MANUFACTURER'S DATA BOOK

MISSISSIPPI POWER

DEKALB, MISSISSIPPI

KEMPER COUNTY 1 – IGCC PROJECT

P.O. NO: 17496-0001

REQ. NO: MC202

ITEM NO: HX0052

WASTEWATER AMMONIA PURIFIER REBOILER

1-15" x 168" NEN EXCHANGER

ENERGY JOB NO: X-7926

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 24SEP12

Energy Exchanger Company
Energy Industrial Park
1844 North Garnett Road/Tulsa, OK 74116-1612
(918) 437-3000/FAX (918) 437-7144

Southern Company Generation **Kemper County**
MM209778 0 Unit 1

ENERGY EXCHANGER COMPANY PO: MPC17496-0001
X-7926-MDB Rev: 0
IGCC - GASIFIER - MULTIPAGE - SHELL AND TUBE HEAT EXCHANGE - WAST

Mississippi Power
Kemper County 1 – IGCC Project
P.O. No: 17496-0001
Req. No: MC202
Item No: HX0052
Energy Job No: X-7926

MANUFACTURER'S DATA BOOK

TABLE OF CONTENTS

SECTION 1

IQS Inspection Services, Inc. Inspection & Expediting Services

117 Cornerstone Ct.
Sapulpa, OK 74066

Richard Duke –Owner
Office: 918-224-7472
Cell: 918-640-7911
Email: rmduke@cox.net

I.Q.S. Work Order 556
Inspection Shipping Release Notice 11-BB

Client:	SOUTHERN CO.	Purchase Order #:	MPC-17645; MPC17496 & MPC- 17497
EWO:	MPC9117.T61401	Supplier:	ENERGY EXCHANGERS
Shop Order #	SO # 7926	Location:	TULSA, OK
Project:	KEMPER COUNTY IGCC UNIT	Supplier Ref. #:	

Item #	Description	Qty Ordered	Qty Released	Balance
	15-168 NEN exchanger TAG # HX0052	1	1	0
	THE UNIT & FINAL DOCUMENTATION ARE COMPLETE			

This does not relieve the Vendor of any responsibility to ensure that the material or equipment meets all contractual requirements. This notice is issued according to IQS' best knowledge, experience, codes and specifications available to us during this inspection. Neither IQS nor any member of its inspection force is to be held liable for the acceptance of or payment for released items, or the default or negligence on the part of the vendors' obligation to supply quality equipment and materials or breach the conditions of his contract with the purchaser. Actual acceptance of equipment/material is predicated on the purchaser's site inspection, operational integrity and the fulfillment of all contractual warranties connected thereto.

Date: 8/4/12
Bill Bronaugh
IQS

SECTION 2

Energy Exchanger Company

HEAT EXCHANGER SPECIFICATION SHEET

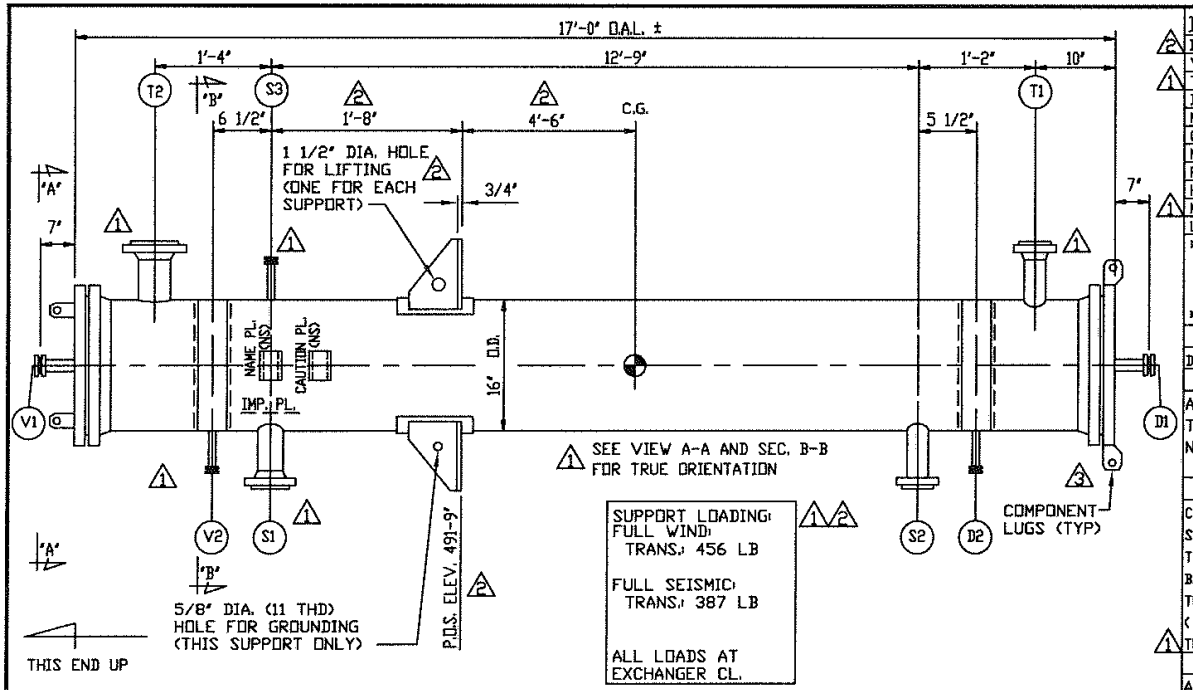
Ref. No.: 17496-0001 (REQ. No.: MC202)
REV. 0 AS PURCHASED

REV	LN #							
2	1							
0	2							
5	3	Customer	SOUTHERN COMPANY SERVICES			Job No.: X-7926 "AS BUILT"		
5	4	Address				Rev.: 5	Date:	7/24/2012
	5	Plant Location	KEMPER COUNTY, MS			File:	10-7309	
	6	Service of Unit	WASTEWATER AMMONIA PURIFIER REBOILER			Item: HX0052		
1	7	Size 15-168	Type NEN	Vert		Connected in 1	Parallel 1	Series
5	8	Surf./Unit ☐ Gross / ☑ Eff	501 ft²; Shells/Unit 1			Surf./Shell ☐ Gross ☑ Eff.	501	ft²
	9	PERFORMANCE OF ONE UNIT						
	10	Fluid Allocation	Shell Side			Tube Side		
	11	Fluid Name	IP STEAM			SOUR WATER		
4	12	Fluid Quantity, Total lb/hr	9547			59161		
4	13	Vapor (In/Out)					8637	
4	14	Liquid				59161	50524	
4	15	Steam	9547					
4	16	Water		9547				
	17	Noncondensable						
3	18	Temperature (In/Out) °F	475.	419.4		304.1	332.62	
3	19	Density (Vapor/Liquid) Lb/Ft³				38.33	0.7730	40.57
3	20	Viscosity cP				0.144	0.0170	0.1303
	21	Molecular Weight						
	22	Molecular Weight, Noncondensable						
3	23	Specific Heat Btu/lb-F				1.1110	0.4710	1.1608
3	24	Thermal Conductivity Btu/hr-ft-F				0.2199	0.0213	0.2489
	25	Latent Heat Btu/lb						
	26	Inlet Pressure psia	310.			297 @ COLUMN BOTTOM		
3	27	Velocity ft/sec	15.35			6.05		
3	28	Pressure Drop, Allow./Calc. psi	5.00 / 0.89			/ 2.1 (2)		
	29	Fouling Resistance (Min.) Hr-Ft-°F/Btu	0.0005			0.002		
3	30	Heat Exchanged	7963000			Btu/hr; M.T.D. (Corrected)	102.64	°F
3	31	Transfer Rate, Service	154.85			Btu/hr-ft²-F; Clean	450.92	Btu/hr-ft²-F
	32	CONSTRUCTION OF ONE SHELL				Sketch (Bundle/Nozzle Orientation)		
	33		Shell Side	Tube Side				
2	34	Design/Test Pressure psig	455 / FV / 595 (4)	320 / 420 (4)				
	35	Design Temperature (Max/Min) °F	515/10	385/10				
	36	No. Passes Per Shell	1	1				
	37	Corrosion Allowance inch	0.125	0.125				
4	38	Connections — In	1 - 4" 300RF	1 - 3" 300RF				
4	39	Size & — Out	1 - 2" 300RF	1 - 6" 300RF				
2	40	Rating — Balance Line	1 - 3/4" 300RF					
4	41	Tube No. 185	OD 0.75	in; Thk. ☑ Min ☐ Avg 0.083	in; Length 14.	ft; Pitch 0.9375	in	30°
0	42	Tube Type	BARE		Material	SA-179		
5	43	Shell SA-106B	☑ ID ☐ OD 15.		in ;Shell Cover N/A		☐ Integ.	☐ Remov.
1	44	Channel or Bonnet	SA-333-6 (PWHT)		Channel Cover	SA-266-4N	☐ Integ.	☑ Remov.
1	45	Tubesheet-Stationary	SA-266-4N		Tubesheet - Floating			
5	46	Floating Head Cover	N/A		Impingement Protection	PLATE ON BUNDLE (SA-36)		
5	47	Baffles-Cross	11 - SA-36	Type H SEG	% Cut (☑ Dia. ☐ Area) 31.	Spacing c/c 13.75	Inlet	In
5	48	Baffles-Long	N/A		Seal Type			
5	49	Supports - Tube	N/A	U-Bend		Type		
5	50	Bypass Seal Arrangement	N/A		Tube-Tubesheet Joint	TWO GROOVES & EXPANDED		
	51	Expansion Joint	NONE		Type			
	52	ρv² - Inlet Nozzle		Bundle Entrance		Bundle Exit		
5	53	Gaskets - Shell Side	N/A		Tube Side	321 SS DJ FLEXIBLE GRAPHITE FILLED		
5	54	- Floating Head	N/A					
1	55	Code Requirements	ASME SECTION VIII, DIV. 1 (STAMP: YES)			TEMA Class	R	
1	56	Weight/Shell	4,300#	Filled With Water	5,500#	Bundle	N/A	
	57	REMARKS						
5	58	(1) DELETED.						
2	59	(2) UNIT IS VERTICAL THERMOSYPHON REBOILER. INLET PIPING EQUIVALENT LENGTH IS 60 FT. OUTLET PIPING EQUIVALENT						
3	60	LENGTH IS 30 FT. LIQUID STATIC HEAD IS 15 FT.						
2	61	(3) APPLY NACE FOR WET H2S SERVICE ON TUBE SIDE.						
2	62	(4) TUBE SIDE IS SUBJECT TO STEAM OUT AT 250°F AND 15 PSIG. STEAM OUT ON THE TUBE SIDE ALONE IS NOT ALLOWED. STEAM OUT						
2	63	SHELL SIDE FIRST WHILE SHELL IS STILL HOT, STEAM OUT TUBE SIDE.						
	64							
	65							

X:\s\x-7926.xls

Mike Dowell 8/7/12

CERTIFIED AS-BUILT



DESIGN DATA	SHELL	TUBE
DESIGN PRESSURE P.S.I.G.	455 *	320 *
VACUUM PRESSURE P.S.I.G.	FV	N/A
TEST PRESSURE P.S.I.G.	595 (SHOP: 600)	420 (SHOP: 425)
DESIGN TEMP. Deg. F.	515	385
M.D.M.T. Deg. F.	10	10
CORROSION ALLOWANCE	1/8"	1/8"
NUMBER OF PASSES	1	1
RADIOGRAPH	NONE	SPOT
HEAT TREAT REQUIRED	NO	YES
MAWP (H&C) P.S.I.G.	455**	320**
LIMITED BY:	FIXED TUBESHEET	FIXED TUBESHEET

* DESIGN PRESSURES ACCOUNT FOR 8 PSI DUE TO STATIC HEAD
ALSO VALIDATED FOR STEAM OUT OF 15 PSIG @ 250°F
STEAM OUT SHELL SIDE FIRST. WHILE SHELL IS STILL HOT, STEAM OUT TUBE SIDE
STEAM OUT OF TUBE SIDE ALONE IS NOT ALLOWED

** MAWP IS AT THE TOP OF THE EXCHANGER

ESTIMATED WEIGHTS, LBS.

DRY: 4300 BUNDLE: NA WET: 5500

SPECIFICATIONS

ASME CODE SECT. VIII DIV.1, 2007 ED. A09 Addn.(STAMP YES)
TEMA CLASS R and API-660 APPLIES
NATIONAL BOARD REGISTRATION REQUIRED

MATERIAL

CHANNEL:	SA-333-6
SHELL:	SA-106-B
TUBESHEETS:	SA-266-4N
BAFFLES:	SA-36
TUBES:	SA-179

(185) 3/4" O.D.X 0.083" (MW) X 14'-0" LG.
TUBE PITCH 15/16" △ 30° SURFACE 501 SQ. FT.

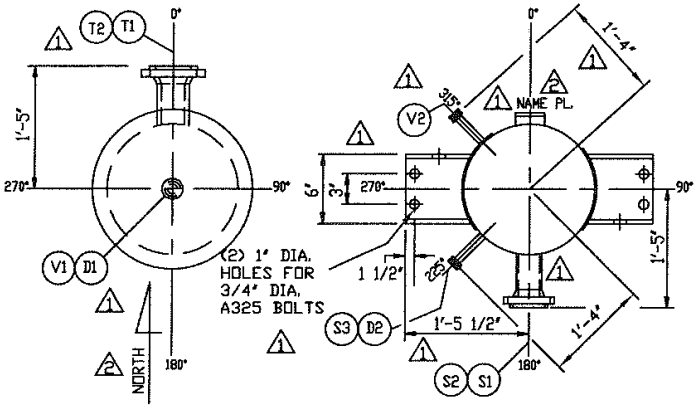
GENERAL NOTES

ALL BOLT HOLES TO STRADDLE NATURAL CENTER LINES.
INSULATION: 2" THK. HC TYPE (BOTH SIDES) (BY OTHERS)
PAINT: SEE PAINT MAP DWG X-7926-AA
GASKETS: 1/8" THK 321 S.S. DJ FLEXIBLE GRAPHITE FILLED
(1) SPARE SET OF GASKETS REQUIRED.
TUBE-TS JOINT: EXPANDED (2 GROOVES)
TUBE SIDE IS IN WET H2S SERVICE, NACE MR0175 APPLIES
NITROGEN PURGE REQUIRED BOTH SIDES FOR TRANSPORT AND STORAGE.

NOZZLE SCHEDULE					
MK	QT	DESCRIPTION		PROCESS	AUXILIARIES
S1	1	4"	300#RF WN	INLET	
S2	1	2"	300#RF LWN	OUTLET	
S3	1	3/4"	300#RF LWN	BAL. LINE	w/ BLIND
D2	1	3/4"	300#RF LWN	DRAIN	w/ BLIND
V2	1	3/4"	300#RF LWN	VENT	w/ BLIND
T1	1	3"	300#RF WN	INLET	
T2	1	6"	300#RF WN	OUTLET	
D1	1	2"	300#RF LWN	DRAIN	w/ BLIND
V1	1	2"	300#RF LWN	VENT	w/ BLIND

CERTIFIED CORRECT FOR FABRICATION
BY: [signature] DATE: 8/7/12

CUST: MISSISSIPPI POWER CO.
c/o SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ. NO: MC202
ITEM NO: HX0052
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
SHIP TO: KEMPER CO., MS



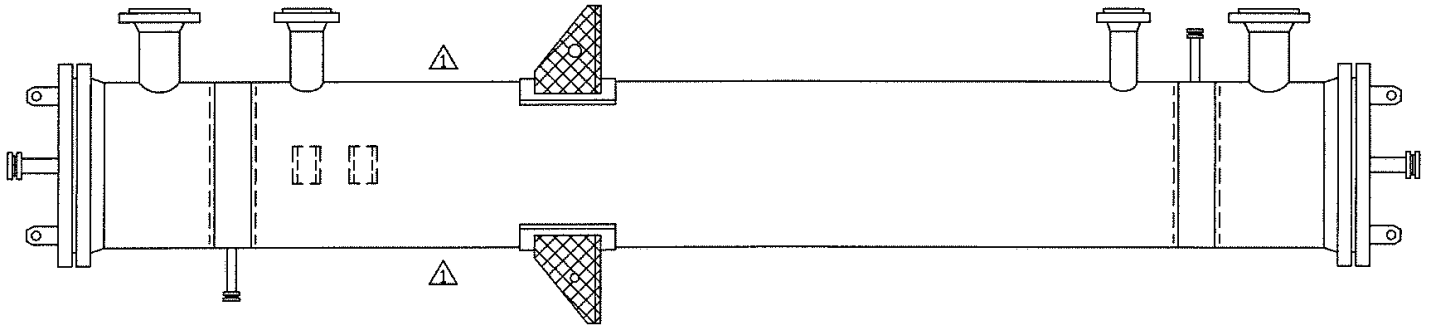
NO.	DATE	REVISIONS	
4	8/7/12	ADD NIT. PURGE NOTE	DM/MD
3	5/31/12	BTTM. CHAN. CVR. LUGS	MD/SG
2	6-23-11	REV'D PER CUST.	WE/DN
1	4-8-11	REV'D PER CUST.	DN/DM

ASSEMBLY AND SPECIFICATIONS FOR
ONE (1) 15-168 N E N

Energy Exchanger Co.
3044 No. Garnett Rd. - Tulsa, Okla. 74116

DWN. BY	MD
DATE	3/7/11
CKD. BY	DN
DWG. NO.	X-7926-A
REV	4

Kemper County MM209778



COATING DATA SHEET - SYSTEM 5 APPLIES.
ABRASIVE BLAST PER SSPC-SP10 WITH AN ANCHOR PROFILE OF 1 TO 2 MILS.
PAINT WITH AMERON , PPG AMERCOTE, DIMETCOTE 9 or 9HS (3.0-4.0 MILS DFT)

COATING DATA SHEET - SYSTEM 3 APPLIES.
ABRASIVE BLAST PER SSPC-SP10 WITH AN ANCHOR PROFILE OF 1 TO 2 MILS.
PAINT WITH AMERON, PPG AMERCOTE, DIMETCOTE 9 or 9HS (2.0-3.0 MILS DFT)
FINISH WITH AMERON, PPG AMERCOTE, PSX 892HS (1.0-2.0 MILS DFT) (COLOR: ALUMINUM)

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

NOTES:
1. A DAILY INSPECTION REPORT SHALL BE MAINTAINED.
2. PAINT SPECIFICATION V42-1TS AND APPLICABLE COATING DATA SHEET SHALL BE BE FURNISHED TO THE PAINTER.

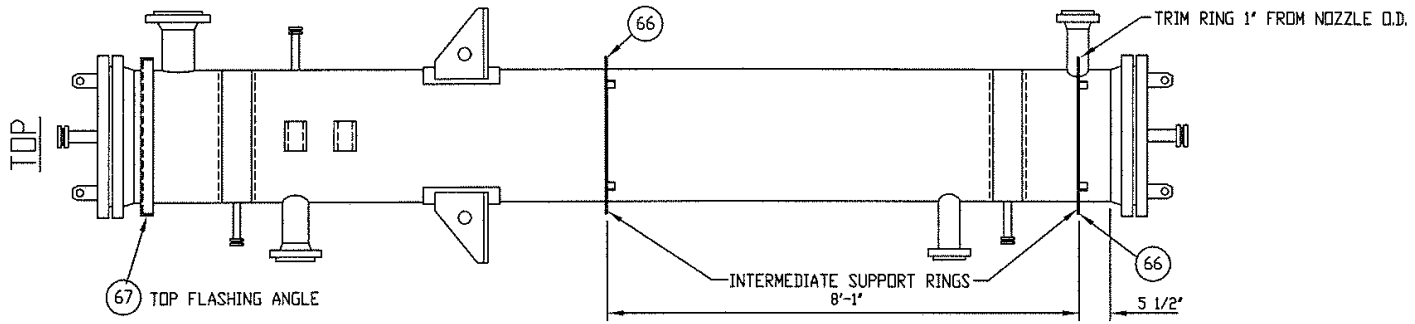
NO.	DATE	REVISIONS
1	6-23-11	REV'D PER CUST. WE/DN

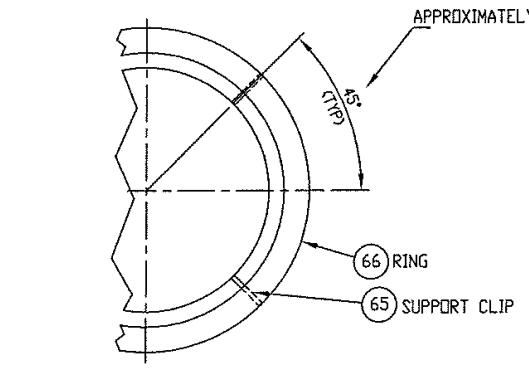
PAINT MAP

DWN. BY S. MIANO
DATE 4-21-11
CKD. BY DM

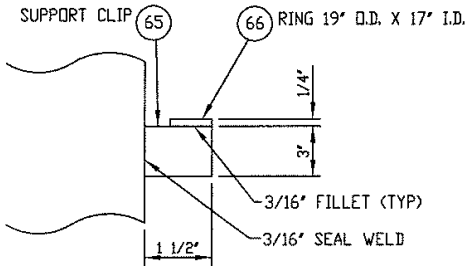
Energy Exchanger Co.
1044 No. Garnett Rd. - Tulsa, Okla. 74116

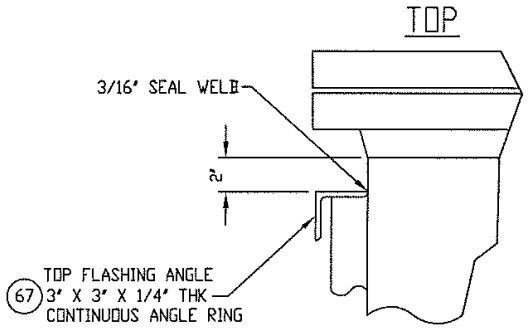
DWG. NO. X-7926-AA
REV 1





INTERMEDIATE SUPPORT RINGS





TOP FLASHING ANGLE

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

NO.	DATE	REVISIONS

INSULATION SUPPORT DETAILS

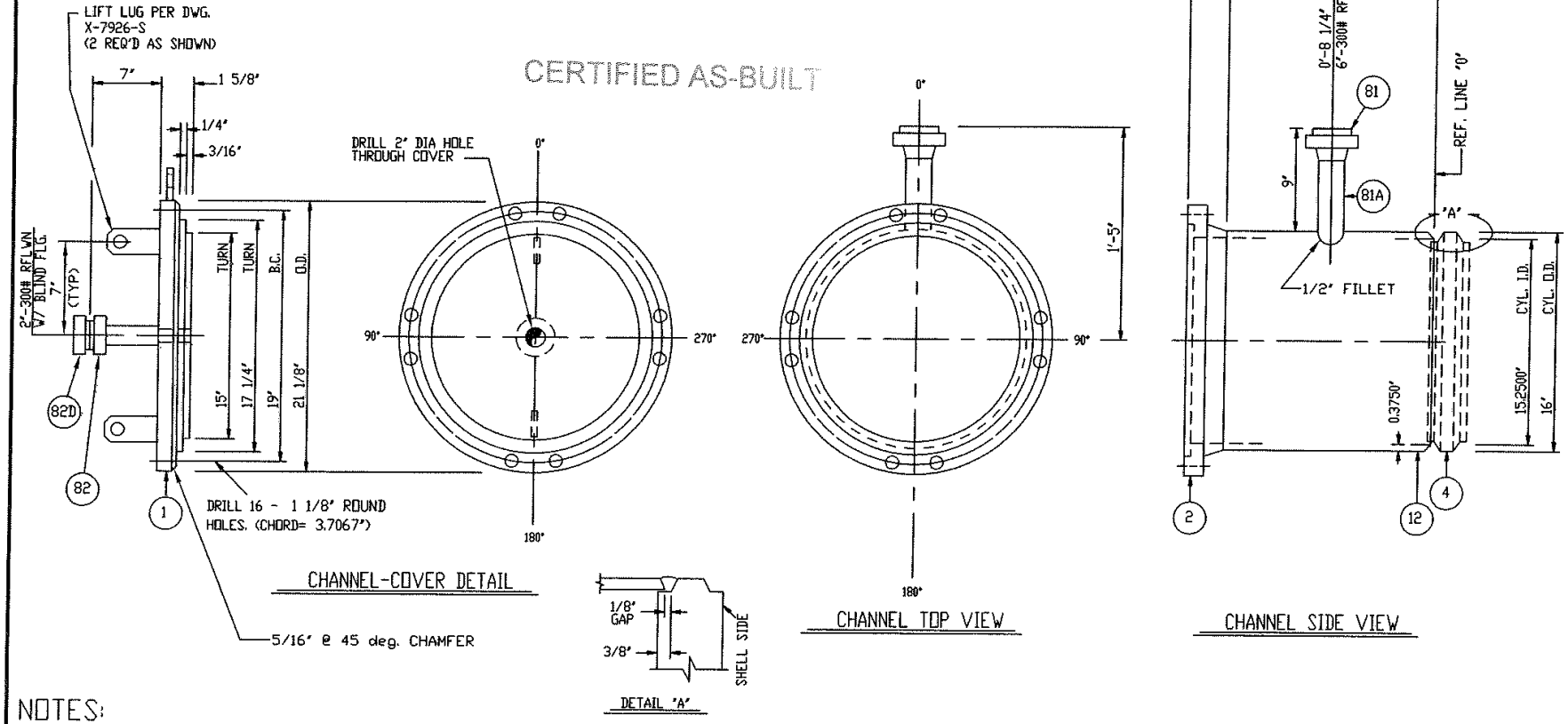
DWN. BY D.MORRISON
DATE 8-17-11
CKD. BY MA

Energy Exchanger Co.
1844 No. Garnett Rd. • Tulsa, Okla. 74116

DWG. NO. X-7926-AB
REV 0

COVER NOTES:
1) MACHINE ALL COVER SURFACES TO 250 Ra
EXCEPT GASKET FACE TO BE 125 Ra.

FOR FLANGE DETAILS SEE DWG. X-7926-K



NOTES:
1) ALL BOLT HOLES TO STRADDLE CENTER LINES.
2) FOR WELD AND BEVEL DETAILS SEE DWG. X-7926-S
3) FOR JOB NOTES SEE DWG. X-7926-R
4) NOZZLE SWING DIMENSION = 36 1/8"

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

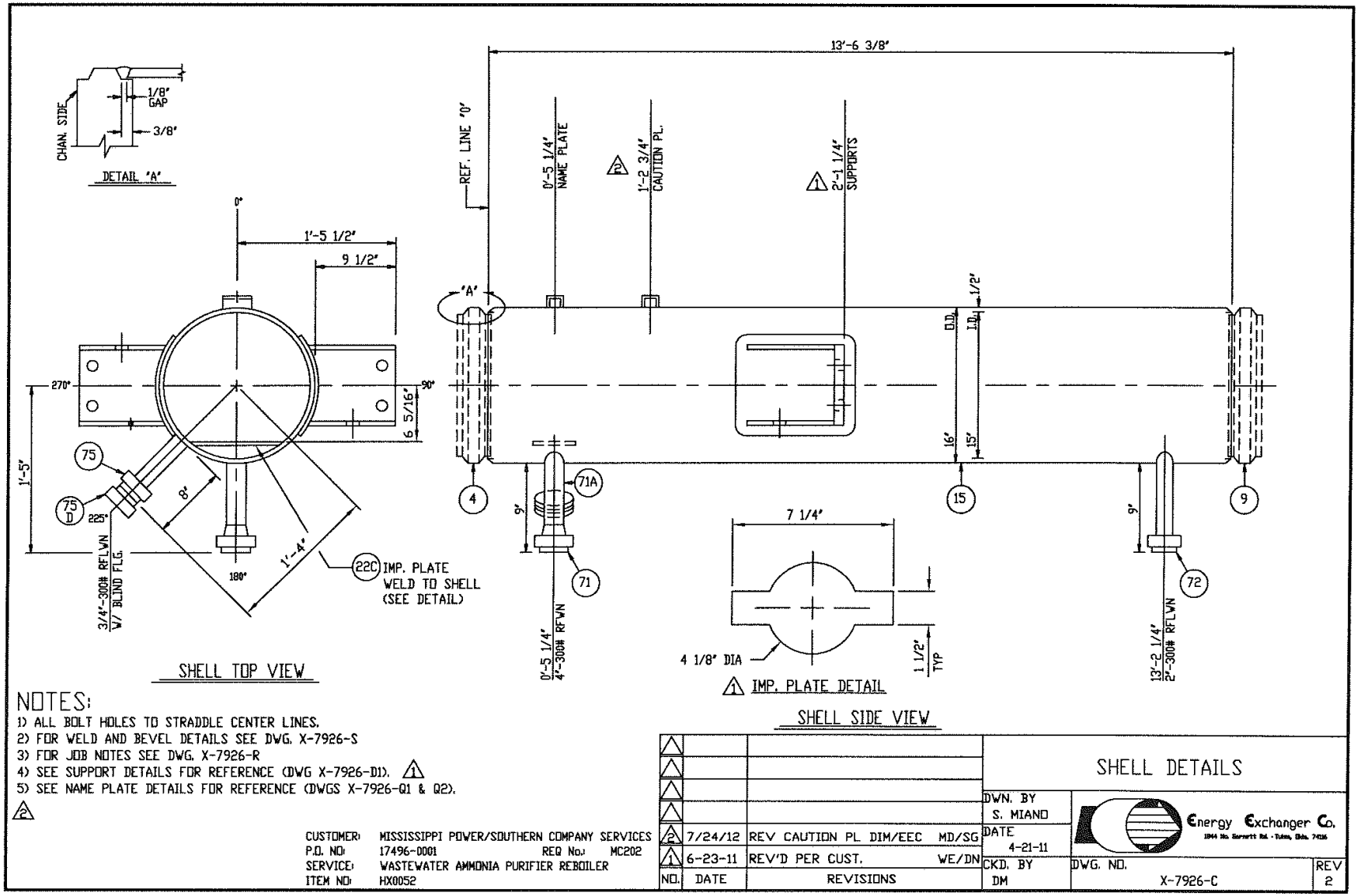
NO.	DATE	REVISIONS

TOP CHANNEL DETAILS

DWN. BY S. MIANO
DATE 4-21-11
CKD. BY

Energy Exchanger Co.
1844 No. Garnett Rd. - Tulsa, Okla. 74116

DWG. NO. X-7926-B
REV 0



NOTES:

1) ALL BOLT HOLES TO STRADDLE CENTER LINES.
2) FOR WELD AND BEVEL DETAILS SEE DWG. X-7926-S
3) FOR JOB NOTES SEE DWG. X-7926-R
4) SEE SUPPORT DETAILS FOR REFERENCE (DWG X-7926-D1). 1
5) SEE NAME PLATE DETAILS FOR REFERENCE (DWGS X-7926-Q1 & Q2).

