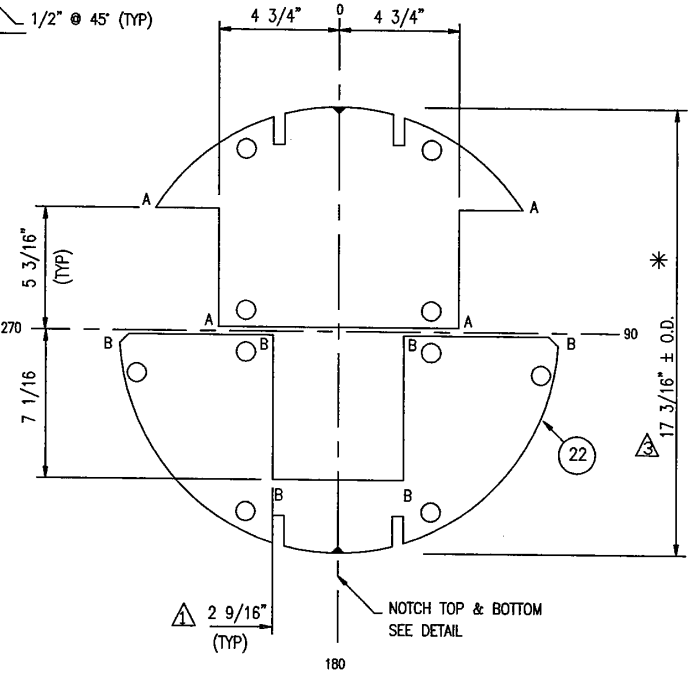
5 -REQD. CUT EEFF

6 -REQD. CUT CCDD





NOTCH DETAIL



VIEW ZZ OF BAFFLES

1/4" THK.

2 5 -REQD. CUT AA-BB

NOTES:

1) DRILL TUBE HOLES IN BAFFLES 1 1/32" DIA. & DEBURR.
2) DRILL TIE ROD HOLES 9/16" DIA.
   SEE TUBE LAYOUT FOR LOCATION.
3) RADIUS ALL CORNERS ON BAFFLE CUTS.
* 4) CHECK SHELL I.D. BEFORE MACHINING BAFFLE O.D.
5) MACHINE O.D. OF BAFFLES TO 250 RMS.

P.O. NO.: MPC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'D. NO.: MC213

NO.	DATE	REVISIONS
3	9/13/12	REV B.O.D."AS BUILT"/FABSCO DD/
2	1/20/12	REV. PER CUST. MK-UP DD/
1	8/30/11	REV. PER CUST. MK-UP KS/DD

TWO - REQ'D.

BAFFLE DETAILS

DWN. BY DS

DATE 4- 7-11

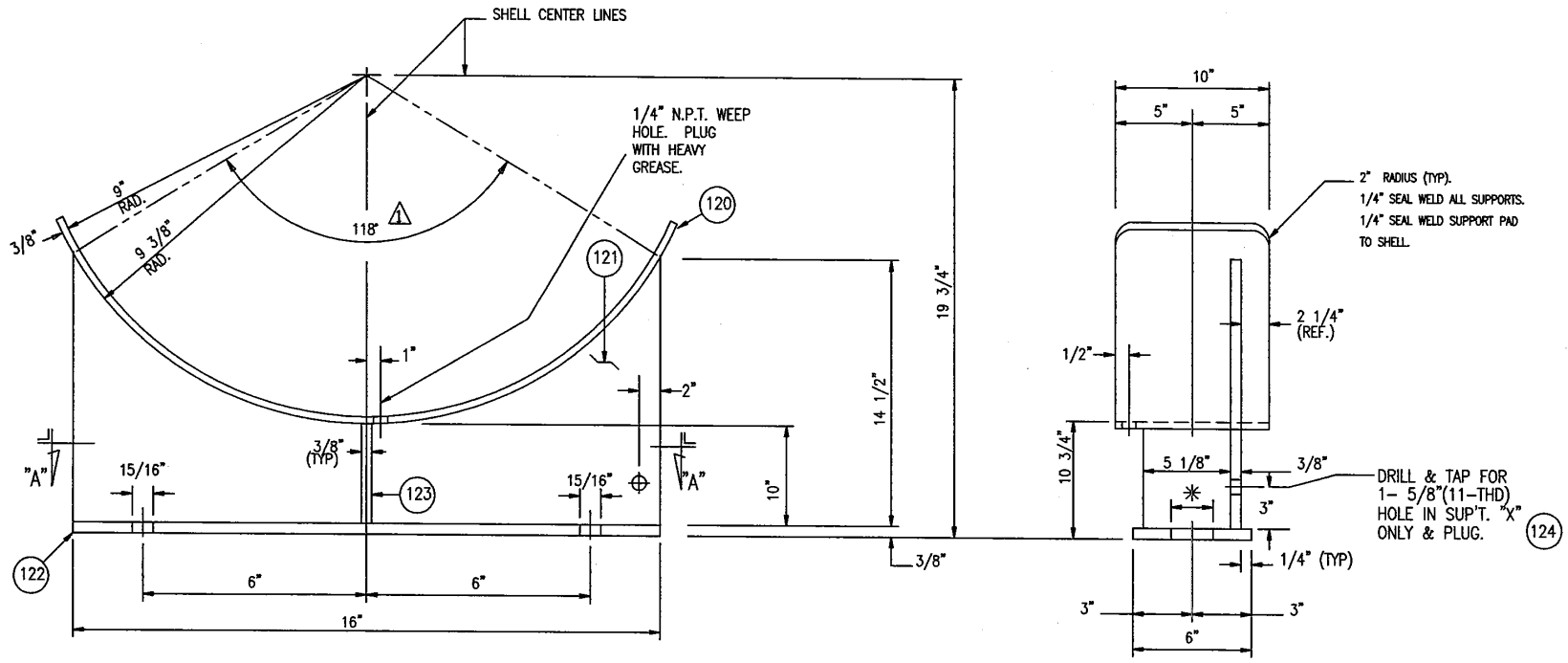
CKD. BY DGD

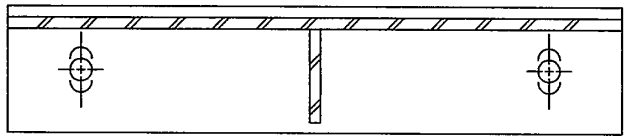
Fabsco SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-8

REV. 3

Kemper County MM233798





SECTION "A-A"

✳ ONE REQUIRED MARKED "X" W/ (2)15/16" ROUND HOLES.
ONE REQUIRED MARKED "Y" W/ (2)15/16" X 1 1/2" LG. SLOTS.
1 FOR 3/4" ANCHOR BOLTS, SA-325 (BY OTHERS)

P.O. NO.: MPC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

NO.	DATE	REVISIONS
1	8/30/11	REV. PER CUST. MK-UP KS

TWO - REQ'D.

SUPPORT DETAILS

DWN. BY DS

DATE 4- 7-11

CKD. BY DGD

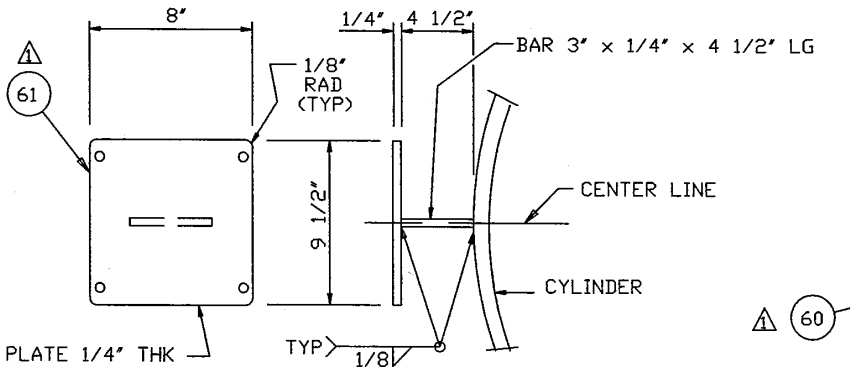
Fabsco SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-9

REV. 1

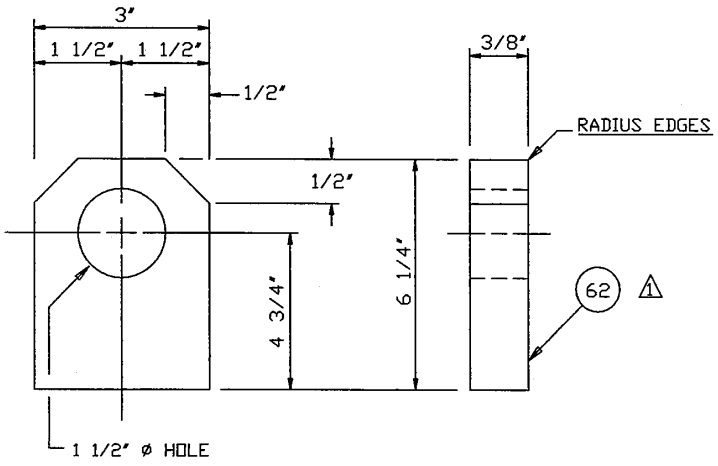
* TO BE ASSIGNED AT TIME OF SHIPMENT

MATERIAL: 18-8 STN. STL.(16 GA)



NAME PLATE BRACKET DETAIL

(ONE) REQUIRED



LIFTING LUG DETAIL

2-REQUIRED

P.O. NO.: MPC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

TWO-REQ'D.

NAT'L BD. *

CERTIFIED BY

FABSCO SHELL & TUBE, LLC

PLANT *, SAPULPA, OKLAHOMA

W
RT-4 S
RT-1 T

△3

△1 60

△1 AREA ***

		MAWP		MAWT	
SHELL	180	PSI AT	290	° F.	
		MAEWP		MAWT	
SHELL	N/A	PSI AT	N/A	°F.	
		MDMT		MAWP	
SHELL	10	°F. AT	180	PSI	
		MAWP		MAWT	
TUBES	150	PSI AT	200	° F.	
		MAEWP		MAWT	
TUBES	N/A	PSI AT	N/A	°F.	
		MDMT		MAWP	
TUBES	10	°F. AT	150	PSI	△2

SERIAL NUMBER	YEAR BUILT	ITEM/TAG NUMBER	△1
S11-10279-*	2012	**	

TEST PRESSURE (SHOP):SHELL- 234 P.S.I. : TUBES- 195 P.S.I.

SERVICE: AGR FLASH GAS COOLER P.O. NO.: MPC17901

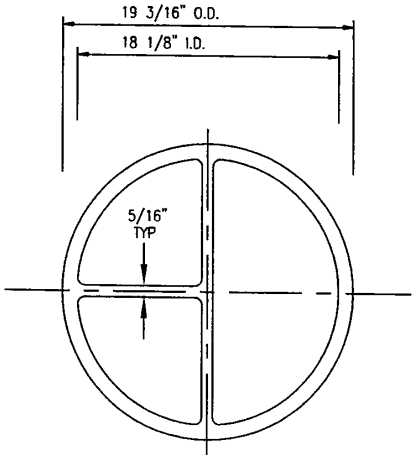
* SERIAL NO.	△1 ** ITEM NO.	△1 *** AREA
S11-10279-7	HX1065	130
S11-10279-8	HX2065	230

NO.	DATE	REVISIONS
△3	7/10/12	REV. PER FABSCO DGD/
△2	1/20/12	REV. PER CUST. MK-UP DD/SF
△1	8/30/11	REV. PER CUST. MK-UP KS/DD

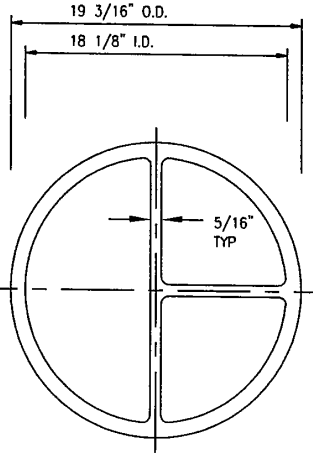
LIFT LUG DETAIL w/ NAME PLATE & BRACKET

DWN. BY	DWG. NO.	REV.
AC	S11-10279-7/8-10	3
DATE 4/7/11		
CKD. BY DGD		

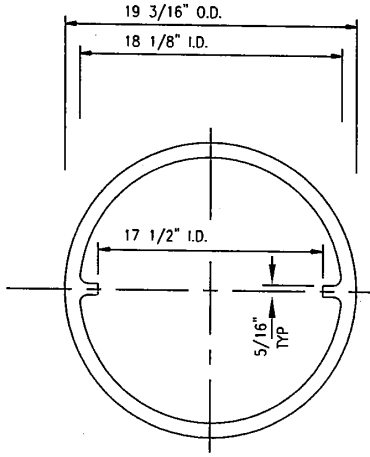
Fabsco SHELL & TUBE, LLC



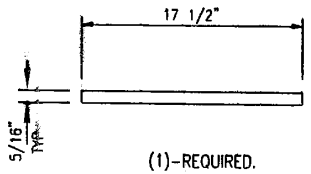
(1)-REQUIRED.
CHANNEL COVER GASKET.
1/8" 304L STN. STL. DBL. JKTD. FLEXIBLE GRAPHITE FILLED, WITH 1/64" THK. GRAPHITE FACING ON BOTH SIDES.



(1)-REQUIRED.
CHANNEL GASKET.
1/8" 304L STN. STL. DBL. JKTD. FLEXIBLE GRAPHITE FILLED, WITH 1/64" THK. GRAPHITE FACING ON BOTH SIDES.



(1)-REQUIRED.
SHELL GASKET.
1/8" 304L STN. STL. DBL. JKTD. FLEXIBLE GRAPHITE FILLED, WITH 1/64" THK. GRAPHITE FACING ON BOTH SIDES.



(1)-REQUIRED.
LONG BAFFLE GROOVE GASKET
1/8" THK. FLEXIBLE GRAPHITE

NOTES:

1) QUANTITIES SHOWN FOR ONE SET
   (6)-SET REQUIRED TOTAL.
   (1) SET TO BE BE USED IN EACH EXCHANGER (2) SETS TOTAL.
   (4) SETS TO BE BOXED AND MARKED WITH P.O. & ITEM NO. & SHIPPED WITH EXCHANGER.
2) ALL RADII TO BE 1/4"

P.O. NO.: MCP17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

NO.	DATE	REVISIONS

TWO - REQ'D.

GASKET DETAILS

DWN. BY DS

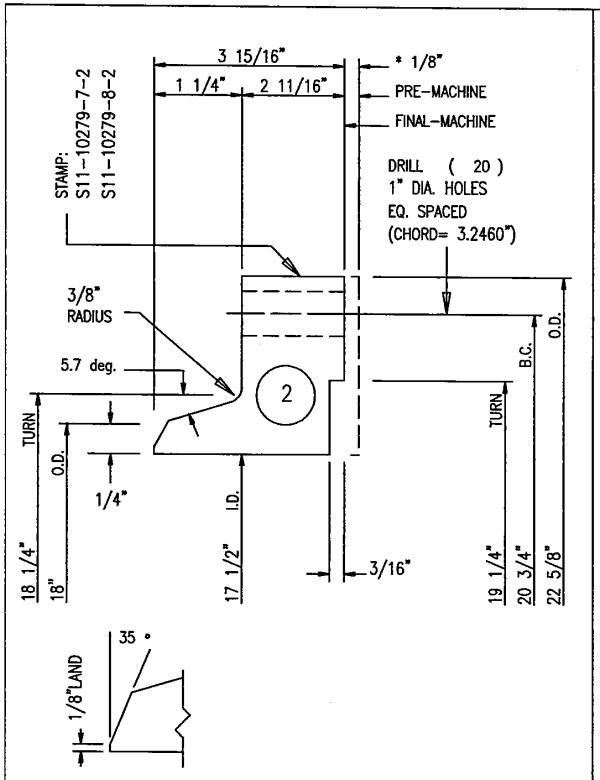
DATE 4- 7-11

CKD. BY

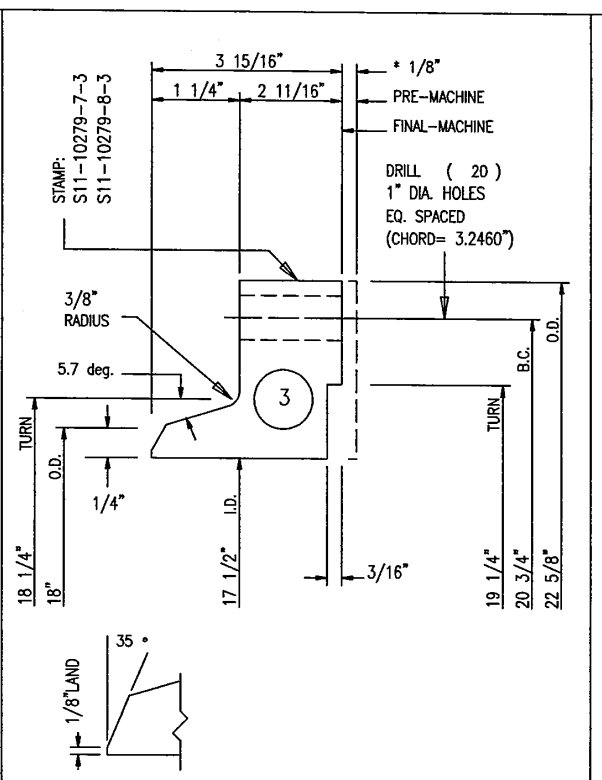
Fabsco
SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-11

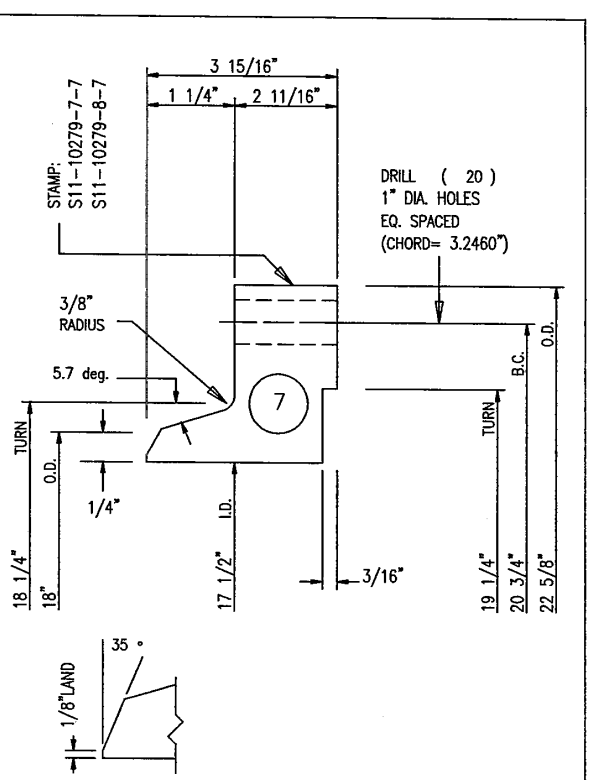
REV. 0



2 GIRTH FLANGE (TWO)REQ'D.



3 GIRTH FLANGE (TWO)REQ'D.



7 GIRTH FLANGE (TWO)REQ'D.

NOTES:

1) MACHINE ALL SURFACES TO 250 RMS
   EXCEPT GASKET SURFACES MACHINE TO 125u IN Ra.
2) ALL BOLT HOLES TO STRADDLE NATURAL CENTER LINES.
3) * FINAL MACHINE FACING AFTER FINAL WELDING.

P.O. NO.: MCP17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

NO.	DATE	REVISIONS

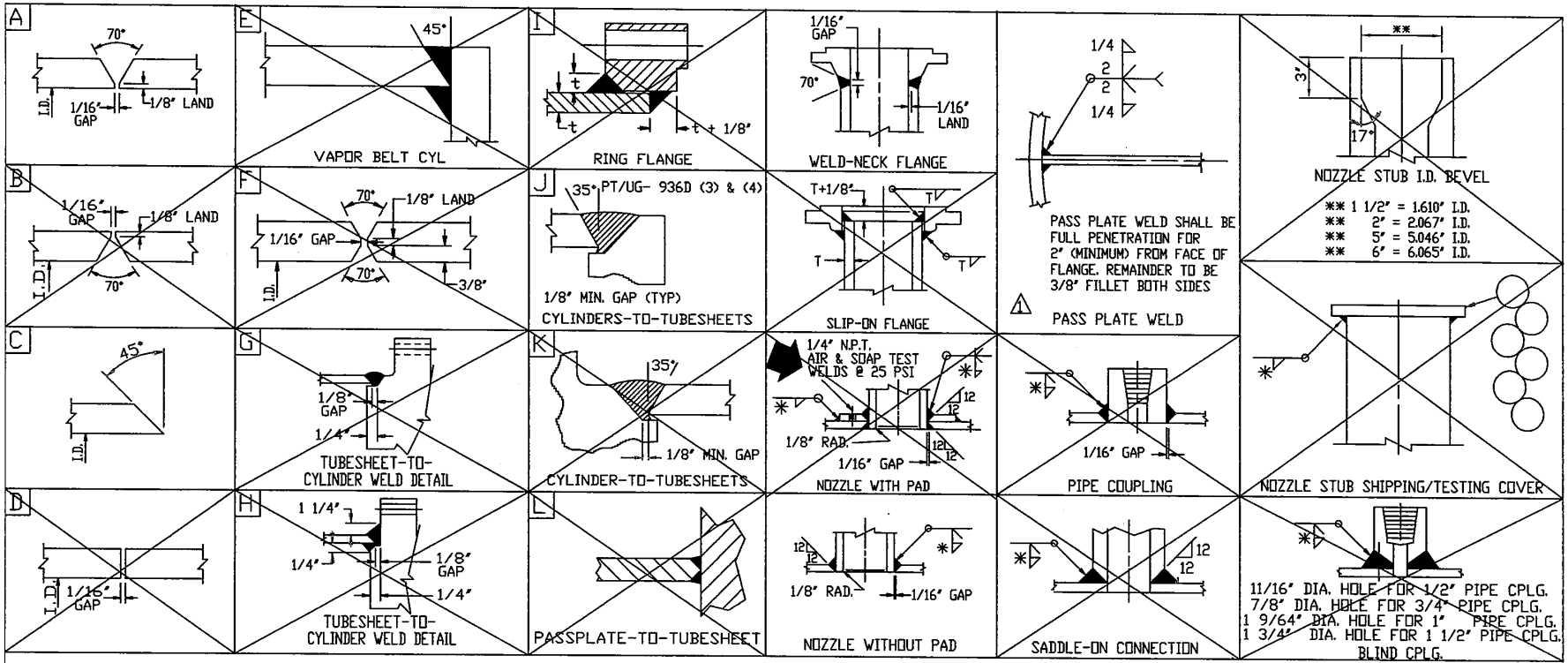
TWO - REQ'D.

GIRTH FLANGES

DWN. BY	DS
DATE	4- 7-11
CKD. BY	

Fabsco
SHELL & TUBE, LLC

DWG.NO.	REV.
S11-10279-7/8-12	0



P.O. NO.: MCP17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N.: MC213

GENERAL NOTES:

1) ALL WELDING SHALL BE IN ACCORDANCE WITH ASME CODE (SECTION IX).

1* 2) ALL FILLET WELDS SHALL BE 3/8", UNLESS NOTED OTHERWISE.

3) LIFTING LUGS SHALL HAVE A 3/8" CONTINUOUS FILLET WELD, UNLESS NOTED OTHERWISE.

1 4) FOR LONG BAFFLE WELD DETAIL, SEE DWG. -3

NO.	DATE	REVISIONS
1	8/30/11	REV. PER CUST. MK-UP KS

WELD & BEVEL DETAILS

DWN. BY: AC
DATE: 4/4/11
CKD. BY: DGD

Fabsco SHELL & TUBE, LLC

DWG.NO.: S11-10279-7/8-13
REV.: 1

MK.NO.	QUAN.	DESCRIPTION	MATERIAL	SUPPLIER	P.O. NO.	DUE
21	102	TUBES 1" O.D.X 0.0910 THK avg PER BEND SCHEDULE	SA-213TP304L			
		FORGED RING MATERIAL				
2	2	FLG 22 5/8" O.D.X 17 1/2" I.D.X 3 15/16" THK (f)	SA-965-F304L			
3	2	FLG 22 5/8" O.D.X 17 1/2" I.D.X 3 15/16" THK (f)	SA-965-F304L			
7	2	FLG 22 5/8" O.D.X 17 1/2" I.D.X 3 15/16" THK (f)	SA-965-F304L			
		TUBESHEETS & COVERS				
19	2	TUBESHEET 19 1/8" O.D.X 1 3/8" THK (f)	SA-240-304L			
1	2	COVER 22 5/8" O.D.X 1 3/4" THK (f)	SA-240-304L			
		BAFFLES				
22	24	BAFFLES PER DWG. -8	SA-240-304L			
22A	2	PL 17 3/8" X 1/4" X 16'-3" LG LONG BAF.	SA-240-304L			
		HEADS				
18	2	ELLIP HD. 18" O.D.X 3/16" THK(min) W/2" SF	SA-240-304L			
9B	4	VAPOR BELT END PLATE: 24"O.D. X 18 1/8" I.D. X 3/4" THK.	SA-240-304L			
		CYLINDERS				
9	2	SMLS.PIPE 18" X(0.2500" Sch10)X 16'-5 3/8" LG.	SA-312TP304L			
9A	2	SMLS.PIPE 24" X(0.2500" Sch10)X 1'-4 1/4" LG.	SA-312TP304L			
4	2	SMLS.PIPE 18" X(0.2500" Sch10)X 1'-10" LG.	SA-312TP304L			

NOTES:

1) ALL WELD BEVELS PER WELD & BEVEL DETAIL DWG ATTACHED.
2) ALL FORMED HEADS TO BE IN ACCORDANCE WITH UCS-79.
3) ALL COLD FORMED PRESSURE PARTS, INCLUDING BUT NOT LIMITED TO CYLINDERS & HEADS, TO BE CERTIFIED AS REQ'D. BY ASME SECTION VIII, DIV. 1, para. UG-79(c).
4) 125-250u IN RaFINSH ON GASKET SURFACES.
5) QUANITIES SHOWN ARE FOR TWO EXCHANGERS.