2

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

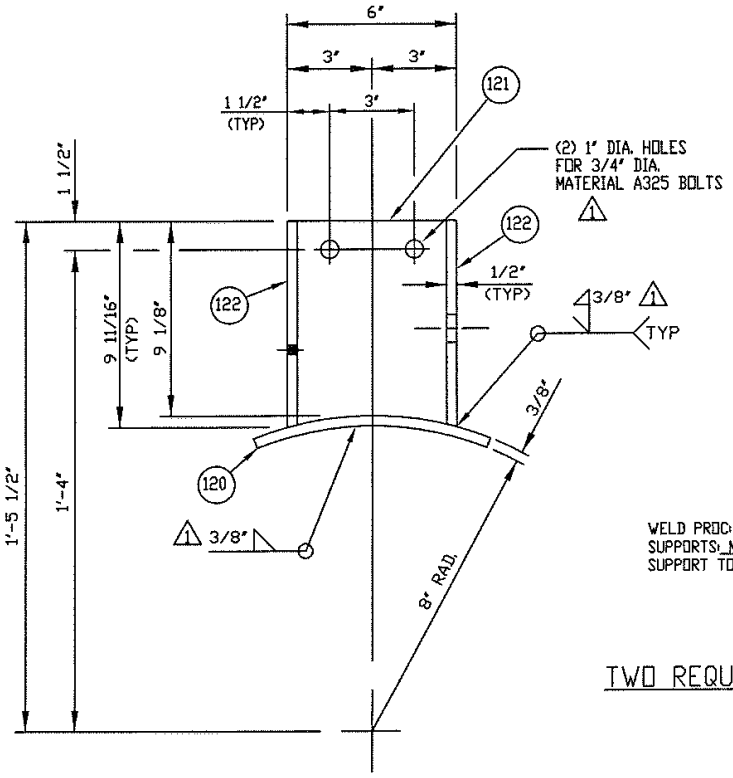
NO.	DATE	REVISIONS
2	7/24/12	REV CAUTION PL DIM/EEC MD/SG
1	6-23-11	REV'D PER CUST. WE/DN

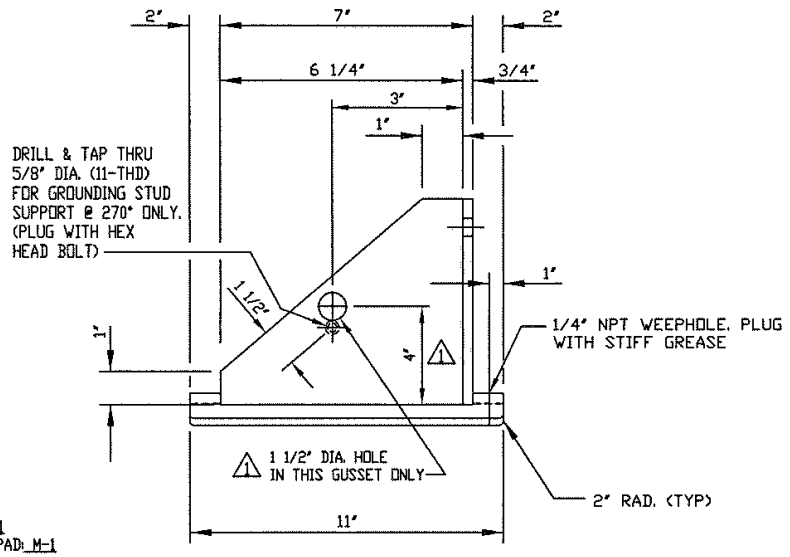
SHELL DETAILS

DWN. BY S. MIAND
DATE 4-21-11
CKD. BY DM

Energy Exchanger Co.
1944 No. Harvard Rd. - Tulsa, Okla. 74115

DWG. NO. X-7926-C
REV 2





WELD PROC:
SUPPORTS: M-1
SUPPORT TO PAD: M-1

TWO REQUIRED

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

NOTE:
1. SEE DWG. X-7926-R FOR JOB NOTES.
2. SEE DWG. X-7926-A FOR ORIENTATION.

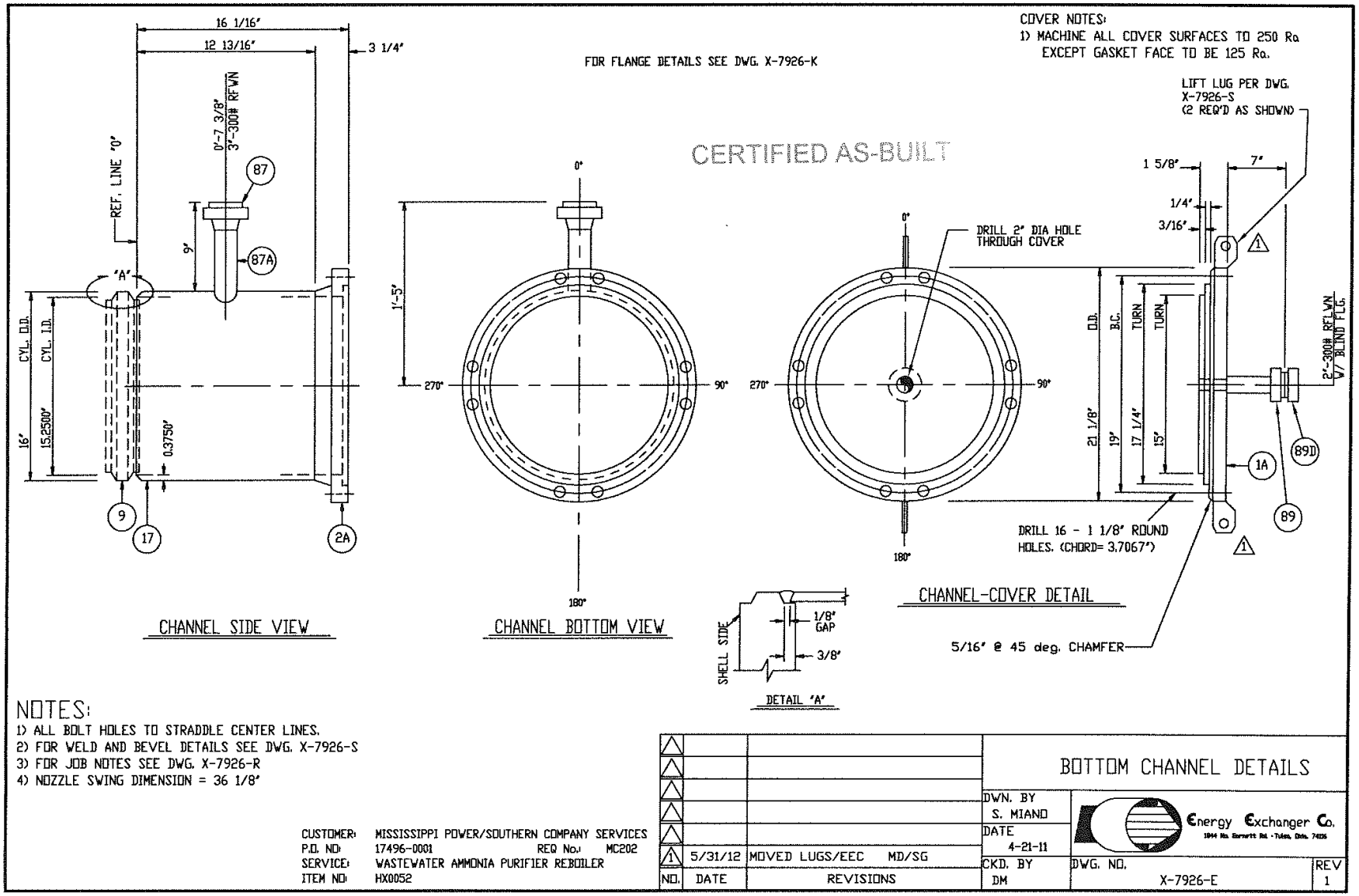
NO.	DATE	REVISIONS
1	6-23-11	REV'D PER CUST. WE/AJ

SUPPORT DETAILS

DWN. BY: S. MIANO
DATE: 4-21-11
CKD. BY: DM

Energy Exchanger Co.
1044 No. Garnett Rd. • Tulsa, Okla. 74116

DWG. NO.: X-7926-D1
REV: 1



NOTES:

1) ALL BOLT HOLES TO STRADDLE CENTER LINES.
2) FOR WELD AND BEVEL DETAILS SEE DWG. X-7926-S
3) FOR JOB NOTES SEE DWG. X-7926-R
4) NOZZLE SWING DIMENSION = 36 1/8"

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

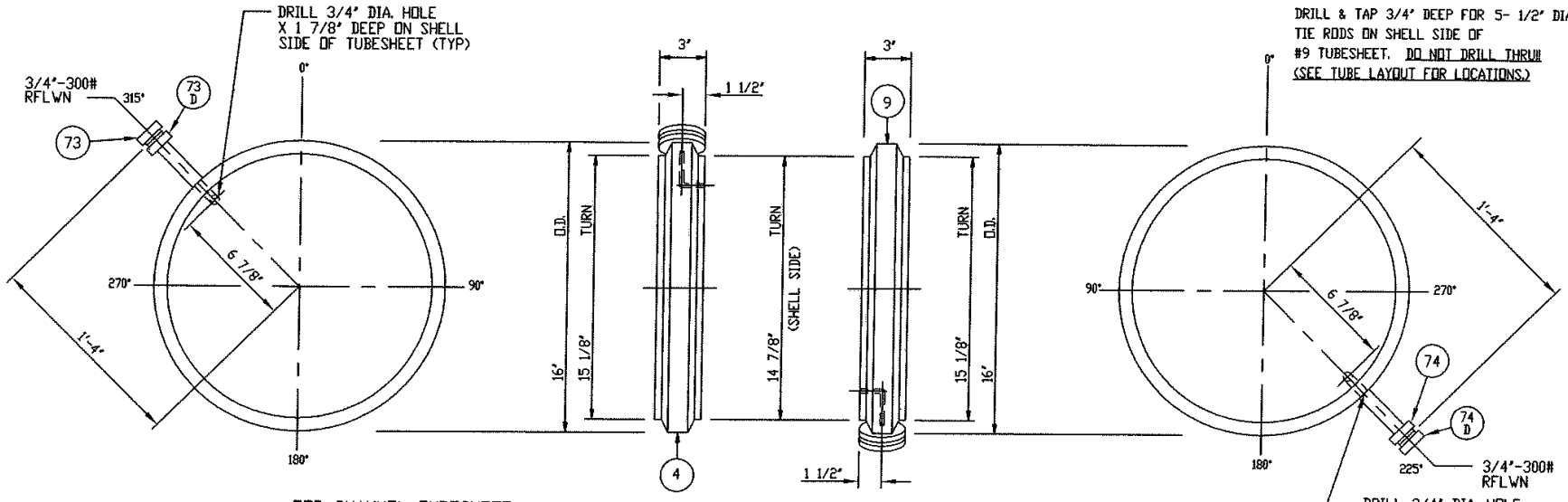
NO.	DATE	REVISIONS
1	5/31/12	MOVED LUGS/EEC MD/SG

BOTTOM CHANNEL DETAILS

DWN. BY: S. MIAND
DATE: 4-21-11
CKD. BY: DM

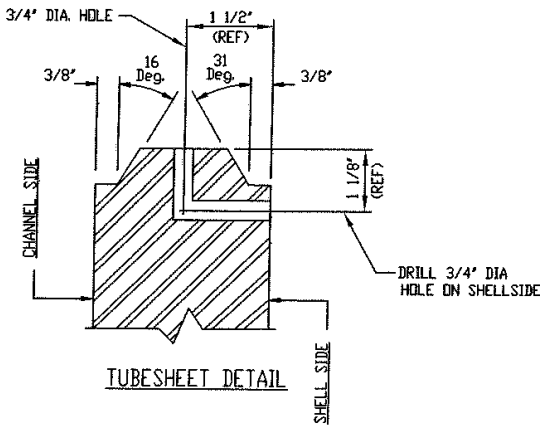
Energy Exchanger Co.
1944 No. Harvard Rd. · Tulsa, Okla. 74115

DWG. NO. X-7926-E
REV 1

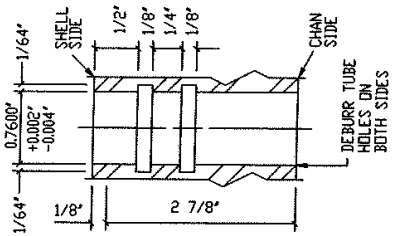


TOP CHANNEL TUBESHEET

BOTTOM CHANNEL TUBESHEET



TUBESHEET DETAIL



TUBE HOLE GROOVING DETAIL

NOTES:

1) MACHINE ALL SURFACES TO 250 Ra EXCEPT GASKET FACE TO BE 125 Ra.
2) FOR JOB NOTES SEE DWG. X-7926-R
3) FOR WELD AND BEVEL DETAILS SEE DWG. X-7926-S.

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

CERTIFIED AS-BUILT

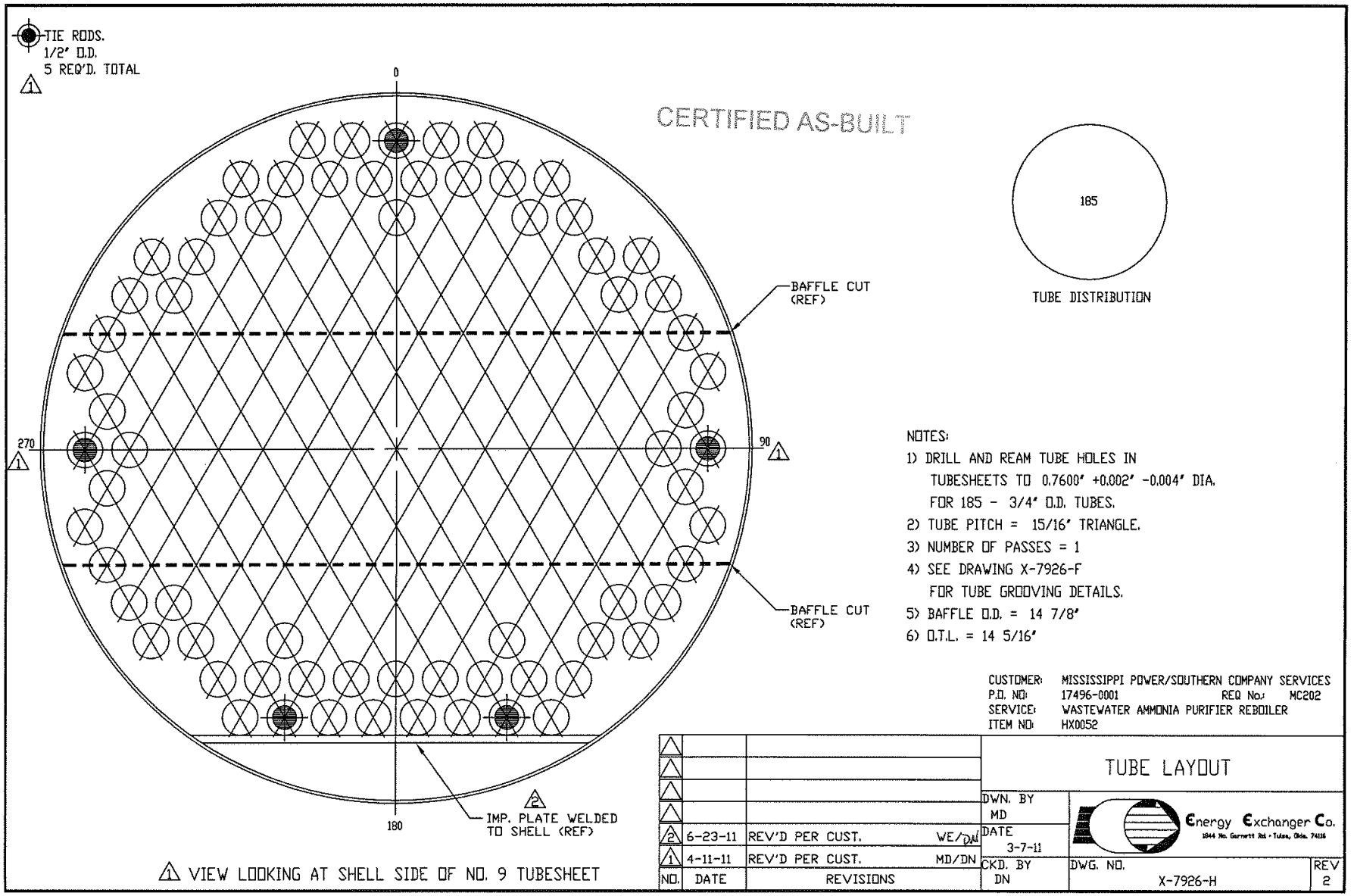
NO.	DATE	REVISIONS

TUBESHEET DETAILS

DWN. BY: S. MIAND
DATE: 4-21-11
CKD. BY:

Energy Exchanger Co.
1844 No. Garnett Rd. • Tulsa, Okla. 74116

DWG. NO. X-7926-F
REV 0



NOTES:

1) DRILL AND REAM TUBE HOLES IN TUBESHEETS TO 0.7600" +0.002" -0.004" DIA. FOR 185 - 3/4" O.D. TUBES.
2) TUBE PITCH = 15/16" TRIANGLE.
3) NUMBER OF PASSES = 1
4) SEE DRAWING X-7926-F FOR TUBE GROOVING DETAILS.
5) BAFFLE O.D. = 14 7/8"
6) O.T.L. = 14 5/16"

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

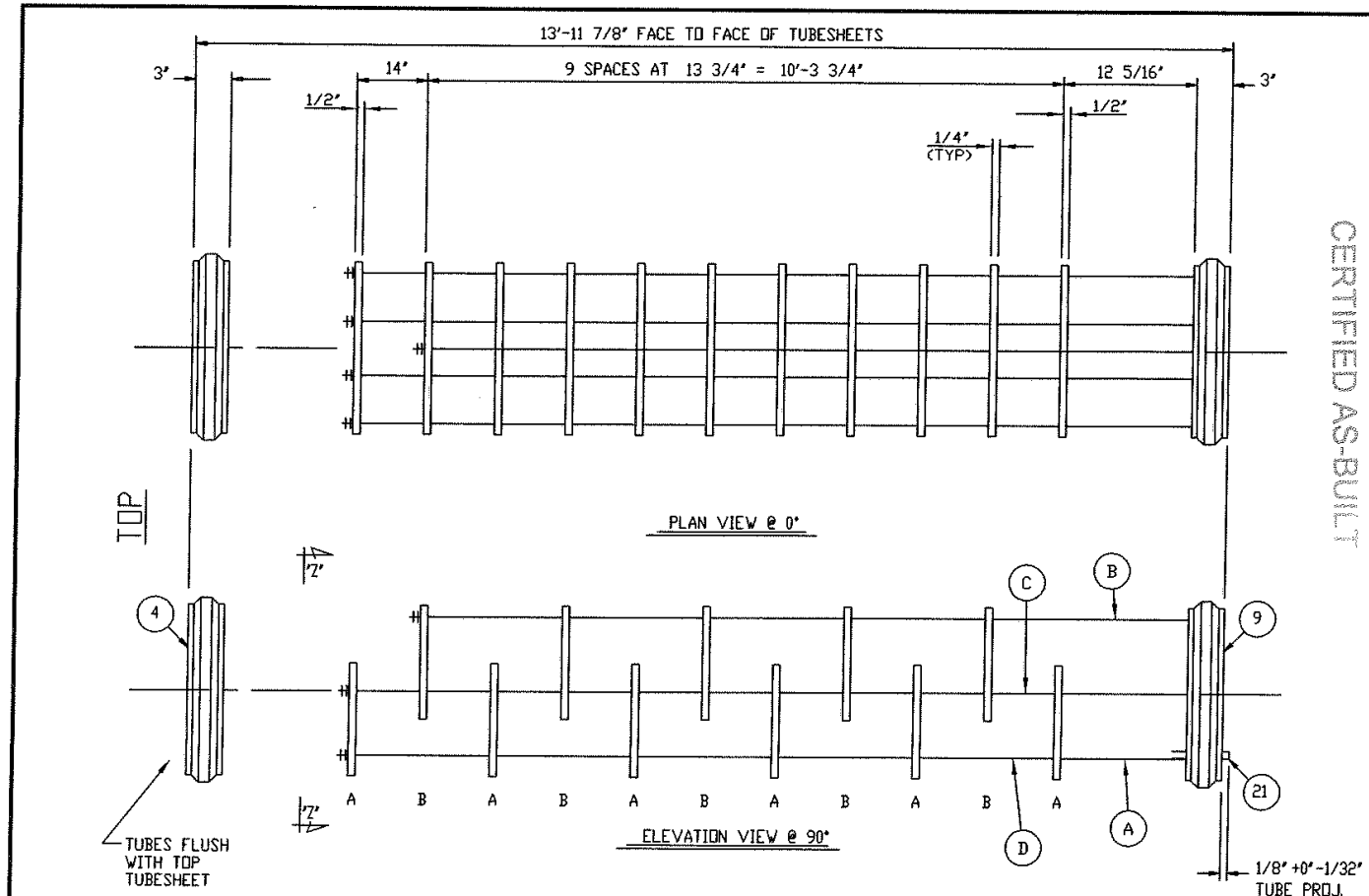
NO.	DATE	REVISIONS	
2	6-23-11	REV'D PER CUST.	WE/DN
1	4-11-11	REV'D PER CUST.	MD/DN

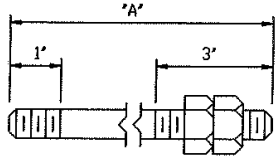
TUBE LAYOUT

DWN. BY: MD
DATE: 3-7-11
CKD. BY: DN

Energy Exchanger Co.
1844 No. Garnett Rd. • Tulsa, Okla. 74116

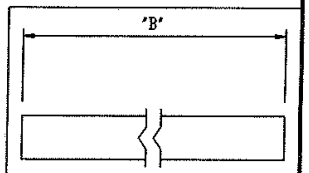
DWG. NO. X-7926-H
REV 2





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

	REQ'D.	"A"
R1	1	11'-6 3/8"
R2	4	12'-8 3/8"
R3		
R4		



3/4" O.D. SPACER TUBING (23A)

	REQ'D.	"B"
A	4	11 13/16"
B	1	25 9/16"
C	20	13 1/2"
D	14	27 1/4"
E		
F		
G		

NOTES:
1) FOR SECTION AND VIEW DETAILS SEE DWG. X-7926-J
2) FOR JOB NOTES SEE DWG. X-7926-R

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

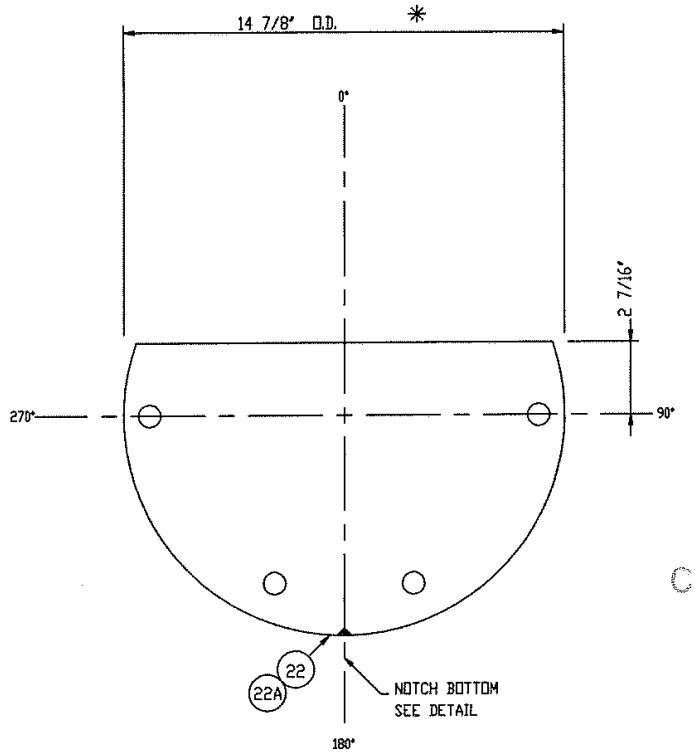
NO.	DATE	REVISIONS

BUNDLE DETAILS

DWN. BY S. MIAND
DATE 4-21-11
CKD. BY

Energy Exchanger Co.
1844 No. Garnett Rd. - Tulsa, Okla. 74116

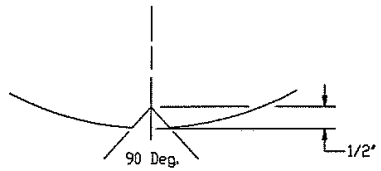
DWG. NO. X-7926-I
REV 0



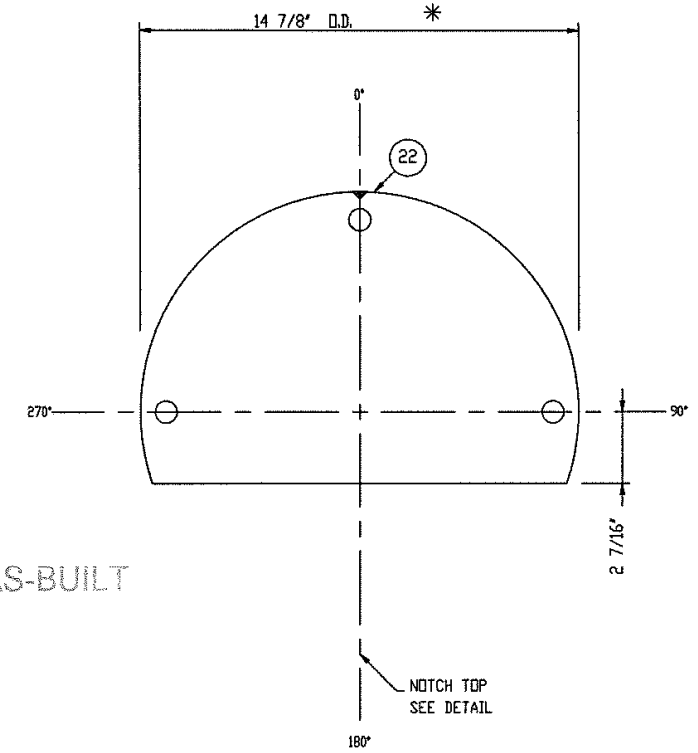
VIEW ZZ OF BAFFLES

4-REQ'D. CUT A (1/4" THK.)

2-REQ'D. CUT A (1/2" THK.)