CUSTOMER: SOUTHERN COMPANY GENERATION
P.O. NO.: MPC17901 REQ'N. NO.: MC213
ITEM NO.: HX1065/2065 SERVICES: AGR FLASH GAS COOLER

NO.	DATE	REVISIONS
1	8/30/11	REV. PER CUST. MK-UP KS

BILL OF MATERIAL

DWN. BY DS
DATE 4/12/11
CKD. BY DGD

Fabsco
SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-14
REV. 1

MK.NO.	QUAN.	DESCRIPTION	MATERIAL	SUPPLIER	P.O. NO.	DUE
		ANSI FLANGES				
71	2	ASME 6" – 300 # RF WN W/ (SchXH BORE) (4)	SA-182F304L			
72	2	ASME 8" – 300 # RF WN W/ (SchXH BORE) (4)	SA-182F304L			
81	2	ASME 4" – 150 # RF WN W/ (SchSTD BORE) (4)	SA-182F304L			
82	2	ASME 4" – 150 # RF WN W/ (SchSTD BORE) (4)	SA-182F304L			
71A	2	SMLS.PIPE 6" X(0.4320" SchXH)X 5 1/2" LG.	SA-312TP304L			
72A	2	SMLS.PIPE 8" X(0.5000" SchXH)X 5 1/2" LG.	SA-312TP304L			
81A	2	SMLS.PIPE 4" X(0.2370" SchSTD)X 7" LG.	SA-312TP304L			
82A	2	SMLS.PIPE 4" X(0.2370" SchSTD)X 7" LG.	SA-312TP304L			
83	2	2" – 300 # RF LWN X 9" LG. (4)	SA-182F304L			
83A	2	2" – 300 # RF BLD FLG. (4)	SA-182F304L			
84	2	2" – 300 # RF LWN X 9" LG. (4)	SA-182F304L			
84A	2	2" – 300 # RF BLD FLG. (4)	SA-182F304L			
		2"-300# BLIND FLANGE MATERIAL				
94	4	.175" THK. 304L STN. STL. SPIRAL WOUND STYLE "CG"				
	16	WITH 304L OUTER COMP. RING.				
95	32	5/8" ø (11 – THD) STUDS X 8 1/2" LG.	SA-193-B7			
96	64	5/8" (11 – THD) HEX NUTS.	SA-194-2H			

SEE DWG. –14 FOR NOTES.

CUSTOMER: SOUTHERN COMPANY GENERATION
P.O. NO.: MPC17901 REQ'N.: MC213
ITEM NO.: HX1065/2065 SERVICE: AGR FLASH GAS COOLER

NO.	DATE	REVISIONS

BILL OF MATERIAL

DWN. BY DS
DATE 5/ 2/11
CKD. BY

Fabsco
SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-15
REV. 0

Kemper County MM233798

MK.NO.	QUAN.	DESCRIPTION	MATERIAL	SUPPLIER	P.O. NO.	DUE
		BOLTING & GASKETS				
40	2	LOT OF GASKETS PER DWG. -11				
41	40	7/8" ROUND X 9-THREAD STUDS X 7" LG. 1&2	SA-193B7			
42	40	7/8" ROUND X 9-THREAD STUDS X 9" LG. 3&7	SA-193B7			
43	160	7/8" HEAVY HEX NUTS 9-THREAD	SA-194-2H			
		MISC. MATERIAL				
60	2	STD. NAME PLATE	STN.STL.			
61	2	STD. NAME PL BRKT . PER DWG. -10	SA-240-304L			
62	6	STD. LIFTING LUGS PER DWG. -10	SA-240-304L			
23	377	FT. 1/2" O.D. TIE RODS	304L STN. STL.			
23B	48	1/2" HEAVY HEX TIE ROD NUTS	304L STN. STL.			
23A	377	FT. 3/4" O.D. SPACER TUBING	304L STN. STL.			
22S 3	8	SEAL BARS 1" X 3/8" THK. X 14'-5 1/2"	304L STN. STL.			
100	4	PULL BOLT PLUGS: 3/4" ø (10-THD.) X 3" LG.	304L STN. STL.			
9C	4	DIVIDER PLATES: 2 3/4" X 1/4" THK. X 1'-4" LG.	SA-240-304L			
50	2	PASS PLATES 8 1/2" X 1/4" THK X 29 7/8" LG.	SA-240-304L			
51	2	PASS PLATES 17 3/8" X 1/4" THK X 29 7/8" LG.	SA-240-304L			
		SUPPORT MATERIAL				
120	4	PLATE 10" X 3/8" THK X 23 1/4" LG.	SA-240-304L			
121	4	PLATE 16" X 3/8" THK X 14 1/2" LG.	SA-516-70			
122	4	PLATE 6" X 3/8" THK X 16" LG.	SA-516-70			
123	4	PLATE 5 1/8" X 3/8" THK X 10" LG.	SA-516-70			
124	2	5/8" ø (11 - THD) MACH. BOLT X 2 1/2" LG.	C'ST.			
		W/ (2) WASHERS & (1) HEX. NUT EACH.				
		NOZZLE COVER MATERIAL				
130 2	2	PL. 15" O.D. X 3/8" THK. W/(12) 9/16" DIA. HOLES	C.-STL.			
1		EQUALLY SPACED ON 13" B.C. (8"-300#)				
131 2	2	GASKET 12 1/2" O.D. X 1/2" THK. (8"-300#)	SOLID RUBBER			
132 2	12	1/2" HEX HD. ALL-THD. BOLTS X 3 1/2" LG. W/(1) HEX NUT	C.-STL.			
1		AND (2) FLAT WASHERS EACH (8"-300#)				
133 2	2	PL. 12 1/2" O.D. X 3/8" THK. W/ (12) 9/16" DIA. HOLES	C.STL.			
1		EQUALLY SPACED ON 10 5/8" B.C. (6"-300#)				
134 2	2	GASKET 10 1/8" O.D. X 1/2" THK. (6"-300#)	SOLID RUBBER			
135 2	12	1/2" HEX HD. ALL-THD. BOLT X 3 1/2" LG. W/(1) HEX NUT	C.-STL.			
1		AND (2) FLAT WASHERS EACH (6"-300#)				
136 2	4	ASME 4" - 150 # RF BLIND FLANGE	SA-105			
137 2	4	GASKET 7" O.D. X 1/2" THK. (4"-150#)	SOLID RUBBER			
138 2	16	1/2" HEX HD. ALL-THD. BOLTS X 4" LG. W/(1) HEX NUT	C.-STL.			
1		AND (2) FLAT WASHERS EACH (4"-150#)				
		PAINT PER DWG.-1A				

CUSTOMER: SOUTHERN COMPANY GENERATION
P.O. NO.: MPC17901 REQ'N. NO.: MC213
ITEM NO.: HX1065/2065 SERVICE: AGR FLASH GAS COOLER

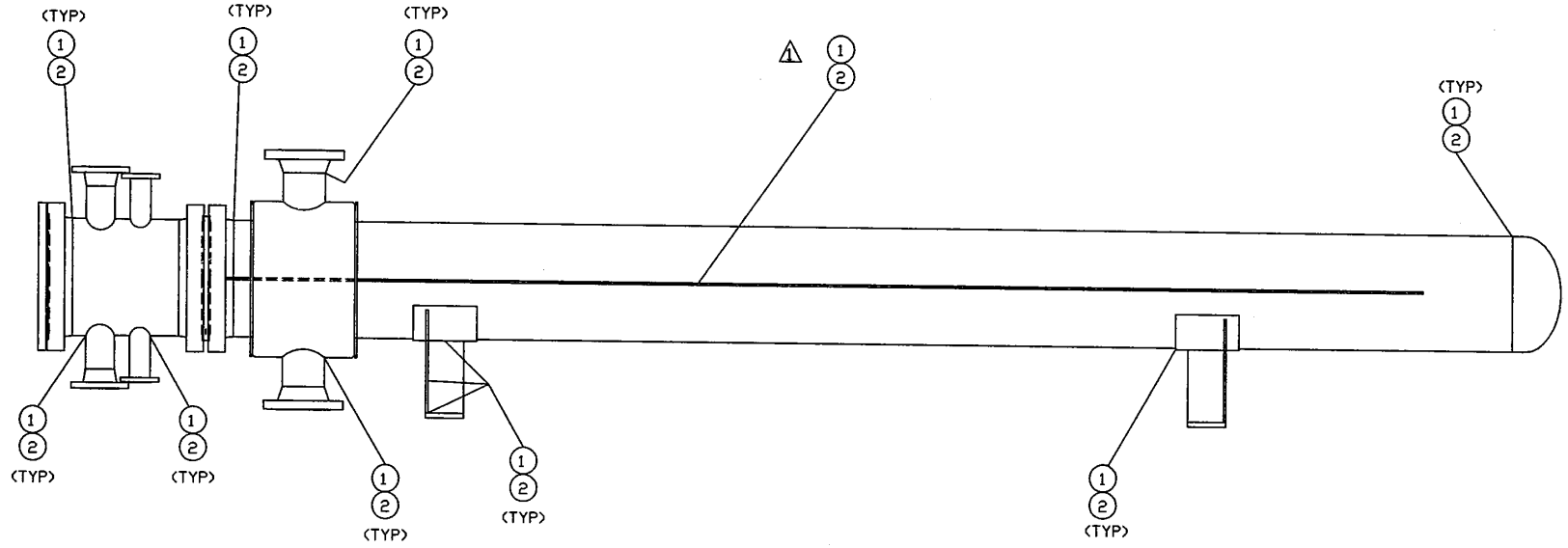
NO.	DATE	REVISIONS
3	9/13/12	REV. PER FABSCO DD/
2	7/5/12	REV. PER FABSCO KS/DD
1	5/2/12	REV. PER FABSCO DGD/SF

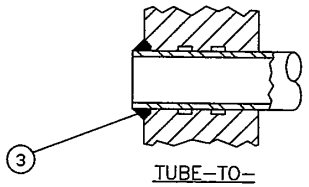
BILL OF MATERIAL

DWN. BY DS
DATE 5/ 2/11
CKD. BY DGD

Fabsco
SHELL & TUBE, LLC

DWG.NO. S11-10279-7/8-16
REV. 3





TUBE–TO–
TUBESHEET WELD

MK.	PROC. #
1	A-189
2	F-132
3	T-189
4	
5	
6	

A P.O. NO.: MPC17901
ITEM NO.: HX1065/2065
SERVICE: AGR FLASH GAS COOLER
REQ'N. NO.: MC213

NO.	DATE	REVISIONS
A	10/27/11	REV. PER CUST. REQUEST KS/DD
1	8/30/11	REV. PER CUST. MK-UP KS/DD

WELD MAP

DWN. BY AC
DATE 4/4/11
CKD. BY DGD

Fabsco
SHELL & TUBE, LLC

DWG. No. S11-10279-7/8-WM
REV. 2

Mechanical Design Calculations

Item/Tag No: HX1065/2065 **Doc. No: S11-10279-7/8-CP** **P.O. No: MPC17901**
REQ. No: MC213

Certified Correct for Fabrication by Fabsco Shell & Tube, LLC

By: *Samuel H.Davis* **Date:** May 2,2011

R1 **Customer: SOUTHERN COMPANY SERVICES** **HORIZONTAL**
Service : AGR FLASH GAS COOLER **U-TUBE**
No. Shells: 1 Par. 1 Ser. 1 Surface: 443 Each 443 TotalSq.fT.
R1 **Size: 17 x 192 " Type: A F U**

R1 **(51) "U"-Tubes x 1.000 OD x 0.091 Thk BWG x 192 " Lg 1.2500 ROT TRI Pitch**

-Jurisdictional code requirements: Design, Material, Fabrication, Inspection, Testing and Documentation in accordance with the ASME Code Section VIII,Division 1, 2010 Edition, and so stamped.
-Impact test requirements: TUBESIDE Exempt from Impact Testing per UG-20(f), UCS-66(a),UHA-51 (c), Fig. UCS-66, general note (c), and UCS-67.SHELLSIDE Exempt from impact testing per fig ucs-66.1
-Loadings per ASME code para. UG-22 that have been defined by the user, or his designated agent, have been considered in the design process.
-This design has been reviewed for compliance with the requirements of UG-120(d).

	Shell	Tubes
Design Press/Ext	180.0 / 0.0 psig	150.0 / 0.0 psig
Test Pressure	234.0 psig	195.0 psig
Design Temp/MDMT	290 / 10 deg.F	200 / 10 deg.F
Corrosion Allowance	0.0000"	0.0000"
No. of Passes	2	4
Radiograph	RT4-S	100%
Stress Relieve	0 ** deg.F	0 deg.F

**** - Exchanger is fabricated using sold 304L Stn. Stl., Requirements Of UOP 4'-11-6, Para. 4.7, Post Weld Heat Treatment does not apply.**
R1

Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
1	Revised per Customer Comments	SR	1/12/12	GD	1/12/12
2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12
3	Corrected cylinder joint efficency	DS	6-20-12	SHD	6-20-12

```
                              SHELL SIDE
================================================================================
 NOM.
 SIZE          PRESS.        TEMP.          C.A.        RT    H.T.          TEMA
  18.000"      180.0psig       290deg.F  0.0000"    SEE BELOW      0deg.F     R
================================================================================
ASME CODE SECTION VIII, DIVISION 1, UG-27                          [ CYLINDER ]
====DESIGN CONDITIONS==============CYLINDER CALCULATIONS ON O.D. FORMULA====
SHELL CYL
MATERIAL: SA-312TP304L     PRESS =  180.0psig   TEMP =    290deg.F
O.D.          NOM. THK.    RW=0/PIPE=1   CORR.ALLOW   EFFICIENCY
  18.0000"      0.2500"        1          0.0000"       0.65
ATM.STRS      DES.STRS     STRS/STRS     MAWP N-C     MAWP CORR.
14200.0psi    14200.0psi   1.000         226.543psig    226.543psig

  P*(RO)
---------- =  0.17416"   + CORR. ALLOW. =  0.17416"   + MTOL. =  0.19904"
S*E+(.4*P)
********************************************************************************

ASME CODE SECTION VIII, DIVISION 1, UG-32                [ ELLIPTICAL HEAD ]
====DESIGN CONDITIONS=======ELLIPTICAL HEAD CALCULATIONS ON O.D. FORMULA====
SHELL HEAD
MATERIAL: SA-240-304L    PRESS =  180.0psig   TEMP =    290deg.F
O.D.            (min)THK.     CORR.ALLOW    EFFICIENCY
  18.0000"       0.1875"       0.0000"       1.00
ATM.STRS        DES.STRS      STRS/STRS     MAWP N-C     MAWP CORR.
  16700.0psi     16700.0psi  1.000         354.565psig  354.565psig

  P*(RO)                                                  0.0000
---------- =  0.09607"   + CORR. ALLOW. =  0.09607"   + MTOL. =  0.09607"
S*E+(.9*P)
********************************************************************************
ASME CODE SEC.VIII DIV.I UG-27              [ ANNULAR DISTRIBUTOR CYLINDER ]
====DESIGN CONDITIONS==============CYLINDER CALCULATIONS ON I.D. FORMULA====

MATERIAL: SA-240-304L      PRESS =  180.0psig   TEMP =    290deg.F
I.D.          NOM. THK.    RW=0/PIPE=1   CORR.ALLOW   EFFICIENCY
  23.5000"      0.2500"        0          0.0000"       1.00
ATM.STRS      DES.STRS     STRS/STRS     MAWP N-C     MAWP CORR.
16700.0psi    12950.0psi   1.290         263.962psig    204.689psig

 P*(R+CA)
---------- =  0.16469"   + CORR. ALLOW. =  0.16469"   + MTOL. =  0.16469"
S*E-(.6*P)
```


Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
1	Revised per Customer Comments	SR	1/12/12	GD	1/12/12
2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12
3	Corrected cylinder joint efficency	DS	6-20-12	SHD	6-20-12

```
                                  FRONT CHAN.
================================================================================
 NOM.
 SIZE          PRESS.        TEMP.          C.A.        RT     H.T.          TEMA
  18.000"      150.0psig       200deg.F  0.0000"      100%         0deg.F     R
================================================================================
ASME CODE SECTION VIII, DIVISION 1, UG-27                          [ CYLINDER ]
====DESIGN CONDITIONS==============CYLINDER CALCULATIONS ON O.D. FORMULA====
CHAN. CYL
MATERIAL: SA-312TP304L      PRESS =  150.0psig   TEMP =    200deg.F
O.D.          NOM. THK.     RW=0/PIPE=1   CORR.ALLOW   EFFICIENCY
  18.0000"      0.2500"         1           0.0000"       1.00
ATM.STRS      DES.STRS      STRS/STRS     MAWP N-C      MAWP CORR.
  14200.0psi    14200.0psi  1.000         348.527psig    348.527psig

  P*(RO)
---------- =  0.09467"   + CORR. ALLOW. =  0.09467"   + MTOL. =  0.10819"
S*E+(.4*P)
********************************************************************************
```


Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
1	Revised per Customer Comments	SR	1/12/12	GD	1/12/12
2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SECTION VIII, DIV.1, UG-37 & UG-16
 NOZ NO= 1      6.00"    300 LB RF  WN
 [INLET   ] SHELL SIDE
 PRESSURE =  180.0psig   TEMP =  290.0deg.F

 -------CYLINDER-----------------------NOZZLE-------
 SA-312TP304L                    SA-312TP304L
 OPER STRS=   14200.0 psi        OPER STRS=   11020.0 psi
 ATM STRS =   14200.0 psi        ATM STRS =   14200.0 psi
 C.A.     =   0.00000"           C.A.     =   0.00000"
 I.D.     =  23.34375"           I.D.     =   5.76100"
 O.D.     =  24.00000"           O.D.     =   6.62500"
 THK.     =   0.32812"           THK.   XH=   0.43200"
 T        =   0.32812"           TN       =   0.43200"
 TR       =   0.15135"           TRN      =   0.05375"
 ET       =   0.17678"           ETN      =   0.37825"

 MIN STD. WT. PIPE+C.A.=  0.24500"   TR+C.A.=  0.15135"
 LIMITS=  11.52200"
 fr1= 0.7761 fr2= 0.7761 fr3= 0.0000 fr4= 0.0000     F=   1.00000
 Min weld sizes:NS=  0.3248" NP=  0.0000" PS=  0.0000" IF=  0.0000"

 AREA REQD.              A =   0.90118in^2
 EXCESS IN CYL.          A1=   0.98422in^2
 EXCESS IN NOZ.(OUTSIDE) A2=   0.48159in^2  H =   0.82031"
 AREA OF FILLETS           =   0.10913in^2
 AREA AVAILABLE            =   1.57494in^2

 NOZ. NECK WELD= 0.37500"  AREA=   0.10913in^2

 < AREA REQD-AREA AVAILABLE >  =   -0.67376in^2

 MAWP N-C=   272.0psig  LIMITED BY AR
 MAWP COR=   247.0psig  LIMITED BY AR
```


Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
1	Revised per Customer Comments	SR	1/12/12	GD	1/12/12
2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SECTION VIII, DIV.1, UG-37 & UG-16
 NOZ NO= 2      8.00"    300 LB RF  WN
 [OUTLET  ] SHELL SIDE
 PRESSURE =  180.0psig   TEMP =  290.0deg.F

 -------CYLINDER-----------------------NOZZLE-------
 SA-312TP304L                    SA-312TP304L
 OPER STRS=   14200.0 psi        OPER STRS=   11020.0 psi
 ATM STRS =   14200.0 psi        ATM STRS =   14200.0 psi
 C.A.     =   0.00000"           C.A.     =   0.00000"
 I.D.     =  23.34375"           I.D.     =   7.62500"
 O.D.     =  24.00000"           O.D.     =   8.62500"
 THK.     =   0.32812"           THK.   XH=   0.50000"
 T        =   0.32812"           TN       =   0.50000"
 TR       =   0.15135"           TRN      =   0.06998"
 ET       =   0.17678"           ETN      =   0.43002"

 MIN STD. WT. PIPE+C.A.=  0.28175"   TR+C.A.=  0.15135"
 LIMITS=  15.25000"
 fr1= 0.7761 fr2= 0.7761 fr3= 0.0000 fr4= 0.0000     F=   1.00000
 Min weld sizes:NS=  0.3248" NP=  0.0000" PS=  0.0000" IF=  0.0000"

 AREA REQD.              A =   1.18790in^2
 EXCESS IN CYL.          A1=   1.30836in^2
 EXCESS IN NOZ.(OUTSIDE) A2=   0.54751in^2  H =   0.82031"
 AREA OF FILLETS           =   0.10913in^2
 AREA AVAILABLE            =   1.96499in^2

 NOZ. NECK WELD= 0.37500"  AREA=   0.10913in^2

 < AREA REQD-AREA AVAILABLE >  =   -0.77709in^2

 MAWP N-C=   260.0psig  LIMITED BY AR
 MAWP COR=   238.0psig  LIMITED BY AR
```


Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
1	Revised per Customer Comments	SR	1/12/12	GD	1/12/12
2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SEC.VIII DIV.I UG-37 & UG-16
  NOZ NO=11      4.00"    150 LB RF  WN
 [INLET & OUTLET  ] FRONT CHANNEL SIDE
 PRESSURE =  150.0psig   TEMP =  200.0deg.F

 -------CYLINDER-----------------------NOZZLE-------
 SA-312TP304L                    SA-312TP304L
 OPER STRS=   14200.0 psi        OPER STRS=   14200.0 psi
 ATM STRS =   14200.0 psi        ATM STRS =   14200.0 psi
 C.A.     =   0.00000"           C.A.     =   0.00000"
 I.D.     =  17.56250"           I.D.     =   4.02600"
 O.D.     =  18.00000"           O.D.     =   4.50000"
 THK.     =   0.21875"           THK. sc40=   0.23700"
 T        =   0.21875"           TN       =   0.23700"
 TR       =   0.09467"           TRN      =   0.02367"
 ET       =   0.12408"           ETN      =   0.21333"

 MIN STD. WT. PIPE+C.A.=  0.20738"   TR+C.A.=  0.09467"
 LIMITS=   8.05200"
 fr1= 1.0000 fr2= 1.0000 fr3= 0.0000 fr4= 0.0000     F=   1.00000
 Min weld sizes:NS=  0.2166" NP=  0.0000" PS=  0.0000" IF=  0.0000"

 AREA REQD.              A =   0.38114in^2
 EXCESS IN CYL.          A1=   0.49954in^2
 EXCESS IN NOZ.(OUTSIDE) A2=   0.23333in^2  H =   0.54688"
 AREA OF FILLETS           =   0.14062in^2
 AREA AVAILABLE            =   0.87350in^2