NOTCH DETAIL



VIEW ZZ OF BAFFLES

1/4" THK.

5-REQ'D. CUT B

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

NOTES:

1) FOR JOB NOTES SEE DWG. X-7926-R
2) DRILL TUBE HOLES IN BAFFLES 25/32" DIA. & DEBURR.
3) DRILL TIE ROD HOLES 9/16" DIA.
   SEE TUBE LAYOUT FOR LOCATION (DWG. X-7926-H). 1
4) RADIUS ALL CORNERS ON BAFFLE CUTS.
* 5) CHECK SHELL I.D. BEFORE MACHINING BAFFLE O.D.
6) MACHINE O.D. OF BAFFLES TO 250 Ra.
7) SEE TUBE LAYOUT FOR BAFFLE CUT LOCATIONS (DWG X-7926-H). 1

NO.	DATE	REVISIONS
1	6-23-11	REV'D PER CUST. WE/

BAFFLE DETAILS

DWN. BY: S. MIANO
DATE: 4-21-11
CKD. BY: DM

Energy Exchanger Co.
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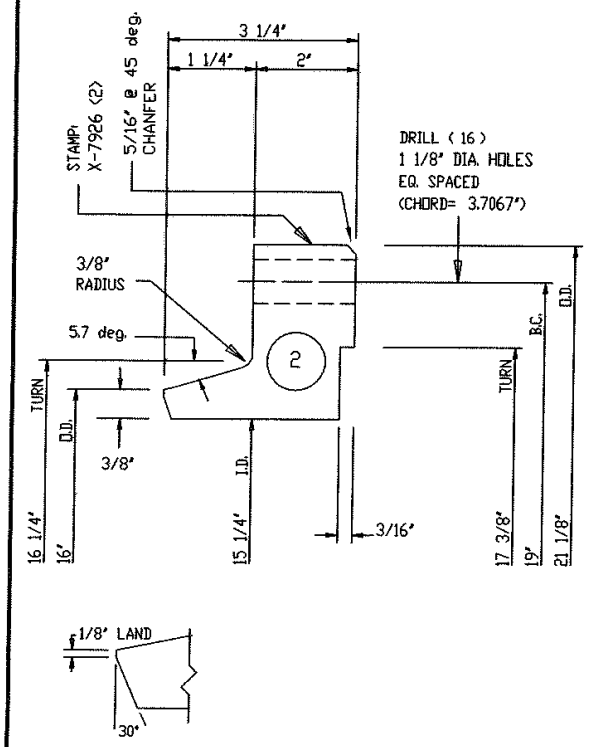
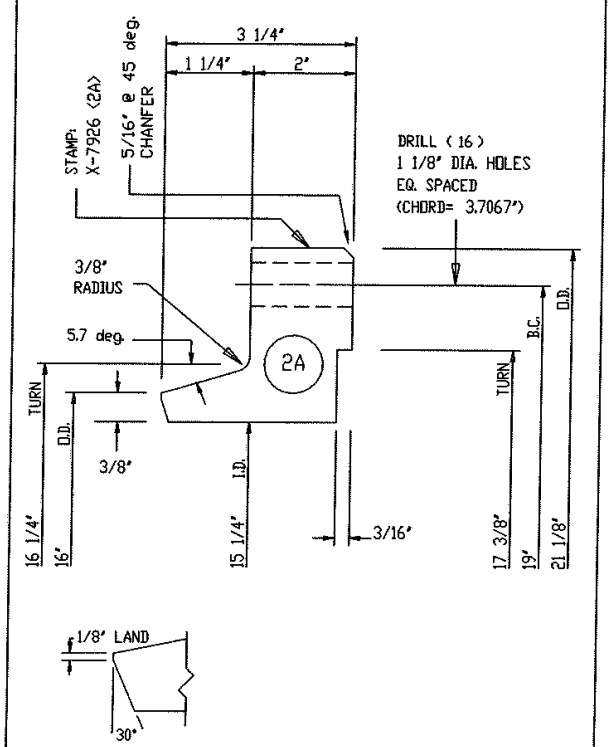
DWG. NO.: X-7926-J
REV: 1



#2 GIRTH FLANGE (ONE) REQ'D.



#2A GIRTH FLANGE (ONE) REQ'D.

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

NOTES:

1) SEE DWG. X-7926-R FOR JOB NOTES.
2) MACHINE ALL SURFACES TO 250 Ra EXCEPT GASKET SURFACES MACHINE TO 125-250 Ra.

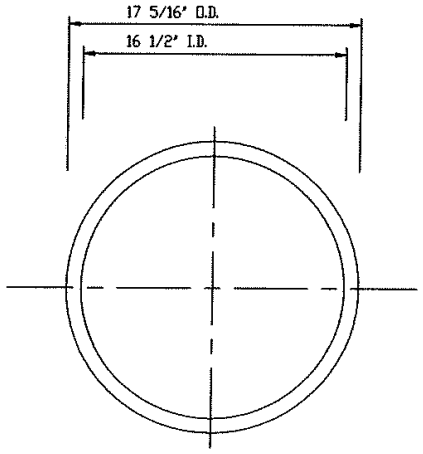
NO.	DATE	REVISIONS

GIRTH FLANGES

DWN. BY S. MIAND
DATE 4-21-11
CKD. BY

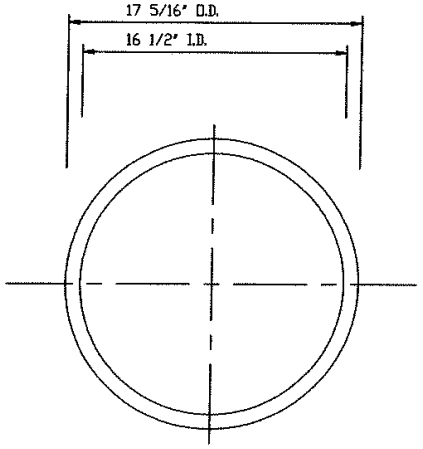
Energy Exchanger Co.
1844 No. Garnett Rd. - Tulsa, Okla. 74116

DWG. NO. X-7926-K
REV 0



(1)-REQUIRED.
TOP CHANNEL COVER GASKET
1/8" THK. 321 STN. STL. D.J.
FLEXIBLE GRAPHITE FILLED

CERTIFIED AS-BUILT



(1)-REQUIRED.
BOTTOM CHANNEL COVER GASKET
1/8" THK. 321 STN. STL. D.J.
FLEXIBLE GRAPHITE FILLED

NOTES:

1) QUANTITIES SHOWN FOR ONE SET
(2)-SETS REQUIRED TOTAL.
ONE SET OF GASKETS TO BE USED IN EXCH. AND
(1) SET TO BE BOXED, MARKED WITH
P.O. & ITEM NO. & SHIPPED WITH EXCHANGER.

2) ALL JACKETED GASKETS TO HAVE
LAP OF GASKET NEAR SIDE.

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

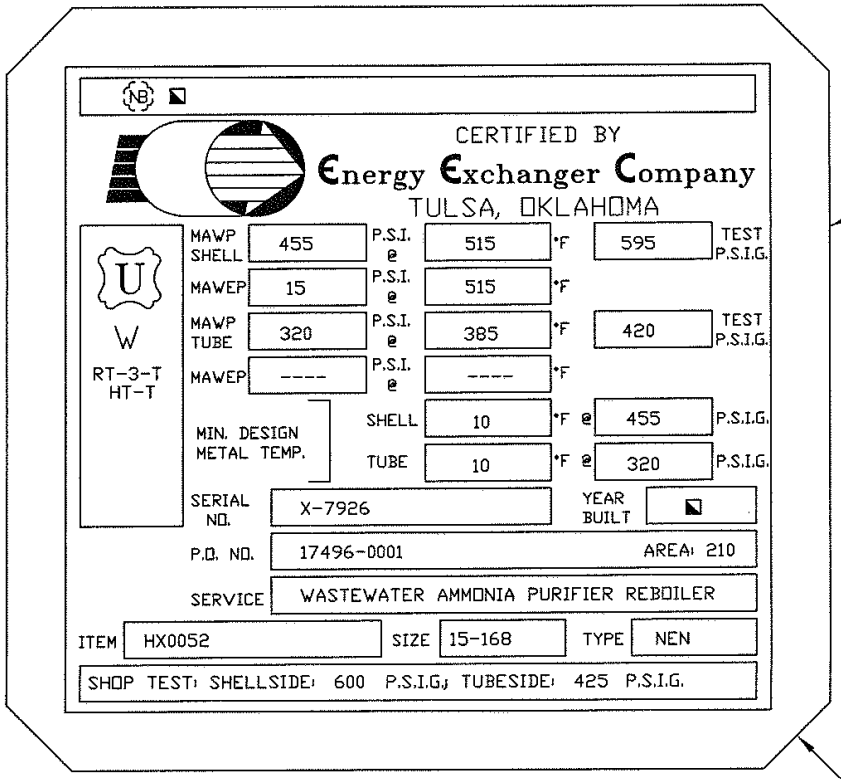
NO.	DATE	REVISIONS
1		
2		
3		
4		
5		
6		

GASKET DETAILS

DWN. BY S. MIANO
DATE 4-21-11
CKD. BY

Energy Exchanger Co.
1844 No. Garnett Rd. - Tulsa, Okla. 74116

DWG. NO. X-7926-0
REV 0



NAME PLATE DETAIL

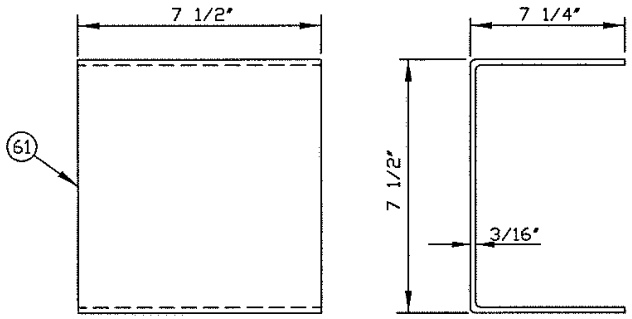
ONE - REQ'D.

SHOP TO ASSIGN AT COMPLETION OF FABRICATION

60

1

CLIP CORNERS & SEAL WELD TO NAME PLATE BRACKET



NAME PLATE BRACKET DETAIL

ONE - REQ'D.

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

NO.	DATE	REVISIONS
1	6-23-11	REV'D PER CUST. WE/DM

NAME PLATE DETAILS

DWN. BY S. MIANO
DATE 4-21-11
CKD. BY DM
DWG. NO. X-7926-Q1
REV 1

Energy Exchanger Co.
1844 No. Garnett Rd. - Tulsa, Okla. 74116

CLIP CORNERS & SEAL WELD
TO NAME PLATE BRACKET

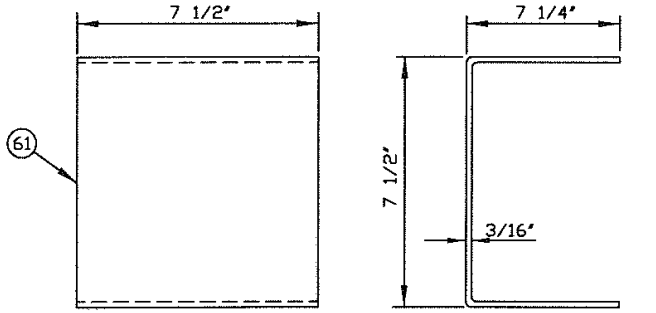
CAUTION

PRESSURES AND TEMPERATURES SHOWN ON THE NAMEPLATE OF THIS HEAT EXCHANGER RELATE ONLY TO PRESSURE RETAINING CAPABILITY. CERTAIN COMPONENTS HAVE BEEN DESIGNED FOR SPECIFIC OPERATING CONDITIONS. DEVIATION FROM THESE CONDITIONS OR A CHANGE IN SERVICE REQUIRE A MECHANICAL DESIGN CHECK BE PERFORMED TO AVOID POSSIBLE DAMAGE TO THE HEAT EXCHANGER OR DANGER TO PERSONNEL.

(60) USE BACK SIDE OF EEC NAME PLATE.
SPLIT IN HALF TO MAKE BOTH NAME PLATES
(FIT BOTH ON SAME BRACKET)

CAUTION PLATE DETAIL

ONE - REQ'D.



CAUTION/WARNING PLATE BRACKET DETAIL

ONE - REQ'D.

WARNING

FIXED TUBESHEET HEAT EXCHANGER
INTRODUCE SHELL SIDE FIRST BEFORE INTRODUCING TUBE SIDE

STEAMOUT TUBE SIDE ALONE IS NOT ALLOWED FOR THIS UNIT.
STEAMOUT SHELL SIDE FIRST, WHILE SHELL SIDE IS HOT
STEAMOUT TUBE SIDE.

(1)

CLIP CORNERS & SEAL WELD
TO NAME PLATE BRACKET

WARNING PLATE DETAIL

ONE - REQ'D.

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

NO.	DATE	REVISIONS
1	7-30-12	REV PER EEC DM/

CAUTION AND WARNING PLATE DETAILS

DWN. BY S. MIAND
DATE 4-21-11
CKD. BY DM

Energy Exchanger Co.
3044 Mt. Everett Rd. - Tulsa, Okla. 74116

DWG. NO. X-7926-02
REV 1

FABRICATION REQUIREMENTS

1. ALL BOLT HOLES TO STRADDLE NATURAL CENTER LINES.
2. NOZZLES SHALL NOT PROTRUDE BEYOND THE INSIDE SURFACE OF THE CHANNEL OR SHELL.
3. CHECK SHELL FOR OUT-OF-ROUNDNESS. USE TWO DISCS EQUAL THE BAFFLE DIA. MOUNTED ON A SHAFT 18" APART.
4. FLANGE FLATNESS TOLERANCE AND SURFACE FINISH SHALL BE MEASURED AFTER THE FLANGE HAS BEEN WELDED & PWHT.
5. CHANNEL COVER, AND BODY FLANGE PERIPHERAL GASKET SURFACES SHALL HAVE A FLATNESS TOLERANCE OF 1/32" AND MEASURED WITH A DIAL GUAGE.

△2

6. ALL FLAME-CUT BEVEL WELDS SHALL BE GROUND TO BRIGHT METAL PRIOR TO WELDING.
7. MATCH MARKS REQUIRED ON CHANNEL COVER AND ALL TEMA FLGS. WITH A SCRIBED LINE 1/8" DEEP AT THE 90° AND 270° POSITIONS.
8. THE FOLLOWING PARTS SHALL BE STAMPED WITH MANUFACTURER'S SERIAL NUMBER & ITEM NUMBER: CHANNEL FLANGE, CHANNEL COVER.
9. TUBESHEET AND TUBE HOLES SHALL BE CLEANED AND DEGREASED IMMEDIATELY PRIOR TO ASSEMBLY WITH A CHLORIDE FREE SOLVENT.
10. PRIOR TO ASSEMBLY, ALL INTERNALS SHALL BE CLEAN AND FREE OF LOOSE SLAG, SCALE OR OTHER DEBRIS.
11. ANY WELD DEFECTS SHALL HAVE THE DEFECT REMOVED AND CONFIRMED IF ORIGINALLY RT, THEN RT REPAIR AND ALSO MT. △2
12. WELD JOINT SURFACES AND A MINIMUM OF 1" OF THE INTERNAL AND EXTERNAL SURFACES OF THE ADJACENT BASE METAL SHALL BE CLEAN AND FREE FROM PAINT, OIL, DIRT, SCALE, OXIDES, AND OTHER FORIEGN MATERIAL DETRIMENTAL TO THE INTEGRITY OF THE WELD.

△1 13. ALL DIMENSIONS TO BE HELD IN TEMA TOLERANCE.

M.T. REQUIREMENTS

△2 1. MT ALL CHANNEL WELDS AFTER PWHT.

△2 2. MT ALL LIFTING LUG WELDS

△2 4. TEMPORARY ATTACHMENT WELDS SHALL BE REMOVED, THE AREAS DRESSED, AND EXAMINED.

△2

HEAT TREAT REQUIREMENTS

TOP CHANNEL, BOTTOM CHANNEL AND TUBESHEETS:

A) HEAT FROM 800 deg.F TO 1150 deg.F ±25 deg. F. AT 400 deg.F PER HOUR.
B) HOLD AT 1150 deg.F ±25 deg. F. FOR 1.00 -HOUR (MIN).
C) COOL FROM 1150 deg.F TO 800 deg.F AT 500 deg.F PER HOUR.
D) FURTHER COOLING MAY BE IN STILL AIR.

ALL MACHINED CONTACT SURFACES AND THREADED CONNECTIONS SHALL BE SUITABLY PROTECTED TO PREVENT SCALING OR LOSS OF FINISH DURING PWHT.

R.T. REQUIREMENTS

1. TUBESIDE: SPOT RADIOGRAPHED.
   AS A MINIMUM, SPOT RADIOGRAPH SHALL BE AS FOLLOWS:
   A) ONE SPOT AT EACH CATEGORY A AND B WELDED JOINT. (NOZZLE WELDS EXEMPT)
   B) AT EACH START AND STOP OF WELDS MADE BY AUTOMATIC SUBMERGED-ARC PROCESS.
   C) SPOTS SHALL BE AT LEAST 10" LG. OR FULL LENGTH IF WELD IS LESS THAN 10".
   D) WELD POROSITY LIMITS FOR SPOT RADIOGRAPHS SHALL BE SAME AS LIMITS FOR FULL RADIOGRAPHED JOINTS.
   E) RT EACH WELD PROCEDURE, WELDER/OPERATOR, & SHIFT.
2. SHELLSIDE : NO RADIOGRAPH
3. RT FILM SHALL BE FINE GRAIN, HD, HIGH CONTRAST FILM (KODAK TYPE AA OR EQUAL) FILM DENSITY OF 2.0-3.5 DETERMINED BY SPECIMEN OR DENSITOMETER.

△2

HARDNESS REQUIREMENTS

1. WELD HARDNESS TESTING, SHALL BE IN ACCORDANCE WITH THE FOLLOWING:
   A) THE WELD METAL & HAZ OF PRESSURE-RETAINING WELDS IN COMPONENTS
   B) BRINELL HARDNESS LIMITS SHALL BE 200 MAX.
   C) HARDNESS SHALL BE DETERMINED USING A 10mm DIA. BALL UNLESS OTHERWISE SPECIFIED.

△2

   E) ONE READING IN THE WELD METAL OF EACH CIRC. SEAM AND ONE READING IN EACH HEAT AFFECTED ZONE.
   F) ONE READING IN THE WELD METAL OF NOZZLE TO EXCHANGER WELDS AND ONE READING IN EACH HEAT AFFECTED ZONE IN 50% OF THE NOZZLES.
   G) IF MORE THAN ONE WELDING PROCEDURE IS USED TO FABRICATE LONG. OR CIRC. WELDS, HARDNESS READINGS SHALL BE MADE OF WELDS DEPOSITED BY EACH PROCEDURE.
   H) TESTING SHALL BE DONE ON ACCESSIBLE INSIDE SURFACES.

△2

CERTIFIED AS-BUILT

HYDROTESTING REQUIREMENTS

1. HOLD FOR AT LEAST ONE HOUR. A HYDROTEST CHART IS REQ'D.
2. MINIMUM TEST WATER TEMP. = 40 deg.F.
3. PAINT OR OTHER COATINGS SHALL NOT BE APPLIED OVER WELDS BEFORE FINAL HYDROTEST.
4. LEAK TEST WELD PADS WITH 15 PSI AIR AND SOAP SOLUTION, OBSERVING WELDS FROM THE INSIDE AND OUTSIDE. △2
5. LEAKAGE AT MAIN FLANGES REQUIRES CUSTOMER NOTIFICATION IN WRITING. ALL CORRECTIVE ACTION SHALL BE SUSPENDED UNTIL APPROVAL IS RECEIVED BY THE CUSTOMER. THE REASON FOR THE LEAK SHALL BE DETERMINED, DOCUMENTED BY AN NCR AND REPAIRED TO THE SATISFACTION OF THE CUSTOMER.
6. IMMEDIATELY AFTER HYDRO, DRAIN AND DRY BY BLOWING WARM AIR NOT TO EXCEED 120°F.

SHIPPING REQUIREMENTS

1. PAINT ON THE SIDE OF THE EXCHANGER AND EACH CRATE: ITEM NO., P.O. NO., AND GROSS WEIGHT. IDENTIFY SPARE PARTS AS "SPARES" AND ITEM NUMBER.
2. CRATES SHALL HAVE A MINIMUM OF 2 STEEL STRAPS ON APPROX. 24" CENTERS. A PACKING LIST SHALL BE PLACED INSIDE AND ATTACHED TO THE OUTSIDE.
3. ALL FLANGED GASKET SURFACES SHALL BE COATED WITH RUST VETO 342 RUST PREVENTIVE AND SHALL BE PROTECTED BY 1/2" STEEL COVERS & A MINIMUM OF (4) BOLTS. PROVIDE A 1/4" NPT DRAIN HOLE WITH PLUG IN BOTTOM COVERS. △3
4. EXPOSED THREADS OF BOLTS SHALL BE PROTECTED WITH RUST VETO 342 RUST PREVENTATIVE TO PREVENT CORROSION DURING TESTING, SHIPPING, AND STORAGE. TAPPED HOLES SHALL BE PLUGGED WITH GREASE.
5. ATTACH A LARGE WEATHERPROOF TAG "CAUTION: THIS EQUIPMENT HAS BEEN TREATED WITH A RUST PREVENTATIVE AND NO PARTS SHOULD BE DISTURBED UNTIL READY TO BE PLACED IN SERVICE. IF PROTECTIVE FILM IS BROKEN, IT SHALL BE RESTORED FOR CONTINUED STORAGE"
6. MARK C-D-G (DRY) WITH A 3" CIRCLE ON HORZ. & VERTICLE CENTERLINES.
7. MARK ON TWO SIDES OF EXCHANGER 180° APART IN 3" LETTERS: "NO WELDING OR BURNING PERMITTED ON THIS EXCHANGER"
8. THE NORTH ORIENTATION SHALL BE CENTER PUNCHED AND MARKED IN A CONTRASTING COLOR ON THE OUTSIDE OF EXCHANGER, LOCATED APPROX. 12 INCHES ABOVE SUPPORT BASE PLATE. THE MARK SHALL BE A 6 INCHE LONG LINE AND NOTED AS "N".
9. SHIPPING SUPPORTS SHALL MATCH CYLINDER CURVATURE.
10. NITROGEN PURGE REQUIRED FOR SHIPPING AND STORAGE. PAINT ON BOTH SIDES OF EXCHANGER WITH 4" HIGH LETTERS "WARNING-NITROGEN PURGED, DANGER OF SUFFOCATION UPON OPENING" △3

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

NO.	DATE	REVISIONS	
△3	8-7-12	REV'D PER CUST.	DM/MD
△2	8/18/11	CORRECTED PER EEC	MD/SG
△1	6-23-11	REV'D PER CUST.	WE/DN

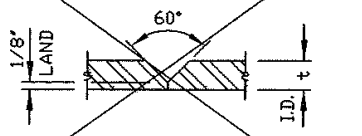
JOB NOTES

DWN. BY: S. MIAND
DATE: 4-21-11
CK'D. BY: DM

Energy Exchanger Co.
3044 No. Garnett Rd. - Tulsa, Okla. 74116

DWG. NO. X-7926-R
REV 3

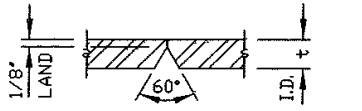
t=LESS THAN 3/8"
LOCATE LONG SEAM 15° ABOVE CL
UNLESS OTHERWISE SPECIFIED.
ALL SEAMS BACK GOUGED & BACK WELDED



CHANNEL WELD PROC: -----
SHELL WELD PROC: -----

LONG OR CIRC WELD BEVEL
(CYL TO FLG, OR CYL)

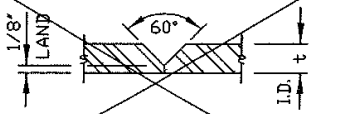
t=3/8" TO 5/8"
LOCATE LONG SEAM 15° ABOVE CL
UNLESS OTHERWISE SPECIFIED.
ALL SEAMS BACK GOUGED & BACK WELDED



CHANNEL WELD PROC: A-62-H
SHELL WELD PROC: -----

LONG OR CIRC WELD BEVEL
(CYL TO FLG, OR CYL)

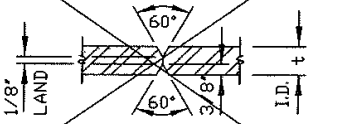
t=7/16" TO 5/8"
ALL SEAMS BACK GOUGED & BACK WELDED



CHANNEL HEAD WELD PROC: -----
SHELL HEAD WELD PROC: -----

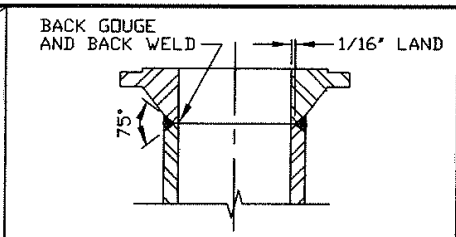
CIRC WELD BEVEL
(CYL TO HEAD)

t=OVER 5/8"
LOCATE LONG SEAM 15° ABOVE CL
UNLESS OTHERWISE SPECIFIED.
ALL SEAMS BACK GOUGED & BACK WELDED



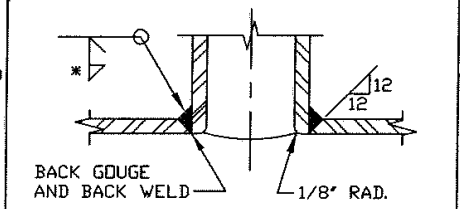
CHANNEL WELD PROC: -----
SHELL WELD PROC: -----

LONG OR CIRC WELD BEVEL
(CYL TO FLG, OR CYL)



CHANNEL WELD PROC: M-79-H
SHELL WELD PROC: M-5

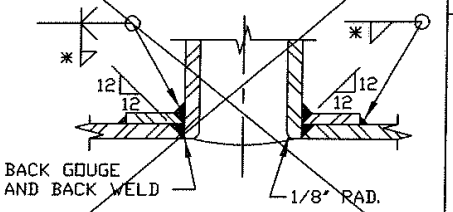
WELD-NECK FLANGE INSTALLATION



CHANNEL WELD PROC: M-76-H
SHELL WELD PROC: M-1

NOZZLE INSTALLATION WITHOUT PAD

(1) 1/4" NPT IN EACH WELD PAD OR SEC. OF WELD PAD. PLUG W/ STIFF GREASE, UNLESS DETAILS SPECIFY OTHERWISE.

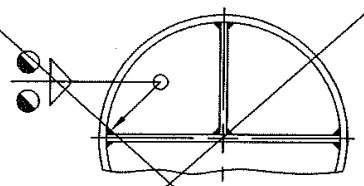


CHANNEL WELD PROC: -----
SHELL WELD PROC: -----

NOZZLE INSTALLATION WITH PAD

WELD THE FOLLOWING ITEMS WITH PROC'S.:

SUPPORT PAD TO SHELL: M-1
NAME PL. BRK'T. TO SHELL: M-1
IMP. PL. TO SHELL: M-1

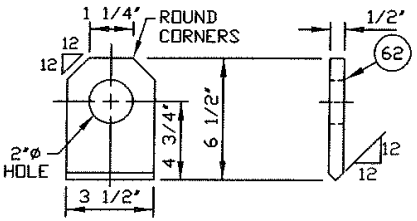


1/4" (MIN.) AT FRONT CHANNEL

PASS PLATE WELDS TO BE FULL PENETRATION FOR 2" (MIN) FROM FACE OF GASKET SURFACE.

WELD PROCEDURE: -----

PASS PLATE WELDS



FULL PENETRATION WELD
W/ 1/4" FILLET WELD

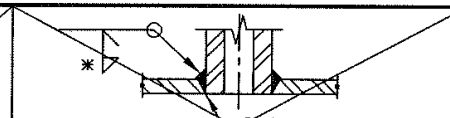
WELD PROCEDURE: M-75-H

LIFTING LUG DETAIL

SHELLSIDE WELDS THAT MAY INTERFERE WITH BUNDLE INSTALLATION OR REMOVAL SHALL BE GROUND FLUSH.