 NOZ. NECK WELD= 0.37500"  AREA=   0.14062in^2

 < AREA REQD-AREA AVAILABLE >  =   -0.49236in^2

 MAWP N-C=   244.0psig  LIMITED BY AR
 MAWP COR=   244.0psig  LIMITED BY AR
```


Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
1	Revised per Customer Comments	SR	1/12/12	GD	1/12/12
2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
ASME SECTION VIII, DIVISION 1, APPENDIX 2    Front Channel to cover flange
DESIGN CONDITIONS           GASKET and BOLTING CALCULATIONS   TABLE
Design Pres=  150.0 psig    Eff.Gsk OD=    19.1250"           No.Passes= 2
Neg.   Pres=   None         Eff.Gsk ID=    18.1250"           N=  0.500"
Design Temp=    200 deg.F   THK= 0.1250"             col.=2   b=  0.250
Flg  Matl=SA-182F304L   Gsk Matl=304L DJ GRAPH F               y=   9000psi
Stud Matl=SA-193B7      Gsk Face=FLAT FACE       w= 0.0000"   m=  3.750
Corr Allow=    0.0000"         Wm2=    192824 #      Am =   7.9515in^2
Flange  Desn Sfo 14300.0 psi   Hp =     24103 #      Ab =   8.3800in^2
        Atm. Sfa 16700.0 psi   H  =     40867 #      W  =   204143 #
Bolting Desn Sb  25000.0 psi   Wm1=     64970 #      Wm1=    64970 #
        Atm. Sa  25000.0 psi    Gasket Width Check  Nmin =    0.1989"
CONDITION    LOAD         x        LEVER ARM   =    MOMENT
             HD =    36079 #       hD=  1.43750"    MD=     51863 in#
Operating    HG =    24103 #       hG=  1.06250"    MG=     25609 in#
             HT =     4787 #       hT=  1.34375"    MT=      6433 in#
                                                    Mo=     83906 in#
Gasket
Seating      HG =   204143 #       hG=  1.06250"    mo=    216902 in#
Allow.Stress-STRESS CALCULATIONS-Operating          SHAPE CONSTANTS
1.5 Sfo Long Hub,SH            7329.8 psi    K    = 1.2929 h/ho=  0.5976
    Sfo Radial Flg,SR           413.8 psi    T    = 1.8004 F   =  0.8352
    Sfo Tang Flg,ST            4901.5 psi    Z    = 3.9785 V   =  0.2948
    Sfo .5(SH+SR)or.5(SH+ST)   6115.7 psi    Y    = 7.7031 f   =  1.0000
    J(APP.2-14)=    0.2571                   U    = 8.4649 e = 0.3993in^-1
Allow.Stress-STRESS CALCULATIONS-Gsk.Seating g1/go= 1.5000 d =   3.753In^3
1.5 Sfa Long Hub,SH           18947.9 psi    ho   =   2.0917"
    Sfa Radial Flg,SR          1069.7 psi
    Sfa Tang Flg,ST           12670.6 psi     OTHER STRESS FORMULA FACTORS
    Sfa .5(SH+SR)or.5(SH+ST)  15809.3 psi        t          2.3750"
    J(APP.2-14)=    0.6459                       Alpha      1.9483
                                                 Beta       2.2645
                                                 Gamma      1.0822
                                                 Delta      3.5694
                                                 Lambda     4.6516
                                                 M            4794 #
                                                 m           12394 #

O.D.       =   22.6250"            THK.          =    2.6875"
I.D.       =   17.5000"            T-Adder       =    0.1250"
GO         =    0.2500"            G1            =    0.3750"
HUB O.D.   =   18.2500"            HUB LEN       =    1.2500"
HUB ANG    =    5.7106deg          RIB LENGTH    =   18.1250"
G(MEAN)    =   18.6250"            G(CALC)       =   18.6250"
G(MIN.)    =   18.0000"            G(MAX.)       =   18.7500"
B.C.       =   20.7500"            B.S.C.F.      =    1.0000
No. STUDS  =   20                  STUD DIAMETER =    0.8750"
R          =    1.2500"            E             =    0.9375"
BOLT SPAC  =    3.2460"            TORQUE        =       208ft#
MIN. SPAC  =    2.0625"            TEMA MAX. SPAC=    5.1029"
FLG TURN   =    0.1875"            FACING        =    RECESS
BPRIME     =    0.0000"            BG1           =    0.0000"
FLG RWT    =       183Lbs          FLG FWT       =       125Lbs
```


Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
1	Revised per Customer Comments	SR	1/12/12	GD	1/12/12
2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
Flange stress factor=0.9700        Bolting stress factor=0.9700
```


Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
1	Revised per Customer Comments	SR	1/12/12	GD	1/12/12
2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
                ///// FRONT COVER CALCULATIONS /////

EXCHANGER TYPE....= A F U              MATERIAL..........= SA-240-304L
PRESSURE..........=       150.0 psig   CORROSION ALLOWANCE=      0.0000"
TURN LOW..........=      0.1875"       TURN HIGH.........=      0.3125"
S  COVER STRESS...=     16700.0 psi    E.................=         1.0
Sb  STRESS BOLTS..=     25000.0 psi    Ab................=      8.3800 in^2
d.................=     18.6250"       C.................=      0.3000
W.................=      204143 #      Wm1...............=       64970 #
hG (ASME).........=      1.0625"       hG (TEMA).........=      1.0625"
G (TEMA)..........=     18.6250"       E (MOD.) x (10)-6..=        27.5 psi
COVER THK SET HOLD=     [ NO]

[ PER ASME SECT.VIII UG-34 USING Wm1 (OPERATING) ]

              ____________________
             /  C P     1.9 Wm1 hG
THK = d  _  /  ----- + -------------  =     1.1647"
          / /    S E     S   E  d^3

[ PER ASME SECT.VIII UG-34 USING W (GASKET SEATING) ]

              _________________
             /    1.9 W hG
THK = d  _  /   -------------  =     1.1511"
          / /     S   E  d^3

[ PER TEMA RCB-9.2 FLAT CHANNEL COVER ]
MAXIMUM DEFLECTION =    0.0300"
DEFLECTION at     1.5131"       THICK =    0.0300"

                 _                          _
          G
Y =   ----------     0.0435 G^3 P + 0.5 Sb Ab hG   =    0.0272"
   E (    1.562 )^3  _                          _

[ COV THK Min ] TEMA Deflection     =    1.5131" +    0.1875" =    1.7006"
[ COV THK Min ] CODE Operating      =    1.1647" +    0.1875" =    1.3522"
[ COV THK Min ] CODE Gasket Seating =    1.1511" +    0.1875" =    1.3386"
ACTUAL COVER THICKNESS USED (SET HOLD[ NO])=    1.7500"
```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2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
           MAIN FLG IS FLANGE MARK # 2

CODE 46 MAIN FLG. SET: GASKET WIDTH WILL NOT CONTROL MAWP.
CODE 46 COMP FLG. SET: GASKET WIDTH WILL NOT CONTROL MAWP.

            /// INDIVIDUAL COMPONENTS ///
 MAWP CORR. MAIN FLG     =   340.0 Limited by: Flange stress.
 MAWP CORR. COVER        =   205.0

 MAWP N-C   MAIN FLG     =   397.0 Limited by: Flange stress.
 MAWP N-C   COVER        =   222.0
```


Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
1	Revised per Customer Comments	SR	1/12/12	GD	1/12/12
2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
ASME SECTION VIII, DIVISION 1, APPENDIX 2   Front chan to tubesheet flange
DESIGN CONDITIONS           GASKET and BOLTING CALCULATIONS   TABLE
Design Pres=  150.0 psig    Eff.Gsk OD=    19.1250"           No.Passes= 2
Neg.   Pres=   None         Eff.Gsk ID=    18.1250"           N=  0.500"
Design Temp=    200 deg.F   THK= 0.1250"             col.=2   b=  0.250
Flg  Matl=SA-182F304L   Gsk Matl=304L DJ GRAPH F               y=   9000psi
Stud Matl=SA-193B7      Gsk Face=FLAT FACE       w= 0.0000"   m=  3.750
Corr Allow=    0.0000"         Wm2=    192824 #      Am =   7.9515in^2
Flange  Desn Sfo 14300.0 psi   Hp =     24103 #      Ab =   8.3800in^2
        Atm. Sfa 16700.0 psi   H  =     40867 #      W  =   204143 #
Bolting Desn Sb  25000.0 psi   Wm1=     77964 #      Wm1=    77964 #
        Atm. Sa  25000.0 psi    Gasket Width Check  Nmin =    0.1989"
CONDITION    LOAD         x        LEVER ARM   =    MOMENT
             HD =    36079 #       hD=  1.43750"    MD=     51863 in#
Operating    HG =    37097 #       hG=  1.06250"    MG=     39415 in#
             HT =     4787 #       hT=  1.34375"    MT=      6433 in#
                                                    Mo=     97713 in#
Gasket
Seating      HG =   204143 #       hG=  1.06250"    mo=    216902 in#
Allow.Stress-STRESS CALCULATIONS-Operating          SHAPE CONSTANTS
1.5 Sfo Long Hub,SH            8535.9 psi    K    = 1.2929 h/ho=  0.5976
    Sfo Radial Flg,SR           481.9 psi    T    = 1.8004 F   =  0.8352
    Sfo Tang Flg,ST            5708.0 psi    Z    = 3.9785 V   =  0.2948
    Sfo .5(SH+SR)or.5(SH+ST)   7122.0 psi    Y    = 7.7031 f   =  1.0000
    J(APP.2-14)=    0.2994                   U    = 8.4649 e = 0.3993in^-1
Allow.Stress-STRESS CALCULATIONS-Gsk.Seating g1/go= 1.5000 d =   3.753In^3
1.5 Sfa Long Hub,SH           18947.9 psi    ho   =   2.0917"
    Sfa Radial Flg,SR          1069.7 psi
    Sfa Tang Flg,ST           12670.6 psi     OTHER STRESS FORMULA FACTORS
    Sfa .5(SH+SR)or.5(SH+ST)  15809.3 psi        t         2.3750"
    J(APP.2-14)=    0.6459                       Alpha     1.9483
                                                 Beta      2.2645
                                                 Gamma     1.0822
                                                 Delta     3.5694
                                                 Lambda    4.6516
                                                 M           5583 #
                                                 m          12394 #

O.D.       =   22.6250"            THK.          =    2.6875"
I.D.       =   17.5000"            T-Adder       =    0.1250"
GO         =    0.2500"            G1            =    0.3750"
HUB O.D.   =   18.2500"            HUB LEN       =    1.2500"
HUB ANG    =    5.7106deg          RIB LENGTH    =   18.1250"
G(MEAN)    =   18.6250"            G(CALC)       =   18.6250"
G(MIN.)    =   18.0000"            G(MAX.)       =   18.7500"
B.C.       =   20.7500"            B.S.C.F.      =    1.0000
No. STUDS  =   20                  STUD DIAMETER =    0.8750"
R          =    1.2500"            E             =    0.9375"
BOLT SPAC  =    3.2460"            TORQUE        =       208ft#
MIN. SPAC  =    2.0625"            TEMA MAX. SPAC=    5.1029"
FLG TURN   =    0.1875"            FACING        =    RECESS
BPRIME     =    0.0000"            BG1           =    0.0000"
FLG RWT    =       183Lbs          FLG FWT       =       125Lbs
```


Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
1	Revised per Customer Comments	SR	1/12/12	GD	1/12/12
2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
Flange stress factor=0.9700        Bolting stress factor=0.9700
```


Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
1	Revised per Customer Comments	SR	1/12/12	GD	1/12/12
2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
ASME SECTION VIII, DIVISION 1, APPENDIX 2        Shell to tubesheet flange
DESIGN CONDITIONS           GASKET and BOLTING CALCULATIONS   TABLE
Design Pres=  180.0 psig    Eff.Gsk OD=    19.1250"           No.Passes= 2
Neg.   Pres=   None         Eff.Gsk ID=    18.1250"           N=  0.500"
Design Temp=    290 deg.F   THK= 0.1250"             col.=2   b=  0.250
Flg  Matl=SA-182F304L   Gsk Matl=304L DJ GRAPH F               y=   9000psi
Stud Matl=SA-193B7      Gsk Face=FLAT FACE       w= 0.0000"   m=  3.750
Corr Allow=    0.0000"         Wm2=    192824 #      Am =   7.9515in^2
Flange  Desn Sfo 12950.0 psi   Hp =     28923 #      Ab =   8.3800in^2
        Atm. Sfa 16700.0 psi   H  =     49040 #      W  =   204143 #
Bolting Desn Sb  25000.0 psi   Wm1=     77964 #      Wm1=    77964 #
        Atm. Sa  25000.0 psi    Gasket Width Check  Nmin =    0.1989"
CONDITION    LOAD         x        LEVER ARM   =    MOMENT
             HD =    43295 #       hD=  1.43750"    MD=     62236 in#
Operating    HG =    28923 #       hG=  1.06250"    MG=     30731 in#
             HT =     5745 #       hT=  1.34375"    MT=      7720 in#
                                                    Mo=    100688 in#
Gasket
Seating      HG =   204143 #       hG=  1.06250"    mo=    216902 in#
Allow.Stress-STRESS CALCULATIONS-Operating          SHAPE CONSTANTS
1.5 Sfo Long Hub,SH            8795.8 psi    K    = 1.2929 h/ho=  0.5976
    Sfo Radial Flg,SR           496.6 psi    T    = 1.8004 F   =  0.8352
    Sfo Tang Flg,ST            5881.8 psi    Z    = 3.9785 V   =  0.2948
    Sfo .5(SH+SR)or.5(SH+ST)   7338.8 psi    Y    = 7.7031 f   =  1.0000
    J(APP.2-14)=    0.3137                   U    = 8.4649 e = 0.3993in^-1
Allow.Stress-STRESS CALCULATIONS-Gsk.Seating g1/go= 1.5000 d =   3.753In^3
1.5 Sfa Long Hub,SH           18947.9 psi    ho   =   2.0917"
    Sfa Radial Flg,SR          1069.7 psi
    Sfa Tang Flg,ST           12670.6 psi     OTHER STRESS FORMULA FACTORS
    Sfa .5(SH+SR)or.5(SH+ST)  15809.3 psi        t          2.3750"
    J(APP.2-14)=    0.6459                       Alpha      1.9483
                                                 Beta       2.2645
                                                 Gamma      1.0822
                                                 Delta      3.5694
                                                 Lambda     4.6516
                                                 M            5753 #
                                                 m           12394 #

O.D.       =   22.6250"            THK.          =    2.6875"
I.D.       =   17.5000"            T-Adder       =    0.1250"
GO         =    0.2500"            G1            =    0.3750"
HUB O.D.   =   18.2500"            HUB LEN       =    1.2500"
HUB ANG    =    5.7106deg          RIB LENGTH    =   18.1250"
G(MEAN)    =   18.6250"            G(CALC)       =   18.6250"
G(MIN.)    =   18.0000"            G(MAX.)       =   18.7500"
B.C.       =   20.7500"            B.S.C.F.      =    1.0000
No. STUDS  =   20                  STUD DIAMETER =    0.8750"
R          =    1.2500"            E             =    0.9375"
BOLT SPAC  =    3.2460"            TORQUE        =       208ft#
MIN. SPAC  =    2.0625"            TEMA MAX. SPAC=    5.1029"
FLG TURN   =    0.1875"            FACING        =    RECESS
BPRIME     =    0.0000"            BG1           =    0.0000"
FLG RWT    =       183Lbs          FLG FWT       =       125Lbs
```


Revisions to this Page					
No.	Detailed Description of the Revision	By	Date	Apdd.	Date
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2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
Flange stress factor=0.9700        Bolting stress factor=0.9700
```


Revisions to this Page					
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2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
            MAIN FLG IS FLANGE MARK # 3
            COMP FLG IS FLANGE MARK # 7

 CODE 46 MAIN FLG. SET: GASKET WIDTH WILL NOT CONTROL MAWP.
 CODE 46 COMP FLG. SET: GASKET WIDTH WILL NOT CONTROL MAWP.

             /// INDIVIDUAL COMPONENTS ///
  MAWP CORR. MAIN FLG     =   340.0 Limited by: Flange stress.
  MAWP CORR. COMP FLG     =   308.0 Limited by: Flange stress.
  MAWP CORR. T.S.[STD DIA]=   164.0

  MAWP N-C   MAIN FLG     =   397.0 Limited by: Flange stress.
  MAWP N-C   COMP FLG     =   397.0 Limited by: Flange stress.
  MAWP N-C   T.S.[STD DIA]=   164.0


      /// AS MATING FLANGES (NO VACCUUM INCLUDED) ///
  MAWP CORR. MAIN FLG     =   308.0
  MAWP CORR. COMP FLG     =   308.0 Limited by: Flange stress.

  MAWP N-C   MAIN FLG     =   397.0 Limited by: Flange stress.
  MAWP N-C   COMP FLG     =   397.0 Limited by: Flange stress.
```


Revisions to this Page					
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2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
                    ***** TUBE CALCULATIONS *****

Tube size........=       1.00000"     Straight or U-Tube.= U-Tube
Internal Press...=     150.00000psig  External press.....=     180.00000psig
Temperature used.=     290.00000deg.  Tube Matl MT#123...= SA-213TP304L
Stress Oper......=   12950.00000psi   Stress Atm.........=   16700.00000psi
Yield............=   19400.00195psi   Inside Radius......=       0.40900"
Joint Eff........=       1.00000      Mill tol...= 0.00% =       0.00000"
Wall Thk. t......=       0.09100"     Tube gauge.........=
Mean Rad., R.....=       1.50000"     Tube Length........=     192.00000"
Corrosion ID.....=       0.00000"     Corrosion OD.......=       0.00000"
Thinning factor..=       1.16667

tr = PR/SE - .6P =       0.00477"     (tr*TF)+MT+CA......=       0.00557"

MAWP Internal H/C=    2216.10352psig  MAWP Internal N/C..=    2857.83228psig
MAWP External H/C=     956.56287psig  MAWP External N/C..=    1309.67029psig



                **** ASME PRESSURE/TEMPERATURE RATING ****


---- SHELL NOZZLES -----------------DESIGN PRESS=  180.0 DESIGN TEMP=  290.0
NOZ# 1      6.0- 300#  MT# FLG= 206 GROUP=2.3  @70deg.= 600.00 @TEMP= 460.50
NOZ# 2      8.0- 300#  MT# FLG= 206 GROUP=2.3  @70deg.= 600.00 @TEMP= 460.50

---- FRONT CHANNEL NOZZLES ---------DESIGN PRESS=  150.0 DESIGN TEMP=  200.0
NOZ#11      4.0- 300#  MT# FLG= 206 GROUP=2.3  @70deg.= 600.00 @TEMP= 510.00
NOZ#12      4.0- 300#  MT# FLG= 206 GROUP=2.3  @70deg.= 600.00 @TEMP= 510.00
```


Revisions to this Page					
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2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
                /// TEMA PASS PLATE CALCULATIONS ///
                          Per RCB-9.132


                    _________
                   /  q B
          t = b   / -------
                \/   1.5 S

TUBE SIDE PRESSURE DROP   q =  10.00000

FRONT PASS PLATE THK..... =   0.25000
MATERIAL................. = SA-240-304L
STRESS OPER.............. =  16700.00
FRONT Chan ID............ =  17.50000
FRONT Chan OAL........... =  21.62500
a........................ =  20.18750
b........................ =  17.50000
TABLE RCB-9.132.......... = Long sides fixed
a/b...................... =   1.15357
B........................ =   0.45229
t........................ =   0.23515
Min fillet leg [both sides] = 3/4t = .75 x 0.23515 = 0.17636
```


Revisions to this Page					
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2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

```
============================== EXCHANGER DATA ==============================

                      ///// DRY WEIGHTS [Pounds] /////
EXCHANGER.=     4086.55   ROUGH WT..=     4440.31   BUNDLE....=     2175.25
SHELL.....=     1107.23   FRONT CH..=      548.40   REAR CH...=        0.09
FLTG. HEAD=        0.00   BOLTS.....=       77.57
BOTT SUPTS=      143.03   TOP SUPTS.=        0.00
FC P-PLS..=       34.97   RC P-PLS..=        0.00   FH P-PLS..=        0.00

                      ///// WET WEIGHTS [Pounds] /////
EXCHANGER FLOODED WITH WATER TUBES AND SHELL SIDE.............=     5901.34
EXCHANGER FLOODED WITH WATER TUBE  SIDE.......................=     4645.43
EXCHANGER FLOODED WITH WATER SHELL SIDE.......................=     5342.46
WTR.TOTAL.=     1814.79   WTR.TUBES.=      558.88   WTR.SHELL.=     1255.91

     ///// CENTER OF GRAVITIES [Inches fron outline reference] /////
EXCHANGER DRY.................................................=       72.81
BUNDLE DRY ...................................................=       92.91
SHELL DRY.....................................................=       81.19
FRONT CHANNEL DRY.............................................=      -13.51
REAR CHANNEL DRY..............................................=        0.00
EXCHANGER FLOODED WITH WATER TUBES AND SHELL SIDE.............=       78.74
EXCHANGER FLOODED WITH WATER TUBE  SIDE.......................=       71.99
EXCHANGER FLOODED WITH WATER SHELL SIDE.......................=       80.07

              ///// WEIGHT ON SUPPORTS [Pounds] /////
EXCH DRY.........................[LEFT]=     2901.05 [RIGHT]=     1185.50
EXCH FLOODED W/ WTR TUBES & SHELL.[LEFT]=     3898.04 [RIGHT]=     2003.30
EXCH FLOODED W/ WTR TUBE  SIDE....[LEFT]=     3329.69 [RIGHT]=     1315.74
EXCH FLOODED W/ WTR SHELL SIDE....[LEFT]=     3469.40 [RIGHT]=     1873.06

               ///// SURFACE AREAS [Square Feet] /////
TUBES OUTSIDE GROSS...........................................=      446.99
TUBES OUTSIDE EFFECTIVE.......................................=      443.38
EXCHANGER.....................................................=      122.03
SHELL.........................................................=       89.80
FRONT CHANNEL.................................................=       18.46
REAR  CHANNEL.................................................=        0.00
FRONT TUBESHEET [Tubshts included to shell if fixed tubesheet]=        0.63
BOTTOM SUPPORTS...............................................=       13.15
TOP    SUPPORTS...............................................=        0.00
```


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ASME SEC.VIII DIV.1 UHX-12

(U-Tube) Configuration d			
No or EPC=Elastic-Plastic	Calcs SSC=Simply Supported Calcs		=NO
MT Tubes	=SA-213TP304L	MT Tubesheets	=SA-240-304L
MT Channel	=SA-312TP304L	MT Shell	=SA-312TP304L
Diameter (Do)	= 17.1250"	Pass Lane Area (AL)	= 74.328in^2
Perimeter of layout (CP)	= 0.0000"	Area enclosed by CP (AP)	= 0.000in^2
Tubesheet thickness (h)	= 1.3750"	Tubesheet thickness HOLD	= NO
Tube Pitch (p)	= 1.2500"	Pitch type = Rot Triangle (30 Deg)	
Diameter of tube (dt)	= 1.0000"	Tube thickness (tt)	= 0.0910"
Exp length of tube (ltx)	= 0.0000"	Exp depth ratio (Rho)	= 0.9500
Groove channel side (hg)	= 0.1875"	Groove shell side	= 0.0000"
Channel I.D. (Dc)	= 17.5000"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 17.5000"	Shell thickness (Ts)	= 0.2500"
TS outside diameter (A)	= 19.1250"	Bolt circle (C)	= 20.7500"
G Channel side (Gc or G1)	= 18.6250"	G Shell side (Gs or G1)	= 18.6250"
Bolt load Chan side (Wc)	=204143.89#	Bolt load Sh side (Ws)	=204143.89#
1.8*Sqrt(Dc*Tc)	= 0.0000"	1.8*Sqrt(Ds*(Ts or Ts1))	= 0.0000"
Thickness at Top TS (tr)	= 1.0000"	Outer Tube Circle	= 17.1250"
hr Ch Op= 0.0000"	Ch Atm= 0.0000"	Sh Op= 0.0000"	Sh Atm = 0.0000"
Tubes welded Backside TS	=NO	Hole Size in Tubesheet	= 0.0000"
Design Press Chan (Pt)	= 150.0psig	Design Press Shell (Ps)	= 180.0psig
Design Temp Chan	= 200.0deg.	Design Temp Shell	= 290.0deg.
Corr Chan	= 0.00000"	Corr Shell	= 0.00000"
Corr Chan side TS (ct)	= 0.00000"	Corr Shell side TS (cs)	= 0.00000"

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```
                    ASME SEC.VIII DIV.1 UHX-12     Case  1

(U-Tube)  Configuration d
Tubesheet Thickness (h)    =   1.3750"
Exp length of tube (ltx)   =   1.3062"      Exp depth ratio (Rho)     =   0.9500"
Channel I.D. (Dc)          =  17.5000"      Channel thickness (Tc)    =   0.2500"
Shell I.D. (Ds)            =  17.5000"      Shell thickness (Ts)      =   0.2500"

Press Chan (Pt)            =    150.0psi    Press Shell (Ps)          =      0.0p
Corr Chan                  =  0.00000"      Corr Shell                =  0.00000"
Corr Chan side TS (ct)     =  0.00000"      Corr Shell side TS (cs)   =  0.00000"
           Temp          Stress          Yield            Modulus  Coef   Poiss
                                                           x10^6    x10^-6 Ratio
Temp TS  T = 290deg.F S  = 16700psi   Sy =      0psi   E  =27.0500      V =.000
Temp TBS Tt= 290deg.F St = 12950psi   Syt=      0psi   Et =27.0500      Vt=.000
Temp CH  Tc= 200deg.F Sc = 14200psi   Syc=  21400psi   Ec =27.5000      Vc=.300
Temp SH  Ts= 290deg.F Ss = 14200psi   Sys=  19400psi   Es =27.0500      Vs=.300

Mu=  0.2000 d*=  0.8659"    P*=  1.5189"    Mu*=  0.4299 hg'=  0.1875"    hgs'=
Wmax     = 204143.8906#        Rho s    = 1.087591290
Rho c    = 1.087591290         Mts      =-525.6760864In-Lb/In h/p     = 1.10000
E*       = 13253880.00psi      v*       = 0.288465917         Beta s  =
Kappa s  =          0.0#       Lambda s =          0.0psi     Delta s =
Delta c  =          0.0In^3/Lb Beta c   =          0.0in^-1   Kappa c =
Lambda c =          0.0psi     Omega s  =          0.0in^2    Omega c =
K        = 1.116788268         F        = 0.160403192         M*      =-525.676
Mp       =-262.9884338In-Lb/In Mo       =-2523.286865In-Lb/In M       = 2523.28
Sigma s,m=          0.0psi     Sigma s,b=          0.0psi     Sigma s =
Sigma c,m=          0.0psi     Sigma c,b=          0.0psi     Sigma c =
Sigma      24974 psi    <= 2S      33400 psi   [OK               ]
Tau         2335 psi    <= .8S     13360 psi   [OK               ]
```


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```
                    ASME SEC.VIII DIV.1 UHX-12     Case  2

(U-Tube)  Configuration d
Tubesheet Thickness (h)    =   1.3750"
Exp length of tube (ltx)   =   1.3062"      Exp depth ratio (Rho)     =   0.9500"
Channel I.D. (Dc)          =  17.5000"      Channel thickness (Tc)    =   0.2500"
Shell I.D. (Ds)            =  17.5000"      Shell thickness (Ts)      =   0.2500"

Press Chan (Pt)            =      0.0psi    Press Shell (Ps)          =    180.0p
Corr Chan                  =  0.00000"      Corr Shell                =  0.00000"
Corr Chan side TS (ct)     =  0.00000"      Corr Shell side TS (cs)   =  0.00000"
           Temp          Stress          Yield            Modulus  Coef   Poiss
                                                           x10^6    x10^-6 Ratio
Temp TS  T = 290deg.F S  = 16700psi   Sy =      0psi   E  =27.0500      V =.000
Temp TBS Tt= 290deg.F St = 12950psi   Syt=      0psi   Et =27.0500      Vt=.000
Temp CH  Tc= 200deg.F Sc = 14200psi   Syc=  21400psi   Ec =27.5000      Vc=.300
Temp SH  Ts= 290deg.F Ss = 14200psi   Sys=  19400psi   Es =27.0500      Vs=.300

Mu=  0.2000 d*=  0.8659"    P*=  1.5189"    Mu*=  0.4299 hg'=  0.1875"    hgs'=
Wmax     = 204143.8906#        Rho s    = 1.087591290
Rho c    = 1.087591290         Mts      = 630.8112793In-Lb/In h/p     = 1.10000
E*       = 13253880.00psi      v*       = 0.288465917         Beta s  =
Kappa s  =         0.0#        Lambda s =         0.0psi      Delta s =
Delta c  =         0.0In^3/Lb  Beta c   =         0.0in^-1    Kappa c =
Lambda c =         0.0psi      Omega s  =         0.0in^2     Omega c =
K        = 1.116788268         F        = 0.160403192         M*      = 630.811
Mp       = 315.5860901In-Lb/In Mo       = 3027.944336In-Lb/In M       = 3027.94
Sigma s,m=         0.0psi      Sigma s,b=         0.0psi      Sigma s =
Sigma c,m=         0.0psi      Sigma c,b=         0.0psi      Sigma c =
Sigma      29969 psi    <= 2S      33400 psi   [OK               ]
Tau         2802 psi    <= .8S     13360 psi   [OK               ]
```


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```
                    ASME SEC.VIII DIV.1 UHX-12     Case  3

(U-Tube)  Configuration d
Tubesheet Thickness (h)    =   1.3750"
Exp length of tube (ltx)   =   1.3062"      Exp depth ratio (Rho)     =   0.9500"
Channel I.D. (Dc)          =  17.5000"      Channel thickness (Tc)    =   0.2500"
Shell I.D. (Ds)            =  17.5000"      Shell thickness (Ts)      =   0.2500"

Press Chan (Pt)            =    150.0psi    Press Shell (Ps)          =    180.0p
Corr Chan                  =  0.00000"      Corr Shell                =  0.00000"
Corr Chan side TS (ct)     =  0.00000"      Corr Shell side TS (cs)   =  0.00000"
           Temp          Stress          Yield            Modulus  Coef   Poiss
                                                           x10^6    x10^-6 Ratio
Temp TS  T = 290deg.F S  = 16700psi   Sy =      0psi   E  =27.0500      V =.000
Temp TBS Tt= 290deg.F St = 12950psi   Syt=      0psi   Et =27.0500      Vt=.000
Temp CH  Tc= 200deg.F Sc = 14200psi   Syc=  21400psi   Ec =27.5000      Vc=.300
Temp SH  Ts= 290deg.F Ss = 14200psi   Sys=  19400psi   Es =27.0500      Vs=.300

Mu=  0.2000 d*=  0.8659"    P*=  1.5189"    Mu*=  0.4299 hg'=  0.1875"    hgs'=
Wmax     = 204143.8906#        Rho s    = 1.087591290
Rho c    = 1.087591290         Mts      = 105.1352158In-Lb/In h/p     = 1.10000
E*       = 13253880.00psi      v*       = 0.288465917         Beta s  =
Kappa s  =         0.0#        Lambda s =         0.0psi      Delta s =
Delta c  =         0.0In^3/Lb  Beta c   =         0.0in^-1    Kappa c =
Lambda c =         0.0psi      Omega s  =         0.0in^2     Omega c =
K        = 1.116788268         F        = 0.160403192         M*      = 105.135
Mp       = 52.59768295In-Lb/In Mo       = 504.6573792In-Lb/In M       = 504.657
Sigma s,m=         0.0psi      Sigma s,b=         0.0psi      Sigma s =
Sigma c,m=         0.0psi      Sigma c,b=         0.0psi      Sigma c =
Sigma       4994 psi    <= 2S      33400 psi   [OK               ]
Tau          467 psi    <= .8S     13360 psi   [OK               ]




         /////////// Recap of all Cases //////////
(Case Number  1)OK
(Case Number  2)OK
(Case Number  3)OK
(hr Calc StatTS)OK
(hr Calc StatTS)..
```


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Input Values:

```
Wind Design Code                ASCE-7 98/02/05/IBC-03/STS-1
Basic Wind Speed                    [V]             100.00  mile/hr
Surface Roughness Category                  C: Open Terrain
Importance Factor                                     1.15
Type of Surface                             Moderately Smooth
Base Elevation                                      396.00  in
Percent Wind for Hydrotest                            33.0
Using User defined Wind Press. Vs Elev.                  N
Height of Hill or Escarpment     H or Hh            0.0000  in
Distance Upwind of Crest              Lh            0.0000  in
Distance from Crest to the Vessel      x            0.0000  in
Type of Terrain ( Hill, Escarpment )                  Flat
Damping Factor (Beta) for Wind (Ope)                0.0100
Damping Factor (Beta) for Wind (Empty)              0.0000
Damping Factor (Beta) for Wind (Filled)             0.0000
```

Wind Analysis Results

Static Gust-Effect Factor, Operating Case [G]:

```
= min(0.85, 0.925((1 + 1.7 * gQ * Izbar * Q )/( 1 + 1.7 * gV * Izbar)))
= min(0.85,0.925((1+1.7*3.400*0.228*0.959)/(1+1.7*3.400*0.228)))
= min(0.85, 0.904 )
= 0.850
```

```
Natural Frequency of Vessel (Operating)          33.000 Hz
Natural Frequency of Vessel (Empty)              33.000 Hz
Natural Frequency of Vessel (Test)               33.000 Hz
```

Note: Per Section 1609 of IBC 2003/06/09 these results are also applicable for the determination of Wind Loads on structures (1609.1.1).

```
User Entered Importance Factor is                1.150
Force Coefficient                          [Cf]  0.624
Structure Height to Diameter ratio               11.277
```

This is classified as a rigid structure. Static analysis performed.

Sample Calculation for the First Element

The ASCE code performs all calculations in Imperial Units only. The wind pressure is therefore computed in these units.

Value of [Alpha] and [Zg]:

```
Exposure Category: C from Table C6-2
Alpha = 9.500 : Zg = 10800.000 in
```

Effective Height [z]:

```
= Centroid Height + Vessel Base Elevation
= 19.750 + 396.000 = 415.750 in
= 34.646 ft. Imperial Units
```

Velocity Pressure coefficient evaluated at height z [Kz]:

```
Because z (34.646 ft.) > 15 ft.
= 2.01 * ( z / Zg ) ^ 2 / Alpha
= 2.01 * ( 34.646/900.000 )^2/9.500
= 1.012
```

Type of Hill: No Hill

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Wind Directionality Factor [Kd]:
= 0.95 per [6-6 ASCE-7 98][6-4 ASCE-7 02/05]

As there is No Hill Present: [Kzt]:
K1 = 0, K2 = 0, K3 = 0

Topographical Factor [Kzt]:
= (1 + K1 * K2 * K3)²
= (1 + 0.000 * 0.000 * 0.000)²
= 1.0000

Velocity Pressure evaluated at height z, Imperial Units [qz]:
= 0.00256 * Kz * Kzt * Kd * I * Vr(mph)²
= 0.00256 * 1.012 * 1.000 * 0.950 * 1.150 * 100.000²
= 28.3 psf

Force on the first element [F]:
= qz * G * Cf * WindArea
= 28.317 * 0.850 * 0.624 * 0.454
= 6.8 lbf

Element	Hgt (z) in	K1	K2	K3	Kz	Kzt	qz psf
S11-10279-7/8	415.8	0.000	0.000	0.000	1.012	1.000	28.317
S11-10279-7/8	415.8	0.000	0.000	0.000	1.012	1.000	28.317
S11-10279-7/8	415.8	0.000	0.000	0.000	1.012	1.000	28.317

Wind Loads on Masses/Equipment/Piping

ID	Wind Area in²	Elevation in	Pressure psf	Force lbf
WGHT:[1 OF 1]	1152.00	468.81	28.32	226.54

Wind Load Calculation

From	To	Wind Height in	Wind Diameter in	Wind Area in²	Wind Pressure psf	Element Wind Load lbf
10	20	415.750	21.6000	65.4103	28.3171	6.81980
20	30	415.750	21.6000	4263.30	28.3171	671.036
30	40	415.750	21.6000	65.4103	28.3171	6.81980

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Input Values:

Earthquake Analysis Results per ASCE 7-2005

```
Short-period site coefficient 11.4-1                    Fa: 1.200
Long -period site coefficient 11.4-2                    Fv: 1.700
Maximum Mapped Acceleration Value for Short Periods     Ss: 0.200
Maximum Mapped Acceleration Value for 1 Sec. Period     S1: 1.000
Response Modification Factor                             R: 3.000
Importance Factor                                       Ie: 1.250
Site Class                                                   C
```

Seismic Analysis Results:

```
Sms = Fa * Ss = 1.200 * 0.200 = 0.240
Sm1 = Fv * S1 = 1.700 * 1.000 = 1.700
Sds = 2/3 * Sms = 2/3 * 0.240 = 0.160

Sds = Max( 0.8*Sds, SdsUser )
    = Max( 0.128 , 0.163 )
    = 0.163

Sd1 = 2/3 * Sm1 = 2/3 * 1.700 = 1.133

Sd1 = Max( 0.8*Sd1, Sd1User )
    = Max( 0.907 , 0.099 )
    = 0.907
```

Check Approximate Fundamental Period from 12.8-7 [Ta]:

$= Ct * hn^{x}$ where Ct = 0.020, x = 0.75 and hn = Structural Height (ft.)

$= 0.020 * (1.4583^{0.75})$

= 0.027 seconds

The Coefficient Cu from Table 12.8-1 is : 1.400

Fundamental Period (1/Frequency) [T]:

= (1/Natural Frequency) = (1/33.000)

= 0.030

Check the Value of T which is the smaller of Cu*Ta and T:

= Minimum Value of (1.400 * 0.027 , 0.030) per 12.8.2

= 0.030

As the time period is < 0.06 second, use section 15.4.2.

Compute the Base Shear per equation 15.4-5, [V]:

= 0.3 * Sds * W * I

= 0.3 * 0.163 * 7181 * 1.25

= 438.974 lbf

Note: Loads multiplied by the Scalar multiplier value of 0.7000

Final Base Shear, V = 307.28 lbf

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Earthquake Load Calculation

From	To	Earthquake Height in	Earthquake Weight lbf	Element Ope Load lbf
10	20	8.75000	1436.32	61.4564
20	Sadl	8.75000	1436.32	61.4564
Sadl	30	8.75000	1436.32	61.4564
20	30	8.75000	1436.32	61.4564
30	40	8.75000	1436.32	61.4564

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ASME Horizontal Vessel Analysis: Stresses for the Left Saddle
(per ASME Sec. VIII Div. 2 based on the Zick method.)

Horizontal Vessel Stress Calculations : Operating Case

Input and Calculated Values:

Vessel Mean Radius	Rm	11.81	in
Stiffened Vessel Length per 4.15.6	L	182.06	in
Distance from Saddle to Vessel tangent	a	29.00	in
Saddle Width	b	5.50	in
Saddle Bearing Angle	theta	118.00	degrees
Wear Plate Width	b1	10.00	in
Wear Plate Bearing Angle	theta1	145.00	degrees
Wear Plate Thickness	tr	0.3750	in
Wear Plate Allowable Stress	Sr	17100.00	psi
Inside Depth of Head	h2	5.81	in
Shell Allowable Stress used in Calculation		17100.00	psi
Head Allowable Stress used in Calculation		20000.00	psi
Circumferential Efficiency in Plane of Saddle		1.00	
Circumferential Efficiency at Mid-Span		1.00	
Saddle Force Q, Operating Case		5135.57	lbf

Horizontal Vessel Analysis Results:	Actual	Allowable	
Long. Stress at Top of Midspan	4415.89	17100.00	psi
Long. Stress at Bottom of Midspan	5349.11	17100.00	psi
Long. Stress at Top of Saddles	6493.53	17100.00	psi
Long. Stress at Bottom of Saddles	3991.58	17100.00	psi
Tangential Shear in Shell	912.56	13680.00	psi
Circ. Stress at Horn of Saddle	941.96	21375.00	psi
Circ. Compressive Stress in Shell	119.74	17100.00	psi

Intermediate Results: Saddle Reaction Q due to Wind or Seismic

Saddle Reaction Force due to Wind Ft [Fwt]:
= Ftr * (Ft/Num of Saddles + Z Force Load) * B / E
= 3.00 * (766.2/2 + 0) * 19.7500/20.2506
= 1120.9 lbf

Saddle Reaction Force due to Wind Fl or Friction [Fwl]:
= Max(Fl, Friction Load, Sum of X Forces) * B / Ls
= Max(106.75 , 1605.86 , 0) * 19.7500/134.0000
= 236.7 lbf

Saddle Reaction Force due to Earthquake Fl or Friction [Fsl]:
= Max(Fl, Friction Force, Sum of X Forces) * B / Ls
= Max(273.88 , 1605.86 , 0) * 19.7500/134.0000
= 236.7 lbf

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Saddle Reaction Force due to Earthquake Ft [Fst]:
```
= Ftr * ( Ft/Num of Saddles + Z Force Load ) * B / E
= 3.00 * ( 273/2 + 0 ) * 19.7500/20.2506
= 400.7 lbf
```

Load Combination Results for Q + Wind or Seismic [Q]:
```
= Saddle Load + Max( Fwl, Fwt, Fsl, Fst )
= 4014 + Max( 236 , 1120 , 236 , 400 )
= 5135.6 lbf
```

Summary of Loads at the base of this Saddle:

Vertical Load (including saddle weight)	5206.53	lbf
Transverse Shear Load Saddle	383.11	lbf
Longitudinal Shear Load Saddle	1605.86	lbf

Formulas and Substitutions for Horizontal Vessel Analysis:

Note: Wear Plate is Welded to the Shell, k = 0.1

The Computed K values from Table 4.15.1:

K1 = 0.1035	K2 = 1.2043	K3 = 0.9157	K4 = 0.4095
K5 = 0.7680	K6 = 0.0546	K7 = 0.0546	K8 = 0.3424
K9 = 0.2741	K10 = 0.0595	K1* = 0.1871	K6p = 0.0347
K7P = 0.0347			

The suffix 'p' denotes the values for a wear plate if it exists.

Note: Dimension a is greater than or equal to Rm / 2.

Moment per Equation 4.15.3 [M1]:
```
= -Q*a [1 - (1- a/L + (R²-h2²)/(2a*L))/(1+(4h2)/3L)]
= -5135*29.00[1-(1-29.00/182.06+(11.812²-5.812²)/
  (2*29.00*182.06))/(1+(4*5.81)/(3*182.06))]
= -27404.3 in-lb
```

Moment per Equation 4.15.4 [M2]:
```
= Q*L/4(1+2(R²-h2²)/(L²))/(1+(4h2)/( 3L))-4a/L
= 5135*182.1/4(1+2(11.812²-5.812²)/(182.06²))/(1+(4*5.812)/
  (3*182.063))-4*29.00/182.06
= 76704.5 in-lb
```

Longitudinal Stress at Top of Shell (4.15.6) [Sigma1]:
```
= P * Rm/(2t) - M2/(pi*Rm²t)
= 310.00 * 11.812/(2*0.375 ) - 76704.5/(pi*11.8²*0.375 )
= 4415.89 psi
```

Longitudinal Stress at Bottom of Shell (4.15.7) [Sigma2]:
```
= P * Rm/(2t) + M2/(pi * Rm² * t)
= 310.00 * 11.812/(2 * 0.375 ) + 76704.5/(pi * 11.8² * 0.375 )
= 5349.11 psi
```

Longitudinal Stress at Top of Shell at Support (4.15.10) [Sigma*3]:
```
= P * Rm/(2t) - M1/(K1*pi*Rm²t)
= 310.00*11.812/(2*0.375)--27404.3/(0.1035*pi*11.8²*0.375)
= 6493.53 psi
```


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2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

Longitudinal Stress at Bottom of Shell at Support (4.15.11) [Sigma*4]:
```
= P * Rm/(2t) + M1/(K1* * pi * Rm² * t)
= 310.00*11.812/(2*0.375)+-27404.3/(0.1871*pi*11.8²*0.375)
= 3991.58 psi
```

Maximum Shear Force in the Saddle (4.15.5) [T]:
```
= Q(L-2a)/(L+(4*h2/3))
= 5135 ( 182.06 - 2 * 29.00 )/(182.06 + ( 4 * 5.81/3))
= 3356.6 lbf
```

Shear Stress in the shell no rings, not stiffened (4.15.14) [tau2]:
```
= K2 * T / ( Rm * t )
= 1.2043 * 3356.64/( 11.8125 * 0.3750 )
= 912.56 psi
```

Decay Length (4.15.22) [x1,x2]:
```
= 0.78 * sqrt( Rm * t )
= 0.78 * sqrt( 11.812 * 0.375 )
= 1.642 in
```

Circumferential Stress in shell, no rings (4.15.23) [sigma6]:
```
= -K5 * Q * k / ( t * ( b + X1 + X2 ) )
= -0.7680 * 5135 * 0.1/( 0.375 * ( 5.50 + 1.64 + 1.64 ) )
= -119.74 psi
```

Effective reinforcing plate width (4.15.1) [B1]:
```
= min( b + 1.56 * sqrt( Rm * t ), 2a  )
= min( 5.50 + 1.56 * sqrt( 11.812 * 0.375 ), 2 * 29.000 )
= 8.78 in
```

Wear Plate/Shell Stress ratio (4.15.29) [eta]:
```
= min( Sr/S, 1 )
= min( 17100.000/17100.000 , 1 )
= 1.0000
```

Circumferential Stress at wear plate (4.15.26) [sigma6,r]:
```
= -K5 * Q * k / ( B1( t + eta * tr ) )
= -0.7680 * 5135 * 0.1/( 8.783 ( 0.375 + 1.000 * 0.375 ) )
= -59.87 psi
```

Circ. Comp. Stress at Horn of Saddle, L>=8Rm (4.15.27) [sigma7,r]:
```
= -Q/(4(t+eta*tr)b1) - 3*K7*Q/(2(t+eta*tr)²)
= -5135/(4(0.375 + 1.000 * 0.375 )8.783 ) -
    3 * 0.055 * 5135/(2(0.375 + 1.000 * 0.375 )²)
= -941.96 psi
```

Free Un-Restrained Thermal Expansion between the Saddles [Exp]:
```
= Alpha * Ls * ( Design Temperature - Ambient Temperature )
= 0.671E-05 * 134.000 * ( 205.0 - 70.0 )
= 0.121 in
```

Results for Vessel Ribs, Web and Base:

Baseplate Length	Bplen	16.0000	in
Baseplate Thickness	Bpthk	0.3750	in
Baseplate Width	Bpwid	6.0000	in
Number of Ribs (inc. outside ribs)	Nribs	1	
Rib Thickness	Ribtk	0.3750	in
Web Thickness	Webtk	0.3750	in
Web Location	Webloc	Side	

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Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Io
Shell	0.	5.	1.	0.
Wearplate	1.	4.	2.	1.
Web	5.	3.	19.	125.
BasePlate	10.	2.	23.	234.
Totals	16.	14.	45.	360.

```
Value  C1 = Sumof(Ay)/Sumof(A)              =          3.  in
Value   I = Sumof(Io) - C1*Sumof(Ay)        =        222.  in**4
Value  As = Sumof(A) - Ashell               =          9.  in²

K1 = (1+Cos(beta)-.5*Sin(beta)² )/(pi-beta+Sin(beta)*Cos(beta)) =   0.1999

Fh = K1 * Q = 0.1999 * 5135.569 = 1026.5900 lbf

Tension Stress, St = ( Fh/As )       =       108.4187  psi
Allowed Stress, Sa = 0.6 * Yield Str =     22800.0000  psi

d  = B - R*Sin(theta) / theta        =        12.3233  in
Bending Moment, M  = Fh * d          =     12650.9326  in-lb

Bending Stress, Sb = ( M * C1 / I  ) =       175.9178  psi
Allowed Stress, Sa = 2/3 * Yield Str =     25333.3340  psi
```

Minimum Thickness of Baseplate per Moss :

```
= ( 3 * ( Q + Saddle_Wt ) * BasePlateWidth / ( 2 * BasePlateLength *
  AllStress ))½
= ( 3 * (5135 + 70 ) * 6.00/( 2 * 16.000 * 25333.334 ))½
= 0.340 in
```

Input Data for Base Plate Bolting Calculations:

```
Total Number of Bolts per BasePlate          Nbolts          2
Total Number of Bolts in Tension/Baseplate      Nbt          2
Bolt Material Specification                               SA-325
Bolt Allowable Stress                          Stba    20200.00  psi
Bolt Corrosion Allowance                        Bca      0.0000  in
Distance from Bolts to Edge                  Edgedis     2.0000  in
Nominal Bolt Diameter                           Bnd      0.7500  in
Thread Series                                Series          TEMA
BasePlate Allowable Stress                        S    20000.00  psi
Area Available in a Single Bolt              BltArea      0.3020  in²
Saddle Load QO (Weight)                          QO      4085.6  lbf
Saddle Load QL (Wind/Seismic contribution)       QL       236.7  lbf
Maximum Transverse Force                         Ft       383.1  lbf
Maximum Longitudinal Force                       Fl      1605.9  lbf
Saddle Bolted to Steel Foundation                        No
```

Bolt Area Calculation per Dennis R. Moss

Bolt Area Requirement Due to Longitudinal Load [Bltarearl]:

```
= 0.0 (QO > QL --> No Uplift in Longitudinal direction)
```


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Bolt Area due to Shear Load [Bltarears]:
= Fl / (Stba * Nbolts)
= 1605.86/(20200.00 * 2.00)
= 0.0397 in²

Bolt Area due to Transverse Load

Moment on Baseplate Due to Transverse Load [Rmom]:
= B * Ft + Sum of X Moments
= 19.75 * 383.11 + 0.00
= 7566.36 in-lb

Eccentricity (e):
= Rmom / QO
= 7566.36/4085.62
= 1.85 in < Bplen/6 --> No Uplift in Transverse direction

Bolt Area due to Transverse Load [Bltareart]:
= 0 (No Uplift)

Required of a Single Bolt [Bltarear]
= max[Bltarearl, Bltarears, Bltareart]
= max[0.0000 , 0.0397 , 0.0000]
= 0.0397 in²

ASME Horizontal Vessel Analysis: Stresses for the Right Saddle
(per ASME Sec. VIII Div. 2 based on the Zick method.)

Input and Calculated Values:

Vessel Mean Radius	Rm	11.81	in
Stiffened Vessel Length per 4.15.6	L	182.06	in
Distance from Saddle to Vessel tangent	a	43.00	in
Saddle Width	b	5.50	in
Saddle Bearing Angle	theta	118.00	degrees
Wear Plate Width	b1	10.00	in
Wear Plate Bearing Angle	theta1	145.00	degrees
Wear Plate Thickness	tr	0.3750	in
Wear Plate Allowable Stress	Sr	17100.00	psi
Inside Depth of Head	h2	5.81	in
Shell Allowable Stress used in Calculation		17100.00	psi
Head Allowable Stress used in Calculation		20000.00	psi
Circumferential Efficiency in Plane of Saddle		1.00	
Circumferential Efficiency at Mid-Span		1.00	
Saddle Force Q, Operating Case		3365.37	lbf

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Horizontal Vessel Analysis Results:	Actual	Allowable	
Long. Stress at Top of Midspan	4863.34	17100.00	psi
Long. Stress at Bottom of Midspan	4901.66	17100.00	psi
Long. Stress at Top of Saddles	7101.94	17100.00	psi
Long. Stress at Bottom of Saddles	3655.12	17100.00	psi
Tangential Shear in Shell	463.04	13680.00	psi
Circ. Stress at Horn of Saddle	617.27	21375.00	psi
Circ. Compressive Stress in Shell	78.47	17100.00	psi

Intermediate Results: Saddle Reaction Q due to Wind or Seismic

Saddle Reaction Force due to Wind Ft [Fwt]:
= Ftr * (Ft/Num of Saddles + Z Force Load) * B / E
= 3.00 * (766.2/2 + 0) * 19.7500/20.2506
= 1120.9 lbf

Saddle Reaction Force due to Wind Fl or Friction [Fwl]:
= Max(Fl, Friction Load, Sum of X Forces) * B / Ls
= Max(106.75 , 897.78 , 0) * 19.7500/134.0000
= 132.3 lbf

Saddle Reaction Force due to Earthquake Fl or Friction [Fsl]:
= Max(Fl, Friction Force, Sum of X Forces) * B / Ls
= Max(273.88 , 897.78 , 0) * 19.7500/134.0000
= 132.3 lbf

Saddle Reaction Force due to Earthquake Ft [Fst]:
= Ftr * (Ft/Num of Saddles + Z Force Load) * B / E
= 3.00 * (273/2 + 0) * 19.7500/20.2506
= 400.7 lbf

Load Combination Results for Q + Wind or Seismic [Q]:
= Saddle Load + Max(Fwl, Fwt, Fsl, Fst)
= 2244 + Max(132 , 1120 , 132 , 400)
= 3365.4 lbf

Summary of Loads at the base of this Saddle:

Vertical Load (including saddle weight)	3436.33	lbf
Transverse Shear Load Saddle	383.11	lbf
Longitudinal Shear Load Saddle	897.78	lbf

Formulas and Substitutions for Horizontal Vessel Analysis:

Note: Wear Plate is Welded to the Shell, k = 0.1

The Computed K values from Table 4.15.1:

K1 = 0.1035	K2 = 1.2043	K3 = 0.9157	K4 = 0.4095
K5 = 0.7680	K6 = 0.0546	K7 = 0.0546	K8 = 0.3424
K9 = 0.2741	K10 = 0.0595	K1* = 0.1871	K6p = 0.0347
K7P = 0.0347			

The suffix 'p' denotes the values for a wear plate if it exists.

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Moment per Equation 4.15.3 [M1]:

```
= -Q*a [1 - (1- a/L + (R²-h2²)/(2a*L))/(1+(4h2)/3L)]
= -3365*43.00[1-(1-43.00/182.06+(11.812²-5.812²)/
  (2*43.00*182.06))/(1+(4*5.81)/(3*182.06))]
= -37753.7 in-lb
```

Moment per Equation 4.15.4 [M2]:

```
= Q*L/4(1+2(R²-h2²)/(L²))/(1+(4h2)/( 3L))-4a/L
= 3365*182.1/4(1+2(11.812²-5.812²)/(182.06²))/(1+(4*5.812)/
  (3*182.063))-4*43.00/182.06
= 3149.7 in-lb
```

Longitudinal Stress at Top of Shell (4.15.6) [Sigma1]:

```
= P * Rm/(2t) - M2/(pi*Rm²t)
= 310.00 * 11.812/(2*0.375 ) - 3149.7/(pi*11.8²*0.375 )
= 4863.34 psi
```

Longitudinal Stress at Bottom of Shell (4.15.7) [Sigma2]:

```
= P * Rm/(2t) + M2/(pi * Rm² * t)
= 310.00 * 11.812/(2 * 0.375 ) + 3149.7/(pi * 11.8² * 0.375 )
= 4901.66 psi
```

Longitudinal Stress at Top of Shell at Support (4.15.10) [Sigma*3]:

```
= P * Rm/(2t) - M1/(K1*pi*Rm²t)
= 310.00*11.812/(2*0.375)--37753.7/(0.1035*pi*11.8²*0.375)
= 7101.94 psi
```

Longitudinal Stress at Bottom of Shell at Support (4.15.11) [Sigma*4]:

```
= P * Rm/(2t) + M1/(K1* * pi * Rm² * t)
= 310.00*11.812/(2*0.375)+-37753.7/(0.1871*pi*11.8²*0.375)
= 3655.12 psi
```

Maximum Shear Force in the Saddle (4.15.5) [T]:

```
= Q(L-2a)/(L+(4*h2/3))
= 3365 ( 182.06 - 2 * 43.00 )/(182.06 + ( 4 * 5.81/3))
= 1703.2 lbf
```

Shear Stress in the shell no rings, not stiffened (4.15.14) [tau2]:

```
= K2 * T / ( Rm * t )
= 1.2043 * 1703.19/( 11.8125 * 0.3750 )
= 463.04 psi
```

Decay Length (4.15.22) [x1,x2]:

```
= 0.78 * sqrt( Rm * t )
= 0.78 * sqrt( 11.812 * 0.375 )
= 1.642 in
```

Circumferential Stress in shell, no rings (4.15.23) [sigma6]:

```
= -K5 * Q * k / ( t * ( b + X1 + X2 ) )
= -0.7680 * 3365 * 0.1/( 0.375 * ( 5.50 + 1.64 + 1.64 ) )
= -78.47 psi
```

Effective reinforcing plate width (4.15.1) [B1]:

```
= min( b + 1.56 * sqrt( Rm * t ), 2a  )
= min( 5.50 + 1.56 * sqrt( 11.812 * 0.375 ), 2 * 43.000 )
= 8.78 in
```


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Wear Plate/Shell Stress ratio (4.15.29) [eta]:

```
= min( Sr/S, 1 )
= min( 17100.000/17100.000 , 1 )
= 1.0000
```

Circumferential Stress at wear plate (4.15.26) [sigma6,r]:

```
= -K5 * Q * k / ( B1( t + eta * tr ) )
= -0.7680 * 3365 * 0.1/( 8.783 ( 0.375 + 1.000 * 0.375 ) )
= -39.23 psi
```

Circ. Comp. Stress at Horn of Saddle, L>=8Rm (4.15.27) [sigma7,r]:

```
= -Q/(4(t+eta*tr)b1) - 3*K7*Q/(2(t+eta*tr)²)
= -3365/(4(0.375 + 1.000 * 0.375 )8.783 ) -
    3 * 0.055 * 3365/(2(0.375 + 1.000 * 0.375 )²)
= -617.27 psi
```

Results for Vessel Ribs, Web and Base

Baseplate Length	Bplen	16.0000	in
Baseplate Thickness	Bpthk	0.3750	in
Baseplate Width	Bpwid	6.0000	in
Number of Ribs (inc. outside ribs)	Nribs	1	
Rib Thickness	Ribtk	0.3750	in
Web Thickness	Webtk	0.3750	in
Web Location	Webloc	Side	

Moment of Inertia of Saddle - Lateral Direction

	Y	A	AY	Io
Shell	0.	5.	1.	0.
Wearplate	1.	4.	2.	1.
Web	5.	3.	19.	125.
BasePlate	10.	2.	23.	234.
Totals	16.	14.	45.	360.

Value C1 = Sumof(Ay)/Sumof(A)	=	3.	in
Value I = Sumof(Io) - C1*Sumof(Ay)	=	222.	in**4
Value As = Sumof(A) - Ashell	=	9.	in²

K1 = (1+Cos(beta)-.5*Sin(beta)²)/(pi-beta+Sin(beta)*Cos(beta)) = 0.1999

Fh = K1 * Q = 0.1999 * 3365.372 = 672.7310 lbf

Tension Stress, St = (Fh/As)	=	71.0475	psi
Allowed Stress, Sa = 0.6 * Yield Str	=	22800.0000	psi
d = B - R*Sin(theta) / theta	=	12.3233	in
Bending Moment, M = Fh * d	=	8290.2373	in-lb
Bending Stress, Sb = (M * C1 / I)	=	115.2801	psi
Allowed Stress, Sa = 2/3 * Yield Str	=	25333.3340	psi

Minimum Thickness of Baseplate per Moss :

```
= ( 3 * ( Q + Saddle_Wt ) * BasePlateWidth / ( 2 * BasePlateLength *
  AllStress ))½
= ( 3 * (3365 + 70 ) * 6.00/( 2 * 16.000 * 25333.334 ))½
= 0.276 in
```


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2	CORRECTED LOADING CALC PG 27-37	RS	2/9/12	rds	2/9/12

Input Data for Base Plate Bolting Calculations:

Total Number of Bolts per BasePlate	Nbolts	2	
Total Number of Bolts in Tension/Baseplate	Nbt	2	
Bolt Material Specification		SA-325	
Bolt Allowable Stress	Stba	20200.00	psi
Bolt Corrosion Allowance	Bca	0.0000	in
Distance from Bolts to Edge	Edgedis	2.0000	in
Nominal Bolt Diameter	Bnd	0.7500	in
Thread Series	Series	TEMA	
BasePlate Allowable Stress	S	20000.00	psi
Area Available in a Single Bolt	BltArea	0.3020	in²
Saddle Load QO (Weight)	QO	2315.4	lbf
Saddle Load QL (Wind/Seismic contribution)	QL	132.3	lbf
Maximum Transverse Force	Ft	383.1	lbf
Maximum Longitudinal Force	Fl	1605.9	lbf
Saddle Bolted to Steel Foundation		No	

Bolt Area Calculation per Dennis R. Moss

Bolt Area Requirement Due to Longitudinal Load [Bltarearl]:
= 0.0 (QO > QL --> No Uplift in Longitudinal direction)

Bolt Area due to Shear Load [Bltarears]:
= Fl / (Stba * Nbolts)
= 1605.86/(20200.00 * 2.00)
= 0.0397 in²

Bolt Area due to Transverse Load

Moment on Baseplate Due to Transverse Load [Rmom]:
= B * Ft + Sum of X Moments
= 19.75 * 383.11 + 0.00
= 7566.36 in-lb

Eccentricity (e):
= Rmom / QO
= 7566.36/2315.42
= 3.27 in > Bplen/6 --> Uplift in Transverse direction

f = Bplen / 2 - Edgedis
= 16.00/2 - 2.00
= 6.00 in

Modular Ratio Of Steel/Concrete (n1):
= ES / EC
= 29500000/3122018
= 9.45

K1 = 3 (e - 0.5 * Bplen)
= 3 (3.27 - 0.5*16.00)
= -14.20 in

K2 = 6 * n1 * At / Bpwid * (f + e)
= 6 * 9.45 * 0.60/6.00 * (6.00 + 3.27)
= 52.89 in ²

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```
K3 = -K2 * (0.5 * Bplen + f)
   = -52.89 * (0.5 * 16.00 + 6.00 )
   = -740.51 in ³
```

Iteratively Solving for the Effective Bearing Length:

```
Y³ + K1 * Y² + K2 * Y + K3 = 0
Y³ + -14.20 * Y² + 52.89 * Y + -740.51 = 0
Y  = 14.16 in

Num = (Bplen / 2 - Y / 3 - e)
    = (16.00/2 - 14.16/3 - 3.27 )
    = 0.01

Denom = (Bplen / 2 - Y / 3 + f)
      = (16.00/2 - 14.16/3 + 6.00 )
      = 9.28
```

Total Bolt Tension Force [Tforce]:

```
= - QO * Num / Denom
= - 2315.42 * 0.01/9.28
= -3.41 lbf
```

Bolt Area Required due to Transverse Load [Bltareart]

```
= Tforce / (Stba * Nbt)
= -3.41/( 20200.00 * 2.00 )
= -0.0001 in²
```

Required of a Single Bolt [Bltarear]

```
= max[Bltarearl, Bltarears, Bltareart]
= max[0.0000 , 0.0397 , -0.0001 ]
= 0.0397 in²
```

Baseplate Thickness Calculation per D. Moss:

Bearing Pressure (fc)

```
= 2 * (QO + Tforce) / (Y * Bplen)
= 2 * (2315.42 + -3.41 )/(14.16 * 16.00 )
= 20.42 psig
```

Distance from Baseplate Edge to the Web [ADIST]:

```
= (Bplen - Weblngth) / 2
= (16.00 - 14.00 )/2
= 1.0000 in
```

Overturning Moment due To Bolt Tension [Mt]:

```
= Tforce * Adist
= -3.41 * 1.00
= -3.41 in-lb
```

Equivalent Bearing Pressure (f1):

```
= fc * (Y - Adist) / Y
= 20.42 * (14.16 - 1.00 )/14.16
= 18.97 psig
```


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Overturning Moment due to Bearing Pressure [Mc]:
= (Adist² * Bpwid / 6) * (f1 + 2 * fc)
= (1.00² * 6.00/6) * (18.97 + 2 * 20.42)
= 59.81 in-lb

Baseplate Required Thickness [Treq]:
= (6 * max(Mt,Mc) / (Bpwid * Sba))½
= (6 *max(-3.41 ,59.81/(6.00 * 30000.00))½
= 0.0446 in

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FABSCO JOB #: S11-10279-8
CUSTOMER P.O.#: MPC17901

QUALITY CONTROL INSPECTION PLAN / CHECKLIST

(*) DENOTES A.I. HOLD POINTS mk AUTHORIZED INSPECTOR 9/1/11 DATE

INSPECTIONS PERFORMED	FABSCO Q.C.	AUTHORIZED INSPECTOR	REMARKS
REVIEW DWG/CALC, WPS/PQR AND WELDER QUALIFICATION RECORDS	W	* mk 9/1/11	
EXAM. PLATE EDGES/SURF.	W		
CHECK NOZZ. PIPE THKNS.	W		
CHECK HEAD/SHELL THKNS.	W		
VERIFY NOZZ. FLG. RATING	W		
CHECK MATERIAL IDENTIF.	W		
REVIEW MILL TEST REPORTS	W	* mk 9/27/12	
CHK FITUP CHAN. LONG SEAM	W N/A		
CHK FITUP CHAN. GIRTH SEAMS JMW	W 08.08.12 JB		
CHK FITUP CHAN NOZZ.	W 08.08.12 JB		
CHK. FITUP SHELL LONGSEAM	W		
CHK FITUP SHELL GIRTH SEAM JMW	W		
CHK FITUP SHELL NOZZLES	W		
PERFORM PMI (IF REQUIRED)	W		
PERFORM/WITNESS NDE PT	W		
PERFORM/WITNESS NDE MT	W		
PERFORM/WITNESS NDE UT	W		
CHECK OUT OF ROUNDNESS	W 09.17.12 JB		
CHK ALL WELDS FOR APPEARANCE, SIZE & WELDERS STAMP	W 09.19.12 JB	* PART STAMPED	
REVIEW RADIOGRAPHS	W	*	
INTERNAL INSP. CHANNEL	W 09.18.12 JB	*	
	W	*	
INTERNAL INSP. SHELL	W 09.17.12 JB	*	
REVIEW HEAT CHARTS	W	*	
WITNESS HYDROSTATIC TEST SS	W 09.18.12 JB	* mk 9/18/12	
TS	W 09.19.12 JB	* mk 9/19/12	
CHK NAMEPLATE/STAMPING	W 09.19.12 JB	* mk 9/27/12	
DATA REPORT CHECKED/SIGNED	W	* mk 9/27/12	
CHK FINAL DIMENSIONAL	W 09.19.12 JB		
CHK FINAL APPEARANCE/PAINT	W		

NOTES: W= WITNESS BLANK LINES ARE FOR CUSTOMER REQUIREMENTS

FABSCO
SHELL & TUBE, LLC
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P.O. Box 988
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918/224-7550 Fax 918/224-3564

CERTIFICATE OF HYDROSTATIC TESTING

FABSCO SHELL & TUBE, L.L.C. JOB NUMBER:	S11-10279-8
CUSTOMER NAME:	Southern Company Services
CUSTOMER PURCHASE ORDER NUMBER	MPC17901
CUSTOMER ITEM NUMBER:	HX2065

THIS IS TO CERTIFY THE ABOVE UNIT WAS HYDROSTATICALLY TESTED PER ASME CODE SECTION VIII DIVISION 1.

SHELLSIDE TEST PRESSURE PSI	TUBESIDE TEST PRESSURE PSI	DATE TESTING PERFORMED
234		09-18-12
	195	09-19-12

WITNESSED BY: ONEBEACON INSURANCE COMPANY AUTHORIZED INSPECTOR.

SIGNED FABSCO SHELL & TUBE, L.L.C. BY _____
QUALITY CONTROL DEPARTMENT

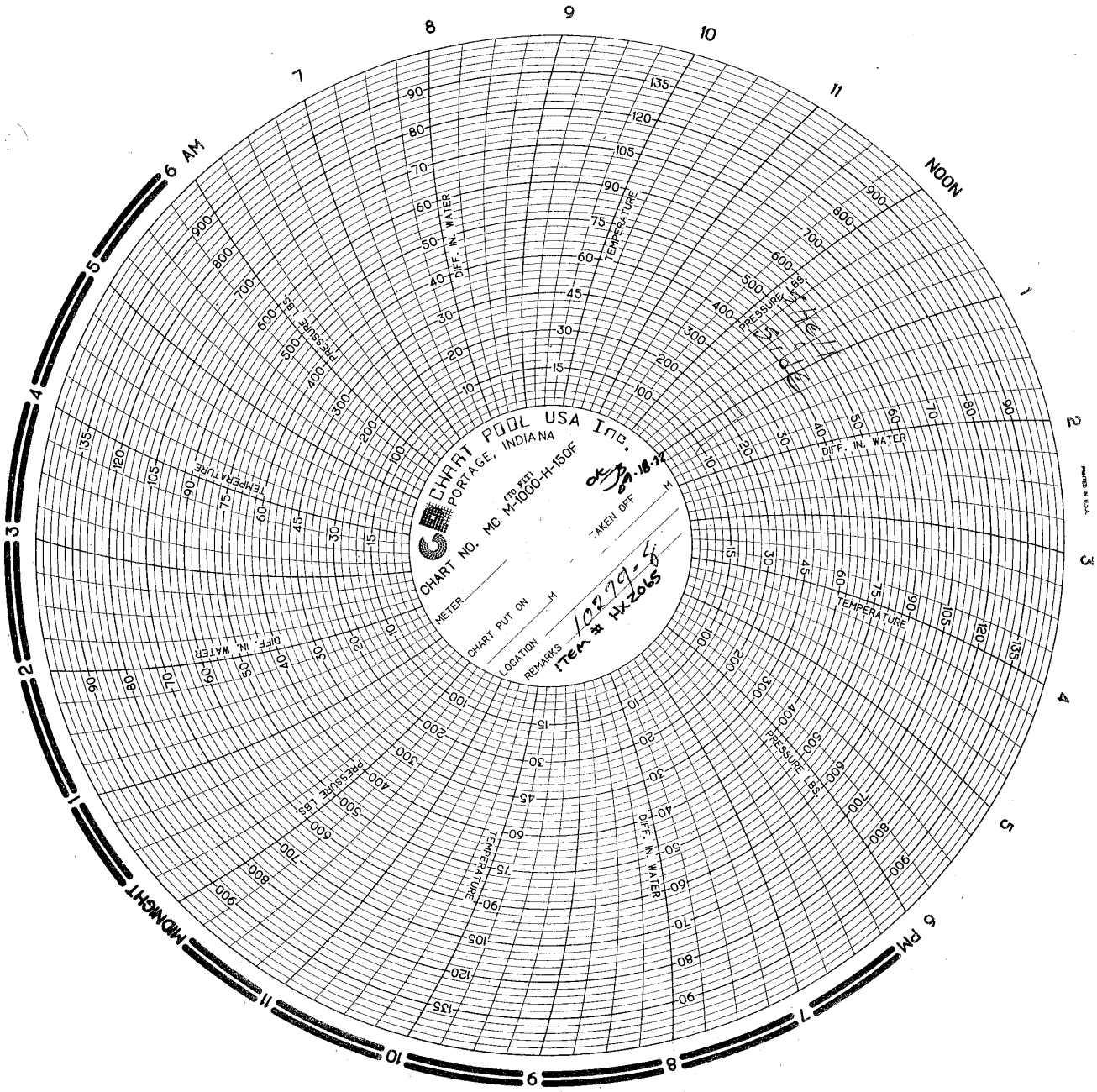
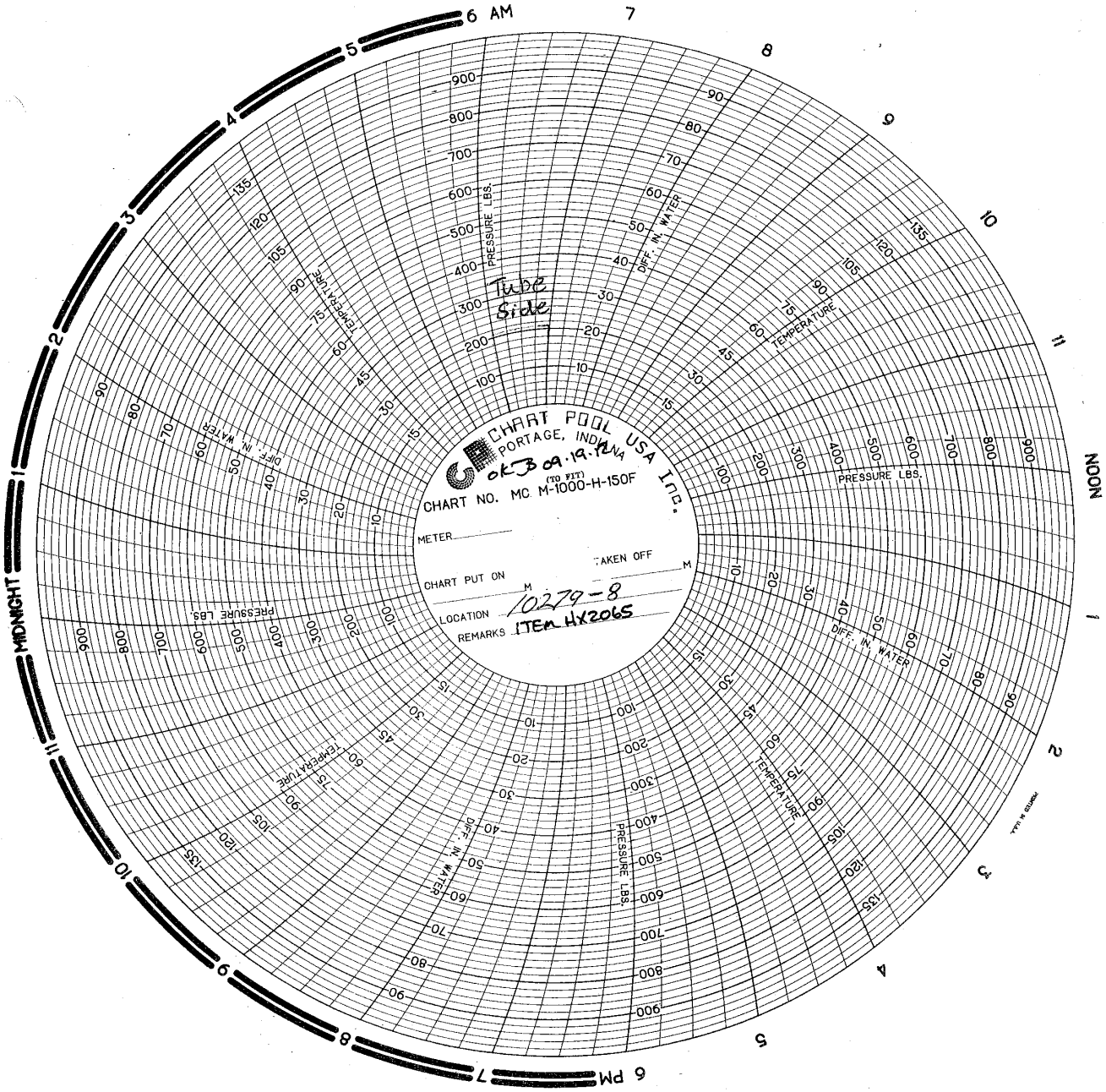


CHART POOL USA Inc.
PORTAGE, INDIANA
CHART NO. MC M-1000-H-150F
(7 DAY)
METER
CHART PUT ON M
TAKEN OFF M
LOCATION
REMARKS
Item # HX2065
6 AM
NOON
6 PM
MIDNIGHT
TEMPERATURE
DIFF. IN. WATER
PRESSURE LBS.


6 AM
7
8
9
10
11
NOON
1
2
3
4
5
6 PM
7
8
9
10
11
MIDNIGHT
1
2
3
4
5
PRESSURE LBS.
DIFF. IN. WATER
TEMPERATURE
Tube Side
CHART POOL USA Inc.
PORTAGE, INDIANA
CK3 09-19-RNA
(TO FIT)
CHART NO. MC M-1000-H-150F
METER
CHART PUT ON M
TAKEN OFF M
LOCATION 10279-8
REMARKS ITEM HX2065

FABSCO
SHELL & TUBE, LLC
2410 Industrial Road
P.O. Box 988
Sapulpa, OK 74066
(918)224-7550 Fax(918)224-3564

LIQUID PENETRANT EXAMINATION

FABSCO SHELL & TUBE, L.L.C. JOB NUMBER: S11·10279·8
CUSTOMER NAME: SOUTHERN CO.
CUSTOMER P.O. NO; MPC 17901
CUSTOMER ITEM NUMBER: HX 1065

PARTS EXAMINED / WELD JOINT EXAMINED: SHELL
EDGES OF GROOVED AND BEVELED LONG BAFFLE SLOTS.