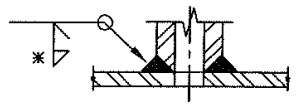
1/4" MINIMUM FILLET WELDS FOR ALL NON PRESSURE ATTACHMENTS UNLESS NOTED OTHERWISE

* ALL FILLETS WELDS TO BE 3/8" UNLESS NOTED OTHERWISE



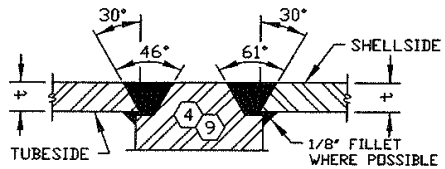
CHANNEL WELD PROC: -----
SHELL WELD PROC: -----

AUXILLARY NOZZLE INSTALLATION
(TO PIPE, CYLINDER OR HEAD)



CHANNEL WELD PROC: M-79-H
TUBESHEET WELD PROC: M-1

SADDLE-ON NOZZLE INSTALLATION



CHANNEL WELD PROC: A-62-H
SHELL WELD PROC: M-6

CIRCUMFERENTIAL SEAM
(TUBESHEET TO CYL)

CERTIFIED AS-BUILT

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

NO.	DATE	REVISIONS

WELD & BEVEL DETAILS

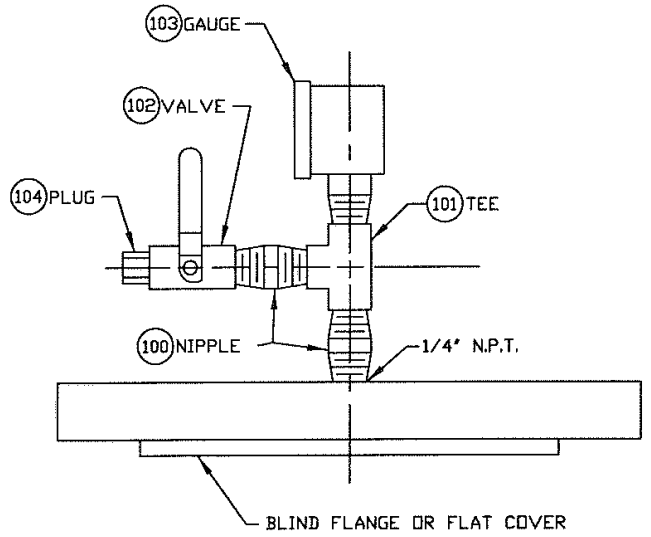
DWN. BY S. MIANO
DATE 4-21-11
CKD. BY

Energy Exchanger Co.
1844 No. Garnett Rd. · Tulsa, Okla. 74116

DWG. NO. X-7926-S
REV 0

NOTES:

1) BOTH SIDES SHALL BE THOROUGHLY DRAINED AND DRIED AFTER HYDROTEST. REMOVE MOISTURE BY BLOWING HOT AIR (150°F., MAXIMUM).
2) A) SEAL ALL EXTERNAL OPENINGS WITH A 1/8" THK. RUBBER-GASKETED BLIND FLANGE OR FLAT COVER.
   B) INSTALL A CONNECTION WITH A VALVE AND PRESSURE GAUGE.
   C) PRESSURE TO 15 PSIG AND DEPRESSURIZE TWICE; REPRESSURE TO 15 PSIG WITH DRY NITROGEN.
3) STENCIL BY EACH NOZZLE: "CONTENTS UNDER N2 PRESSURE; DO NOT OPEN WITHOUT PURCHASER'S APPROVAL".
4) TACKWELD A PIECE OF PIPE TO EACH COVER EQUIPPED WITH THE FITTING AND GAUGE ASSEMBLY, FOR PROTECTION DURING SHIPMENT.



ONLY ONE BLIND FLANGE OR COVER SHALL BE TAPPED FOR CHANNEL SIDE, AND ONE FOR SHELL SIDE.

PROVIDE 1/4" N.P.T. WITH PLUG ON BOTTOM COVERS FOR DRAINING PURPOSES.

CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

NO.	DATE	REVISIONS
1		
2		
3		
4		
5		
6		

NITROGEN PURGE DETAILS

DWN. BY D.MORRISON
DATE 8/7/12
CKD. BY MD

Energy Exchanger Co.
3944 No. Garnett Rd. - Tulsa, Okla. 74116

DWG. NO. X-7926-X
REV 0

BILL OF MATERIAL

PART NO	ONE REQ'D., DESCRIPTION OF ONE	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
21	TUBES 3/4" O.D. X 0.083" (MIN.) THK. X 14'-0" LG.	SA-179	185	185					*
	FORGED RING MATERIAL								
2	FLG. 21 1/8" O.D. X 15 1/4" I.D. X 3 1/4" THK.	SA-266-4N	1	1		1			*
2A	FLG. 21 1/8" O.D. X 15 1/4" I.D. X 3 1/4" THK.	SA-266-4N	1	1		1			*
	TUBESHEETS & COVERS								
4	TUBESHEET 16" O.D. X 3" THK.	SA-266-4N	1	1		1			*
9	TUBESHEET 16" O.D. X 3" THK.	SA-266-4N	1	1		1			*
1	COVER 21 1/8" O.D. X 1 5/8" THK.	SA-266-4N	1	1		1			*
1A	COVER 21 1/8" O.D. X 1 5/8" THK.	SA-266-4N	1	1		1			*
	BAFFLES								
22	BAFFLES 14 7/8" O.D. X 1/4" THK.	SA-36	9	9					*
22A	FIRST & LAST BAFFLES 14 7/8" O.D. X 1/2" THK.	SA-36	2	2					*
	HEADS								
	CYLINDERS								
12	SMLS. PIPE 16" O.D. X (0.3750" Sch. 30) X 1'-2 15/16" LG.	SA-333-6	1	1		1			*
15	SMLS. PIPE 16" O.D. X (0.5000" Sch. XH) X 13'-6 5/8" LG.	SA-106B	1	1					*
17	SMLS. PIPE 16" O.D. X (0.3750" Sch. 30) X 1'-1 1/16" LG.	SA-333-6	1	1		1			*

NOTES: MATERIAL SHALL NOT ORIGINATE IN EITHER CHINA OR NORTH KOREA.
1) MATERIAL HARDNESS SHALL NOT EXCEED 22 HRC.
2) MATERIAL HARDNESS SHALL NOT EXCEED 187 HB.

* DENOTES PRELIMINARY ORDER

CERTIFIED AS-BUILT

REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER

NO.	DATE	DESCRIPTION

Energy Exchanger Co.
1844 No. Garnett Rd. • Tulsa, Okla.74116

CUST: MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES
P.O.: 17496-0001
ITEM: HX0052

PB/M	DR: MD	CK: DN	DATE: 3/8/11	DWG. NO.	REV
FB/M	DR: SM	CK:	DATE: 4-21-11	X-7926-1BM	0

BILL OF MATERIAL

PART NO	ONE REQ'D., DESCRIPTION OF ONE	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
	ASME FLANGES								
71	ASME 4"-300# RFWN W/ (Sch. 120 BORE)	SA-105	1	1					*
72	ASME 2"-300# RFLWN X 10" LG. (2.0000" BORE)	SA-105	1	1					*
81	ASME 6"-300# RFWN W/ (Sch. 120 BORE)	SA-105N	1	1		2			*
87	ASME 3"-300# RFWN W/ (Sch. 160 BORE)	SA-105N	1	1		2			*
73	ASME 3/4"-300# RFLWN X 9" LG. (0.7500" BORE)	SA-105	1	1					*
74	ASME 3/4"-300# RFLWN X 9" LG. (0.7500" BORE)	SA-105	1	1					*
75	ASME 3/4"-300# RFLWN X 9" LG. (0.7500" BORE)	SA-105	1	1					*
82	ASME 2"-300# RFLWN X 9" LG. (2.000" BORE)	SA-105N	1	1		2			*
89	ASME 2"-300# RFLWN X 9" LG. (2.000" BORE)	SA-105N	1	1		2			*
71A	SMLS. PIPE 4 1/2" O.D. X (0.4380" Sch. 120) X 7" LG.	SA-106B	1	1					*
81A	SMLS. PIPE 6 5/8" O.D. X (0.5620" Sch. 120) X 6 3/4" LG.	SA-333-6	1	1		1			*
87A	SMLS. PIPE 3 1/2" O.D. X (0.4380" Sch. 160) X 7" LG.	SA-333-6	1	1		1			*
73D	ASME 3/4"-300# RF-BLIND FLANGE	SA-105	1	1					*
74D	ASME 3/4"-300# RF-BLIND FLANGE	SA-105	1	1					*
75D	ASME 3/4"-300# RF-BLIND FLANGE	SA-105	1	1					*
82D	ASME 2"-300# RF-BLIND FLANGE	SA-105N	1	1		2			*
89D	ASME 2"-300# RF-BLIND FLANGE	SA-105N	1	1		2			*
	COUPLINGS								

SEE DWG. X-7926-1BM FOR MATERIAL NOTES.

* DENOTES PRELIMINARY ORDER

CERTIFIED AS-BUILT

REQ No: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER

NO.	DATE	DESCRIPTION
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Energy Exchanger Co.
1844 No. Garnett Rd. • Tulsa, Okla.74116

CUST: MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES
P.O.: 17496-0001
ITEM: HX0052

PB/M	DR: MD	CK: DN	DATE: 3/8/11
FB/M	DR: SM	CK: [illegible]	DATE: 4-21-11

DWG. NO. X-7926-2BM
REV 0

BILL OF MATERIAL

PART NO	ONE REQ'D, DESCRIPTION OF ONE	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
	BOLTING & GASKETS								
40	LOT OF GASKETS PER DWG. X-7926-D		2	2					
41	1" ROUND X 8-THREAD STUDS X 6" LG. 1&2	SA-193-B7	16	16					
42	1" ROUND X 8-THREAD STUDS X 6" LG. 1A&2A	SA-193-B7	16	16					
43	1" HEAVY HEX NUTS 8-THREAD	SA-194-2H	64	64					
44	5/8" DIA. (11 THD) STUDS X 3 1/8" LG. (3/4"-300# RF)	SA-193-B7	12	12					
44A	5/8" (11 THD) HEAVY HEX NUTS (3/4"-300# RF)	SA-194-2H	24	24					
45	5/8" DIA. (11 THD) STUDS X 3 5/8" LG. (2"-300# RF)	SA-193-B7	16	16					
45A	5/8" (11 THD) HEAVY HEX NUTS (2"-300# RF)	SA-194-2H	32	32					
	.175" THK 321 STN. STL. SPRL. WND. FLEXIBLE GRAPHITE FILLED GSK'T.				3				
	WITH 1/8" THK. C-STL. OUTER RING FOR:								
44B	(3/4"-300# RF)		3	3					
45B	(2"-300# RF)		2	2					
	MISC. MATERIAL								
60	STD. NAME PLATE	STN. STL.	2	2					
61	STD. NAME PLATE BRK'T.	SA-516-70	2	2					
62	LIFTING LUGS 3 1/2" X 1/2" X 6 1/2" LG	SA-516-70	4	4					
23	FT. 1/2" O.D. TIE RODS	C-STL.	63	63					
23A	FT. 3/4" O.D. SPACER TUBING	SA-214	63	63					
23B	1/2" TIE ROD HEX NUTS	C-STL.	10	10					
22C	4 1/8" X 1/4" THK. X 7 1/4" IMP. PLATE	SA-36	1	1	1				
63	DELETE				1				
64	DELETE				1				
	INSULATION SUPPORT MATERIAL								
65	PLATE 1 1/2" X 1/4" THK X 3" LG (CLIPS)	SA-36	8	8	2				
66	PLATE RING 19" O.D. X 17" I.D. X 1/4" THK	SA-36	2	2	2				
67	ANGLE 3" X 3" X 1/4" THK X 70 LG. (ROLLED LEG IN TO 16 1/8" I.D.)	SA-36	1	1	2				
70	NOZZLE SHIPPING COVERS PER SKETCH								
	SUPPORT MATERIAL								
120	PLATE 11" X 3/8" THK X 10 1/4" LG	SA-516-70	2	2					
121	PLATE 6" X 3/4" THK X 9 11/16" LG	SA-516-70	2	2					
122	PLATE 6 1/4" X 1/2" THK X 9 11/16" LG	SA-516-70	4	4					
125	GROUNDING BOLT 5/8" DIA (11 THD) X 2" LG HEX HD BOLT	C-STL.	1	1					
	NITROGEN PURGE MATERIAL								
100	1/4" PIPE NIPPLE X 2" LG. (THRD. OUTSIDE EACH END)	C. STL.	4	4	4				
101	1/4" STRAIGHT TEE (THRD. INSIDE EACH END)	C. STL.	2	2	4				
102	1/4" PIPE VALVE (INSIDE THRD.) (#5X713)	BRASS	2	2	4				
103	1/4" PRESSURE GAUGE (#5X939)(P570K-60LM)(0-60 PSIG)		2	2	4				
104	1/4" PIPE PLUG	C. STL.	2	2	4				

* DENOTES PRELIMINARY ORDER

CERTIFIED AS-BUILT

REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER

NO.	DATE	DESCRIPTION
4	8/6/12	ADD NITROGEN PURGE DM/
3	5/31/12	REV MATL P/N 45A MD/SG
2	8-17-11	REV PER CUSTOMER COMMENTS DM/MD
1	6-23-11	REV'D PER CUST. WE/SM

Energy Exchanger Co.
1844 No. Garnett Rd. • Tulsa, Okla.74116

CUST: MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES
P.O.: 17496-0001 ITEM: HX0052

PB/M	DR: -----	CK: ----	DATE: ----	DWG. NO.	REV
FB/M	DR: SM	CK: DM	DATE: 4-21-11	X-7926-3BM	4

X-7926 PACKING LIST

LINE NO	SPARE PARTS LIST	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
SP1	SPARE GASKETS PER DWG. X-7926-D		1 SET(S)	1 SET(S)					
SP2									
SP3									
SP4									
SP5									
SP6									
SP7									
SP8									
SP9									
SP10									

SPARE PARTS TO BE BOXED & TAGGED WITH P.O. NO., ITEM NO., SHIPPING WT. & "SPARE GASKETS AND PARTS"

LINE NO	STACKING MATERIAL	MATERIAL SPEC.	QTY ONE	TOT QTY	REV	NOTE	PO NO	PROMISED	
S1									
S2									
S3									
S4									
S5									
S6									
S7									
S8									
S9									
S10									
S11									
S12									
S13									
S14									
S15									
S16									
S17									
S18									
S19									
S20									
S21									
S22									
S23									
S24									
S25									

* DENOTES PRELIMINARY ORDER

DO NOT ORDER
FROM PACKING LIST

CERTIFIED AS-BUILT

REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER

NO.	DATE	DESCRIPTION
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Energy Exchanger Co.
1844 No. Garnett Rd. • Tulsa, Okla.74116

CUST: MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES
P.O.: 17496-0001 ITEM: HX0052

PB/M	DR: ----	CK: ----	DATE: ----	DWG. NO.	REV
FB/M	DR: SM	CK: DA	DATE: 4-21-11	X-7926-PL	0

Energy Exchanger Company

Mike Dowell 7/24/12
CERTIFIED AS-BUILT

DATE: 3/8/2011
PAGE: 1 of 37

MECHANICAL CALCULATIONS

CUSTOMER:	MISSISSIPPI POWER c/o SOUTHERN COMPANY SERVICES
DESTINATION:	KEMPER COUNTY, MISSISSIPPI
P.O. No.:	17496-0001
ITEM No.:	HX0052
E.E.C. SERIAL No.:	X-7926
SERVICE:	WASTEWATER AMMONIA PURIFIER REBOILER
REQ. NO.:	MC202

DESIGN DATA		
	SHELL SIDE	**TUBE SIDE**
DESIGN PRESSURE	455 PSIG * / FV	320 PSIG */**
DESIGN TEMP.	515°F	385°F **
M.D.M.T.	10 °F	10 °F
CORR. ALLOW.	1/8"	1/8"
NO. PASSES	ONE	ONE
M.A.W.P. (H&C)	455 PSIG	320 PSIG
LIMITED BY	FIXED TUBESHEET	FIXED TUBESHEET

NOTE: ALL LOADING CONDITIONS REFERENCED IN PARA. UG-22 HAVE BEEN ADDRESSED

- DESIGNED TO ASME SEC VIII, DIV 1, 2007 ED, '09 AD.
- MATERIAL ARE IMPACT TEST EXEMPT PER UG-20(f)

* CALCULATIONS ADD 8 PSIG TO ACCOUNT FOR STATIC HEAD WHEN ERECTED

** DESIGN ALSO VALIDATED FOR STEAM OUT OF 15 PSIG @ 250°F.

REVISION LOG

DATE	PAGE	REV.	DESCRIPTION
4/8/2011	28,35-36	1	REV PER CUSTOMER COMMENT & EEC
7/25/2011	AS NOTED	2	FV TO STEAM OUT & MODIFY LUG PER CUSTOMER

W.O. No.: X-7926

SHELL SIDE

NOM. SIZE	PRESS.	TEMP.	C.A.	RT	H.T.	TEMA
16.000"	463.0psig *	515deg.F	0.1250"	NONE	0deg.F	R

ASME CODE SEC.VIII DIV.I UG-27 [CYLINDER]

====DESIGN CONDITIONS==========CYLINDER CALCULATIONS ON O.D. FORMULA====

SHELL CYL

MATERIAL: SA-106B	PRESS = 463.0psig *	TEMP = 515deg.F		
O.D.	NOM. THK.	RW=0/PIPE=1	CORR.ALLOW	EFFICIENCY
16.0000"	0.5000"	1	0.1250"	0.85
ATM.STRS	DES.STRS	STRS/STRS	MAWP N-C	MAWP CORR.
17100.0psi	17100.0psi	1.000	812.660psig	576.786psig

P*(RO)
---------- = 0.25163" + CORR. ALLOW. = 0.37663" + MTOL. = 0.43043"
S*E+(.4*P)

****

* DESIGN PRESSURE HAS BEEN INCREASED BY 8 PSI DUE TO STATIC HEAD

----- External Pressure Calculations -----

Ext Press Chart....=	1 CS-2
Actual Chart Used..=	1 CS-2
Material.....=	SA-106B
OD.....=	16.00000
T.....=	0.31250
L.....=	168.00000
Temp.....=	515.00000
Stress from MT.....=	17100.00000
Yield from MT.....=	28244.99805
2 x Stress.....=	34200.00000
B1 from Chart@Right=	0.00000
Yield= 2 x B1 x 0.9=	0.00000
S.....=	0.00000
DO/T.....=	51.20000
L/DO.....=	10.50000
A.....=	0.00044
B.....=	5755.72559
PA1.....=	0.00000
PA2.....=	0.00000
PA.....=	149.88869

TOP & BOTTOM CHANNELS

NOM. SIZE	PRESS.	TEMP.	C.A.	RT	H.T.	TEMA
16.000"	328.0psig *	385deg.F	0.1250"	SPOT	1150deg.F	R

ASME CODE SEC.VIII DIV.I UG-27 [CYLINDER]

====DESIGN CONDITIONS==========CYLINDER CALCULATIONS ON O.D. FORMULA====

CHANNEL CYLINDERS

MATERIAL: SA-333-6 PRESS = 328.0psig * TEMP = 385deg.F

O.D.	NOM. THK.	RW=0/PIPE=1	CORR.ALLOW	EFFICIENCY
16.0000"	0.3750"	1	0.1250"	0.85

ATM.STRS	DES.STRS	STRS/STRS	MAWP N-C	MAWP CORR.
17100.0psi	17100.0psi	1.000	606.106psig	372.839psig

$$\frac{P*(RO)}{S*E+(.4*P)} = 0.17891" + \text{CORR. ALLOW.} = 0.30391" + \text{MTOL.} = 0.34733"$$

****

* DESIGN PRESSURE HAS BEEN INCREASED BY 8 PSI DUE TO STATIC HEAD

----- External Pressure Calculations -----

Ext Press Chart....=	1 CS-2
Actual Chart Used..=	1 CS-2
Material.....=	SA-333-6
OD.....=	16.00000
T.....=	0.20313
L.....=	20.00000
Temp.....=	250.00000
Stress from MT.....=	20000.00000
Yield from MT.....=	34200.00000
2 x Stress.....=	40000.00000
B1 from Chart@Right=	0.00000
Yield= 2 x B1 x 0.9=	0.00000
S.....=	0.00000
DO/T.....=	78.76729
L/DO.....=	1.25000
A.....=	0.00152
B.....=	13868.42188
PA1.....=	0.00000
PA2.....=	0.00000
PA.....=	234.75772

```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SEC.VIII DIV.I UG-37 & UG-16
NOZ NO= S1      4.00"    300 LB RF  WN
[INLET] SHELL SIDE
PRESSURE =  463.0psig *  TEMP =  515.0deg.F

-------CYLINDER-----------------------NOZZLE-------
SA-106B                          SA-106B
OPER STRS=   17100.0 psi         OPER STRS=   17100.0 psi
ATM STRS =   17100.0 psi         ATM STRS =   17100.0 psi
C.A.     =   0.12500"            C.A.     =   0.12500"
I.D.     =  15.12500"            I.D.     =   3.62400"
O.D.     =  16.00000"            O.D.     =   4.50000"
THK.     =   0.43750"            THK.sc120=   0.43800"
T        =   0.31250"            TN       =   0.31300"
TR       =   0.21429"            TRN      =   0.06027"
ET       =   0.09821"            ETN      =   0.25273"

MIN STD. WT. PIPE+C.A.=  0.33237"   TR+C.A.=  0.33929"
LIMITS=   7.74800"
fr1= 1.0000 fr2= 1.0000 fr3= 0.0000 fr4= 0.0000     F=   1.00000
Min weld sizes:NS=  0.3094" NP=  0.0000" PS=  0.0000" IF=  0.0000"

AREA REQD.              A =   0.83015in^2
EXCESS IN CYL.          A1=   0.38048in^2
EXCESS IN NOZ.(OUTSIDE) A2=   0.39489in^2  H =   0.78125"
AREA OF FILLETS           =   0.14062in^2
AREA AVAILABLE            =   0.91599in^2

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

< AREA REQD-AREA AVAILABLE >  =   -0.08584in^2

MAWP N-C=   742.0psig  LIMITED BY AR
MAWP COR=   485.0psig  LIMITED BY AR

* DESIGN PRESSURE HAS BEEN INCREASED BY 8 PSI DUE TO STATIC HEAD
```

EXTERNAL PRESSURE VERIFICATION:

```
NOZTYP[ 0.0] X-7926         4.00"- 300# RF  WN   PRESS= -15 TEMP= 515  INLET
<<<<<< CYLINDER >>>>  <<<<<< NOZZLE >>>>>>
      SA-106B               SA-106B
OPER STRS=17100.0000  OPER STRS=17100.0000  Area reqd.      A=  0.2729
ATM STRS =17100.0000  ATM STRS =17100.0000  Excess in cyl A1=  0.6648
C.A.     =   0.12500  C.A.     =   0.12500  Excess in noz A2=  0.4562 H= 0.7812
I.D.     =  15.12500  I.D.     =   3.62400  Excess in noz A3=  0.0000 H= 0.0000
O.D.     =  16.00000  O.D.     =   4.50000  Area fillets    =  0.1406
THK.     =   0.43750  THK.sc120=   0.43800  Area avail.     =  1.2617
T        =   0.31250  TN       =   0.31300  Noz neck weld   =  0.3750 A= 0.1406
TR       =   0.14090  TRN      =   0.02100  Pad weld        =  0.0000 A= 0.0000
ET       =   0.17160  ETN      =   0.29200  Internal weld   =  0.0000 A= 0.0000
PIPE F=1.0000 E1=1.0000  SHELL TOL=0.8750 (Min USED)  NOZ TOL=1.0000 (Nom USED)
MIN STD. WT. PIPE+C.A.=0.33237   TR[using abs(P)]+C.A.=0.13202   CHORD=  0.0000
LIMITS=   7.74800    fr1= 1.0000 fr2= 1.0000 fr3= 0.0000 fr4= 0.0000
Min weld sizes: NS= 0.3094 NP= 0.0000 PS= 0.0000 IF= 0.0000
Area reqd-Area avail =<< -0.98873>>
```

```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SEC.VIII DIV.I UG-37 & UG-16
NOZ NO= T1      3.00"    300 LB RF  WN
[INLET] REAR CHANNEL or COVER
PRESSURE =  328.0psig *  TEMP =  385.0deg.F

-------CYLINDER-----------------------NOZZLE-------
SA-333-6                          SA-333-6
OPER STRS=   17100.0 psi          OPER STRS=   17100.0 psi
ATM STRS =   17100.0 psi          ATM STRS =   17100.0 psi
C.A.     =   0.12500"             C.A.     =   0.12500"
I.D.     =  15.34375"             I.D.     =   2.62400"
O.D.     =  16.00000"             O.D.     =   3.50000"
THK.     =   0.32812"             THK.sc160=   0.43800"
T        =   0.20312"             TN       =   0.31300"
TR       =   0.15228"             TRN      =   0.03331"
ET       =   0.05084"             ETN      =   0.27969"

MIN STD. WT. PIPE+C.A.=  0.31400"   TR+C.A.=  0.27728"
LIMITS=   5.74800"
fr1= 1.0000 fr2= 1.0000 fr3= 0.0000 fr4= 0.0000     F=   1.00000
Min weld sizes:NS=  0.2011" NP=  0.0000" PS=  0.0000" IF=  0.0000"

AREA REQD.               A =   0.43766in^2
EXCESS IN CYL.           A1=   0.14612in^2
EXCESS IN NOZ.(OUTSIDE) A2=   0.28406in^2  H =   0.50781"
AREA OF FILLETS            =   0.14062in^2
AREA AVAILABLE             =   0.57081in^2

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

< AREA REQD-AREA AVAILABLE >  =   -0.13315in^2

MAWP N-C=   666.0psig  LIMITED BY AR
MAWP COR=   376.0psig  LIMITED BY AR

* DESIGN PRESSURE HAS BEEN INCREASED BY 8 PSI DUE TO STATIC HEAD



      External pressure for steam out:

NOZTYP[ 0.0] X-7926          3.00"- 300# RF  WN   PRESS= -15 TEMP= 250  INLET
<<<<<< CYLINDER >>>>  <<<<<< NOZZLE >>>>>>
      SA-333-6              SA-333-6
OPER STRS=17100.0000  OPER STRS=17100.0000  Area reqd.      A=  0.0814
ATM STRS =17100.0000  ATM STRS =17100.0000  Excess in cyl A1=  0.4210
C.A.      =   0.12500 C.A.      =   0.12500  Excess in noz A2=  0.2987 H= 0.5078
I.D.      =  15.34375 I.D.      =   2.62400  Excess in noz A3=  0.0000 H= 0.0000
O.D.      =  16.00000 O.D.      =   3.50000  Area fillets     =  0.1406
THK.      =   0.32812 THK.sc160=   0.43800  Area avail.      =  0.8604
T         =   0.20312 TN        =   0.31300  Noz neck weld    =  0.3750 A= 0.1406
TR        =   0.05662 TRN       =   0.01890  Pad weld         =  0.0000 A= 0.0000
ET        =   0.14650 ETN       =   0.29410  Internal weld    =  0.0000 A= 0.0000
PIPE F=1.0000 E1=1.0000  SHELL TOL=0.8750 (Min USED)  NOZ TOL=1.0000 (Nom USED)
MIN STD. WT. PIPE+C.A.=0.31400   TR[using abs(P)]+C.A.=0.13202   CHORD=  0.0000
LIMITS=   5.74800    fr1= 1.0000 fr2= 1.0000 fr3= 0.0000 fr4= 0.0000
Min weld sizes: NS= 0.2011 NP= 0.0000 PS= 0.0000 IF= 0.0000
       Area reqd-Area avail =<< -0.77899>>
```

```
NOZZLE REINFORCEMENT CALCULATIONS/ ASME SEC.VIII DIV.I UG-37 & UG-16
NOZ NO= T2      6.00"    300 LB RF  WN
[OUTLET  ] FRONT CHANNEL SIDE
PRESSURE =  328.0psig *  TEMP =  385.0deg.F

-------CYLINDER-----------------------NOZZLE-------
SA-333-6                          SA-333-6
OPER STRS=   17100.0 psi          OPER STRS=   17100.0 psi
ATM STRS =   17100.0 psi          ATM STRS =   17100.0 psi
C.A.     =   0.12500"             C.A.     =   0.12500"
I.D.     =  15.34375"             I.D.     =   5.50100"
O.D.     =  16.00000"             O.D.     =   6.62500"
THK.     =   0.32812"             THK.sc120=   0.56200"
T        =   0.20312"             TN       =   0.43700"
TR       =   0.15228"             TRN      =   0.06305"
ET       =   0.05084"             ETN      =   0.37395"

MIN STD. WT. PIPE+C.A.=  0.37000"   TR+C.A.=  0.27728"
LIMITS=  11.50200"
frl= 1.0000 fr2= 1.0000 fr3= 0.0000 fr4= 0.0000     F=   1.00000
Min weld sizes:NS=  0.2011" NP=  0.0000" PS=  0.0000" IF=  0.0000"

AREA REQD.              A =   0.87577in^2
EXCESS IN CYL.          A1=   0.29240in^2
EXCESS IN NOZ.(OUTSIDE) A2=   0.37979in^2  H =   0.50781"
AREA OF FILLETS           =   0.25000in^2
AREA AVAILABLE            =   0.92219in^2

NOZ. NECK WELD= 0.50000"  AREA=   0.25000in^2

< AREA REQD-AREA AVAILABLE >  =   -0.04641in^2

MAWP N-C=   551.0psig  LIMITED BY AR
MAWP COR=   336.0psig  LIMITED BY AR

* DESIGN PRESSURE HAS BEEN INCREASED BY 8 PSI DUE TO STATIC HEAD
```