Liquid Penetrant Type:	II	Method:	A
Manufacturer I.D.:	Met-L-Chek	Cleaner- E-59A	Penetrant- VP30
Developer-	D70	Lighting Equipment:	Maglite >100 fc
RESULTS:	Acceptable		

REMARKS:
No defects found.

08.14.12
DATE

John Burris L II.
FABSCO SHELL & TUBE, L.L.C.
QUALITY CONTROL DEPARTMENT
NDE EXAMINER

Reference Fabco Shell Tube
LLc. NDE Procedure #4

Liquid Penetrant Examination
11.15.2007
Rev. 3

FABSCO
SHELL & TUBE, LLC
2410 Industrial Road
P.O. Box 988
Sapulpa, OK 74066
(918)224-7550 Fax(918)224-3564

LIQUID PENETRANT EXAMINATION

FABSCO SHELL & TUBE, L.L.C. JOB NUMBER:	S11-10279-8
CUSTOMER NAME:	Southern Company Services
CUSTOMER P.O. NO;	MPC179Q1
CUSTOMER ITEM NUMBER:	HX2065

PARTS EXAMINED / WELD JOINT EXAMINED: #19 TUBESHEET
TUBE TO TUBESHEET WELDS

Liquid Penetrant Type:	II	Method:	A
Manufacturer I.D.:	Met-L-Chek	Cleaner- E-59A	Penetrant- VP30
Developer-	D70	Lighting Equipment:	Streamlite >100 fc
RESULTS:	Acceptable		

REMARKS:
No defects found.

09.03.12
DATE

FABSCO SHELL & TUBE, L.L.C.
QUALITY CONTROL DEPARTMENT
NDE EXAMINER

FABSCO
SHELL & TUBE, LLC
2410 Industrial Road
P.O. Box 988
Sapulpa, OK 74066
(918)224-7550 Fax(918)224-3564

LIQUID PENETRANT EXAMINATION

FABSCO SHELL & TUBE, L.L.C. JOB NUMBER: S11-10279-8
CUSTOMER NAME: SOUTHERN COMPANY SERVICES
CUSTOMER P.O. NO; MPC17901
CUSTOMER ITEM NUMBER: HX2065

PARTS EXAMINED / WELD JOINT EXAMINED: FRONT CHANNEL & SHELL
ALL PRESSURE RETAINING WELDS, TEMPORARY ATTACHMENTS, ARC STRIKES AND LIFTING LUG ATTACHMENT WELDS

Liquid Penetrant Type:	II	Method:	A
Manufacturer I.D.:	Met-L-Chek	Cleaner- E-59A	Penetrant- VP30
Developer-	D70	Lighting Equipment:	Streamlite >100 fc
RESULTS:	Acceptable		

REMARKS:
No defects found.

9-13-12
DATE

FABSCO SHELL & TUBE, L.L.C.
QUALITY CONTROL DEPARTMENT
NDE EXAMINER

Reference Fabco Shell Tube
LLc. NDE Procedure #4

Liquid Penetrant Examination
11.15.2007
Rev. 6

Globe X-Ray Services, Inc.
8441 South Union Tulsa, Oklahoma 74132
(918) 446-1696

OPTICAL EMISSION

Cert. # _____

Customer: FABSCO
Mail Reports to: QC/QA
Test Instrument: ARC MET- 8000 SN 5/5666

Report Number: 63815
Date: 8-15-12
Job Number: 10279-7

Acceptance Criteria/ Applicable Code: ASME SECT II	SFA 5.9 SA-182 SA-240	Element Analysis--%														Accept	Reject
Item/Part	Material Analysis	C	CR	NI	MO	NB	V		PMI		AT						
IT-22A	T-304L	0.020	18.38	8.26	0.37	0.015	0.05		1							✓	
IT-9	T-304L	0.020	18.29	8.04	0.32	0	0.04		2							✓	
IT-7	F-304L	0.021	18.03	8.35	0.34	0.002	0.05		3		50079					✓	
IT-120	T-304L	0.023	18.04	8.21	0.44	0	0.044		4		401468-4					✓	
IT-120	↓	0.019	18.24	8.07	0.42	0	0.041		5		↓					✓	
SHELL-RS1	ER.308L	0.023	19.65	10.33	0.14	0	0.019		6		–					✓	
IT-9C	T-304L	0.020	18.40	8.06	0.31	0.002	0.056		7		979207					✓	
↓	↓	0.021	18.74	8.14	0.30	0.010	0.059		8		5VD5					✓	
IT-9B	T-304L	0.017	18.41	8.05	0.33	0.006	0.058		9		837131					✓	
↓	↓	0.016	18.18	8.13	0.27	0	0.056		10		A7Y7					✓	
IT-18	T-304L	0.016	18.28	8.06	0.38	0.011	0.051		11		2C890					✓	
IT-2	F-304L	0.021	18.48	8.11	0.34	0.005	0.055		12		50079					✓	
IT-3	↓	0.020	18.40	8.18	0.34	0.009	0.058		13		50079					✓	
IT-4	TP.304L	0.023	18.19	8.10	0.32	0	0.048		14							✓	
CHAN-RS1	ER.308L	0.021	19.61	10.18	0.15	0.012	0.032		15		–					✓	
↓ RS-2	↓	0.022	19.57	10.31	0.16	0.011	0.032		16		–					✓	

LV II
Inspector

Customer Representative

GX-12

Kemper County MM233798

Globe X-Ray Services, Inc.
8441 South Union Tulsa, Oklahoma 74132
(918) 446-1696

OPTICAL EMISSION

Cert. # _____

Customer: FABSCO
Mail Reports to: QC/QA
Test Instrument: ARC MET · 8000 SN 515666

Report Number: 63819
Date: 8-16-12
Job Number: 10279-7

Acceptance Criteria/ Applicable Code: ASME SECT II	SFA 5.9 SA-312 SA-182	Element Analysis--%													Accept	Reject
Item/Part	Material Analysis	C	CR	NI	MO	NB	V		PMI		HT					
IJ-84	F-304L	0.023	18.10	8.28	0V2	0.018	0.079		17		M359				✓	
IJ-83	↓	0.022	18.10	8.29	0.44	0.020	0.074		18		↓				✓	
IJ-81	F-304L	0.022	18.03	8.38	0.36	0.023	0.088		19		87396/1				✓	
IJ-82	F-304L	0.022	18.05	8.39	0.36	0.006	0.068		20		↓				✓	
IJ-81 PIPE	TP-304L	0.027	18.22	8.06	0.24	0.001	0.069		21						✓	
IJ-82 PIPE	↓	0.027	18.30	8.06	0.22	0.00	0.069		22						✓	
IJ-81 RS	ER-308L	0.028	19.66	10.25	0.13	0	0		23		—				✓	
IJ-82 RS	↓	0.029	19.60	10.28	0.15	0	0		24		—				✓	
IJ-62	T-304L	0.018	18.33	8.11	0.29	0.019	0.077		25		COX3				✓	
↓	↓	0.018	1830	8.07	0.29	0.020	0.076		26		↓				✓	
IJ-72 FLNG	F-304L	0.018	18.27	8.12	0.48	0	0.053		27		83171/1				✓	
IJ-72 PIPE	TP-304L	0.026	18.04	8.01	0.50	0	0.075		28						✓	
IJ-72 RS	ER-308L	0.022	18.87	10.07	0.13	0.041	0.056		29		—				✓	
IJ-71 FLNG	F-304L	0.021	18.38	8.44	0.31	0.016	0.077		30		84245/1				✓	
IJ-71 PIPE	TP-304L	0.025	18.16	8.52	0.27	0.024	0.024		31		F126013				✓	
IJ-71 RS	ER-308L	0.025	18.97	10.17	0.15	0.043	0.02		32		—				✓	

LV II
Inspector

Customer Representative

GX-12

Kemper County MM233798

Globe X-Ray Services, Inc.
8441 South Union Tulsa, Oklahoma 74132
(918) 446-1696

OPTICAL EMISSION

Cert. # _____

Customer: FABSCO
Mail Reports to: QC/QA
Test Instrument: ARCMET-8000 SN 515666

Report Number: 63819
Date: 8-16-12 8/17-12
Job Number: 10279-7

Acceptance Criteria/ Applicable Code: ASME SECT II SA-240 SA-312		Element Analysis--%														Accept	Reject
Item/Part	Material Analysis	C	CR	NI	MO	NB	V		PMI		HT						
IT-9A	TP-304L	0.020	18.12	8.04	0.14	0	0.08		33		743096					✓	
IT-62	T-304L	0.021	18.43	8.11	0.29	0.018	0.078		34		C0X3					✓	
IT-61	T-304L	0.014	18.76	8.40	0.29	0.007	0.053		35		5VD5					✓	
IT-61A	↓	0.019	18.67	8.21	0.37	0.015	0.050		36		979475					✓	
IT-83A	F-304L	0.026	18.29	8.66	0.23	0	0.055		37		85853/1					✓	
IT-84A	↓	0.022	18.41	8.60	0.23	0	0.059		38		↓					✓	
IT-50	T-304L	0.021	18.57	8.06	0.36	0.015	0.047		39		[illegible]	979475				✓	
IT-51	↓	0.020	18.55	8.10	0.36	0.014	0.052		40		979475					✓	

Inspector

Customer Representative

GX-12

Kemper County MM233798

Globe X-Ray Services, Inc.
8441 South Union Tulsa, Oklahoma 74132
(918) 446-1696

OPTICAL EMISSION

Cert. # _____

Customer: FABSCO
Mail Reports to: QC/QA
Test Instrument: ARC MET 8000 SN515666

Report Number: 64764
Date: 9-12-12
Job Number: 10279-7

Acceptance Criteria/ Applicable Code		Element Analysis--%													Accept	Reject
ASME SECT-II		SA-240														
Item/Part	Material Analysis	C	CR	NI	MO		HT		IT							
1/4 PLATE	T-304L	0.025	18.05	8.13	0.27		D1A3		22A						✓	

LVII
Inspector

Customer Representative

GX-12

Kemper County MM233798

FABSCO
SHELL & TUBE, LLC
2410 Industrial Road
P.O. Box 988
Sapulpa, OK 74066
(918)224-7550 Fax(918)224-3564

FERRITE CONTENT TESTING REPORT

FABSCO SHELL & TUBE, L.L.C. JOB NUMBER: S11-10279-8
CUSTOMER NAME: Southern Co.
CUSTOMER P. O. NUMBER: MPC179011
CUSTOMER ITEM NUMBER: HX2065

Instrument: **FISCHER FERRITESCOPE MP30, S/N:085-22010A**
Probe: **EGAB1.3-FE** Reference Standards: S/N: N-2298
Ferrite Point Count: %FE_____ FN ✓ Reference Calibration:_____
Material Type/Grade: 304L SA240-~~316~~ 304L

Part / Weld Identification #	MEAN FE/FN	MIN. FE/FN	MAX. FE/FN	STD. DEV.	# OF TESTS	Accept FE/FN	Rejected FE/FN
SHELL RS-1		4.5	7.9		6/6	6.2	
RS-2		3.3	6.3		6/6	5.3	
LS-1		3.9	6.9		6/6	4.9	
LS-2		3.8	7.2		6/6	5.9	
NOZ 71		4.7	6.8		6/6	5.7	
NOZ 72		3.4	6.9		6/6	5.5	
FRONT CHANNEL RS-1		3.9	6.7		6/6	5.3	
RS-2		4.1	7.3		6/6	5.7	
LS-1		3.5	7.2		6/6	5.4	
NOZ 81		4.4	7.2		6/6	6.2	
NOZ 82		4.0	7.7		6/6	6.2	

09.17.12
DATE:

John Burns
FABSCO SHELL & TUBE, L.L.C.
QUALITY CONTROL DEPARTMENT
NDE EXAMINER

GLOBE X-RAY SERVICES, INC.

8441 SOUTH UNION • TULSA, OKLAHOMA 74132 • (918) 446-1696

N.R.C. #35-15194-01
TEXAS #5-1892
FAA # CS2R753K

RADIOGRAPHIC
TECHNIQUE SHEET

PAGE _____ OF _____

MFG/CUST.	JOB#/ID			RT DATE
J + M	93057.3 NO2 72			8-8-12
MAT'L TYPE	**MAT'L THK.**	**WELD REINF.**	**TOTAL THK.**	**RT TECHNIQUE**
C-S.	1/2	1/8	5/8	GXS IB03
ISOTOPE/ X-RAY VOLTAGE	**CI./MA.**	**FOCAL SIZE**	**SOD**	**OFD**	**EXPOSURE TIME**
E-192	59 ci	.141	8 1/2	5/8	:32

EXPOSURE	VIEWING	FILM PROCESS	Pb
SINGLE WALL ☐ DBL. WALL ☑	SINGLE WALL ☑ DBL. WALL ☐	MAN. ☑ AUTO ☐	FRT .010 BK. .010

FILM MFG/TYPE	NO. EXPOSURES	RT QUALITY	APPLICABLE CODE SPEC.	ACCEPTANCE STD.
Agfa/D5		2T	ASME Sa V	ASME Sec ~~VIII~~

RT TRCH. LEVEL II	RT PROCEDURE
D Echols k Nelson	GXS IB

PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	WELDER	#HOLE/IQI	SHIM SIZE	IQI & SIDE	FILM DENSITY	ACCEPT	REJECT	SLAG	POR	CRACK	IP	LF	UC	FILM ARTIFACT	COMMENTS
RS-1	T-2	F	1	1/A	1BF	2.0+	✓									
	2-3						✓									
	3-T						✓									

FILM INTERPRETATION BY: D Echols [signature] DATE: 8-8-12

A.I./CUST. [signature] [signature] DATE: 8-20-12

GSX ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO INTERPRETATION

(GX-9)

GLOBE X-RAY SERVICES, INC.

8441 SOUTH UNION • TULSA, OKLAHOMA 74132 • (918) 446-1696

N.R.C. #35-15194-01
TEXAS #5-1892
FAA # CS2R753K

RADIOGRAPHIC
TECHNIQUE SHEET

PAGE _____ OF _____

MFG/CUST.	JOB#/ID	RT DATE
J+M	93057.3 Shell	8-9-12

MAT'L TYPE	MAT'L THK.	WELD REINF.	TOTAL THK.	RT TECHNIQUE
C.S.	1/4	1/8	3/8	GXS 1B 01

ISOTOPE/ X-RAY VOLTAGE	CI./MA.	FOCAL SIZE	SOD	OFD	EXPOSURE TIME
Ir 192	68 ci	.141	9"	3/8"	:18

EXPOSURE	VIEWING	FILM PROCESS	Pb
SINGLE WALL ☑ DBL. WALL ☐	SINGLE WALL ☑ DBL. WALL ☐	MAN. ☑ AUTO ☐	FRT .010 BK. .010

FILM MFG/TYPE	NO. EXPOSURES	RT QUALITY	APPLICABLE CODE SPEC.	ACCEPTANCE STD.
Agfa/D-5		2T	ASME Sec V	ASME Sec ~~VIII~~

RT TRCH. LEVEL II	RT PROCEDURE
C Sallis D Echols	GXS 1B

PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	WELDER	#HOLE/IDENT	SHIM SIZE	IQI & SIDE	FILM DENSITY	ACCEPT	REJECT	SLAG	POR	CRACK	IP	LF	UC	FILM ARTIFACT	COMMENTS
RS-1	T-2	A	1	N/A	1A	2.0+	✓									
	2-3						✓									
	3-4						✓									
	4-5						✓									
	5-T						✓									

FILM INTERPRETATION BY: D Echols L11 — DATE: 8-9-12

A.I./CUST.: Wayne Stadler — DATE: 8-20-12

GSX ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO INTERPRETATION

(GX-9)

GLOBE X-RAY SERVICES, INC.

8441 SOUTH UNION • TULSA, OKLAHOMA 74132 • (918) 446-1696

N.R.C. #35-15194-01
TEXAS #5-1892
FAA # CS2R753K

RADIOGRAPHIC
TECHNIQUE SHEET

PAGE _____ OF _____

MFG/CUST.	JOB#/ID	RT DATE
J+M	93057.3	8-27-12

MAT'L TYPE	MAT'L THK.	WELD REINF.	TOTAL THK.	RT TECHNIQUE
SS	.250	.125	.375	GXS-1B-03

ISOTOPE/ X-RAY VOLTAGE	CI./MA.	FOCAL SIZE	SOD	OFD	EXPOSURE TIME
Ir-192	89 ci	.159	18"	.375	1:20

EXPOSURE	VIEWING	FILM PROCESS	Pb
SINGLE WALL ☐ DBL. WALL ☑	SINGLE WALL ☑ DBL. WALL ☐	MAN. ■ AUTO ☐	FRT .010 BK. .010

FILM MFG/TYPE	NO. EXPOSURES	RT QUALITY	APPLICABLE CODE SPEC.	ACCEPTANCE STD.
AGFA D-5		2T	ASME Sec. V	ASME VIII

RT TRCH. LEVEL II	RT PROCEDURE
A. Hall Lv. II J. Stewart	GXS-1B

PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	WELDER ID	# HOLE/WIRE	SHIM SIZE	IQI & SIDE	FILM DENSITY	ACCEPT	REJECT	SLAG	POR	CRACK	IP	LF	UC	FILM ARTIFACT	COMMENTS
RS-2	T-2		1	N/A	1BF	2-4	✓									
	2-3						✓									
	3-4						✓									
	4-T						✓									

FILM INTERPRETATION BY: [signature] DATE: 8-27-12

A.I./CUST. [signature] 8/30/12 [signature] DATE: 8-28-12

...ITY FOR LOSSES OF ANY KIND DUE TO INTERPRETATION

(GX-9)

GLOBE X-RAY SERVICES, INC.

8441 SOUTH UNION • TULSA, OKLAHOMA 74132 • (918) 446-1696

N.R.C. #35-15194-01
TEXAS #5-1892
FAA # CS2R753K

RADIOGRAPHIC
TECHNIQUE SHEET

PAGE _____ OF _____

MFG/CUST. J+M			JOB#/ID 93057.3 Shell (R)			RT DATE 8-28-12
MAT'L TYPE .5	MAT'L THK. .432		WELD REINF. .125	TOTAL THK. .557		RT TECHNIQUE 6XS-1B-03
ISOTOPE/ X-RAY VOLTAGE Ir-192	CI./MA. 89 ci		FOCAL SIZE .159	SOD 6 5/8	OFD .557	EXPOSURE TIME :17
EXPOSURE: SINGLE WALL ☐ DBL. WALL ☑	VIEWING: SINGLE WALL ☑ DBL. WALL ☐			FILM PROCESS: MAN. ■ AUTO ☐		Pb FRT .010 BK. .010
FILM MFG/TYPE AGFA D-5	NO. EXPOSURES	RT QUALITY 2T	APPLICABLE CODE SPEC. ASME Sec. V		ACCEPTANCE STD. ASME VIII	
RT TRCH. LEVEL II A. Hall Lv. II		L. Hisel			RT PROCEDURE 6XS-1B	

PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	WELDER I.D.	#HOLE/WIRE	SHIZE	IQI & SIDE	DENSITY FILM	ACCEPT	REJECT	SLAG	POR	CRACK	IP	LF	UC	FILM ARTIFACT	COMMENTS
N02 T1	T-2	F	1	N/A	IBF	2-4	✓									
	2-3						✓									
	3-T						✓									

FILM INTERPRETATION BY: [signature] DATE: 8-27-12

A.I./CUST. [signature] DATE: 8-28-12

ITY FOR LOSSES OF ANY KIND DUE TO INTERPRETATION

(GX-9)

GLOBE X-RAY SERVICES, INC.

8441 SOUTH UNION • TULSA, OKLAHOMA 74132 • (918) 446-1696

N.R.C. #35-15194-01
TEXAS #5-1892
FAA # CS2R753K

RADIOGRAPHIC
TECHNIQUE SHEET

PAGE _____ OF _____

MFG/CUST. J+M		JOB#/ID 93057.4 Noz.82			RT DATE 9-6-12
MAT'L TYPE S.S.	MAT'L THK. .237	WELD REINF. .125	TOTAL THK. .362		RT TECHNIQUE GXS-1-B-03
ISOTOPE/ X-RAY VOLTAGE Ir192	CI./MA. 81 ci.	FOCAL SIZE .154	SOD 4"	OFD .362	EXPOSURE TIME 811
EXPOSURE: SINGLE WALL ☐ DBL. WALL ☑	VIEWING: SINGLE WALL ☑ DBL. WALL ☐	FILM PROCESS: MAN. ☑ AUTO ☐			Pb FRT .010 BK. .010
FILM MFG/TYPE AgfaD-3	NO. EXPOSURES	RT QUALITY 2-2T	APPLICABLE CODE SPEC. ASME Sec. V		ACCEPTANCE STD. ASME Sec. VIII
RT JRCH. LEVEL II G. Zulpo Level II					RT PROCEDURE GXS-I-B

PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	WELDER	#HOLE/WIRE	SHIZE	IQI & SIDE	FILM DENSITY	ACCEPT	REJECT	SLAG	POR	CRACK	IP	LF	UC	FILM ARTIFACT	COMMENTS
					ASTM											
Noz82RS-1	T-2	A	1	N/A	1-B		✓									
	2-3						✓									
	3-T						✓			✓						Por. within code

FILM INTERPRETATION BY: Gary Zulpo Level II — DATE: 9-6-12

A.I./CUST. Wayne Wilson Bill Bruen — DATE: 9-7-12

GSX ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO INTERPRETATION

(GX-9)

GLOBE X-RAY SERVICES, INC.