External pressure for steam out:

```
NOZTYP[ 0.0] X-7926         6.00"- 300# RF  WN   PRESS= -15 TEMP= 250  OUTLET
 <<<<<< CYLINDER >>>>  <<<<<< NOZZLE >>>>>>
       SA-333-6              SA-333-6
OPER STRS=17100.0000  OPER STRS=17100.0000  Area reqd.     A=  0.1628
ATM STRS =17100.0000  ATM STRS =17100.0000  Excess in cyl A1=  0.8425
C.A.     =   0.12500  C.A.     =   0.12500  Excess in noz A2=  0.4160 H= 0.5078
I.D.     =  15.34375  I.D.     =   5.50100  Excess in noz A3=  0.0000 H= 0.0000
O.D.     =  16.00000  O.D.     =   6.62500  Area fillets    =  0.1914
THK.     =   0.32812  THK.sc120=   0.56200  Area avail.     =  1.4499
T        =   0.20312  TN       =   0.43700  Noz neck weld   =  0.4375 A= 0.1914
TR       =   0.05662  TRN      =   0.02740  Pad weld        =  0.0000 A= 0.0000
ET       =   0.14650  ETN      =   0.40960  Internal weld   =  0.0000 A= 0.0000
PIPE F=1.0000 E1=1.0000  SHELL TOL=0.8750 (Min USED)  NOZ TOL=1.0000 (Nom USED)
MIN STD. WT. PIPE+C.A.=0.37000   TR[using abs(P)]+C.A.=0.13202   CHORD=  0.0000
LIMITS=  11.50200    frl= 1.0000 fr2= 1.0000 fr3= 0.0000 fr4= 0.0000
Min weld sizes: NS= 0.2011 NP= 0.0000 PS= 0.0000 IF= 0.0000
Area reqd-Area avail =<< -1.28710>>
```

ASME SEC.VIII DIV.1 APPENDIX 2 Front Channel to cover flange

DESIGN CONDITIONS		GASKET and BOLTING CALCULATIONS		TABLE	
Design Pres=	328.0 psig *	Eff.Gsk OD=	17.2500"	No.Passes=	1
Neg. Pres=	None	Eff.Gsk ID=	16.5000"	N=	0.375"
Design Temp=	385 deg.F	THK= 0.1250"	col.=2	b=	0.188
Flg Matl=SA-266-4N		Gsk Matl=S.S. DJNAF		y=	9000psi
Bolt Matl=SA-193B7		Gsk Face=FLAT FACE	w= 0.0000"	m=	3.750

Corr Allow=	0.1250"	Wm2=	89461 #	Am =	3.9125in^2
Flange Desn Sfo	20000.0 psi	Hp =	24452 #	Ab =	8.8160in^2
Atm. Sfa	20000.0 psi	H =	73358 #	W =	159105 #
Bolting Desn Sb	25000.0 psi	Wm1=	97811 #	Wm1=	97811 #
Atm. Sa	25000.0 psi	Gasket Width Check		Nmin =	0.2310"

CONDITION	LOAD	x	LEVER ARM =	MOMENT	
	HD =	61890 #	hD= 1.56250"	MD=	96704 in#
Operating	HG =	24452 #	hG= 1.06250"	MG=	25981 in#
	HT =	11467 #	hT= 1.40625"	MT=	16126 in#
				Mo=	138812 in#
Gasket					
Seating	HG =	159105 #	hG= 1.06250"	mo=	169049 in#

Allow.Stress-STRESS CALCULATIONS-Operating		SHAPE CONSTANTS			
1.5 Sfo&2.5 Sno Long Hub,SH	21395.1 psi	K =	1.3629	h/ho=	0.6350
Sfo Radial Flg,SR	1849.6 psi	T =	1.7703	F =	0.8305
Sfo Tang Flg,ST	11366.6 psi	Z =	3.3323	V =	0.2891
Sfo .5(SH+SR)or.5(SH+ST)	16380.8 psi	Y =	6.4305	f =	1.0000
J(APP.2-14)= 0.6860		U =	7.0664	e =	0.4219in^-1

Allow.Stress-STRESS CALCULATIONS-Gsk.Seating		g1/go= 1.5000	d = 3.008In^3
1.5 Sfa&2.5 Sna Long Hub,SH	26055.6 psi	ho = 1.9685"	
Sfa Radial Flg,SR	2252.5 psi		
Sfa Tang Flg,ST	13842.6 psi	OTHER STRESS FORMULA FACTORS	
Sfa .5(SH+SR)or.5(SH+ST)	19949.1 psi	t	1.8125"
J(APP.2-14)= 0.7942		Alpha	1.7647
		Beta	2.0195
		Gamma	0.9968
		Delta	1.9798
		Lambda	2.9766
		M	8955 #
		m	10906 #

O.D.	21.1250"	THK.		2.0000"	
I.D.	15.2500"	T-Adder		0.0000"	
GO	0.3750"	G1		0.5000"	
HUB O.D.	16.2500"	HUB LEN		1.2500"	
HUB ANG	5.7106deg	RIB LENGTH		0.0000"	
G(MEAN)	16.8750"	G(CALC)		16.8750"	
G(MIN.)	15.8750"	G(MAX.)		17.0000"	
B.C.	19.0000"	B.S.C.F.		1.0000	
No. BOLTS	16	BOLT DIAMETER		1.0000"	
R	1.3750"	E		1.0625"	
BOLT SPAC	3.7067"	TORQUE		146ft#	
MIN. SPAC	2.2500"	TEMA MAX. SPAC		4.5588"	
FLG TURN	0.1875"	FACING		RECESS	
BPRIME	0.0000"	BG1		0.0000"	
FLG RWT	154Lbs	FLG FWT		97Lbs	

* DESIGN PRESSURE HAS BEEN INCREASED BY 8 PSI DUE TO STATIC HEAD

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

EXCHANGER TYPE....=	N E N	MATERIAL.....=	SA-266-4N
PRESSURE.....=	328.0 psig	CORROSION ALLOWANCE=	0.1250"
TURN LOW.....=	0.1875"	TURN HIGH.....=	0.2500"
S COVER STRESS...=	20000.0 psi	E.....=	1.0
Sb STRESS BOLTS..=	25000.0 psi	Ab.....=	8.8160 in^2
d.....=	16.8750"	C.....=	0.3000
W.....=	159105 #	Wm1.....=	97811 #
hG (ASME).....=	1.0625"	hG (TEMA).....=	0.0000"
G (TEMA).....=	16.8750"	E (MOD.) x (10)-6..=	27.8 psi
COVER THK SET HOLD=	[NO]		

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

$$THK = d \sqrt{\frac{C\,P}{S\,E} + \frac{1.9\,Wm1\,hG}{S\,E\,d^3}} = 1.4093"$$

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

$$THK = d \sqrt{\frac{1.9\,W\,hG}{S\,E\,d^3}} = 0.9755"$$

[COV THK Min] CODE Operating	=	1.4093" +	0.1250" =	1.5343"
[COV THK Min] CODE Gasket Seating	=	0.9755" +	0.1250" =	1.1005"

ACTUAL COVER THICKNESS USED (SET HOLD[NO])= 1.6250"

MAIN FLG IS FLANGE MARK # 2
COMP FLG IS FLANGE MARK # 0

/// INDIVIDUAL COMPONENTS ///

MAWP CORR.	MAIN FLG =	330.0	Limited by: Flange stress.
MAWP CORR.	COVER =	330.0	
MAWP N-C	MAIN FLG =	462.0	Limited by: Flange stress.
MAWP N-C	COVER =	436.0	

ASME SEC.VIII DIV.1 UHX-13

(FTS) Configuration a

No or EPC=Elastic-Plastic Calcs SSC=Simply Supported Calcs			=SSC
MT Tubes	=SA-179	MT Tubesheets	=SA-266-4N
MT Channel	=SA-333-6	MT Shell	=SA-106B
Diameter (Do)	= 14.2708"	Pass Lane Area (AL)	= 0.000in^2
Perimeter of layout (CP)	= 0.0000"	Area enclosed by CP (AP)	= 0.000in^2
Tubesheet thickness (h)	= 3.0000"	Tubesheet thickness HOLD	= NO
Tube Pitch (p)	= 0.9375"	Pitch type = Triangle	(60 Deg)
Diameter of tube (dt)	= 0.7500"	Tube thickness (tt)	= 0.0830"
Exp length of tube (ltx)	= 0.0000"	Exp depth ratio (Rho)	= 0.9500
Groove channel side (hg)	= 0.0000"	Groove shell side	= 0.0000"
Channel I.D. (Dc)	= 15.2500"	Channel thickness (Tc)	= 0.3750"
Shell I.D. (Ds)	= 15.0000"	Shell thickness (Ts)	= 0.5000"
TS outside diameter (A)	= 16.0000"	Bolt circle (C)	= 0.0000"
G Channel side (Gc or G1)	= 0.0000"	G Shell side (Gs or G1)	= 0.0000"
Bolt load Chan side (Wc)	= 0.0#	Bolt load Sh side (Ws)	= 0.0#
1.8*Sqrt(Dc*Tc)	= 0.0000"	1.8*Sqrt(Ds*(Ts or Ts1))	= 0.0000"
Thickness at Top TS (tr)	= 3.0000"	Outer Tube Circle	= 14.2708"
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"
Radial Differential Thermal Expansion Adjacent to Tubesheet			= NO

Design Press Chan (Pt)	= 328.0psig	Design Press Shell (Ps)	= 463.0psig
Design Temp Chan	= 385.0deg.	Design Temp Shell	= 515.0deg.
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

Number Tubes (Nt)	= 185.00	F-F Tubesheets (Lt)	= 167.8750"
Un-supported Tube Span (l)	= 27.50000"	Support Constant (k)	= 1.00000
Expansion Joint	= None	Exp Joint I.D.	= 0.00000"
Spring Rate Corr (Kj)	= 0.#	Spring Rate Un-Corr (Kjn)	= 0.#
MT Thickened Shl	=	Thk Thickened Shl (Ts1)	= 0.00000"
Len Thickened Shl (lll)	= 0.00000"	Len Thickened Shl (lll')	= 0.00000"

Calculate/Conservative For Ps* and Pc* = Calculated values for Ps* and Pc*

* DESIGN PRESSURE HAS BEEN INCREASED BY 8 PSI DUE TO STATIC HEAD

ASME SEC.VIII DIV.1 UHX-13 Case 1

(FTS) Configuration a

Tubesheet Thickness (h)	= 2.7500"		
F-F Tubesheets (Lt)	= 167.6250"	F-F Inside Tubesheets (L)	= 162.1250"
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.5000"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 15.2500"	Shell thickness (Ts)	= 0.3750"
Press Chan (Pt)	= 328.0psi	Press Shell (Ps)	= 0.0psi
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi

Mu= 0.2000 d*= 0.6406" P*= 0.9375" Mu*= 0.3167 hg'= 0.0000" hgs'= 0.0000"

W	= 0.0#	wj	= 0.0"	ao	= 7.135405064"
Rho s	= 1.068614841	Rho c	= 1.086133122	Chi s	= 0.489028096
Chi t	= 0.690186620	Ks	= 3065028.500Lb/In	Kt	= 29157.69727Lb/In
Ks,t	= 0.568210900	j	= 1.000000000	Beta s	= 0.75098288$1in^-1$
Kappa s	= 195800.8281#	Lambda s	= 4477665.500psi	Beta c	= 0.91610521$1in^-1$
Kappa c	= 72776.67188#	Lambda c	= 2178102.500psi	h/p	= 2.933333397
E*	= 8183711.000psi	v*	= 0.343179107	Xa	= 1.815992355
Zd	= 0.234626889	Zv	= 0.167576507	Zm	= 0.688905299
K	= 1.121169686	F	= 0.781989098	Phi	= 1.050351381
Q1	=-0.062311340	Qz1	= 1.219081044	Qz2	= 0.677825630
U	= 1.355651259	Gamma	= 0.0"	Omega s	= 0.0in^2
Omega c	= 0.0in^2	Omega s*	=-2.227341890in^2	Omega c*	=-1.231768727in^2
Delta s	= 0.000004880In^3/Lb	Delta c	= 0.000007360In^3/Lb	Gamma b	= 0.0
Ps'	= 0.0psi	Pt'	= 864.6029663psi	P Gamma	= 0.0psi
PW	= 0.0psi	Prim	=-10.75755882psi	Es,w	= 0.850000024
Pe	=-289.3275757psi	Q2	= 234.4058228#	Q3	=-0.094136558
Fm	= 0.140259594	Es,w1	= 0.0	lt	= 27.50000000"
Rt	= 0.237638906"	Ft	= 115.7217941	Ct	= 159.8189392
Fs	= 2.000000000	Stb	= 6700.172363psi	Ft,min	= 0.761786759
Sigmat,1	=-29.70440865psi	Sigmat,2	= 586.3126831psi	Ft,max	= 1.190080166
Sigma s,m	= 336.0374146psi	Sigma s,b	=-5881.111816psi	Sigma s	= 6217.149414psi
Sigma c,m	= 5003.301758psi	Sigma c,b	= 20745.13477psi	Sigma c	= 25748.43750psi

Thermal Expansion Acting on this Case (No)

/// Sigma per Simply Supported Calculations ///

Betas,Kappas,Lambdas,Deltas,Omegas=0 Betac,Kappac,Lambdac,Deltac,Omegac=0

F	= 0.247800201	Phi	= 0.332840055	Q1	= 0.010443920
Qz1	= 1.285379529	Qz2	= 0.950378060	U	= 1.900756121
Omega s*	= 0.123963267in^2	Omega c*	= 0.642959952in^2	Prim	= 7.873120308psi
Pe	=-275.4316101psi	Q2	=-171.5542755#	Q3	= 0.034910910

Sigma = | -6799 psi |

Sigma	-5175 psi	<= 1.5S	29130 psi	[OK	Per Simply Sup]
Tau	-1876 psi	<= .8S	15536 psi	[OK	]
Sigmat,max	586 psi	< St	13384 psi	[OK	]
Sigmat,min	-29 psi	<= Stb	6700 psi	[OK	]
Sigma s	6217 psi	<= Spss	56489 psi	[OK	Per Simply Sup]
Sigma c	25748 psi	<= Spsc	60130 psi	[OK	Per Simply Sup]
Sigmas,m	336 psi	<=SsEs,w	14535 psi	[OK	] Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 2

(FTS) Configuration a

Tubesheet Thickness (h)	= 2.7500"		
F-F Tubesheets (Lt)	= 167.6250"	F-F Inside Tubesheets (L)	= 162.1250"
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.5000"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 15.2500"	Shell thickness (Ts)	= 0.3750"
Press Chan (Pt)	= 0.0psi	Press Shell (Ps)	= 463.0psi
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi

Mu= 0.2000 d*= 0.6406" P*= 0.9375" Mu*= 0.3167 hg'= 0.0000" hgs'= 0.0000"

W	= 0.0#	wj	= 0.0"	ao	= 7.135405064"
Rho s	= 1.068614841	Rho c	= 1.086133122	Chi s	= 0.489028096
Chi t	= 0.690186620	Ks	= 3065028.500Lb/In	Kt	= 29157.69727Lb/In
Ks,t	= 0.568210900	j	= 1.000000000	Beta s	= 0.750982881in^-1
Kappa s	= 195800.8281#	Lambda s	= 4477665.500psi	Beta c	= 0.916105211in^-1
Kappa c	= 72776.67188#	Lambda c	= 2178102.500psi	h/p	= 2.933333397
E*	= 8183711.000psi	v*	= 0.343179107	Xa	= 1.815992355
Zd	= 0.234626889	Zv	= 0.167576507	Zm	= 0.688905299
K	= 1.121169686	F	= 0.781989098	Phi	= 1.050351381
Q1	=-0.062311340	Qz1	= 1.219081044	Qz2	= 0.677825630
U	= 1.355651259	Gamma	= 0.0"	Omega s	= 0.0in^2
Omega c	= 0.0in^2	Omega s*	=-2.227341890in^2	Omega c*	=-1.231768727in^2
Delta s	= 0.000004880In^3/Lb	Delta c	= 0.000007360In^3/Lb	Gamma b	= 0.0
Ps'	= 811.0084839psi	Pt'	= 0.0psi	P Gamma	= 0.0psi
PW	= 0.0psi	Prim	= 27.45861244psi	Es,w	= 0.850000024
Pe	= 277.1334229psi	Q2	=-598.3196411#	Q3	=-0.147119388
Fm	= 0.118377589	Es,w1	= 0.0	lt	= 27.50000000"
Rt	= 0.237638906"	Ft	= 115.7217941	Ct	= 159.8189392
Fs	= 2.000000000	Stb	= 6700.172363psi	Ft,min	= 0.808290243
Sigmat,1	= 12.00926876psi	Sigmat,2	=-447.4617615psi	Ft,max	= 1.141799331
Sigma s,m	= 2979.139404psi	Sigma s,b	= 16118.24707psi	Sigma s	= 19097.38672psi
Sigma c,m	= 0.0psi	Sigma c,b	=-3273.823486psi	Sigma c	= 3273.823486psi

Thermal Expansion Acting on this Case (No)

/// Sigma per Simply Supported Calculations ///

Betas,Kappas,Lambdas,Deltas,Omegas=0 Betac,Kappac,Lambdac,Deltac,Omegac=0

F	= 0.247800201	Phi	= 0.332840055	Q1	= 0.010443920
Qz1	= 1.285379529	Qz2	= 0.950378060	U	= 1.900756121
Omega s*	= 0.123963267in^2	Omega c*	= 0.642959952in^2	Prim	=-2.142708778psi
Pe	= 260.0437012psi	Q2	= 46.68935013#	Q3	= 0.017496770

Sigma = | 6180 psi |

Sigma	4183 psi	<= 1.5S	29130 psi	[OK	Per Simply Sup]
Tau	1797 psi	<= .8S	15536 psi	[OK	]
Sigmat,max	447 psi	< St	13384 psi	[OK	]
Sigmat,min	-447 psi	<= Stb	6700 psi	[OK	]
Sigma s	19097 psi	<= Spss	56489 psi	[OK	Per Simply Sup]
Sigma c	3273 psi	<= Spsc	60130 psi	[OK	Per Simply Sup]
Sigmas,m	2979 psi	<=SsEs,w	14535 psi	[OK	] Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 3

```
(FTS)  Configuration a
Tubesheet Thickness (h)    =   2.7500"
F-F Tubesheets (Lt)        = 167.6250"      F-F Inside Tubesheets (L)= 162.1250"
Exp length of tube (ltx)   =   2.6125"      Exp depth ratio (Rho)    =   0.9500"
Channel I.D. (Dc)          =  15.5000"      Channel thickness (Tc)   =   0.2500"
Shell I.D. (Ds)            =  15.2500"      Shell thickness (Ts)     =   0.3750"

Press Chan (Pt)            =    328.0psi    Press Shell (Ps)         =    463.0psi
Corr Chan                  =  0.12500"      Corr Shell               =  0.12500"
Corr Chan side TS (ct)     =  0.12500"      Corr Shell side TS (cs)  =  0.12500"
```

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi

```
Mu=  0.2000 d*=  0.6406"    P*=  0.9375"    Mu*=  0.3167 hg'=  0.0000"    hgs'=  0.0000"
W         =          0.0#        wj        =          0.0"        ao       = 7.135405064"
Rho s     = 1.068614841          Rho c     = 1.086133122          Chi s    = 0.489028096
Chi t     = 0.690186620          Ks        = 3065028.500Lb/In     Kt       = 29157.69727Lb/In
Ks,t      = 0.568210900          j         = 1.000000000          Beta s   = 0.750982881in^-1
Kappa s   = 195800.8281#         Lambda s  = 4477665.500psi       Beta c   = 0.916105211in^-1
Kappa c   = 72776.67188#         Lambda c  = 2178102.500psi       h/p      = 2.933333397
E*        = 8183711.000psi       v*        = 0.343179107          Xa       = 1.815992355
Zd        = 0.234626889          Zv        = 0.167576507          Zm       = 0.688905299
K         = 1.121169686          F         = 0.781989098          Phi      = 1.050351381
Q1        =-0.062311340          Qz1       = 1.219081044          Qz2      = 0.677825630
U         = 1.355651259          Gamma     =          0.0"        Omega s  =          0.0in^2
Omega c   =          0.0in^2     Omega s*  =-2.227341890in^2      Omega c* =-1.231768727in^2
Delta s   = 0.000004880In^3/Lb   Delta c   = 0.000007360In^3/Lb   Gamma b  =          0.0
Ps'    =    811.0084839psi      Pt'    =    864.6029663psi      P Gamma  =          0.0psi
PW        =          0.0psi      Prim      = 16.70105362psi       Es,w     = 0.850000024
Pe        =-12.19415951psi       Q2        =-363.9138184#         Q3       = 1.109990358
Fm        = 0.644170761          Es,w1     =          0.0         lt       = 27.50000000"
Rt        = 0.237638906"         Ft        = 115.7217941          Ct       = 159.8189392
Fs        = 2.000000000          Stb       = 6700.172363psi       Ft,min   =-0.295084894
Sigmat,1 =-17.69507408psi        Sigmat,2  = 138.8509216psi       Ft,max   = 2.287344933
Sigma s,m= 3315.177002psi        Sigma s,b= 10237.13477psi        Sigma s  = 13552.31152psi
Sigma c,m= 5003.301758psi        Sigma c,b= 17471.31250psi        Sigma c  = 22474.61328psi
Thermal Expansion Acting on this Case (No )
              /// Sigma per Simply Supported Calculations ///
Betas,Kappas,Lambdas,Deltas,Omegas=0    Betac,Kappac,Lambdac,Deltac,Omegac=0
F         = 0.247800201          Phi       = 0.332840055          Q1       = 0.010443920
Qz1       = 1.285379529          Qz2       = 0.950378060          U        = 1.900756121
Omega s*  = 0.123963267in^2      Omega c*= 0.642959952in^2        Prim     = 5.730411530psi
Pe        =-15.38790512psi       Q2        =-124.8649292#         Q3       = 0.329196513
                                                          Sigma    = |     -618 psi  |
Sigma      |  -1001 psi  | <= 1.5S    29130 psi   [OK Per Simply Sup]
Tau        |    -79 psi  | <= .8S     15536 psi   [OK               ]
Sigmat,max |    138 psi  | <  St       13384 psi   [OK               ]
Sigmat,min |    -17 psi  | <= Stb       6700 psi   [OK               ]
Sigma s    |  13552 psi  | <= Spss     56489 psi   [OK Per Simply Sup]
Sigma c    |  22474 psi  | <= Spsc     60130 psi   [OK Per Simply Sup]
Sigmas,m   |   3315 psi  | <=SsEs,w    14535 psi   [OK               ] Step 10
```

ASME SEC.VIII DIV.1 UHX-13 Case 4

(FTS) Configuration a

Tubesheet Thickness (h)	= 2.7500"		
F-F Tubesheets (Lt)	= 167.6250"	F-F Inside Tubesheets (L)	= 162.1250"
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.5000"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 15.2500"	Shell thickness (Ts)	= 0.3750"
Press Chan (Pt)	= 0.0psi	Press Shell (Ps)	= 0.0psi
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi

Tt,m = 390deg.F At,m= 7.0800In/In
Ts,m = 422deg.F As,m= 7.1440In/In

Mu= 0.2000	d*= 0.6406"	P*= 0.9375"	Mu*= 0.3167	hg'= 0.0000"	hgs'= 0.0000"
W	= 0.0#	wj	= 0.0"	ao	= 7.135405064"
Rho s	= 1.068614841	Rho c	= 1.086133122	Chi s	= 0.489028096
Chi t	= 0.690186620	Ks	= 3065028.500Lb/In	Kt	= 29157.69727Lb/In
Ks,t	= 0.568210900	j	= 1.000000000	Beta s	= 0.750982881in^-1
Kappa s	= 195800.8281#	Lambda s	= 4477665.500psi	Beta c	= 0.916105211in^-1
Kappa c	= 72776.67188#	Lambda c	= 2178102.500psi	h/p	= 2.933333397
E*	= 8183711.000psi	v*	= 0.343179107	Xa	= 1.815992355
Zd	= 0.234626889	Zv	= 0.167576507	Zm	= 0.688905299
K	= 1.121169686	F	= 0.781989098	Phi	= 1.050351381
Q1	=-0.062311340	Qz1	= 1.219081044	Qz2	= 0.677825630
U	= 1.355651259	Gamma	=-0.040383380"	Omega s	= 2.351305246in^2
Omega c	= 1.874728680in^2	Omega s*	=-2.227341890in^2	Omega c*	=-1.231768727in^2
Delta s	= 0.000004880In^3/Lb	Delta c	= 0.000007360In^3/Lb	Gamma b	= 0.0
Ps'	= 0.0psi	Pt'	= 0.0psi	P Gamma	=-1361.885132psi
PW	= 0.0psi	Prim	= 0.0psi	Es,w	= 0.850000024
Pe	=-450.1355896psi	Q2	= 0.0#	Q3	=-0.062311340
Fm	= 0.153403476	Es,wl	= 0.0	lt	= 0.0"
Rt	= 0.0"	Ft	= 0.0	Ct	= 0.0
Fs	= 0.0	Stb	= 0.0psi	Ft,min	= 0.733853519
Sigmat,1	= 1642.155518psi	Sigmat,2	= 2727.956543psi	Ft,max	= 1.219080925
Sigma s,m	=-3911.373779psi	Sigma s,b	=-8685.994141psi	Sigma s	= 12597.36816psi
Sigma c,m	= 0.0psi	Sigma c,b	= 10008.71875psi	Sigma c	= 10008.71875psi

Thermal Expansion Acting on this Case (Yes)

Sigma	-8806 psi	<= Sps	58260 psi	[OK	]	
Tau	-2919 psi	<= .8S	15536 psi	[OK	]	
Sigmat,max	2727 psi	<= 2St	26769 psi	[OK	]	
Sigma s	12597 psi	<= Spss	56489 psi	[OK	]	
Sigma c	10008 psi	<= Spsc	60130 psi	[OK	]	
Sigmas,m	-3911 psi	<=2Ss	34200 psi	[OK	]	Step 10
Sigmas,m	-3911 psi	<=Ss,b	13402 psi	[OK	]	Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 5

```
(FTS)  Configuration a
Tubesheet Thickness (h)    =   2.7500"
F-F Tubesheets (Lt)        = 167.6250"      F-F Inside Tubesheets (L)= 162.1250"
Exp length of tube (ltx)   =   2.6125"      Exp depth ratio (Rho)    =   0.9500"
Channel I.D. (Dc)          =  15.5000"      Channel thickness (Tc)   =   0.2500"
Shell I.D. (Ds)            =  15.2500"      Shell thickness (Ts)     =   0.3750"

Press Chan (Pt)            =    328.0psi    Press Shell (Ps)         =      0.0psi
Corr Chan                  =  0.12500"      Corr Shell               =  0.12500"
Corr Chan side TS (ct)     =  0.12500"      Corr Shell side TS (cs)  =  0.12500"
```

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi

```
Tt,m       = 390deg.F                                   At,m= 7.0800In/In
Ts,m       = 422deg.F                                   As,m= 7.1440In/In

Mu=  0.2000 d*=  0.6406"    P*=  0.9375"    Mu*=  0.3167 hg'=  0.0000"    hgs'=  0.0000"
W          =          0.0#       wj       =          0.0"      ao      = 7.135405064"
Rho s      = 1.068614841         Rho c     = 1.086133122       Chi s   = 0.489028096
Chi t      = 0.690186620         Ks        = 3065028.500Lb/In  Kt      = 29157.69727Lb/In
Ks,t       = 0.568210900         j         = 1.000000000       Beta s  = 0.750982881in^-1
Kappa s    = 195800.8281#        Lambda s  = 4477665.500psi    Beta c  = 0.916105211in^-1
Kappa c    = 72776.67188#        Lambda c  = 2178102.500psi    h/p     = 2.933333397
E*         = 8183711.000psi      v*        = 0.343179107       Xa      = 1.815992355
Zd         = 0.234626889         Zv        = 0.167576507       Zm      = 0.688905299
K          = 1.121169686         F         = 0.781989098       Phi     = 1.050351381
Q1         =-0.062311340         Qz1       = 1.219081044       Qz2     = 0.677825630
U          = 1.355651259         Gamma     =-0.040383380"      Omega s = 2.351305246in^2
Omega c    = 1.874728680in^2     Omega s*  =-2.227341890in^2    Omega c*=-1.231768727in^2
Delta s    = 0.000004880In^3/Lb  Delta c   = 0.000007360In^3/Lb Gamma b =          0.0
Ps'    =           0.0psi       Pt'    =   864.6029663psi     P Gamma =-1361.885132psi
PW         =          0.0psi     Prim      =-10.75755882psi    Es,w    = 0.850000024
Pe         =-739.4631348psi      Q2        = 234.4058228#      Q3      =-0.074763499
Fm         = 0.148260713         Es,w1     =          0.0      lt      =          0.0"
Rt         =          0.0"       Ft        =          0.0      Ct      =          0.0
Fs         =          0.0        Stb       =          0.0psi   Ft,min  = 0.744782865
Sigmat,1 = 1612.451050psi        Sigmat,2 = 3314.269043psi     Ft,max  = 1.207733870
Sigma s,m=-3575.336182psi        Sigma s,b=-14567.10547psi     Sigma s = 18142.44141psi
Sigma c,m= 5003.301758psi        Sigma c,b= 30753.85352psi     Sigma c = 35757.15625psi
Thermal Expansion Acting on this Case (Yes)
```

Sigma	-13982 psi	<= Sps	58260 psi	[OK]	
Tau	-4796 psi	<= .8S	15536 psi	[OK]	
Sigmat,max	3314 psi	<= 2St	26769 psi	[OK]	
Sigma s	18142 psi	<= Spss	56489 psi	[OK]	
Sigma c	35757 psi	<= Spsc	60130 psi	[OK]	
Sigmas,m	-3575 psi	<=2Ss	34200 psi	[OK]	Step 10
Sigmas,m	-3575 psi	<=Ss,b	13402 psi	[OK]	Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 6

(FTS) Configuration a

Tubesheet Thickness (h)	= 2.7500"		
F-F Tubesheets (Lt)	= 167.6250"	F-F Inside Tubesheets (L)	= 162.1250"
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.5000"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 15.2500"	Shell thickness (Ts)	= 0.3750"
Press Chan (Pt)	= 0.0psi	Press Shell (Ps)	= 463.0psi
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi
Tt,m	= 390deg.F			At,m= 7.0800In/In			
Ts,m	= 422deg.F			As,m= 7.1440In/In			

Mu= 0.2000	d*= 0.6406"	P*= 0.9375"	Mu*= 0.3167	hg'= 0.0000"	hgs'= 0.0000"
W = 0.0#	wj = 0.0"			ao = 7.135405064"	
Rho s = 1.068614841	Rho c = 1.086133122			Chi s = 0.489028096	
Chi t = 0.690186620	Ks = 3065028.500Lb/In			Kt = 29157.69727Lb/In	
Ks,t = 0.568210900	j = 1.000000000			Beta s = 0.75098288$1in^-1$	
Kappa s = 195800.8281#	Lambda s = 4477665.500psi			Beta c = 0.91610521$1in^-1$	
Kappa c = 72776.67188#	Lambda c = 2178102.500psi			h/p = 2.933333397	
E* = 8183711.000psi	v* = 0.343179107			Xa = 1.815992355	
Zd = 0.234626889	Zv = 0.167576507			Zm = 0.688905299	
K = 1.121169686	F = 0.781989098			Phi = 1.050351381	
Q1 = -0.062311340	Qz1 = 1.219081044			Qz2 = 0.677825630	
U = 1.355651259	Gamma = -0.040383380"			Omega s = 2.351305246in^2	
Omega c = 1.874728680in^2	Omega s* = -2.227341890in^2			Omega c* = -1.231768727in^2	
Delta s = 0.000004880In^3/Lb	Delta c = 0.000007360In^3/Lb			Gamma b = 0.0	
Ps' = 811.0084839psi	Pt' = 0.0psi			P Gamma = -1361.885132psi	
PW = 0.0psi	Prim = 27.45861244psi			Es,w = 0.850000024	
Pe = -173.0021667psi	Q2 = -598.3196411#			Q3 = 0.073543288	
Fm = 0.209511697	Es,w1 = 0.0			lt = 0.0"	
Rt = 0.0"	Ft = 0.0			Ct = 0.0	
Fs = 0.0	Stb = 0.0psi			Ft,min = 0.614612877	
Sigmat,1 = 1654.164917psi	Sigmat,2 = 2280.494873psi			Ft,max = 1.342878938	
Sigma s,m = -932.2342529psi	Sigma s,b = 7432.252930psi			Sigma s = 8364.487305psi	
Sigma c,m = 0.0psi	Sigma c,b = 6734.895508psi			Sigma c = 6734.895508psi	

Thermal Expansion Acting on this Case (Yes)

Sigma	-4622 psi	<= Sps	58260 psi	[OK	]	
Tau	-1122 psi	<= .8S	15536 psi	[OK	]	
Sigmat,max	2280 psi	<= 2St	26769 psi	[OK	]	
Sigma s	8364 psi	<= Spss	56489 psi	[OK	]	
Sigma c	6734 psi	<= Spsc	60130 psi	[OK	]	
Sigmas,m	-932 psi	<=2Ss	34200 psi	[OK	]	Step 10
Sigmas,m	-932 psi	<=Ss,b	13402 psi	[OK	]	Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 7

```
(FTS)  Configuration a
Tubesheet Thickness (h)    =   2.7500"
F-F Tubesheets (Lt)        = 167.6250"      F-F Inside Tubesheets (L)= 162.1250"
Exp length of tube (ltx)   =   2.6125"      Exp depth ratio (Rho)    =   0.9500"
Channel I.D. (Dc)          =  15.5000"      Channel thickness (Tc)   =   0.2500"
Shell I.D. (Ds)            =  15.2500"      Shell thickness (Ts)     =   0.3750"

Press Chan (Pt)            =    328.0psi    Press Shell (Ps)         =    463.0psi
Corr Chan                  =  0.12500"      Corr Shell               =  0.12500"
Corr Chan side TS (ct)     =  0.12500"      Corr Shell side TS (cs)  =  0.12500"
```

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi

```
Tt,m       = 390deg.F                                   At,m= 7.0800In/In
Ts,m       = 422deg.F                                   As,m= 7.1440In/In

Mu=  0.2000 d*=  0.6406"    P*=  0.9375"    Mu*=  0.3167 hg'=  0.0000"    hgs'=  0.0000"
W          =         0.0#       wj       =         0.0"       ao       = 7.135405064"
Rho s      = 1.068614841        Rho c     = 1.086133122        Chi s    = 0.489028096
Chi t      = 0.690186620        Ks        = 3065028.500Lb/In   Kt       = 29157.69727Lb/In
Ks,t       = 0.568210900        j         = 1.000000000        Beta s   = 0.75098288lin^-1
Kappa s    = 195800.8281#       Lambda s  = 4477665.500psi     Beta c   = 0.916105211in^-1
Kappa c    = 72776.67188#       Lambda c  = 2178102.500psi     h/p      = 2.933333397
E*         = 8183711.000psi     v*        = 0.343179107        Xa       = 1.815992355
Zd         = 0.234626889        Zv        = 0.167576507        Zm       = 0.688905299
K          = 1.121169686        F         = 0.781989098        Phi      = 1.050351381
Q1         =-0.062311340        Qz1       = 1.219081044        Qz2      = 0.677825630
U          = 1.355651259        Gamma     =-0.040383380"       Omega s  = 2.351305246in^2
Omega c    = 1.874728680in^2    Omega s*  =-2.227341890in^2     Omega c*=-1.231768727in^2
Delta s    = 0.000004880In^3/Lb Delta c   = 0.000007360In^3/Lb Gamma b  =         0.0
Ps'    =   811.0084839psi      Pt'    =   864.6029663psi      P Gamma  =-1361.885132psi
PW         =         0.0psi     Prim      = 16.70105362psi     Es,w     = 0.850000024
Pe         =-462.3297424psi     Q2        =-363.9138184#       Q3       =-0.031391341
Fm         = 0.166173488        Es,w1     =         0.0        lt       =         0.0"
Rt         =         0.0"       Ft        =         0.0        Ct       =         0.0
Fs         =         0.0        Stb       =         0.0psi     Ft,min   = 0.706714809
Sigmat,1 = 1624.460449psi       Sigmat,2 = 2866.807617psi     Ft,max   = 1.247256994
Sigma s,m=-596.1968384psi       Sigma s,b= 1551.140869psi     Sigma s  = 2147.337646psi
Sigma c,m= 5003.301758psi       Sigma c,b= 27480.03125psi     Sigma c  = 32483.33203psi
Thermal Expansion Acting on this Case (Yes)
```

Sigma	-9798 psi	<= Sps	58260 psi	[OK]	
Tau	-2999 psi	<= .8S	15536 psi	[OK]	
Sigmat,max	2866 psi	<= 2St	26769 psi	[OK]	
Sigma s	2147 psi	<= Spss	56489 psi	[OK]	
Sigma c	32483 psi	<= Spsc	60130 psi	[OK]	
Sigmas,m	-596 psi	<=2Ss	34200 psi	[OK]	Step 10
Sigmas,m	-596 psi	<=Ss,b	13402 psi	[OK]	Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 8

(FTS) Configuration a

Tubesheet Thickness (h)	= 3.0000"		
F-F Tubesheets (Lt)	= 167.8750"	F-F Inside Tubesheets (L)	= 161.8750"
Exp length of tube (ltx)	= 2.8500"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.2500"	Channel thickness (Tc)	= 0.3750"
Shell I.D. (Ds)	= 15.0000"	Shell thickness (Ts)	= 0.5000"
Press Chan (Pt)	= 328.0psi	Press Shell (Ps)	= 0.0psi
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 x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi

Mu= 0.2000 d*= 0.6406" P*= 0.9375" Mu*= 0.3167 hg'= 0.0000" hgs'= 0.0000"

W	= 0.0#	wj	= 0.0"	ao	= 7.135405064"
Rho s	= 1.051096559	Rho c	= 1.068614841	Chi s	= 0.489028096
Chi t	= 0.690186620	Ks	= 4060272.000Lb/In	Kt	= 29202.72852Lb/In
Ks,t	= 0.751553595	j	= 1.000000000	Beta s	= 0.652987421in^-1
Kappa s	= 403557.5938#	Lambda s	= 6561481.500psi	Beta c	= 0.750982881in^-1
Kappa c	= 201349.5469#	Lambda c	= 3951385.000psi	h/p	= 3.200000048
E*	= 8183711.000psi	v*	= 0.343179107	Xa	= 1.701923966
Zd	= 0.290400684	Zv	= 0.171428442	Zm	= 0.700460076
K	= 1.121169686	F	= 1.091558099	Phi	= 1.466158032
Q1	=-0.098789386	Qz1	= 1.147183657	Qz2	= 0.428855240
U	= 0.857710540	Gamma	= 0.0"	Omega s	= 0.0in^2
Omega c	= 0.0in^2	Omega s*	=-2.835061073in^2	Omega c*	=-1.925397873in^2
Delta s	= 0.000003540In^3/Lb	Delta c	= 0.000004750In^3/Lb	Gamma b	= 0.0
Ps'	= 0.0psi	Pt'	= 723.7817993psi	P Gamma	= 0.0psi
PW	= 0.0psi	Prim	=-10.63892651psi	Es,w	= 0.850000024
Pe	=-293.8066406psi	Q2	= 311.5614929#	Q3	=-0.140445143
Fm	= 0.124783158	Es,w1	= 0.0	lt	= 0.0"
Rt	= 0.0"	Ft	= 0.0	Ct	= 0.0
Fs	= 0.0	Stb	= 0.0psi	Ft,min	= 0.843329072
Sigmat,1	= 106.3562698psi	Sigmat,2	= 504.9070129psi	Ft,max	= 1.116201997
Sigma s,m	= 224.6351318psi	Sigma s,b	=-3699.683838psi	Sigma s	= 3924.318848psi
Sigma c,m	= 3254.634766psi	Sigma c,b	= 13458.42090psi	Sigma c	= 16713.05469psi

Thermal Expansion Acting on this Case (No)

/// Sigma per Simply Supported Calculations ///

Betas,Kappas,Lambdas,Deltas,Omegas=0 Betac,Kappac,Lambdac,Deltac,Omegac=0

F	= 0.247800201	Phi	= 0.332840055	Q1	=-0.004834560
Qz1	= 1.214750290	Qz2	= 0.704934061	U	= 1.409868121
Omega s*	= 0.068162687in^2	Omega c*	= 0.569926202in^2	Prim	= 5.176469803psi
Pe	=-278.3838501psi	Q2	=-151.5931854#	Q3	= 0.016556310

Sigma = | -5741 psi |

Sigma	-3928 psi	<= 1.5S	29130 psi	[OK	Per Simply Sup]
Tau	-1747 psi	<= .8S	15536 psi	[OK	]
Sigmat,max	504 psi	< St	13384 psi	[OK	]
Sigma s	3924 psi	<= Spss	56489 psi	[OK	Per Simply Sup]
Sigma c	16713 psi	<= Spsc	60130 psi	[OK	Per Simply Sup]
Sigmas,m	224 psi	<=SsEs,w	14535 psi	[OK	] Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 9

```
(FTS)  Configuration a
Tubesheet Thickness (h)    =   3.0000"
F-F Tubesheets (Lt)        = 167.8750"      F-F Inside Tubesheets (L)= 161.8750"
Exp length of tube (ltx)   =   2.8500"      Exp depth ratio (Rho)    =   0.9500"
Channel I.D. (Dc)          =  15.2500"      Channel thickness (Tc)   =   0.3750"
Shell I.D. (Ds)            =  15.0000"      Shell thickness (Ts)     =   0.5000"

Press Chan (Pt)            =      0.0psi    Press Shell (Ps)         =    463.0psi
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 x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi

```
Mu=  0.2000 d*=  0.6406"    P*=  0.9375"    Mu*=  0.3167 hg'=  0.0000"    hgs'=  0.0000"
W        =          0.0#        wj       =          0.0"        ao       = 7.135405064"
Rho s    = 1.051096559          Rho c    = 1.068614841          Chi s    = 0.489028096
Chi t    = 0.690186620          Ks       = 4060272.000Lb/In     Kt       = 29202.72852Lb/In
Ks,t     = 0.751553595          j        = 1.000000000          Beta s   = 0.652987421in^-1
Kappa s  = 403557.5938#         Lambda s = 6561481.500psi       Beta c   = 0.750982881in^-1
Kappa c  = 201349.5469#         Lambda c = 3951385.000psi       h/p      = 3.200000048
E*       = 8183711.000psi       v*       = 0.343179107          Xa       = 1.701923966
Zd       = 0.290400684          Zv       = 0.171428442          Zm       = 0.700460076
K        = 1.121169686          F        = 1.091558099          Phi      = 1.466158032
Q1       =-0.098789386          Qz1      = 1.147183657          Qz2      = 0.428855240
U        = 0.857710540          Gamma    =          0.0"        Omega s =          0.0in^2
Omega c  =          0.0in^2     Omega s* =-2.835061073in^2      Omega c*=-1.925397873in^2
Delta s  = 0.000003540In^3/Lb   Delta c  = 0.000004750In^3/Lb   Gamma b =          0.0
Ps'    =   712.1762695psi       Pt'    =          0.0psi       P Gamma =          0.0psi
PW       =          0.0psi      Prim     = 22.11296082psi       Es,w     = 0.850000024
Pe       = 293.7540283psi       Q2       =-647.5791016#         Q3       =-0.185386166
Fm       = 0.105413839          Es,w1    =          0.0         lt       = 27.50000000"
Rt       = 0.237638906"         Ft       = 115.7217941          Ct       = 159.8189392
Fs       = 2.000000000          Stb      = 6700.172363psi       Ft,min   = 0.874724805
Sigmat,l =-151.7903748psi       Sigmat,2 =-457.8683167psi       Ft,max   = 1.084322572
Sigma s,m= 2248.613770psi       Sigma s,b= 11225.03125psi       Sigma s  = 13473.64453psi
Sigma c,m=          0.0psi      Sigma c,b=-1941.632080psi       Sigma c  = 1941.632080psi
Thermal Expansion Acting on this Case (No )
             /// Sigma per Simply Supported Calculations ///
Betas,Kappas,Lambdas,Deltas,Omegas=0   Betac,Kappac,Lambdac,Deltac,Omegac=0
F        = 0.247800201          Phi      = 0.332840055          Q1       =-0.004834560
Qz1      = 1.214750290          Qz2      = 0.704934061          U        = 1.409868121
Omega s* = 0.068162687in^2      Omega c*= 0.569926202in^2      Prim     =-0.873914421psi
Pe       = 275.5547180psi       Q2       = 25.59262848#         Q3       =-0.001186180
                                                        Sigma    = |     5457 psi  |
Sigma     |   3318 psi  | <= 1.5S    29130 psi   [OK Per Simply Sup]
Tau       |   1746 psi  | <= .8S     15536 psi   [OK                ]
Sigmat,max|    457 psi  | <  St      13384 psi   [OK                ]
Sigmat,min|   -457 psi  | <= Stb      6700 psi   [OK                ]
Sigma s   |  13473 psi  | <= Spss    56489 psi   [OK Per Simply Sup]
Sigma c   |   1941 psi  | <= Spsc    60130 psi   [OK Per Simply Sup]
Sigmas,m  |   2248 psi  | <=SsEs,w   14535 psi   [OK                ] Step 10
```

ASME SEC.VIII DIV.1 UHX-13 Case 10

(FTS) Configuration a

Tubesheet Thickness (h)	= 3.0000"		
F-F Tubesheets (Lt)	= 167.8750"	F-F Inside Tubesheets (L)	= 161.8750"
Exp length of tube (ltx)	= 2.8500"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.2500"	Channel thickness (Tc)	= 0.3750"
Shell I.D. (Ds)	= 15.0000"	Shell thickness (Ts)	= 0.5000"
Press Chan (Pt)	= 328.0psi	Press Shell (Ps)	= 463.0psi
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 x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi	V =.300	Sps =	58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi	Vt=.300		
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi	Vc=.300	Spsc=	60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi	Vs=.300	Spss=	56489psi

Mu= 0.2000 d*= 0.6406" P*= 0.9375" Mu*= 0.3167 hg'= 0.0000" hgs'= 0.0000"

W	= 0.0#	wj	= 0.0"	ao	= 7.135405064"
Rho s	= 1.051096559	Rho c	= 1.068614841	Chi s	= 0.489028096
Chi t	= 0.690186620	Ks	= 4060272.000Lb/In	Kt	= 29202.72852Lb/In
Ks,t	= 0.751553595	j	= 1.000000000	Beta s	= 0.652987421in^-1
Kappa s	= 403557.5938#	Lambda s	= 6561481.500psi	Beta c	= 0.750982881in^-1
Kappa c	= 201349.5469#	Lambda c	= 3951385.000psi	h/p	= 3.200000048
E*	= 8183711.000psi	v*	= 0.343179107	Xa	= 1.701923966
Zd	= 0.290400684	Zv	= 0.171428442	Zm	= 0.700460076
K	= 1.121169686	F	= 1.091558099	Phi	= 1.466158032
Q1	=-0.098789386	Qz1	= 1.147183657	Qz2	= 0.428855240
U	= 0.857710540	Gamma	= 0.0"	Omega s	= 0.0in^2
Omega c	= 0.0in^2	Omega s*	=-2.835061073in^2	Omega c*	=-1.925397873in^2
Delta s	= 0.000003540In^3/Lb	Delta c	= 0.000004750In^3/Lb	Gamma b	= 0.0
Ps'	= 712.1762695psi	Pt'	= 723.7817993psi	P Gamma	= 0.0psi
PW	= 0.0psi	Prim	= 11.47403431psi	Es,w	= 0.850000024
Pe	=-0.052605059psi	Q2	=-336.0176392#	Q3	= 250.8166199
Fm	= 125.4954987	Es,w1	= 0.0	lt	= 27.50000000"
Rt	= 0.237638906"	Ft	= 115.7217941	Ct	= 159.8189392
Fs	= 1.250000000	Stb	= 10720.27539psi	Ft,min	=-174.4750366
Sigmat,1	=-45.43417740psi	Sigmat,2	= 47.03876877psi	Ft,max	= 179.1358643
Sigma s,m	= 2473.249023psi	Sigma s,b	= 7525.347168psi	Sigma s	= 9998.595703psi
Sigma c,m	= 3254.634766psi	Sigma c,b	= 11516.78906psi	Sigma c	= 14771.42383psi

Thermal Expansion Acting on this Case (No)

/// Sigma per Simply Supported Calculations ///

Betas,Kappas,Lambdas,Deltas,Omegas=0 Betac,Kappac,Lambdac,Deltac,Omegac=0

F	= 0.247800201	Phi	= 0.332840055	Q1	=-0.004834560
Qz1	= 1.214750290	Qz2	= 0.704934061	U	= 1.409868121
Omega s*	= 0.068162687in^2	Omega c*	= 0.569926202in^2	Prim	= 4.302555561psi
Pe	=-2.829133034psi	Q2	=-126.0005569#	Q3	= 1.744656920

Sigma = | -288 psi |

Sigma	-707 psi	<= 1.5S	29130 psi	[OK	Per Simply Sup]
Tau	0 psi	<= .8S	15536 psi	[OK	]
Sigmat,max	47 psi	< St	13384 psi	[OK	]
Sigmat,min	-45 psi	<= Stb	10720 psi	[OK	]
Sigma s	9998 psi	<= Spss	56489 psi	[OK	Per Simply Sup]
Sigma c	14771 psi	<= Spsc	60130 psi	[OK	Per Simply Sup]
Sigmas,m	2473 psi	<=SsEs,w	14535 psi	[OK	] Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 11

(FTS) Configuration a

Tubesheet Thickness (h)	= 3.0000"		
F-F Tubesheets (Lt)	= 167.8750"	F-F Inside Tubesheets (L)	= 161.8750"
Exp length of tube (ltx)	= 2.8500"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.2500"	Channel thickness (Tc)	= 0.3750"
Shell I.D. (Ds)	= 15.0000"	Shell thickness (Ts)	= 0.5000"
Press Chan (Pt)	= 0.0psi	Press Shell (Ps)	= 0.0psi
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 x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi	V =.300	Sps =	58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi	Vt=.300		
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi	Vc=.300	Spsc=	60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi	Vs=.300	Spss=	56489psi

Tt,m = 390deg.F At,m= 7.0800In/In
Ts,m = 422deg.F As,m= 7.1440In/In

Mu= 0.2000 d*= 0.6406" P*= 0.9375" Mu*= 0.3167 hg'= 0.0000" hgs'= 0.0000"

W	= 0.0#	wj	= 0.0"	ao	= 7.135405064"
Rho s	= 1.051096559	Rho c	= 1.068614841	Chi s	= 0.489028096
Chi t	= 0.690186620	Ks	= 4060272.000Lb/In	Kt	= 29202.72852Lb/In
Ks,t	= 0.751553595	j	= 1.000000000	Beta s	= 0.652987421in^-1
Kappa s	= 403557.5938#	Lambda s	= 6561481.500psi	Beta c	= 0.750982881in^-1
Kappa c	= 201349.5469#	Lambda c	= 3951385.000psi	h/p	= 3.200000048
E*	= 8183711.000psi	v*	= 0.343179107	Xa	= 1.701923966
Zd	= 0.290400684	Zv	= 0.171428442	Zm	= 0.700460076
K	= 1.121169686	F	= 1.091558099	Phi	= 1.466158032
Q1	=-0.098789386	Qz1	= 1.147183657	Qz2	= 0.428855240
U	= 0.857710540	Gamma	=-0.040321112"	Omega s	= 2.903223753in^2
Omega c	= 2.495324135in^2	Omega s*	=-2.835061073in^2	Omega c*	=-1.925397873in^2
Delta s	= 0.000003540In^3/Lb	Delta c	= 0.000004750In^3/Lb	Gamma b	= 0.0
Ps'	= 0.0psi	Pt'	= 0.0psi	P Gamma	=-1361.885132psi
PW	= 0.0psi	Prim	= 0.0psi	Es,w	= 0.850000024
Pe	=-544.8251343psi	Q2	= 0.0#	Q3	=-0.098789386
Fm	= 0.142736554	Es,w1	= 0.0	lt	= 0.0"
Rt	= 0.0"	Ft	= 0.0	Ct	= 0.0
Fs	= 0.0	Stb	= 0.0psi	Ft,min	= 0.814228356
Sigmat,1	= 2205.285889psi	Sigmat,2	= 3103.194336psi	Ft,max	= 1.145751119
Sigma s,m	=-3579.255371psi	Sigma s,b	=-7406.755371psi	Sigma s	= 10986.01074psi
Sigma c,m	= 0.0psi	Sigma c,b	= 8855.452148psi	Sigma c	= 8855.452148psi

Thermal Expansion Acting on this Case (Yes)

Sigma	-8333 psi	<= Sps	58260 psi	[OK	]	
Tau	-3239 psi	<= .8S	15536 psi	[OK	]	
Sigmat,max	3103 psi	<= 2St	26769 psi	[OK	]	
Sigma s	10986 psi	<= Spss	56489 psi	[OK	]	
Sigma c	8855 psi	<= Spsc	60130 psi	[OK	]	
Sigmas,m	-3579 psi	<=2Ss	34200 psi	[OK	]	Step 10
Sigmas,m	-3579 psi	<=Ss,b	13949 psi	[OK	]	Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 12

(FTS) Configuration a

Tubesheet Thickness (h)	= 3.0000"		
F-F Tubesheets (Lt)	= 167.8750"	F-F Inside Tubesheets (L)	= 161.8750"
Exp length of tube (ltx)	= 2.8500"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.2500"	Channel thickness (Tc)	= 0.3750"
Shell I.D. (Ds)	= 15.0000"	Shell thickness (Ts)	= 0.5000"
Press Chan (Pt)	= 328.0psi	Press Shell (Ps)	= 0.0psi
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 x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi

Tt,m = 390deg.F At,m= 7.0800In/In
Ts,m = 422deg.F As,m= 7.1440In/In

Mu= 0.2000 d*= 0.6406" P*= 0.9375" Mu*= 0.3167 hg'= 0.0000" hgs'= 0.0000"

W	= 0.0#	wj	= 0.0"	ao	= 7.135405064"
Rho s	= 1.051096559	Rho c	= 1.068614841	Chi s	= 0.489028096
Chi t	= 0.690186620	Ks	= 4060272.000Lb/In	Kt	= 29202.72852Lb/In
Ks,t	= 0.751553595	j	= 1.000000000	Beta s	= 0.652987421in^-1
Kappa s	= 403557.5938#	Lambda s	= 6561481.500psi	Beta c	= 0.750982881in^-1
Kappa c	= 201349.5469#	Lambda c	= 3951385.000psi	h/p	= 3.200000048
E*	= 8183711.000psi	v*	= 0.343179107	Xa	= 1.701923966
Zd	= 0.290400684	Zv	= 0.171428442	Zm	= 0.700460076
K	= 1.121169686	F	= 1.091558099	Phi	= 1.466158032
Q1	=-0.098789386	Qz1	= 1.147183657	Qz2	= 0.428855240
U	= 0.857710540	Gamma	=-0.040321112"	Omega s	= 2.903223753in^2
Omega c	= 2.495324135in^2	Omega s*	=-2.835061073in^2	Omega c*	=-1.925397873in^2
Delta s	= 0.000003540In^3/Lb	Delta c	= 0.000004750In^3/Lb	Gamma b	= 0.0
Ps'	= 0.0psi	Pt'	= 723.7817993psi	P Gamma	=-1361.885132psi
PW	= 0.0psi	Prim	=-10.63892651psi	Es,w	= 0.850000024
Pe	=-838.6317749psi	Q2	= 311.5614929#	Q3	=-0.113383077
Fm	= 0.136446759	Es,w1	= 0.0	lt	= 0.0"
Rt	= 0.0"	Ft	= 0.0	Ct	= 0.0
Fs	= 0.0	Stb	= 0.0psi	Ft,min	= 0.824423552
Sigmat,1	= 2311.642334psi	Sigmat,2	= 3608.101318psi	Ft,max	= 1.135398865
Sigma s,m	=-3354.620361psi	Sigma s,b	=-11106.43945psi	Sigma s	= 14461.05957psi
Sigma c,m	= 3254.634766psi	Sigma c,b	= 22313.87305psi	Sigma c	= 25568.50781psi

Thermal Expansion Acting on this Case (Yes)

Sigma	-12262 psi	<= Sps	58260 psi	[OK	]	
Tau	-4986 psi	<= .8S	15536 psi	[OK	]	
Sigmat,max	3608 psi	<= 2St	26769 psi	[OK	]	
Sigma s	14461 psi	<= Spss	56489 psi	[OK	]	
Sigma c	25568 psi	<= Spsc	60130 psi	[OK	]	
Sigmas,m	-3354 psi	<=2Ss	34200 psi	[OK	]	Step 10
Sigmas,m	-3354 psi	<=Ss,b	13949 psi	[OK	]	Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 13

(FTS) Configuration a

Tubesheet Thickness (h)	= 3.0000"		
F-F Tubesheets (Lt)	= 167.8750"	F-F Inside Tubesheets (L)	= 161.8750"
Exp length of tube (ltx)	= 2.8500"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.2500"	Channel thickness (Tc)	= 0.3750"
Shell I.D. (Ds)	= 15.0000"	Shell thickness (Ts)	= 0.5000"
Press Chan (Pt)	= 0.0psi	Press Shell (Ps)	= 463.0psi
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 x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi
Tt,m	= 390deg.F			At,m= 7.0800In/In			
Ts,m	= 422deg.F			As,m= 7.1440In/In			

Mu= 0.2000	d*= 0.6406"	P*= 0.9375"	Mu*= 0.3167	hg'= 0.0000"	hgs'= 0.0000"
W = 0.0#	wj = 0.0"	ao = 7.135405064"			
Rho s = 1.051096559	Rho c = 1.068614841	Chi s = 0.489028096			
Chi t = 0.690186620	Ks = 4060272.000Lb/In	Kt = 29202.72852Lb/In			
Ks,t = 0.751553595	j = 1.000000000	Beta s = 0.652987421in^-1			
Kappa s = 403557.5938#	Lambda s = 6561481.500psi	Beta c = 0.750982881in^-1			
Kappa c = 201349.5469#	Lambda c = 3951385.000psi	h/p = 3.200000048			
E* = 8183711.000psi	v* = 0.343179107	Xa = 1.701923966			
Zd = 0.290400684	Zv = 0.171428442	Zm = 0.700460076			
K = 1.121169686	F = 1.091558099	Phi = 1.466158032			
Q1 =-0.098789386	Qz1 = 1.147183657	Qz2 = 0.428855240			
U = 0.857710540	Gamma =-0.040321112"	Omega s = 2.903223753in^2			
Omega c = 2.495324135in^2	Omega s* =-2.835061073in^2	Omega c*=-1.925397873in^2			
Delta s = 0.000003540In^3/Lb	Delta c = 0.000004750In^3/Lb	Gamma b = 0.0			
Ps' = 712.1762695psi	Pt' = 0.0psi	P Gamma =-1361.885132psi			
PW = 0.0psi	Prim = 22.11296082psi	Es,w = 0.850000024			
Pe =-251.0711212psi	Q2 =-647.5791016#	Q3 = 0.002529120			
Fm = 0.186404258	Es,wl = 0.0	lt = 0.0"			
Rt = 0.0"	Ft = 0.0	Ct = 0.0			
Fs = 0.0	Stb = 0.0psi	Ft,min = 0.743447363			
Sigmat,1 = 2053.495850psi	Sigmat,2 = 2645.326172psi	Ft,max = 1.217622638			
Sigma s,m=-1330.641724psi	Sigma s,b= 3818.275391psi	Sigma s = 5148.916992psi			
Sigma c,m= 0.0psi	Sigma c,b= 6913.820801psi	Sigma c = 6913.820801psi			

Thermal Expansion Acting on this Case (Yes)

Sigma	-5015 psi	<= Sps	58260 psi	[OK	]	
Tau	-1492 psi	<= .8S	15536 psi	[OK	]	
Sigmat,max	2645 psi	<= 2St	26769 psi	[OK	]	
Sigma s	5148 psi	<= Spss	56489 psi	[OK	]	
Sigma c	6913 psi	<= Spsc	60130 psi	[OK	]	
Sigmas,m	-1330 psi	<=2Ss	34200 psi	[OK	]	Step 10
Sigmas,m	-1330 psi	<=Ss,b	13949 psi	[OK	]	Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 14

(FTS) Configuration a

Tubesheet Thickness (h)	= 3.0000"		
F-F Tubesheets (Lt)	= 167.8750"	F-F Inside Tubesheets (L)	= 161.8750"
Exp length of tube (ltx)	= 2.8500"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.2500"	Channel thickness (Tc)	= 0.3750"
Shell I.D. (Ds)	= 15.0000"	Shell thickness (Ts)	= 0.5000"
Press Chan (Pt)	= 328.0psi	Press Shell (Ps)	= 463.0psi
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 x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 515deg.F	S = 19420psi	Sy = 29045psi	E =26.9950psi		V =.300	Sps = 58260psi
Temp TBS	Tt= 515deg.F	St = 13384psi	Syt= 21005psi	Et =27.1800psi		Vt=.300	
Temp CH	Tc= 385deg.F	Sc = 17100psi	Syc= 30065psi	Ec =27.7600psi		Vc=.300	Spsc= 60130psi
Temp SH	Ts= 515deg.F	Ss = 17100psi	Sys= 28244psi	Es =26.9950psi		Vs=.300	Spss= 56489psi

Tt,m = 390deg.F At,m= 7.0800In/In
Ts,m = 422deg.F As,m= 7.1440In/In

Mu= 0.2000 d*= 0.6406" P*= 0.9375" Mu*= 0.3167 hg'= 0.0000" hgs'= 0.0000"

W	= 0.0#	wj	= 0.0"	ao	= 7.135405064"
Rho s	= 1.051096559	Rho c	= 1.068614841	Chi s	= 0.489028096
Chi t	= 0.690186620	Ks	= 4060272.000Lb/In	Kt	= 29202.72852Lb/In
Ks,t	= 0.751553595	j	= 1.000000000	Beta s	= 0.652987421in^-1
Kappa s	= 403557.5938#	Lambda s	= 6561481.500psi	Beta c	= 0.750982881in^-1
Kappa c	= 201349.5469#	Lambda c	= 3951385.000psi	h/p	= 3.200000048
E*	= 8183711.000psi	v*	= 0.343179107	Xa	= 1.701923966
Zd	= 0.290400684	Zv	= 0.171428442	Zm	= 0.700460076
K	= 1.121169686	F	= 1.091558099	Phi	= 1.466158032
Q1	=-0.098789386	Qz1	= 1.147183657	Qz2	= 0.428855240
U	= 0.857710540	Gamma	=-0.040321112"	Omega s	= 2.903223753in^2
Omega c	= 2.495324135in^2	Omega s*	=-2.835061073in^2	Omega c*	=-1.925397873in^2
Delta s	= 0.000003540In^3/Lb	Delta c	= 0.000004750In^3/Lb	Gamma b	= 0.0
Ps'	= 712.1762695psi	Pt'	= 723.7817993psi	P Gamma	=-1361.885132psi
PW	= 0.0psi	Prim	= 11.47403431psi	Es,w	= 0.850000024
Pe	=-544.8777466psi	Q2	=-336.0176392#	Q3	=-0.074564837
Fm	= 0.153177202	Es,w1	= 0.0	lt	= 0.0"
Rt	= 0.0"	Ft	= 0.0	Ct	= 0.0
Fs	= 0.0	Stb	= 0.0psi	Ft,min	= 0.797305107
Sigmat,1	= 2159.851807psi	Sigmat,2	= 3150.232910psi	Ft,max	= 1.162935019
Sigma s,m	=-1106.006470psi	Sigma s,b	= 118.5915146psi	Sigma s	= 1224.598022psi
Sigma c,m	= 3254.634766psi	Sigma c,b	= 20372.24219psi	Sigma c	= 23626.87695psi

Thermal Expansion Acting on this Case (Yes)

Sigma	-8944 psi	<= Sps	58260 psi	[OK	]
Tau	-3239 psi	<= .8S	15536 psi	[OK	]
Sigmat,max	3150 psi	<= 2St	26769 psi	[OK	]
Sigma s	1224 psi	<= Spss	56489 psi	[OK	]
Sigma c	23626 psi	<= Spsc	60130 psi	[OK	]
Sigmas,m	-1106 psi	<=2Ss	34200 psi	[OK	] Step 10
Sigmas,m	-1106 psi	<=Ss,b	13949 psi	[OK	] Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 15

(FTS) Configuration a

Tubesheet Thickness (h)	= 2.7500"		
F-F Tubesheets (Lt)	= 167.6250"	F-F Inside Tubesheets (L)	= 162.1250"
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.5000"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 15.2500"	Shell thickness (Ts)	= 0.3750"
Press Chan (Pt)	= -15.0psi	Press Shell (Ps)	= 15.0psi
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 250deg.F	S = 20000psi	Sy = 32400psi	E =28.3500psi		V =.300	Sps = 64800psi
Temp TBS	Tt= 250deg.F	St = 13400psi	Syt= 23400psi	Et =28.5500psi		Vt=.300	
Temp CH	Tc= 70deg.F	Sc = 17100psi	Syc= 35000psi	Ec =29.2000psi		Vc=.300	Spsc= 70000psi
Temp SH	Ts= 250deg.F	Ss = 17100psi	Sys= 31500psi	Es =28.3500psi		Vs=.300	Spss= 63000psi
Tt,m	= 250deg.F			At,m= 6.8000In/In			
Ts,m	= 250deg.F			As,m= 6.8000In/In			

Mu= 0.2000	d*= 0.6436"	P*= 0.9375"	Mu*= 0.3135	hg'= 0.0000"	hgs'= 0.0000"
W	= 0.0#	wj	= 0.0"	ao	= 7.135405064"
Rho s	= 1.068614841	Rho c	= 1.086133122	Chi s	= 0.489028096
Chi t	= 0.690186620	Ks	= 3218876.000Lb/In	Kt	= 30627.38477Lb/In
Ks,t	= 0.568097115	j	= 1.000000000	Beta s	= 0.750982881in^-1
Kappa s	= 205628.9531#	Lambda s	= 4702419.500psi	Beta c	= 0.916105211in^-1
Kappa c	= 76551.83594#	Lambda c	= 2291088.000psi	h/p	= 2.933333397
E*	= 8473583.000psi	v*	= 0.345110953	Xa	= 1.821840048
Zd	= 0.232152075	Zv	= 0.167142197	Zm	= 0.687355042
K	= 1.121169686	F	= 0.791096687	Phi	= 1.064112782
Q1	=-0.063094512	Qz1	= 1.220655560	Qz2	= 0.681773245
U	= 1.363546491	Gamma	= 0.0"	Omega s	= 2.351305246in^2
Omega c	= 1.874728799in^2	Omega s*	=-2.227341890in^2	Omega c*	=-1.231768847in^2
Delta s	= 0.000004650In^3/Lb	Delta c	= 0.000006990In^3/Lb	Gamma b	= 0.0
Ps'	= 26.27744675psi	Pt'	= -39.54505539psi	P Gamma	= 0.0psi
PW	= 0.0psi	Prim	= 1.389595509psi	Es,w	= 0.850000024
Pe	= 22.19907761psi	Q2	=-29.96763420#	Q3	=-0.116123118
Fm	= 0.131072953	Es,w1	= 0.0	lt	= 27.50000000"
Rt	= 0.237638906"	Ft	= 115.7217941	Ct	= 155.1886749
Fs	= 2.000000000	Stb	= 7337.745605psi	Ft,min	= 0.778746426
Sigmat,1	= 1.992301345psi	Sigmat,2	=-41.38737488psi	Ft,max	= 1.171834469
Sigma s,m	= 81.05524445psi	Sigma s,b	= 792.9991455psi	Sigma s	= 874.0543823psi
Sigma c,m	=-228.8095245psi	Sigma c,b	=-1057.013428psi	Sigma c	= 1285.822998psi

Thermal Expansion Acting on this Case (Yes)

Sigma	374 psi	<= Sps	64800 psi	[OK	]
Tau	143 psi	<= .8S	16000 psi	[OK	]
Sigmat,max	41 psi	<= 2St	26800 psi	[OK	]
Sigmat,min	-41 psi	<= Stb	7337 psi	[OK	]
Sigma s	874 psi	<= Spss	63000 psi	[OK	]
Sigma c	1285 psi	<= Spsc	70000 psi	[OK	]
Sigmas,m	81 psi	<=2Ss	34200 psi	[OK	] Step 10

ASME SEC.VIII DIV.1 UHX-13 Case 16

(FTS) Configuration a

Tubesheet Thickness (h)	= 2.7500"		
F-F Tubesheets (Lt)	= 167.6250"	F-F Inside Tubesheets (L)	= 162.1250"
Exp length of tube (ltx)	= 2.6125"	Exp depth ratio (Rho)	= 0.9500"
Channel I.D. (Dc)	= 15.5000"	Channel thickness (Tc)	= 0.2500"
Shell I.D. (Ds)	= 15.2500"	Shell thickness (Ts)	= 0.3750"
Press Chan (Pt)	= 15.0psi	Press Shell (Ps)	= -15.0psi
Corr Chan	= 0.12500"	Corr Shell	= 0.12500"
Corr Chan side TS (ct)	= 0.12500"	Corr Shell side TS (cs)	= 0.12500"

	Temp	Stress	Yield	Modulus x10^6	Coef x10^-6	Poisson Ratio	Prim Plus Stress
Temp TS	T = 250deg.F	S = 20000psi	Sy = 32400psi	E =28.3500psi		V =.300	Sps = 64800psi
Temp TBS	Tt= 250deg.F	St = 13400psi	Syt= 23400psi	Et =28.5500psi		Vt=.300	
Temp CH	Tc= 250deg.F	Sc = 17100psi	Syc= 31500psi	Ec =28.3500psi		Vc=.300	Spsc= 63000psi
Temp SH	Ts= 250deg.F	Ss = 17100psi	Sys= 31500psi	Es =28.3500psi		Vs=.300	Spss= 63000psi
Tt,m	= 250deg.F				At,m= 6.8000In/In		
Ts,m	= 250deg.F				As,m= 6.8000In/In		

Mu= 0.2000	d*= 0.6436"	P*= 0.9375"	Mu*= 0.3135	hg'= 0.0000"	hgs'= 0.0000"
W	= 0.0#	wj	= 0.0"	ao	= 7.135405064"
Rho s	= 1.068614841	Rho c	= 1.086133122	Chi s	= 0.489028096
Chi t	= 0.690186620	Ks	= 3218876.000Lb/In	Kt	= 30627.38477Lb/In
Ks,t	= 0.568097115	j	= 1.000000000	Beta s	= 0.750982881in^-1
Kappa s	= 205628.9531#	Lambda s	= 4702419.500psi	Beta c	= 0.916105211in^-1
Kappa c	= 74323.43750#	Lambda c	= 2224395.000psi	h/p	= 2.933333397
E*	= 8473583.000psi	v*	= 0.345110953	Xa	= 1.821840048
Zd	= 0.232152075	Zv	= 0.167142197	Zm	= 0.687355042
K	= 1.121169686	F	= 0.785942256	Phi	= 1.057179570
Q1	=-0.062597513	Qz1	= 1.221113086	Qz2	= 0.683654904
U	= 1.367309809	Gamma	= 0.0"	Omega s	= 2.351305246in^2
Omega c	= 1.874728680in^2	Omega s*	=-2.227341890in^2	Omega c*	=-1.231768727in^2
Delta s	= 0.000004650In^3/Lb	Delta c	= 0.000007200In^3/Lb	Gamma b	= 0.0
Ps'	= -26.27744675psi	Pt'	= 39.54505539psi	P Gamma	= 0.0psi
PW	= 0.0psi	Prim	=-1.393430710psi	Es,w	= 0.850000024
Pe	=-22.19604301psi	Q2	= 30.05034447#	Q3	=-0.115779750
Fm	= 0.131214440	Es,w1	= 0.0	lt	= 27.50000000"
Rt	= 0.237638906"	Ft	= 115.7217941	Ct	= 155.1886749
Fs	= 2.000000000	Stb	= 7337.745605psi	Ft,min	= 0.778442085
Sigmat,1	=-2.037630558psi	Sigmat,2	= 41.40456772psi	Ft,max	= 1.172150493
Sigma s,m	=-81.02886963psi	Sigma s,b	=-793.9796143psi	Sigma s	= 875.0084839psi
Sigma c,m	= 228.8095245psi	Sigma c,b	= 1047.676636psi	Sigma c	= 1276.486206psi

Thermal Expansion Acting on this Case (Yes)

Sigma	-375 psi	<= Sps	64800 psi	[OK	]	
Tau	-143 psi	<= .8S	16000 psi	[OK	]	
Sigmat,max	41 psi	<= 2St	26800 psi	[OK	]	
Sigmat,min	-2 psi	<= Stb	7337 psi	[OK	]	
Sigma s	875 psi	<= Spss	63000 psi	[OK	]	
Sigma c	1276 psi	<= Spsc	63000 psi	[OK	]	
Sigmas,m	-81 psi	<=2Ss	34200 psi	[OK	]	Step 10
Sigmas,m	-81 psi	<=Ss,b	17100 psi	[OK	]	Step 10

***** TUBE CALCULATIONS *****

Tube size.....=	0.75000"	Straight or U-Tube.=	Straight Tube
Internal Press...=	343.00000psig*	External press.....=	478.00000psig*
Temperature used.=	515.00000deg.	Tube Matl MT# 34...=	SA-179
Stress Oper.....=	13384.99902psi	Stress Atm.....=	13400.00000psi
Yield.....=	21005.00195psi	Inside Radius.....=	0.29200"
Joint Eff.....=	1.00000	Mill tol...= 0.00% =	0.00000"
Wall Thk. t.....=	0.08300"	Tube gauge.....=	
Mean Rad., R.....=	0.00000"	Tube Length.....=	168.00000"
Corrosion ID.....=	0.00000"	Corrosion OD.....=	0.00000"
Thinning factor..=	1.00000		
tr = PR/SE - .6P =	0.00760"	(tr*TF)+MT+CA.....=	0.00760"
MAWP Internal H/C=	3250.30688psig	MAWP Internal N/C..=	3253.94971psig
MAWP External H/C=	1928.78552psig	MAWP External N/C..=	2159.90234psig

* DESIGN PRESSURE HAS BEEN INCREASED BY 8 PSI DUE TO STATIC HEAD

Energy Exchanger Company

Customer :	SOUTHERN / MISS. POWER CO.	Item No.	HX 0052	W.O. :	X-7926
Subject :	Seismic and Wind Loading Factors	Date	3/8/2011	By :	MD/DN

Wind Loading

Given Data: From Customer Spec

Exposure Cat	C	
Occupancy Cat	III	
Importance Fact	1.150	
Kzt	1.000	
V	100.000	mph
qz = 0.00256KzKztKdV^2I		
Height of vessel	15.000	ft or less
Alpha	9.5	Table 6-2
Zg	900	Table 6-2
Kz	0.849	Table 6-3
Kd	0.950	(Table 6-4)
qz =	23.742	
G	0.850	
Cf =	0.800	(Fig 6-21)
Wind Pressure	= qz*G*Cf	
	16.144	psf

Seismic Loading

Given Data: From Customer Spec

Occupancy Cat:	III	
Design Cat:	B	
Reliability	1	
Importance Factor	1.25	
Site Class	C	
R (Table 15.4.2)	3	
Sds	0.1630	g
Sd1	0.0990	g
Cs = Sds/(R/I)	0.0679	
Min Cs =	0.0100	

SNOW LOADS

Pg	5	psf
CAT	C	
Ct	1.2	
I	1.1	
Pf = 0.7*Ct*I	6.6	psf
SNOW LOAD AREA	28	sf
ADDITIONAL WEIGHT	184.8	lbs

Input Echo, Leg & Lug Item 1, Description: X-7926 SUPPORTS

Design Internal Pressure		463.00	psig ← INCLUDES 8 PSI FOR STATIC HEAD
Design Temperature for Attachment	TEMP	515.00	F
Vessel Outside Diameter	OD	16.000	in.
Vessel Wall Thickness	Ts	0.4375	in.
Vessel Corrosion Allowance	Cas	0.1250	in.
Vessel Material		SA-106 B	
Vessel Material UNS Number		K03006	
Vessel Allowable Stress at Design	S	17100.00	psi
Analysis Type:		Support Lug	
Tangent to Tangent Length of Vessel	TANTAN	13.431	ft.
Height of Bottom Tangent Above Grade		1.677	ft.
Empty Weight of Vessel	Wemp	4484.80	lb. ← WEIGHTS INCLUDE 316.8 LB
Operating Weight of Vessel (vertical load)	W	5684.80	lb. FOR SNOW LOADING
Force Coefficient (Shape factor)	Cf	0.800	
Additional Area		0.00	in²
User defined Wind Pressure		16.144	psf
Design Wind Code		ASCE 7-05	⚠1
Type of Hill		None	
User Entered Seismic Zone Factor	Cs	0.068	
Additional Horizontal Force on Vessel	FF	0.00	lb.
Location of Horizontal Force above Base Point	FH	0.00	ft.