8441 SOUTH UNION • TULSA, OKLAHOMA 74132 • (918) 446-1696

N.R.C. #35-15194-01
TEXAS #5-1892
FAA # CS2R753K

RADIOGRAPHIC
TECHNIQUE SHEET

PAGE _____ OF _____

MFG/CUST. J+M		JOB#/ID 93057,4		RT DATE 9-6-12
MAT'L TYPE S,S,	MAT'L THK. 1/4"	WELD REINF. ,125	TOTAL THK. 3/8"	RT TECHNIQUE GXS-1-B-01/02
ISOTOPE/ X-RAY VOLTAGE IR192	CI./MA. 81 ci.	FOCAL SIZE ,154	SOD 8 3/4 / 17 4	OFD 3/8" / EXPOSURE TIME :16 / 1:00

EXPOSURE: SINGLE WALL ☑ DBL. WALL ☐ | VIEWING: SINGLE WALL ☑ DBL. WALL ☐ | FILM PROCESS: MAN. ☑ AUTO ☐ | Pb FRT .010 BK. .010

FILM MFG/TYPE AgfaD-5	NO. EXPOSURES	RT QUALITY 2-2T	APPLICABLE CODE SPEC. ASME Sec. V	ACCEPTANCE STD. ASME Sec. VIII

RT TRCH. LEVEL II G, Zulpo Level II — RT PROCEDURE GXS-I-B

PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	WELDER ID	#HOLE/R	SHIZME	IQI & SIDE	DENSITY FILM	ACCEPT	REJECT	SLAG	POR	CRACK	IP	LF	UC	ARTIFACT FILM	COMMENTS
RS-1	T-2	T	1	N/A	ASTM I-B		/									
	2-3						/									
	3-4						/									
	4-T						/									
RS-2	T-2	T					/									
	2-3						/									
	3-4						/									
	4-T						/									
LS-1	1-2	A					/									
	2-3						/									

FILM INTERPRETATION BY: Gary Zulpo Level II — DATE: 9-6-12

A.I./CUST. M Pope 9/7/12 Bill Brown — DATE: 9-7-12

GSX ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO INTERPRETATION

(GX-9)

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N.R.C. #35-15194-01
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RADIOGRAPHIC
TECHNIQUE SHEET

PAGE _____ OF _____

MFG/CUST. J + M		JOB#/ID 93057.4			RT DATE 8-8-12
MAT'L TYPE C.S.	MAT'L THK. .237	WELD REINF. Y8	TOTAL THK. .352	RT TECHNIQUE GXS IB03	
ISOTOPE/ X-RAY VOLTAGE Ir 192	CI./MA. 59 ci	FOCAL SIZE .141	SOD 4½	OFD .352	EXPOSURE TIME :10
EXPOSURE: SINGLE WALL ☐ DBL. WALL ☑	VIEWING: SINGLE WALL ☑ DBL. WALL ☐	FILM PROCESS: MAN. ☑ AUTO ☐			Pb FRT .010 BK. .010
FILM MFG/TYPE Agfa/D5	NO. EXPOSURES	RT QUALITY 2T	APPLICABLE CODE SPEC. ASME Sec V		ACCEPTANCE STD. ASME Sec VIII
RT TRCH. LEVEL II D Echols & Nelson				RT PROCEDURE GXS IB	

PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	WELDER ID	#HOLE/R	SHIZME	IQI & SIDE	FILM DENSITY	ACCEPT	REJECT	SLAG	POR	CRACK	IP	LF	UC	FILM ARTIFACT	COMMENTS
N02 S1 RS-1	T-2	F	1	A	IB	2.0+		✓	✓							
	2-3							✓	✓							
	3-T						✓									
N02 S2 RS-1	T-2							✓	✓							
	2-3							✓	✓							
	3-T							✓	✓							

FILM INTERPRETATION BY: D Echols [signature] DATE: 8-8-12

A.I./CUST. [signature] [signature] DATE: 8 20 12

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(GX-9)

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TEXAS #5-1892
FAA # CS2R753K

RADIOGRAPHIC
TECHNIQUE SHEET

PAGE _____ OF _____

MFG/CUST. J&M	JOB#/ID 93057.4 (R) Chan			RT DATE 8-10-12
MAT'L TYPE C.S.	MAT'L THK. .250	WELD REINF. .125	TOTAL THK. .375	RT TECHNIQUE G&S-1B-01
ISOTOPE/ X-RAY VOLTAGE Ir-192	CI./MA. 104 ci	FOCAL SIZE .159	SOD 9"	OFD .375
EXPOSURE: SINGLE WALL ☑ DBL. WALL ☐	VIEWING: SINGLE WALL ☐ DBL. WALL ☐	FILM PROCESS: MAN. ■ AUTO ☐		EXPOSURE TIME :10
				Pb FRT .010 BK. .010
FILM MFG/TYPE AGFA D-5	NO. EXPOSURES	RT QUALITY 2T	APPLICABLE CODE SPEC. ASME Sec. II	ACCEPTANCE STD. ASME ~~VIII~~
RT TRCH. LEVEL II A. Hall L II James Stewart				RT PROCEDURE G&S-1B

PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	WELDER ID	# FILM/R	SHIZME	IQI & SIDE	FILM DENSITY	ACCEPT	REJECT	SLAG	POR	CRACK	IP	LF	UC	FILM ARTIFACT	COMMENTS
RS-1	4-5	T	1	N/A	1B	2-4	✓									
	5-T	"	"	"	"	"	✓									

FILM INTERPRETATION BY: [signature] DATE: 8-10-12

A.I./CUST. [signature] DATE: 8-13-12

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TEXAS #5-1892
FAA # CS2R753K

RADIOGRAPHIC
TECHNIQUE SHEET

PAGE _____ OF _____

MFG/CUST.	JOB#/ID	RT DATE
J+M	93057.4	8-9-12

MAT'L TYPE	MAT'L THK.	WELD REINF.	TOTAL THK.	RT TECHNIQUE
C.S.	STD	1/8		GXS 1B 03

ISOTOPE/ X-RAY VOLTAGE	CI./MA.	FOCAL SIZE	SOD	OFD	EXPOSURE TIME
Ir 192	68 ci	.141	4½		:14

EXPOSURE	VIEWING	FILM PROCESS	Pb
SINGLE WALL ☐ DBL. WALL ☑	SINGLE WALL ☑ DBL. WALL ☐	MAN. ☑ AUTO ☐	FRT .010 BK. .010

FILM MFG/TYPE	NO. EXPOSURES	RT QUALITY	APPLICABLE CODE SPEC.	ACCEPTANCE STD.
AgFa/D-5		2T	ASME Sec V	ASME Sec ~~VIII~~

RT TRCH. LEVEL II	RT PROCEDURE
C Sallis D Echols	GXS 1B

PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	WELDER ID	#HOLE/IR	SHIZE	IQI & SIDE	FILM DENSITY	ACCEPT	REJECT	SLAG	POR	CRACK	IP	LF	UC	FILM ARTIFACT	COMMENTS
NO2 81	1-2	F	1	7/A	1AF	2.04.0	✓			X						with in code
	2-3						✓			X						with in code
NO2 82	1-2							X	X							
	2-3							X	X	X						
	3-1							X	X							

FILM INTERPRETATION BY: D Echols CII D Echols DATE: 8-9-12

A.I./CUST.: Wayne Hudson Bill Brown DATE: 8-20-12

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(GX-9)

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N.R.C. #35-15194-01
TEXAS #5-1892
FAA # CS2R753K

RADIOGRAPHIC
TECHNIQUE SHEET

PAGE _____ OF _____

MFG/CUST.	JOB#/ID	RT DATE
J+M	93057.4 CC#2	8-9-12

MAT'L TYPE	MAT'L THK.	WELD REINF.	TOTAL THK.	RT TECHNIQUE
C.S.	1/4	1/8	3/8	GXS IB 07

ISOTOPE/ X-RAY VOLTAGE	CI./MA.	FOCAL SIZE	SOD	OFD	EXPOSURE TIME
Ir 192	68 ci	.141	9"	3/8"	:18

EXPOSURE	VIEWING	FILM PROCESS	Pb
SINGLE WALL ☑ DBL. WALL ☐	SINGLE WALL ☑ DBL. WALL ☐	MAN. ☑ AUTO ☐	FRT .010 BK. .010

FILM MFG/TYPE	NO. EXPOSURES	RT QUALITY	APPLICABLE CODE SPEC.	ACCEPTANCE STD.
Agfa/D-5		2T	ASME Sec V	ASME Sec ~~VIII~~

RT TRCH. LEVEL II: C Sallis D Echols

RT PROCEDURE: GXS IB

PART # SEAM # OR WELD #	LOCATION MARKER INTERVAL	WELDER	# FILM/R	SHIZE	IQI & SIDE	FILM DENSITY	ACCEPT	REJECT	SLAG	POR	CRACK	IP	LF	UC	FILM ARTIFACT	COMMENTS
RS-1	1-2	T	1	1/4	1A	2.0	✓									
	2-3						✓									
	3-4							X	X				X			tie in
	4-5						✓									
	5-T							X	X							
RS-2	T-1						✓									
	1-2						✓									
	2-3						✓									
	3-4						✓									
	4-5						✓									
	5-T						✓									

FILM INTERPRETATION BY: D Echols CII — DATE: 8-9-12

A.I./CUST.: MBone 8/30/12 Bill Brown — DATE: 8 2012

GSX ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO INTERPRETATION

(GX-9)

Protective Coating & Sandblasting Paint Report pg # 1

DATE 9-21-12 TIME 8 (AM)/PM THIS SECTION COVERS SANDBLASTING

CUSTOMER Fabsco JOB OR ITEM NO 10279-708

CONDITIONS CHECK ALL THAT APPLY CLEAR(X) CLOUDY[ ] RAIN[ ] SNOW[ ]

AMBIENT TEMP 71 R/H 66 DEW POINT 59 SURFACE TEMP 71

FIVE DEDREES ABOVE DEPOINT YES(X) OR NO[ ] TYPE OF S/B SSPC-SP 10

CONDITION OF STEEL NEW(X) MILL SCALE[ ] LT RUST[ ] PAINTED[ ]

SURFACE PROFILE AFTER S/B 2.0 - 2.10 NOZZLE PRESSURE 110

THIS SECTION COVERS PAINT APPICATION UNLESS NOTED ALL PAINTING IS DONE INDOORS IN CLIMATED CONTROLLED ENVIRONMENT

AMBIENT TEMP 80 R/H 45 DEW POINT 57 SURFACE TEMP 80

PRIMER 12HD0738B 36/24/24
PRODUCT No 859 MFG carboline BATCH No 12ED502413 SHELF LIFE
uppercoats 12GD599526

2ND COAT
PRODUCT No MFG BATCH No SHELF LIFE

3RD COAT
PRODUCT No MFG BATCH No SHELF LIFE

4TH COAT
PRODUCT No MFG BATCH No SHELF LIFE

MILLAGE PER COAT 1ST 2½-3 2ND 3RD 4TH TOTAL

MILL GAUGE CALIBRATION IS DONE ON A DAILY BASES
ATTACH PRESS-O-FILM TAPE BELOW

#7

#8

SIGNATURE Mark Mattson DATE 9-21-12

Black Beauty was used for Blasting

Protective Coating & Sandblasting Paint Report pg # 2

DATE 9-22-12 TIME 9 AM/PM THIS SECTION COVERS SANDBLASTING

CUSTOMER Fabsco JOB OR ITEM NO 10279-703

CONDITIONS CHECK ALL THAT APPLY CLEAR[X] CLOUDY[ ] RAIN[ ] SNOW[ ]

AMBIENT TEMP 82 R/H 46 DEW POINT 60 SURFACE TEMP 82

FIVE DEDREES ABOVE DEPOINT YES[X] OR NO[ ] TYPE OF S/B SSPC-SP ——

CONDITION OF STEEL NEW[ ] MILL SCALE[ ] LT RUST[ ] PAINTED[X]

SURFACE PROFILE AFTER S/B —— NOZZLE PRESSURE ——

THIS SECTION COVERS PAINT APPICATION UNLESS NOTED ALL PAINTING IS DONE INDOORS IN CLIMATED CONTROLLED ENVIRONMENT

AMBIENT TEMP 87 R/H 37 DEW POINT 58 SURFACE TEMP 87

PRIMER
PRODUCT No 859 MFG Carboline BATCH No SH## 9 SHELF LIFE 3/24/14 (ppors)

2ND COAT
PRODUCT No 890 MFG Carboline BATCH No 12GD3400L 12ED22588 SHELF LIFE 3/15

3RD COAT
PRODUCT No ____ MFG ____ BATCH No ____ SHELF LIFE ____

4TH COAT
PRODUCT No ____ MFG ____ BATCH No ____ SHELF LIFE ____

MILLAGE PER COAT 1ST 2½-3 2ND 4-6 3RD ____ 4TH ____ TOTAL ____

MILL GAUGE CALIBRATION IS DONE ON A DAILY BASES
ATTACH PRESS-O-FILM TAPE BELOW

SIGNATURE Mark Madison DATE 9-22-12

Protective Coating & Sandblasting Paint Report pg # 3

DATE 9-24-12 TIME 8 (AM)/PM THIS SECTION COVERS SANDBLASTING

CUSTOMER Fabsco JOB OR ITEM NO 10279-708

CONDITIONS CHECK ALL THAT APPLY CLEAR CLOUDY[ ] RAIN[ ] SNOW[ ]

AMBIENT TEMP 84 R/H 35 DEW POINT 54 SURFACE TEMP 84

FIVE DEDREES ABOVE DEPOINT YES OR NO[ ] TYPE OF S/B SSPC-SP —

CONDITION OF STEEL NEW[ ] MILL SCALE[ ] LT RUST[ ] PAINTED

SURFACE PROFILE AFTER S/B — NOZZLE PRESSURE —

THIS SECTION COVERS PAINT APPICATION UNLESS NOTED ALL PAINTING IS DONE INDOORS IN CLIMATED CONTROLLED ENVIRONMENT

AMBIENT TEMP 90 R/H 36 DEW POINT 60 SURFACE TEMP 90

Supports

PRIMER PRODUCT No 859 MFG Carboline BATCH No SH#1 SHELF LIFE 36/24/24

2ND COAT PRODUCT No 890 MFG Carboline BATCH No SH#2 SHELF LIFE 36/15

3RD COAT PRODUCT No 134 MFG Carboline BATCH No 12ER26762 12HF96138 SHELF LIFE 36/24

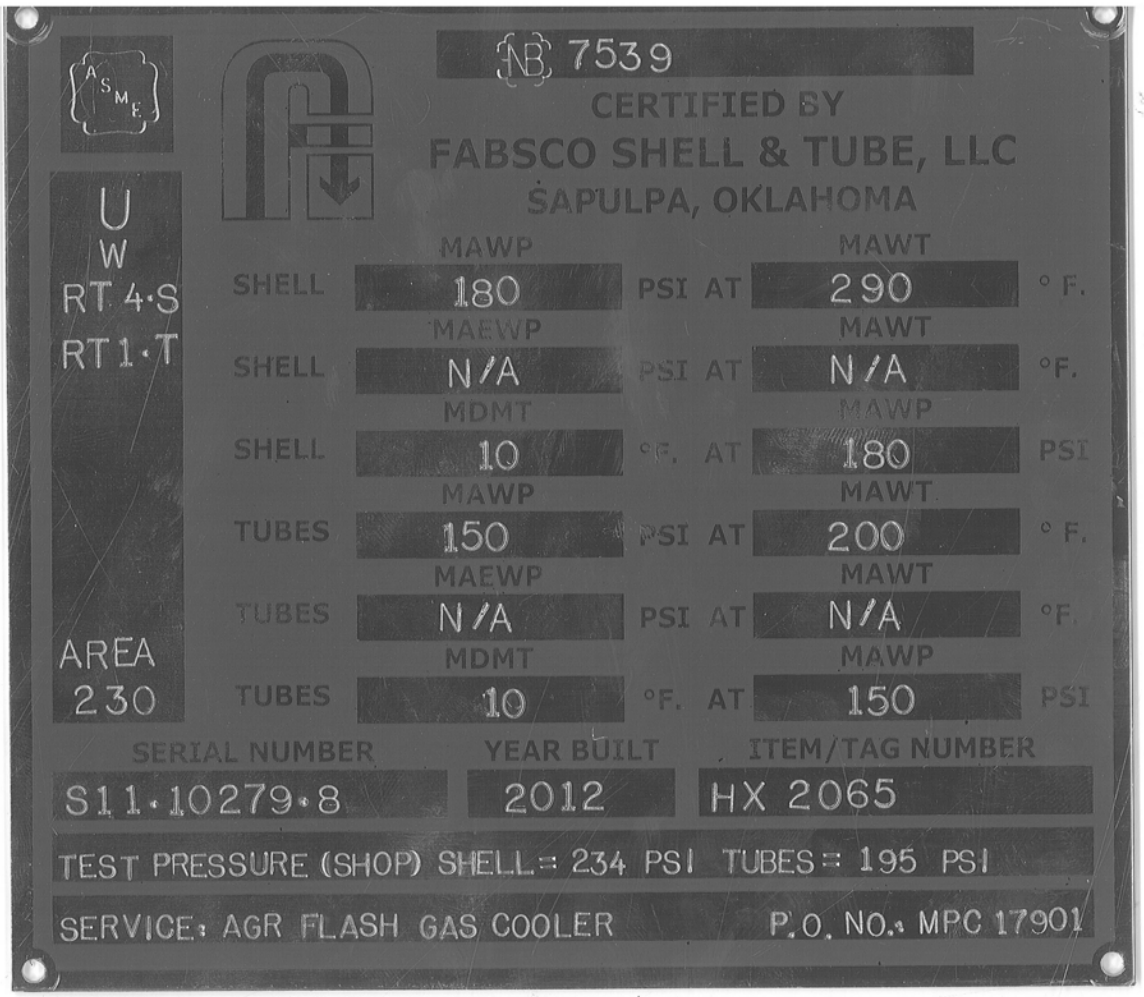
4TH COAT PRODUCT No — MFG — BATCH No — SHELF LIFE —

MILLAGE PER COAT 1ST 2½-3 2ND 4-6 3RD 2½-3½ 4TH — TOTAL 9-12½

Supports

MILL GAUGE CALIBRATION IS DONE ON A DAILY BASES
ATTACH PRESS-O-FILM TAPE BELOW

SIGNATURE Mike McBee DATE 9-24-12


NB 7539
CERTIFIED BY
FABSCO SHELL & TUBE, LLC
SAPULPA, OKLAHOMA
U
W
RT 4-S
RT 1-T
AREA
230
MAWP
MAWT
SHELL 180 PSI AT 290 °F.
MAEWP
MAWT
SHELL N/A PSI AT N/A °F.
MDMT
MAWP
SHELL 10 °F. AT 180 PSI
MAWP
MAWT
TUBES 150 PSI AT 200 °F.
MAEWP
MAWT
TUBES N/A PSI AT N/A °F.
MDMT
MAWP
TUBES 10 °F. AT 150 PSI
SERIAL NUMBER
YEAR BUILT
ITEM/TAG NUMBER
S11-10279-8
2012
HX 2065
TEST PRESSURE (SHOP) SHELL = 234 PSI TUBES = 195 PSI
SERVICE: AGR FLASH GAS COOLER
P.O. NO.: MPC 17901

FABSCO
SHELL & TUBE, LLC

INSTALLATION, OPERATION & MAINTENANCE MANUAL

for

SHELL AND TUBE HEAT EXCHANGERS

FABSCO
SHELL & TUBE, LLC
P.O. Box 988
Sapulpa, Oklahoma 74066
918/224-7550

FORWARD

Included in this manual are Tables and Figures which are reprinted in their entirely from the Standards of the Tubular Exchanger Manufacturers Association Seventh Edition (1988). Pages containing such material contain a citation to that publication.

Additionally, there are extensive extracts of text reprinted from the 7th Edition TEMA Standards. Pages containing such excerpts contain a footnote to that effect.

The information in this publication is based on the collective experience of Industry engineers and technicians. While the information is intended to be comprehensive and thorough, it is subject to change based on particular applications, field experience and technological developments. The Tube Exchanger Manufacturers Association expressly disclaims any warranty of fitness for a particular application, as well as any claims for compensatory, consequential or other damages arising out of or related to the use of this publication.

TABLE OF CONTENTS

GENERAL INSTUCTIONS FOR INSTALLATION, OPERATION AND MAINTENANCE OF SHELL AND TUBE HEAT EXCHANGERS

SAFETY CONSIDERATIONS

LIFTING DEVICES

When eyebolts, lugs, clips or other devices are installed by the manufacturer, it is intended that these lifting devices are to lift only the empty components to which they are attached and not the assembled heat exchanger, unless explicitly specified otherwise.

Proper rigging must be used in lifting assembled heat exchangers. Exchangers are usually much heavier than pressure vessels of comparable dimensions; therefore, weights should be carefully evaluated. Where available, determinations should include reference to manufacturers drawings, added components, bill of lading, etc. Special care must be exercised in handling exchangers with expansion joints.

ROUTING PRECAUTIONARY PROCEDURES

A heat exchanger is a multi-chamber pressure vessel designed at specific limits of pressure, temperature and fluid flow conditions as shown on the exchanger specification sheet and heat exchanger nameplate(s). The process system, which includes the heat exchanger, must be safeguarded so that the heat exchanger design conditions and operating limits are not exceeded. All operating and maintenance personnel should be made aware of specific limitations including pressures and temperatures flow rates, start-up/shut-down procedures and cleaning procedures.

Do not remove channel covers, shell covers, floating head covers, bonnets or connecting piping until all pressure has been relieved and both shell and tube sides are completely drained. Exceptions are permissible when design permits independent pressure testing of shell or tube sides.

Plugged tubes and double tubesheets, unless vented, may remain pressurized after shell and tube side are depressurized. Caution may be exercised in loosening of tube plugs or opening of vents to avoid sudden release of pressure or harmful fluids.

Many heat exchangers circulate fluids, which are toxic, lethal or flammable and dangerous to the human system. These fluids could cause problems if bolted or threaded joints are not maintained in leak-tight condition under operating or no-flow ambient conditions. Proper precautions, such as effective draining and purging, must be taken in handling and decontamination when exchangers are opened for any reason. It is essential that the user advises maintenance or repair personnel, including outside contractors, when toxic, lethal, or flammable conditions exist.

When heat exchangers are cleaned, it is important that full characteristics of the circulating fluids, fouling material, and the cleaning agent be known and care exercised in handling them. Use eye protection, a respirator, or other appropriate protective devices.

Do not blow out heat exchangers with air when the process fluids or the cleaning fluids being handled are flammable or reactive.

SECTION 1
HEAT EXCHANGER NOMENCLATURE

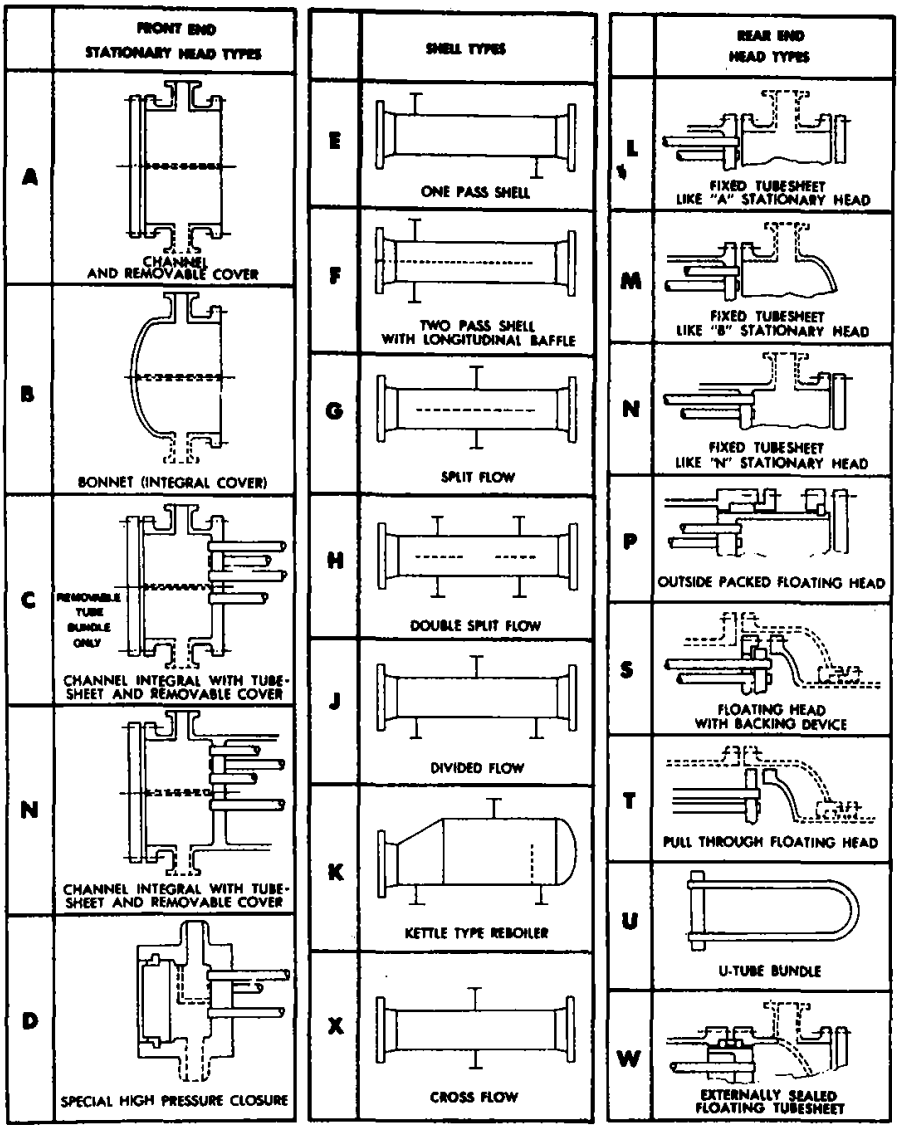
N-1 TYPE DESIGNATION-RECOMMENDED PRACTICE

It is recommended that heat exchanger type be designated by letters as described below.

N-1.1 TYPE

Type designation shall be by letters describing stationary head, shell (omitted for bundles only), and rear head, in that order, as indicated in Figure N-1.1.

FIGURE N-1.1



N-2 NOMENCLATURE OF HEAT EXCHANGER COMPONENTS

For the purpose of establishing standard terminology, Figure N-2 illustrates various types of heat exchangers. Typical parts and connections, for illustrative purposes only, are numbered for identification in Table N-2. (See Note).

TABLE N-2

1. Stationary Head – Channel
2. Stationary Head – Bonnet
3. Stationary Head Flange – Channel or Bonnet
4. Channel Cover
5. Stationary Head Nozzle
6. Stationary Tubesheet
7. Tubes
8. Shell
9. Shell Cover
10. Shell Flange – Stationary Head End
11. Shell Flange – Rear Head End
12. Shell Nozzle
13. Shell Cover Flange
14. Expansion Joint
15. Floating Tubesheet
16. Floating Head Cover
17. Floating Head Flange
18. Floating Head Backing Device
19. Split Shear Ring
20. Slip-on Backing Flanges
21. Floating Head Cover – External
22. Floating Tubesheet Skirt
23. Packing Box
24. Packing
25. Packing Gland
26. Lantern Ring
27. Tie rods and Spacers
28. Transverse Baffles or Support Plates
29. Impingement Plate
30. Longitudinal Baffle
31. Pass Partition
32. Vent Connection
33. Drain Connection
34. Instrument Connection
35. Support Saddle
36. Lifting Lug
37. Support Bracket
38. Weir
39. Liquid Level Connection

NOTE: Manufacturers may identify corresponding parts
Using numbers differing from the above.

Figure N-2

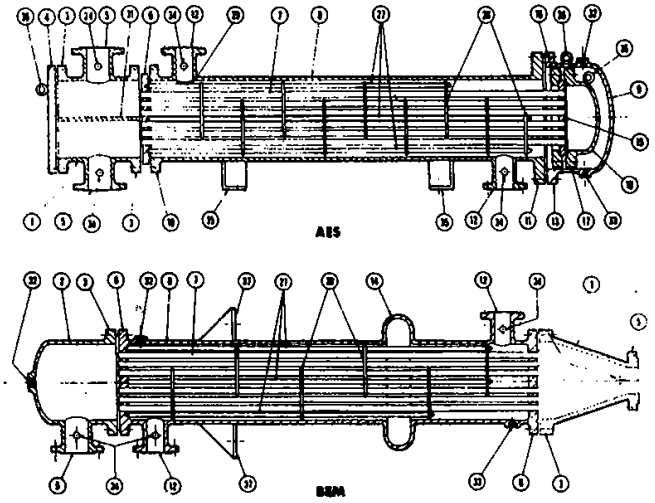
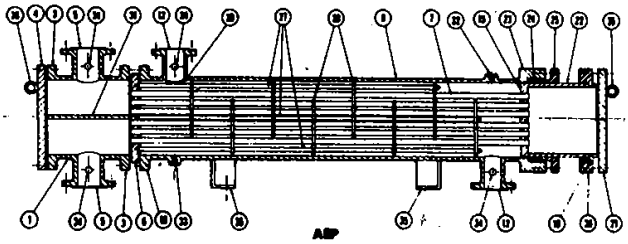
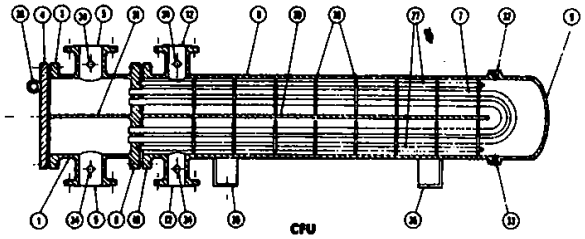
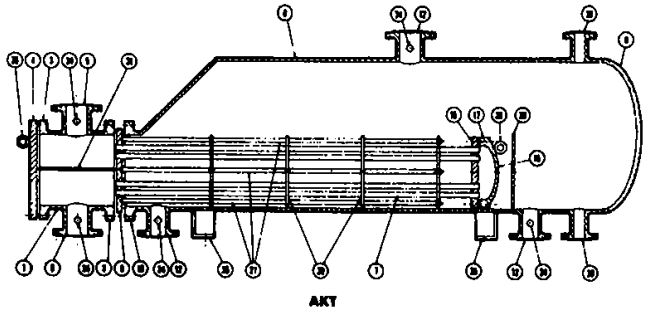
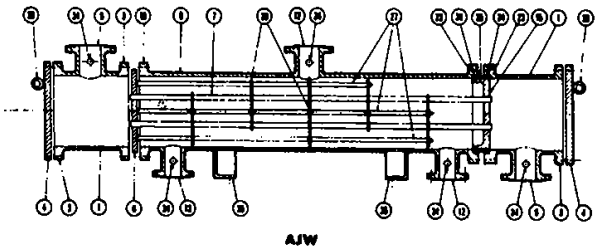


Figure N-2 (Continued)









SECTION 2
HEAT EXCHANGER IDENTIFICATION AND DEFINITIONS

D-2.1 EXCHANGER IDENTIFICATION

D-2.11 COMPLETE EXCHANGER

Manufacturers normally assigned on a serial number, which is unique and permanently identifies each exchanger. Inquiries to the manufacturer should reference this number when it is shown on the nameplate and manufacturer's drawings. Additional useful information normally shown includes size, type, and item number.

D-2.12 EXCHANGER PARTS

Exchanger parts should be identified by the exchanger serial number and by the name and part number corresponding to those shown in Section 1, Table N-2, or as shown on the manufacturer's drawings.

D-2.2 DEFINITIONS

D-2.21 EXCHANGER UNIT

One or more exchangers designed for a specific service.

D-2.22 ITEM NUMBER

The purchaser's identification number for an exchanger unit.

D-2.23 NORMAL OPERATING CONDITIONS

The thermal and hydraulic performance requirements generally specified for designing the heat exchanger.

D-2.24 UPSET CONDITIONS

A departure from specified operating conditions.

D-2.25 PULSATING FLUID CONDITIONS

Conditions of flow generally characterized by rapid fluctuations in pressure and flow rate resulting from sources outside of the heat exchanger such as: pumps, compressors, blowers, etc.

D-2.26 START-UP CONDITIONS

The condition of operation, which exist from the time that flow of either or both process streams, is initiated to the time that steady-state operating conditions are achieved.

D-2.27 SHUTDOWN CONDITIONS

The conditions of operation, which exist, form the time of steady-state operating conditions to the time that flow of both process streams has ceased.

D.2.28 CODE

All references to Code herein mean the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Pressure Vessels.

E-3 INSTALLATION

E-3.1 INSTALLATION PLANNING

E-3.11 CLEARANCE FOR DISMANTLING

For straight tube exchangers fitting with removable bundles, provide sufficient clearance at the stationary head end to permit removal of the bundle from the shell and provide adequate space beyond the rear head and to permit removal of the shell cover and/or floating head cover.

For fixed tubesheet exchangers, provide sufficient clearance at one end to permit withdrawal and replacement of the tubes and enough space beyond the head at the opposite end to permit removal of the bonnet or channel cover.

For U-tube heat exchangers, provide sufficient clearance at the stationary head end to permit withdrawal of the tube bundle, or at the opposite end to permit removal of the shell.

E-3.12 FOUNDATIONS

Foundations must be adequate so that exchangers will not settle and impose excessive strains on the exchanger. Foundation bolts should be set to allow for setting inaccuracies. In concrete footings, pipe sleeves at least one size larger than bolt diameter slipped over the bolt and cast in place are best for this purpose, as they allow the bolt center to be adjusted after the foundation has set.

E-3.13 PIPING

E-1.131 THERMAL EXPANSION

It is essential that adequate provisions be made in the connecting piping to allow for thermal expansion without imposing unspecified piping loads on the exchanger. This is particularly important for single pass internal floating head designs, outside packed floating heads, and fixed tubesheet types with shell expansion joints. Unless precautions are taken, leakage or damage may result.

E-3.132 PULSATION AND VIBRATION

In all installations, care must be taken to eliminate or minimize transmission of fluid pulsations and mechanical vibrations to the heat exchangers.

E-3.14 CLEANING

Convenient means should be provided for cleaning the unit as suggested under "Maintenance." (Section 5).

E-3.15 LEVELING

Exchangers must be installed so that pipe connections are made without forcing, disassembling or loosening of flanged assemblies.

E-3.16 STACKED HEAT EXCHANGERS

The manufacturer normally stacks exchangers prior to completion of fabrication to insure proper alignment of interconnecting nozzles. Shims separating the intermediate shell supports are normally used. Therefore, it is important that shims, if used, match the thicknesses and locations used by the manufacturer.

E-3.17 CONNECTION PROTECTORS

Remove shipping covers and plugs immediately prior to installation. Before connecting to piping, inspect all openings in the heat exchanger or foreign material. The entire system should be clean and free of foreign objects before starting operation. Do not expose heat exchanger internals to moisture or harmful contaminants.

E-3.18 PIPE CONNECTIONS

Pipe connections must be in accordance with the manufacturer's dimensional outline drawing.

E-3.19 FOUNDATION BOLTS

Foundation bolts should be loosened at one end of the unit to allow free expansion of shells. Slotted holes in supports are provide for this purpose.

E-3.20 If the heat exchanger is equipped with a bellows type expansion joint, the expansion joint must be adequately protected during shipping and setting. Shipping supports must be removed in accordance with instructions.

E-3.3 HEAT EXCHANGER STORAGE

Heat exchangers normally are not protected for storage. If storage is necessary, a covered location at uniform temperature is preferable and provisions must be made to protect the heat exchanger interior from moisture, freezing, or harmful contaminants.

E-4 OPERATION

E-4.1 PERFORMANCE OF HEAT EXCHANGERS

Satisfactory performance and service life can be expected only from heat exchangers which are properly installed, operated in accordance with design conditions, and receive preventative maintenance and cleaning on an appropriate schedule. These requirements are the responsibility of the user.

E-4.11 PERFORMANCE FAILURES

The failure of heat exchanger equipment to perform satisfactorily may be caused by one or more factors, such as:

(1) Excessive fouling.
(2) Air or gas binding resulting from improper piping installation or lack of suitable vents.
(3) Operating conditions differing from design conditions.
(4) Mal-distribution of flow in the unit.
(5) Excessive clearances between the baffles and shell and/or tubes, due to corrosion.
(6) Improper thermal design.
(7) Flooding resulting from inadequate drainage of condensate.

E-4.2 OPERATION OF HEAT EXCHANGERS

E-4.21 OPERATING PROCEDURES – NORMAL

Before placing any exchanger in operating, reference should be made to the exchanger drawings, specification sheet(s), and name plate(s) for any special instructions. Local safety and health regulations must be considered. Improper start-up or shutdown sequences, particularly of fixed tubesheet units, may cause leaking of tube-to-tubesheet and/or bolted flanged joints.

E-4.22 START-UP OPERATION

Most exchangers with removable tube bundles may be placed in service by first establishing circulation of the cold medium, followed by the gradual introduction of the hot medium. During start-up all vent valves should be opened and left open until all passages have been purged of air and are completely filled with fluid. For fixed tubesheet exchangers, fluids must be introduced in a manner to minimize differential expansion between the shell and tubes. (Refer E-4.24).

E-4.23 SHUT-DOWN OPERATION

For exchangers with removable bundles, the units may be shut down by first gradually stopping the flow of the hot medium and then stopping the flow of the cold medium. If it is necessary to stop the flow of cold medium, the circulation of hot medium through the exchanger should also be stopped. For fied tubesheet exchangers the unit must be shut down in a manner to minimize differential expansion

E-4.24 START-UP AND SHUT-DOWN RPOCDURES FOR FIXED TUBESHEET EXCHANGERS

When start-up and shutdown instructions are furnished, they must be followed. When specific instructions are not supplied, the recommended procedure is to start, or stop, the circulation of both shell and tube side fluids gradually and at the same time.

E-4.3 OPERATING LIMITATIONS

E-4.31 NORMAL OPERATING CONDITIONS

Equipment must not be operated at conditions more severe than those specified on the heat exchanger specification sheet, and/or nameplates. A change in service or deviation from the specified operating conditions may require that a mechanical design check be made in order to avoid possible damage to the heat exchanger.

E-4.32 SUPPLEMENTAL NAME PLATE DATA

The manufacturer may supply supplemental data where it is pertinent to the operation or testing o the exchanger. This may include information pertaining to differential design and test pressure conditions, restrictions on operating conditions for fixed tubesheet type exchangers, or other restrictive conditions applicable to the design and/or operation of the unit or its components. Such information may be noted on the standard nameplate or on a supplemental plate attached to the exchanger at the nameplate location.

E-4.33 FLOW RATE

Heat exchangers are not to be operated at flow rates greater than those shown on the heat exchanger specification sheet. Excessive flow rates can cause vibration and/or erosion and severely damage the heat exchanger.

E-4.34 HYDRAULIC HAMMER

Exchangers should not be subjected to pulsating, slugging, or unstable flow conditions, which may impair performance or result in destructive hydraulic hammer. Adequate condensate drainage is essential for steam heaters and similar apparatus.

E-4.35 TEMPERATURE SHOCKS

Exchangers normally should not be subjected to abrupt temperature fluctuations. Hot fluid must not be suddenly introduced when the unit is cold, nor cold fluid when the unit is hot.

E-4.36 FLUID TEMPERATURE LIMITS

E-4.361 Heat exchangers are not to be operated at fluid temperature more severe than those shown on the heat exchanger specification sheet.

E-4.362 For fixed tubesheet exchanger's fluid inlet temperatures may be severely limited when there is no fluid on the opposite side. Operation with fluid circulation on one side only should be avoided, unless specifically provided for in the design of the heat exchanger.

E-4.4 BOLTED JOINTS

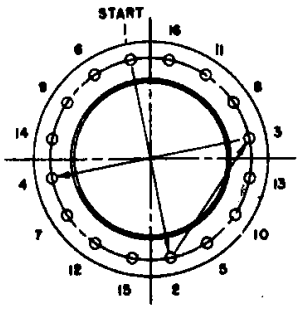
E-4.41 RECOMMENDATIONS FOR RETIGHTENING

Heat exchangers are pressure tested before leaving the manufacturer's shop in accordance with ASME Code requirements. However, normal yielding of gasket joints may occur in the interval between testing in the manufacturer's shop and installation at the job site. Therefore, all external bolted joints may require retightening after installation and, if necessary, after the exchanger has reached operating temperature.

E-4.3 RECOMMENDED BOLT TIGHTENING PROCEDURE

It is important that all bolted joints be tightened uniformly and in a diametrically staggered pattern as illustrated in Figure E-4.rw except for special high pressure closures when the instructions of the manufacturer should be followed.

Figure E-4.42



E-5 MAINTENANCE

E-5.1 INSPECTION OF UNIT

At regular intervals and as frequently as experience indicates, an examination should be made of the interior and exterior condition of the unit. Neglect in keeping all tubes clean may result in complete stoppage of flow through some tubes, which could cause severe thermal strains, leaking tube joints, or structural damage to other components. Sacrificial anodes, when provided, should be inspected to determine whether they should be cleaned or replaced.

E-5.11 INDICATIONS OF FOULING

Exchangers subject to fouling or scaling should be cleaned periodically. A light sludge or scale coating on the tube greatly reduces its efficiency. A marked increase in pressure drop and/or reduction in performance usually indicate cleaning is necessary. The unit should first be checked for air or vapor binding to confirm that this is not the cause for the reduction in performance. Since the difficulty of cleaning increases rapidly as the scale thickness or deposit increases, the intervals between cleanings should not be excessive.

E-5.12 PREVENTATIVE MAINTENANCE

Additional important reasons for inspections include:

(1) Corrosion and erosion may weaken various parts of an exchanger and may eventually cause mechanical failure, or impaired performance.

(2) Determination of fouling and corrosion rates for prediction of service life scheduling downtime.

(3) Implementation of preventive maintenance procedures, which reduce rates of fouling and general deterioration, or eliminate leaks.

E-5.13 ACCESS TO TUBES

Before disassembly, the user must assure himself that the unit has been depressurized, vented and drained, neutralized and/or purged of hazardous materials.

To inspect the inside of the tubes and also make them accessible for cleaning, the following procedures should be used:

(1) Stationary Head End

- (a) Type A, C, & D, removes cover only.
- (b) Type B, remove bonnet.

(2) Rear Head End

- (a) Type L, N. & P, remove cover only.
- (b) Type M, remove bonnet.
- (c) Type S & T, remove shell cover and floating head cover.
- (d) Type W, remove channel cover or bonnet.

E-5.14 LOCATING LEAKS IN TUBES

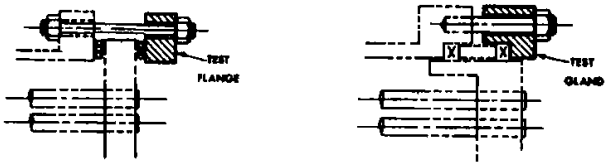
The following procedures may be used to locate perforated or split tubes and leaking joints between tubes and tubesheets. In most cases, the entire front face of each tubesheet will be accessible for inspection. The point where water escapes indicates a defective tube or tube-to-tubesheet joint.

(1) Units with removable channel cover:
Remove channel cover and apply hydraulic pressure in the shell.

(2) Units with bonnet type head:
(a) On fixed tubesheet units where tubesheets are an integral part of the shell, remove bonnet and apply hydraulic pressure in the shell.
(b) On fixed tubesheet units where tubesheets are not an integral part of the shell and on units with removable bundles, remove bonnet, re-bolt tubesheet to shell or install test flange or gland, whichever is applicable, and apply hydraulic pressure in the shell.
See Figure E-5.14-1 for typical test flange and test gland.

CAUTION: Bolting directly to the edges of the tubesheets may result in overstress unless sit was considered in the design of the tubesheets.

Figure E-5.14-1

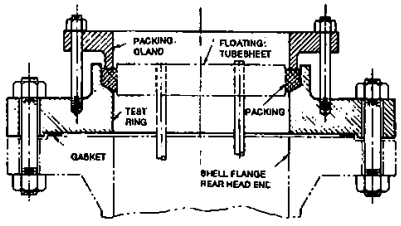


(3) Units with type S or T floating head:
Remove channel cover or bonnet, shell cover and floating head cover. Install test ring and bolt in place with gasket and packing. Apply hydraulic pressure in the shell. A typical test ring is shown in Figure E-5.14-2. When a test rings is not available it is possible to locate leaks in the floating head end by removing the shell cover and applying hydraulic pressure in the tubes. Leaking tube joints may then be located by sighting through the tube lanes.

NOTE: Care must be exercised when testing partially assembled exchangers to prevent over extension of expansion joints or overloading of tubes and/or tube-to0tube-to-tubesheet joints.

Hydrostatic test should be performed so that the temperature of the metal is at least 30°F above the minimum design metal temperature, MDMT.

Figure E-5.14-2



E-5.2 TUBE BUNDLE REMOVAL

Bundles must be withdrawn from the stationary end as noted on the drawing. All parts such as glands, retainer rings, split shear rings and closure packing ust be removed before attempting to remove bundle. Threaded eyebolts may be attached to the stationary tubesheet when tapped holes have been provided for this purpose. When eyebolt tappings are not provided, rods may be passed through two or more tubes and attached to a steel bearing plate over the floating tubesheet. Provide a protective spacer between the bearing plate and tubesheet to protect the tube ends.

E-5.21 HANDLING TUBE BUNLDES

Tube bundles should not be handled with hooks or other devices, which might damage the tubes. Bundles should be supported on cradles or skids. Horizontal tube bundles should be lifted by means of suitable sings. Baffles can be bent and damaged by dragging a bundle over a rough surface. All gasket and packing contact surfaces should be protected from accidental damage since these areas are generally difficult to repair.

E-5.3 CLEANING TUBE BUNDLES

E-5.31 CLEANING METHODS

The heat transfer surfaces of heat exchangers should be kept reasonably clean to assure satisfactory performance. Convenient means for cleaning should be made available.

Heat exchangers may be cleaned by either chemical or mechanical methods. The method selected must be the choice fo the operator of the plant and will depend on the type of deposit and the facilities available in the plant. Following are several cleaning procedure that may be considered:

(1) Circulating hot wash oil or light distillate through tubes or shell at high velocity may effectively remove sludge or similar soft deposits.

(2) Some salt deposits may be washed out by circulating hot fresh water.

(3) Some commercial cleaning compounds are available for removing sludge or scale provided hot wash oil or water is not available or does not give satisfactory results.

(4) High pressure water jet cleaning.

(5) Scrapers, rotating wire brushes, and other mechanical means for removing hard scale, coke, or other deposits.

(6) Employ services of a qualified organization that provides cleaning services. These organizations will check the nature of the deposits to be removed, furnish proper solvents and/or acid solutions containing inhibitors, and provide equipment and personnel for a complete cleaning job.

E-5.32 CLEANING PRECAUTIONS

(1) Tubes should not be cleaned by blowing steam through individual tubes since this heats the tube and may result in severe expansion strain, deformation of the tube, or loosening of the tube-to-tubesheet joint.

(2) When mechanically cleaning a tube bundle, care should be exercised to avoid damaging the tubes.

(3) Cleaning compounds must be compatible with the metallurgy of the exchanger.

(4) Cleaning procedures, especially those which circulate hot fluids through the tubes, can cause significant temperature differentials between the shell and tubes. Such cleaning procedures can cause damage to fixed tubesheet heat exchangers and should be avoided unless specifically provided of in the design of the heat exchanger.

E-5.4 GASKET REPLACEMENT

Gasket and gasket surfaces should be thoroughly cleaned and should be free of scratches and other defects. Gaskets should be properly positioned before attempting to retighten bolts. It is recommended that when a heat exchanger is dismantled for any cause, it's to be reassembled with new gaskets. This will tend to prevent future leaks and/or damage to the gasket seating surfaces of the heat exchanger. Composition gaskets become dried out and brittle so that they do not always provide an effective seal when reused. Metal or metal-jacketed gaskets, when compressed initially, flow to match their contact surfaces. In so doing they are work hardened and, if reused, may provide an imperfect seal or result in deformation and damage to the gasket contact surfaces of exchanger.

Bolted joints and flanges are designed for use with the particular type of gasket specified. Substitution of a gasket of different construction or improper dimensions may result in leakage and damage to gasket surfaces. Therefore, any gasket substitutions should be of compatible design.

Any leakage at a gasketed joint should be rectified and not permitted to persist as it may result in damage to the gasket surfaces.

When metal jacketed filled type gaskets are used with a tongue and groove joint without a nubbin, the gasket should be installed so that the tongue bears on the seamless side of the gasket jacket. When a nubbin is used, the nubbin should bear on the seamless side.

E-5.5 SPARE AND REPLACEMENT PARTS

The procurement of spare or replacement parts from the manufacturer will be facilitated if the correct name for the part, as shown in Section 1, Table N-2, of this manual is given, together with the serial number, type, size, and other information from the nameplate. Replacement parts should be purchased from the original manufacturer.

E-5.6 EXPANDED TUBE JOINTS

E-5.61 TUBE HOLE FINISH

Tube hole finish affects the mechanical strength and leak tightness of an expanded tube-to-tubesheet joint. In general:

(1) A rough tube hole provides more mechanical strength than a smooth tube hole. This is influenced by a complex relationship of modulus of elasticity; yield strength, and hardness of the materials being used.

(2) A smooth tube hole does not provide the mechanical strength that a rough tube hole does, but it can provide a pressure tight joint at a lower level of tube wall reduction.

(3) Very light wall tubes require a smother tube hole finish than heavier wall tubes.

(4) Significant longitudinal scratches can provide leak paths through an expanded tube-to-tubesheet joint and should therefore be removed.

E-5.62 TUBE WALL REDUCTION

The optimum tube wall reduction for an expanded tube-to-tubesheet joint depends on a number of factors, some of which are:

(1) Tube hole finish.

(2) The presence or absence of the tube hole serrations (grooves).

(3) The tube hole size and tolerance.

(4) Tubesheet ligament width and its relation to tube diameter and thickness.

(5) Tube wall thickness.

(6) Tube hardness and change in hardness during cold working.

(7) Tube O.D. tolerance.

(8) Type of expander used.

(9) Type of torque control or final tube thickness control.

(10) Function of tube joint, i.e., strength in resistance to pulling out, minimum cold work for corrosion purposes, freedom from leaks, ease of replacement, etc.

(11) Length of expanded joint.

(12) Compatibility of tube and tubesheet materials.

E-5.63 TUBE EXPANDING

A suitable tube expander should be used to tighten a leaking tube joint. Care should be taken to insure that tubes are not over expanded. Do not re-expand tubes, which are not leaking. Do not expand tubes beyond 1/8" from the back face of the tubesheet.

E-5.64 TYPICAL COMPUTATION OF TUBE WALL REDUCTION

EXAMPLE OF DETERMINING THE EXPANDED TUBE INSIDE DIAMETER FOR A SPECIFIED AMOUNT OF WALL REDUCTION

GIVEN:	TUBE DIAMETER	=	0.750
	TUBE HOLE DIAMETER	=	0.760
	TUBE WALL THICKNESS	=	0.065
	SPECIFIED WALL REDUCTION	=	5%
SOLUTION:	WALL REDUCTION	=	0.065 x 0.05 = 0.00325
	FINAL WALL THICKNESS	=	0.065 – 0.00325 = 0.06175
	FINAL EXPANDED TUBE I.D.	=	0.760 – 2(0.06175) = 0.6365

CAUTION: *THE USE OF NOMINAL DIMENSIONS, WITHOUT ATTENTION TO PERMISSIBLE TOLERANCES CAN LEAD TO INCORRECT CONCLUSIONS.*

EXPANDING PROCEDURES SHOULD BE BASED ON MEASURED DIMENSIONS, NOT NOMINAL DIMENSIONS.

E-5.65 PLUGGING TUBES IN TUBE BUNDLES

In U-tube heat exchangers, and other exchangers of special design, it may not be feasible to remove and replace defective tubes. Defective tubes may be plugged using commercially available tapered plugs with ferrules or tapered only plugs, which may or may not be seal welded. Excessive tube plugging may result in reduced thermal performance, higher-pressure drop, and/or mechanical damage.

E-5.7 WELDED TUBE JOINTS

Welding procedure and testing techniques for either seal welded or strength welded tube joints normally are by agreement between manufacturer and purchaser and therefore should be considered prior to welded tube joints or tube replacements.

E-5.8 END FLANGES AND BOLTING

The purpose of this section is to alert the users, and provide basic data for consideration in assembly and maintenance of bolted flanged joints. Controlling the torque applied in tightening threaded bolts is the most economical and commonly used method for the control of initial tension. There are several factors, which affect the relationship between torque and tension of threaded bolts. A few of the factors are the type of lubricant and/or plating, if any, used on the threads and the materials from which the bolt and nut are manufactured.

In assembling gasketed joints it is essential that the gasket first be seated uniformly by initial tightening of studs using a staggered quarterly pattern. After the gasket is seated, torquing may be completed stepwise to the final desired value, following a staggered or sequential pattern.

The following may be used as references and aids when assembling bolted flanged joints:

1. Recommended assembly and maintenance of flanged joints as shown in the Crane Company Catalog #60, Engineering Data Section.

2. Torque Control, Sixth Edition, Sturtevant Company.

3. ASME Code, Appendix S.

E-5.9 SPECIAL HIGH PRESSURE CLOSURES

E-5.10 REPAIRS, ALTERATION, RERATING, AND REPLACEMENT PARTS.

In order to maintain the Code integrity of the vessel, any repairs by welding, subsequent heat-treating, alterations, replacement pressure parts, or re-rating must be done in accordance with the National Board Inspection Code.

Potentially toxic or harmful contaminants must be neutralized prior to repairs.

Following repair by welding, post weld heat treatment may be a requirement for preservation of resistance to corrosion.