Support Lug with Full Reinforcing Rings?		No	
Number of Support Lugs	NLUG	2	
Location of Support Lugs above Base Point	LLUG	11.7500	ft.
Distance from Vessel OD to Lug Contact Point	DLUG	7.6250	in.
Lug Support Force Bearing Width	WFB	4.0000	in.
Support Lug Material		SA-516 70	
Support Lug Material UNS Number		K02700	
Support Lug Yield Stress	Ylug	30715.00	psi
Radial Width of bottom Support Lug Plate	Wpl	9.1250	in.
Effective Force Bearing Length	Lpl	6.0000	in.
Thickness of bottom Support Lug Plate	Tpl	0.7500	in.
Distance between Gussets	Dgp	5.0000	in.
Mean Width of Gusset Plate	Wgp	5.2500	in.
Height of Gusset Plate	Hgp	6.2500	in.
Thickness of Gusset Plate	Tgp	0.5000	in.
Perform WRC-107 (Loal Stress) Analysis on Lug		Yes	
Lug Pad Width (Circumferential direction)	wpad	10.000	in.
Lug Pad Length (Longitudinal direction)	lpad	11.000	in.
Lug Pad Thickness	tpad	0.375	in.
Occasional Load Factor (AISC A5.2)	Occfac	1.00	

BOLTING:
(4) ¾" DIAM.
A325 BOLTS
TRANSV. LOAD
2843 LB.
CALC. STRESS =
1177 PSI
BOLTING IS
ACCEPTABLE ⚠1

Results for support lugs, Description : X-7926 SUPPORTS

Vessel Wind Area, Af	: 4060.200	in²	
Vessel Wind load = P * Af * Cf	: 455.194	lb.	
Location of Centroid above Base Point	: 8.393	ft.	
Overturning Moment at Support Lug	Mlug	1528.	ft.lb.
Weight Load at the top of one Lug		2842.	lb.
Shear at top of one Lug		0.	lb.

Distance from vessel center to Lug centroid [Rlug]:
= (OD / 2.0 + DLUG) / 12.0
= (16.0000 / 2.0 + 7.6250) / 12.0
= 1.30 ft.

Force on one Lug (compression side) [Flug]:
= (W/Nlug + Mlug/(Rlug * 2))
= (5684 /2 + 1528 /(1.30 * 2))
= 3429.23 lb.

Bearing Area [Ba]:
= Lpl * Wfb
= 6.000 * 4.000
= 24.00 in²

Bending Str. in bottom Plate (Unif. Load) Per Bednar p.156 [Spl2]:
= Beta1 * Flug/Ba * Wfb² / Tpl² per Roark & Young 5th Ed.
= 0.903 * 3429.2 /24.000 * 4.000² / 0.750²
= 3671.65 psi

Allowable Stress for Support Plate [Spa]:
= Min(0.66 * Ylug * Occfac, 0.75 * Ylug)
= Min(0.66 * 30715 * 1.00 , 23036.2)
= 20271.90 psi

Stress in Gusset Plate (Force / Gusset Plate Area) [Sgp]:
= (Flug/2) / (Wgp * Tgp)
= (3429 /2) / (5.250 *0.5000)
= 653.19 psi

Gusset Plate Allowable Stress [Sga]:
= (1-(Klr)^2/(2*Cc^2))*Fy /
(5/3+3*(Klr)/(8*Cc)-(Klr^3)/(8*Cc^3)
= (1-(50.00)^2/(2 * 136.52 ^2)) * 30715 /
(5/3+3*(50.00)/(8* 136.52)-(50.00 ^3)/(8*136.52 ^3)
= 15938.26 psi

Maximum Compressive Stress in the Gussets per Bednar [SgpB]:
= Flug * (3*Dlug - Wpl) / (Tgp* Wpl**2 * (SIN(Alph_G))**2)
= 3429 *(3*7.625 -9.125)/(0.5000 *9.125 **2*(Sin(38.88))**2)
= 2874.00 psi

Gusset Plate Allowable Compressive Stress per Bednar [SgaB]:
= 18000./ (1.+ (1./18000)*(Hgp /SIN(Alph_G)/(.289*Tgp))**2)
= 18000/ (1+ (1/18000)*(6.250 /Sin(38.88)/(0.289*0.5000))**2)
= 14243.44 psi

Summary Of Results

Stress (psi)	Actual	Allowable	P/F
Bottom Plt. Str. (Unif. Load-Bednar) :	3671.65	20271.90	Ok
Gusset Plt. Str. (Force/Gusset Area) :	653.19	15938.26	Ok
Gusset Plt. Max Comp. Str. (Bednar) :	2874.00	14243.44	Ok

Result of WRC-107 analysis on the Vessel-Support Lug Junction:
(Worst load case + Int. Pressure, ref. Pressure Vessel Design Manual, D. Moss)

Sustained (Wt) Forces/Moments for WRC107 Analysis :

Distance from Lug bottom to Lug centroid, b :	2.635	in.
Force on lug in Sustained Condition, Flug_Sus :	2842.40	lb.
Longitudinal Shear = Flug_Sus :	2842.40	lb.
Long. Moment = Flug_Sus * DLUG + FF / Nlug * b :	1806.11	ft.lb.

Occasional (Wind/Seismic) Forces/Moments for WRC107 Analysis :

Horizontal Live load max(Wind, Seismic), V :	455.194	lb.
Force on lug in Occasional Condition, Flug_Occ :	586.83	lb.
Longitudinal Shear = Flug_Occ :	586.83	lb.
Long. Moment = Flug_Occ * DLUG + V / Nlug * b :	422.86	ft.lb.

Parameter C11	C11	3.00	in.
Parameter C22	C22	5.00	in.
Pad Parameter C11P	C11P	10.00	in.
Pad Parameter C22P	C22P	11.00	in.
Thickness of Reinforcing Pad	tpad	0.38	in.

WRC 107 Stress Calculation for SUStained loads:

Radial Load	P	0.0	lb.
Circumferential Shear	VC	0.0	lb.
Longitudinal Shear	VL	2842.4	lb.
Circumferential Moment	MC	0.0	ft.lb.
Longitudinal Moment	ML	1806.1	ft.lb.
Torsional Moment	MT	0.0	ft.lb.

Dimensionless Parameters used : Gamma = 11.68

Dimensionless Loads for Cylindrical Shells at Attachment Junction:

Curves read for 1979	Beta	Figure		Value	Location
N(PHI) / (P/Rm)	0.303	4C		1.763	(A,B)
N(PHI) / (P/Rm)	0.303	3C		1.310	(C,D)
M(PHI) / (P)	0.226	2C1		0.067	(A,B)
M(PHI) / (P)	0.226	1C		0.095	(C,D)
N(PHI) / (MC/(Rm**2 * Beta))	0.221	3A	!	0.403	(A,B,C,D)
M(PHI) / (MC/(Rm * Beta))	0.243	1A		0.091	(A,B,C,D)
N(PHI) / (ML/(Rm**2 * Beta))	0.263	3B	!	1.370	(A,B,C,D)
M(PHI) / (ML/(Rm * Beta))	0.255	1B		0.036	(A,B,C,D)
N(x) / (P/Rm)	0.267	3C		1.436	(A,B)
N(x) / (P/Rm)	0.267	4C		1.844	(C,D)
M(x) / (P)	0.273	1C1		0.081	(A,B)
M(x) / (P)	0.273	2C		0.052	(C,D)
N(x) / (MC/(Rm**2 * Beta))	0.221	4A	!	0.668	(A,B,C,D)
M(x) / (MC/(Rm * Beta))	0.295	2A		0.046	(A,B,C,D)
N(x) / (ML/(Rm**2 * Beta))	0.263	4B	!	0.439	(A,B,C,D)
M(x) / (ML/(Rm * Beta))	0.289	2B		0.054	(A,B,C,D)

Note - The ! mark next to the figure name denotes curve value exceeded.

Stress Concentration Factors Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Attachment Junction

Type of	Stress Values at (psi)							
Stress Load	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P	0	0	0	0	0	0	0	0
Circ. Bend. P	0	0	0	0	0	0	0	0
Circ. Memb. MC	0	0	0	0	0	0	0	0
Circ. Bend. MC	0	0	0	0	0	0	0	0
Circ. Memb. ML	-2236	-2236	2236	2236	0	0	0	0
Circ. Bend. ML	-4862	4862	4862	-4862	0	0	0	0
Tot. Circ. Str.	-7098	2625	7098	-2625	0	0	0	0
Long. Memb. P	0	0	0	0	0	0	0	0
Long. Bend. P	0	0	0	0	0	0	0	0
Long. Memb. MC	0	0	0	0	0	0	0	0
Long. Bend. MC	0	0	0	0	0	0	0	0
Long. Memb. ML	-964	-964	964	964	0	0	0	0
Long. Bend. ML	-6390	6390	6390	-6390	0	0	0	0
Tot. Long. Str.	-7354	5425	7354	-5425	0	0	0	0
Shear VC	0	0	0	0	0	0	0	0
Shear VL	0	0	0	0	-413	-413	413	413
Shear MT	0	0	0	0	0	0	0	0
Tot. Shear	0	0	0	0	-413	-413	413	413
Str. Int.	7354	5425	7354	5425	826	826	826	826

Dimensionless Parameters used : Gamma = 25.10

Dimensionless Loads for Cylindrical Shells at Pad edge:

Curves read for 1979	Beta	Figure		Value	Location
N(PHI) / (P/Rm)	0.707	4C	!	2.131	(A,B)
N(PHI) / (P/Rm)	0.707	3C	!	0.933	(C,D)
M(PHI) / (P)	0.659	2C1	!	0.008	(A,B)
M(PHI) / (P)	0.659	1C	!	0.059	(C,D)
N(PHI) / (MC/(Rm**2 * Beta))	0.658	3A	!	0.727	(A,B,C,D)
M(PHI) / (MC/(Rm * Beta))	0.734	1A	!	0.063	(A,B,C,D)
N(PHI) / (ML/(Rm**2 * Beta))	0.679	3B	!	1.200	(A,B,C,D)
M(PHI) / (ML/(Rm * Beta))	0.694	1B	!	0.009	(A,B,C,D)
N(x) / (P/Rm)	0.685	3C	!	0.933	(A,B)
N(x) / (P/Rm)	0.685	4C	!	2.131	(C,D)
M(x) / (P)	0.689	1C1	!	0.020	(A,B)
M(x) / (P)	0.689	2C	!	0.030	(C,D)
N(x) / (MC/(Rm**2 * Beta))	0.658	4A	!	2.548	(A,B,C,D)
M(x) / (MC/(Rm * Beta))	0.818	2A	!	0.027	(A,B,C,D)
N(x) / (ML/(Rm**2 * Beta))	0.679	4B	!	0.655	(A,B,C,D)
M(x) / (ML/(Rm * Beta))	0.725	2B	!	0.014	(A,B,C,D)

Note - The ! mark next to the figure name denotes curve value exceeded.

Stress Concentration Factors Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Edge of Reinforcing Pad

Type of	Stress Values at (psi)							
Stress Load	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P	0	0	0	0	0	0	0	0
Circ. Bend. P	0	0	0	0	0	0	0	0
Circ. Memb. MC	0	0	0	0	0	0	0	0
Circ. Bend. MC	0	0	0	0	0	0	0	0
Circ. Memb. ML	-1774	-1774	1774	1774	0	0	0	0
Circ. Bend. ML	-2143	2143	2143	-2143	0	0	0	0
Tot. Circ. Str.	-3918	368	3918	-368	0	0	0	0
Long. Memb. P	0	0	0	0	0	0	0	0
Long. Bend. P	0	0	0	0	0	0	0	0
Long. Memb. MC	0	0	0	0	0	0	0	0
Long. Bend. MC	0	0	0	0	0	0	0	0
Long. Memb. ML	-1047	-1047	1047	1047	0	0	0	0
Long. Bend. ML	-3375	3375	3375	-3375	0	0	0	0
Tot. Long. Str.	-4423	2328	4423	-2328	0	0	0	0
Shear VC	0	0	0	0	0	0	0	0
Shear VL	0	0	0	0	-413	-413	413	413
Shear MT	0	0	0	0	0	0	0	0
Tot. Shear	0	0	0	0	-413	-413	413	413
Str. Int.	4423	2328	4423	2328	826	826	826	826

WRC 107 Stress Calculation for OCCasional loads:

Radial Load	P	0.0	lb.
Circumferential Shear	VC	0.0	lb.
Longitudinal Shear	VL	586.8	lb.
Circumferential Moment	MC	0.0	ft.lb.
Longitudinal Moment	ML	422.9	ft.lb.
Torsional Moment	MT	0.0	ft.lb.

Dimensionless Parameters used : Gamma = 11.68
Stress Concentration Factors Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Attachment Junction

Type of	Stress Values at (psi)							
Stress Load	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P	0	0	0	0	0	0	0	0
Circ. Bend. P	0	0	0	0	0	0	0	0
Circ. Memb. MC	0	0	0	0	0	0	0	0
Circ. Bend. MC	0	0	0	0	0	0	0	0
Circ. Memb. ML	-523	-523	523	523	0	0	0	0
Circ. Bend. ML	-1138	1138	1138	-1138	0	0	0	0
Tot. Circ. Str.	-1662	614	1662	-614	0	0	0	0
Long. Memb. P	0	0	0	0	0	0	0	0
Long. Bend. P	0	0	0	0	0	0	0	0
Long. Memb. MC	0	0	0	0	0	0	0	0
Long. Bend. MC	0	0	0	0	0	0	0	0
Long. Memb. ML	-225	-225	225	225	0	0	0	0
Long. Bend. ML	-1496	1496	1496	-1496	0	0	0	0
Tot. Long. Str.	-1721	1270	1721	-1270	0	0	0	0
Shear VC	0	0	0	0	0	0	0	0
Shear VL	0	0	0	0	-85	-85	85	85
Shear MT	0	0	0	0	0	0	0	0
Tot. Shear	0	0	0	0	-85	-85	85	85
Str. Int.	1721	1270	1721	1270	170	170	170	170

Dimensionless Parameters used : Gamma = 25.10
Stress Concentration Factors Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Edge of Reinforcing Pad

Type of	Stress Values at (psi)							
Stress Load	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P	0	0	0	0	0	0	0	0
Circ. Bend. P	0	0	0	0	0	0	0	0
Circ. Memb. MC	0	0	0	0	0	0	0	0
Circ. Bend. MC	0	0	0	0	0	0	0	0
Circ. Memb. ML	-415	-415	415	415	0	0	0	0
Circ. Bend. ML	-501	501	501	-501	0	0	0	0
Tot. Circ. Str.	-917	86	917	-86	0	0	0	0
Long. Memb. P	0	0	0	0	0	0	0	0
Long. Bend. P	0	0	0	0	0	0	0	0
Long. Memb. MC	0	0	0	0	0	0	0	0
Long. Bend. MC	0	0	0	0	0	0	0	0
Long. Memb. ML	-245	-245	245	245	0	0	0	0
Long. Bend. ML	-790	790	790	-790	0	0	0	0
Tot. Long. Str.	-1035	545	1035	-545	0	0	0	0
Shear VC	0	0	0	0	0	0	0	0
Shear VL	0	0	0	0	-85	-85	85	85
Shear MT	0	0	0	0	0	0	0	0
Tot. Shear	0	0	0	0	-85	-85	85	85
Str. Int.	1035	545	1035	545	170	170	170	170

WRC 107 Stress Summations:

Vessel Stress Summation at Attachment Junction

Type of Stress Int.	Stress Values at (psi)							
Location	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Pm (SUS)	4955	5418	4955	5418	4955	5418	4955	5418
Circ. Pm (OCC)	0	0	0	0	0	0	0	0
Circ. Pm(TOTAL)	4955	5418	4955	5418	4955	5418	4955	5418
Circ. Pl (SUS)	-2236	-2236	2236	2236	0	0	0	0
Circ. Pl (OCC)	-523	-523	523	523	0	0	0	0
Circ. Pl(TOTAL)	-2760	-2760	2760	2760	0	0	0	0
Circ. Q (SUS)	-4862	4862	4862	-4862	0	0	0	0
Circ. Q (OCC)	-1138	1138	1138	-1138	0	0	0	0
Circ. Q (TOTAL)	-6000	6000	6000	-6000	0	0	0	0
Long. Pm (SUS)	2477	2477	2477	2477	2477	2477	2477	2477
Long. Pm (OCC)	0	0	0	0	0	0	0	0
Long. Pm(TOTAL)	2477	2477	2477	2477	2477	2477	2477	2477
Long. Pl (SUS)	-964	-964	964	964	0	0	0	0
Long. Pl (OCC)	-225	-225	225	225	0	0	0	0
Long. Pl(TOTAL)	-1190	-1190	1190	1190	0	0	0	0
Long. Q (SUS)	-6390	6390	6390	-6390	0	0	0	0
Long. Q (OCC)	-1496	1496	1496	-1496	0	0	0	0
Long. Q (TOTAL)	-7886	7886	7886	-7886	0	0	0	0
Shear Pm (SUS)	0	0	0	0	0	0	0	0
Shear Pm (OCC)	0	0	0	0	0	0	0	0
Shear Pm(TOTAL)	0	0	0	0	0	0	0	0
Shear Pl (SUS)	0	0	0	0	-413	-413	413	413
Shear Pl (OCC)	0	0	0	0	-85	-85	85	85
Shear Pl(TOTAL)	0	0	0	0	-498	-498	498	498
Shear Q (SUS)	0	0	0	0	0	0	0	0
Shear Q (OCC)	0	0	0	0	0	0	0	0
Shear Q (TOTAL)	0	0	0	0	0	0	0	0
Pm (SUS)	4955	5418	4955	5418	4955	5418	4955	5418
Pm (SUS+OCC)	4955	5418	4955	5418	4955	5418	4955	5418
Pm+Pl (SUS)	2719	3182	7192	7655	5022	5475	5022	5475
Pm+Pl (SUS+OCC)	2195	2658	7715	8178	5052	5500	5052	5500
Pm+Pl+Q (Total)	6599	9173	13716	6395	5052	5500	5052	5500

Type of Stress Int.	Max. S.I. psi	S.I. Allowable	Result
Pm (SUS)	5418	17100	Passed
Pm (SUS+OCC)	5418	20520	Passed
Pm+Pl (SUS)	7655	25650	Passed
Pm+Pl (SUS+OCC)	8178	30780	Passed
Pm+Pl+Q (TOTAL)	13716	51300	Passed

WRC 107 Stress Summations:

Vessel Stress Summation at Reinforcing Pad Edge

Type of Stress Int.	Stress Values at (psi)							
Location	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Pm (SUS)	11162	11625	11162	11625	11162	11625	11162	11625
Circ. Pm (OCC)	0	0	0	0	0	0	0	0
Circ. Pm(TOTAL)	11162	11625	11162	11625	11162	11625	11162	11625
Circ. Pl (SUS)	-1774	-1774	1774	1774	0	0	0	0
Circ. Pl (OCC)	-415	-415	415	415	0	0	0	0
Circ. Pl(TOTAL)	-2190	-2190	2190	2190	0	0	0	0
Circ. Q (SUS)	-2143	2143	2143	-2143	0	0	0	0
Circ. Q (OCC)	-501	501	501	-501	0	0	0	0
Circ. Q (TOTAL)	-2645	2645	2645	-2645	0	0	0	0
Long. Pm (SUS)	5581	5581	5581	5581	5581	5581	5581	5581
Long. Pm (OCC)	0	0	0	0	0	0	0	0
Long. Pm(TOTAL)	5581	5581	5581	5581	5581	5581	5581	5581
Long. Pl (SUS)	-1047	-1047	1047	1047	0	0	0	0
Long. Pl (OCC)	-245	-245	245	245	0	0	0	0
Long. Pl(TOTAL)	-1292	-1292	1292	1292	0	0	0	0
Long. Q (SUS)	-3375	3375	3375	-3375	0	0	0	0
Long. Q (OCC)	-790	790	790	-790	0	0	0	0
Long. Q (TOTAL)	-4166	4166	4166	-4166	0	0	0	0
Shear Pm (SUS)	0	0	0	0	0	0	0	0
Shear Pm (OCC)	0	0	0	0	0	0	0	0
Shear Pm(TOTAL)	0	0	0	0	0	0	0	0
Shear Pl (SUS)	0	0	0	0	-413	-413	413	413
Shear Pl (OCC)	0	0	0	0	-85	-85	85	85
Shear Pl(TOTAL)	0	0	0	0	-498	-498	498	498
Shear Q (SUS)	0	0	0	0	0	0	0	0
Shear Q (OCC)	0	0	0	0	0	0	0	0
Shear Q (TOTAL)	0	0	0	0	0	0	0	0
Pm (SUS)	11162	11625	11162	11625	11162	11625	11162	11625
Pm (SUS+OCC)	11162	11625	11162	11625	11162	11625	11162	11625
Pm+Pl (SUS)	9388	9851	12937	13400	11193	11654	11193	11654
Pm+Pl (SUS+OCC)	8972	9435	13353	13816	11207	11666	11207	11666
Pm+Pl+Q (Total)	6326	12081	15998	11170	11207	11666	11207	11666

Type of Stress Int.	Max. S.I. psi	S.I. Allowable psi	Result
Pm (SUS)	11625	17100	Passed
Pm (SUS+OCC)	11625	20520	Passed
Pm+Pl (SUS)	13400	25650	Passed
Pm+Pl (SUS+OCC)	13816	30780	Passed
Pm+Pl+Q (TOTAL)	15998	51300	Passed

Input Echo, Leg & Lug Item 2, Description: X-7926 SUPPORT GUSSET AS A LIFTING LUG

The support gusset shall have a 1.500" diameter hole that may be used as a lifting lug. Only the edge of the support in contact with the cylinder/pad used in analysis. (Welds to support pad are not utilized and results are very conservative) 1

Design Internal Pressure		0.00	psig
Design Temperature for Attachment	TEMP	100.00	F
Vessel Outside Diameter	OD	16.000	in.
Vessel Wall Thickness	Ts	0.4375	in.
Vessel Corrosion Allowance	Cas	0.1250	in.
Vessel Material		SA-106 B	
Vessel Material UNS Number		K03006	
Vessel Allowable Stress at Design	S	17100.00	psi
Analysis Type:		Lifting Lug	
Empty Weight of Vessel	Wemp	4300.00	lb.
Operating Weight of Vessel (vertical load)	W	26250.00	lb.
Force Coefficient (Shape factor)	Cf	0.800	
Additional Area		0.00	in²
User defined Wind Pressure		16.144	psf
Design Wind Code		ASCE 7-95	
Type of Hill		None	
User Entered Seismic Zone Factor	Cs	0.068	
Lifting Lug Material		SA-516 70	
Lifting Lug Material UNS Number		K02700	
Lifting Lug Yield Stress	YIELD	38000.00	psi
Lifting Lug Orientation to Vessel		Perpendicular	
Total Height of Lifting Lug	w	8.0000	in.
Thickness of Lifting Lug	t	0.5000	in.
Diameter of Hole in Lifting Lug	dh	1.5000	in.
Radius of Semi-Circular Arc of Lifting Lug	r	2.3750	in.
Height of Lug from bottom to Center of Hole	h	3.0000	in.
Offset from Vessel OD to Center of Hole	off	4.0000	in. 2
Minimum thickness of Fillet Weld around Lug	tw	0.3750	in.
Length of weld along side of Lifting Lug	wl	6.2500	in.
Length of Weld along Bottom of Lifting Lug	wb	0.5000	in.
Lift Orientation		Vertical	
Force Along Vessel Axis	Fax	4300.00	lb.
Force Normal to Vessel	Fn	4300.00	lb.
Force Tangential to Vessel	Ft	0.00	lb.
Impact Factor	Impfac	1.50	
Occasional Load Factor (AISC A5.2)	Occfac	1.12	

Results for lifting lugs, Description : X-7926 FLL

Vessel Wind Area, Af	: 5088.000 in²		
Vessel Wind load = P * Af * Cf	: 570.421 lb.		
Location of Centroid above Base Point	: 8.948 ft.		
Weld Group Inertia about the Circumferential Axis	ILC	17.239	in**4
Weld Group Centroid distance in the Long. Direction	YLL	3.373	in.
Dist. of Weld Group Centroid from Lug bottom	YLL_B	2.998	in.
Weld Group Inertia about the Longitudinal Axis	ILL	0.077	in**4
Weld Group Centroid Distance in the Circ. Direction	YLC	0.250	in.

Applying the Impact factor to the loads:

Fax = 4300.00 * 1.50 = 6450.00 lb.
Fn = 4300.00 * 1.50 = 6450.00 lb.

Primary Shear Stress in the Welds due to Shear Loads [Ssll]:

= Sqrt(Fax^2+Ft^2+Fn^2) / ((2*wl+wb) * tw)
= Sqrt(6450 ^2+0 ^2+6450 ^2) / ((2*6.2 +0.5) * 0.3750)
= 1871.11 psi

Shear Stress in the Welds due to Bending Loads [Sblf]:
```
= (Fn*(h-YLL_B)) *YLL/ILC + (Fax*off *YLL/ILC) + (Ft*off *YLC/ILL)
= (6450 *(3.000 -2.998 )) * 3.373 /17.239 +
  (6450 *4.000 * 3.373 /17.239 ) +
  (0 *4.000 * 0.250 /0.077 )
= 5050.42 psi
```

Total Shear Stress for Combined Loads [St]:
```
= Ssll + Sblf
= 1871.113 + 5050.416
= 6921.53 psi
```

Allowable Shear Stress for Combined Loads [Sta]:
```
= 0.4 * Yield * Occfac (AISC Shear All.)
= 0.4 * 38000 * 1.12
= 17100.00 psi
```

Shear Stress in Lug above Hole [Shs]:
```
= Sqrt( Fax^2 + Fn^2 + Ft^2 ) / Sha
= Sqrt( 6450 ^2 + 6450 ^2 + 0 ^2 ) / 1.625
= 5613.34 psi
```

Allowable Shear Stress in Lug above Hole [Sas]:
```
= 0.4 * Yield * Occfac
= 0.4 * 38000 * 1.12
= 17100.00 psi
```

Pin Hole Bearing Stress [Pbs]:
```
= Sqrt( Fax^2 + Fn^2 ) / ( t * dh )
= Sqrt( 6450 ^2 + 6450 ^2 ) / ( 0.500 * 1.500 )
= 12162.24 psi
```

Allowable Bearing Stress [Pba]:
```
= Min( 0.75 * Yield * Occfac, 0.9*Yield ) AISC Bearing All.
= Min( 0.75 * 38000 * 1.12 , 34200.0 )
= 32062.50 psi
```

Bending stress at the base of the lug [Fbs]:
```
= Ft*off / (w*t^(2) / 6) + Fax*off / (w^(2)*t / 6)
= 0 * 4.000 / (8.000 * 0.500 ^(2) / 6) +
  6450 * 4.000 / (8.000 ^(2) * 0.500 / 6)
= 4837.50  psi
```

Tensile stress at the base of the lug [Fa]:
```
= Fn / (w * t) = 6450 / (8.000 * 0.500 )
= 1612.50  psi
```

Total Combined Stress at the base of the lug:
= Fbs + Fa = 6450.0 psi

Lug Allowable Stress for Bending and Tension:
```
= Min( 0.66 * Yield * Occfac, 0.75*Yield )
= Min( 0.66 * 38000 * 1.12 , 28500.0 ) = 28215.0 psi
```

Note: Check the Shell Stresses using method such as WRC-107.

Summary Of Results

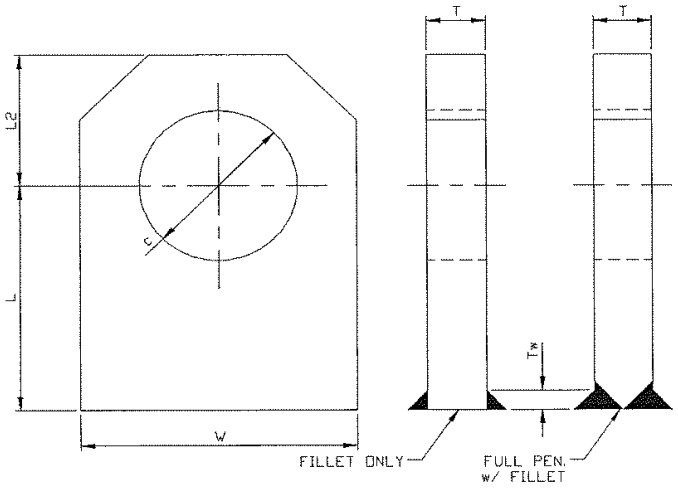
Stress (psi)	Actual	Allowable	P/F
Primary Shear Stress of Weld :	6921.53	17100.00	Ok
Shear Stress above Hole :	5613.34	17100.00	Ok
Pin Hole Bearing Stress :	12162.24	32062.50	Ok
Total Combined Stress at the lug base :	6450.00	28215.00	Ok

Energy Exchanger Company

Customer :	MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES	Item No	HX0052	W.O. :	X-7926
Subject :	LIFTING LUG CALCULATION	Date	3/9/2011	By :	MD/DN

Note : Lugs are not designed for side loading. Do not side load lugs.

Material	SA-516-70	
Yield Strength	38000	psi
T =	1/2	in
Tw =	1/4	in
W=	3 1/2	in
L =	4 3/4	in
L2=	1 3/4	in
OAL =	6 1/2	in
C=	2	in
Analysis Type	Full Pen w/ Fillet	
Impact Factor	1.500	
Occasional Load Factor	1.125	
Heaviest Lug Load	150	#
	(CHANNEL COVER)	
Weld Group Area (Aw)	2.651	in^2
Weld Group Inertia (Iw)	3.067	in^4
Shear Area (As)	0.375	in^2
Lug Inertia (I)	1.786	in^4



Allowable Loading

Shear Stress	17100	psi
0.4 * Yield * Occ Factor		
Bearing Stress	32062.5	psi
MIN(0.75*Yield*Occ Factor, 0.9*Yield)		
Combined	28215	psi
MIN(.66*Yield*Occ Factor, 0.75*Yield)		

Calculated Loads

Primary Shear in Welds	84.87 psi
Load*Impact/(Aw)	
Bending Shear Stress in Welds	146.71 psi
Load*Impact*(W+2*Tw)/2/(Iw)	
Total Combined Shear	231.57 psi
Shear in Lug Above Hole	400.00 psi
Load*Impact/(As)	
Pin Hole Bearing Stress	225.00 psi
Load*Impact/(T*C)	
Bending Stress @ Lug Base	1046.94 psi
Load*Impact*L/(W^2*T/6)	
Tensile @ Lug Base	128.57 psi
Load*Impact/(W*T)	
Total Combined Stress @ lug Base	1175.51 psi

SECTION 3

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 ENERGY EXCHANGER COMPANY, 1844 NORTH GARNETT ROAD, TULSA, OK 74116 (Name and address of Manufacturer)
2. Manufactured for SOUTHERN COMPANY SERVICES, INC. 42 INVERNESS CENTER PARKWAY BIRMINGHAM, AL 35242 (Name and address of Purchaser)
3. Location of installation MISSISSIPPI POWER COMPANY DEKALB, MISSISSIPPI (Name and address)
4. Type: VERT. (Horiz., vert., or sphere) | HEAT EXCHANGER (Tank, separator, kt. vessel, heat exh., etc.) | X-7926 (Mfg's serial No.)
   N/A (CRN) | X-7926-A REV. 4 (Drawing No.) | 6052 (Nat'l Bd. No.) | 2012 (Year built)
5. ASME Code, Section VIII, Div. 1 2007 EDITION, '09 ADD. [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 (b) Overall length (ft & in.): 13'-6 3/8"

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	16" O.D.	13'-6 3/8"	SA-106-B	1/2"	1/8"	S	NONE	0.85	7	NONE	0.85	N/A	N/A

7. Heads: (a) NA (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)														
(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 455 (internal) 15 (external) psi at max. temp. 515 (internal) 515 (external) °F Min. design metal temp. 10 °F at 455 psi.
10. Impact test NO, EXEMPT PER UG-20(f) [Indicate *yes* or *no* and the component(s) impact tested] at test temperature of NA °F.
11. Hydro., ~~pneu., or comb.~~ Test press. 600 P.S.I.G. *(2)* Proof test NA

Items 12 and 13 to be completed for tube sections.

12. Tubesheet: SA-266-4N [Stationary (Mat'l Spec. No.)] | 15 1/4" [Dia., in. (subject to press.)] | 3" (Nom. thk., in.) | 1/4" (Corr. Allow., in.) | Welded [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-179 (Mat'l Spec. No., Grade or Type) | 3/4" (O.D., in.) | 0.083" (MIN.) THK. (Nom. thk., in. or gauge) | 185 (Number) | Straight [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): 1/1 (b) Overall length (ft & in.): 1'-2 11/16"/1'-0 13/16"

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	16" O.D.	1'-2 11/16"	SA-333-6	3/8"	1/8"	S	NONE	0.85	1 *(1)*	SPOT	0.85	1150	1.00
1	16" O.D.	1'-0 13/16"	SA-333-6	3/8"	1/8"	S	NONE	0.85	1 *(1)*	SPOT	0.85	1150	1.00

15. Heads: (a) SA-266-4N H.T.@ 1150 deg F. for 1 HR. (Mat'l Spec. No., Grade or Type) (H.T. - Time & Temp.) (b) SA-266-4N H.T.@ 1150 deg F. for 1 HR. (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 5/8"	1/8"						16 7/8					
(b)	END	1 5/8"	1/8"						16 7/8"					

If removable, bolts used (describe other fastening) (a) SA-193-B7, 1" DIA., 16 (b) SA-193-B7, 1" DIA., 16 (Mat'l Spec. No., Grade, size, No.)

FORM U-1 (Back)

16. MAWP 320 (internal) NA (external) psi at max. temp. 385 (internal) NA (external) °F Min. design metal temp. 10 °F at 320 psi.

17. Impact test NO, EXEMPT PER UG-20(f) (indicate yes or no and the component(s) impact tested) at test temperature of NA °F.

18. Hydro., ~~pneu., or comb.~~ Test press. 425 P.S.I.G. *(2)* Proof test 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	4"-300#	RFWN	SA-106-B	SA-105	0.4380"	1/8"	WELD	WELDED	WELDED	SHELL
OUTLET	1	2"-300#	RFLWN	SA-105	—	0.6600"	1/8"	WELD	WELDED	—	SHELL
BAL. LINE	1	3/4"-300#	RFLWN	SA-105	—	0.5700"	1/8"	WELD	WELDED	—	SHELL
VENT/DRAIN	1/1	3/4"-300#	RFLWN	SA-105	—	0.5700"	1/8"	WELD	WELDED	—	TUBESHEETS
INLET	1	3"-300#	RFWN	SA-333-6	SA-105N	0.4380"	1/8"	WELD	WELDED	WELDED	BOTTOM CHAN.
OUTLET	1	6"-300#	RFWN	SA-333-6	SA-105N	0.5620"	1/8"	WELD	WELDED	WELDED	TOP CHANNEL
VENT/DRAIN	1/1	2"-300#	RFLWN	SA-105N	—	0.6600"	1/8"	WELD	WELDED	—	CHAN. COVERS

20. Supports: Skirt NO (Yes or no) Lugs — (No.) Legs — (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)

22. Remarks: SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER, P.O. NO: 17496-0001; ITEM NO.: HX0052
SIZE: 15-168, TYPE: NEN, TUBES DESIGNED W/ 0" C.A., SAFETY RELIEF DEVICES BY OTHERS
LINES 14-18 INCLUDES (2) 21 1/8" O.D. X 15 1/4" I.D. X 3 1/4" THK., SA-266-4N, RING
(1) Cylinder to tubesheet circumferential seams are Type 7, with .85 Efficiency; (2) Field Test: Shell Side=595 PSIG; Tube Side= 420 PSIG

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 BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1.

U Certificate Authorization No. 12370 Expires SEPTEMBER 27 ,20 13

Date 7-23-12 Name ENERGY EXCHANGER COMPANY (Manufacturer) Signed (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 COMPANY of LYNN, MA have inspected the pressure vessel described in this Manufacturer's Data Report on 7.23.2012, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. By signing this certificate neither the Inspector nor his 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 7.23.12 Signed (Authorized Inspector) Commissions N.B.# 12064 A OKLA.# 7 (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 BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. U Certificate of Authorization No.

U Certificate of Authorization No. Expires ,20

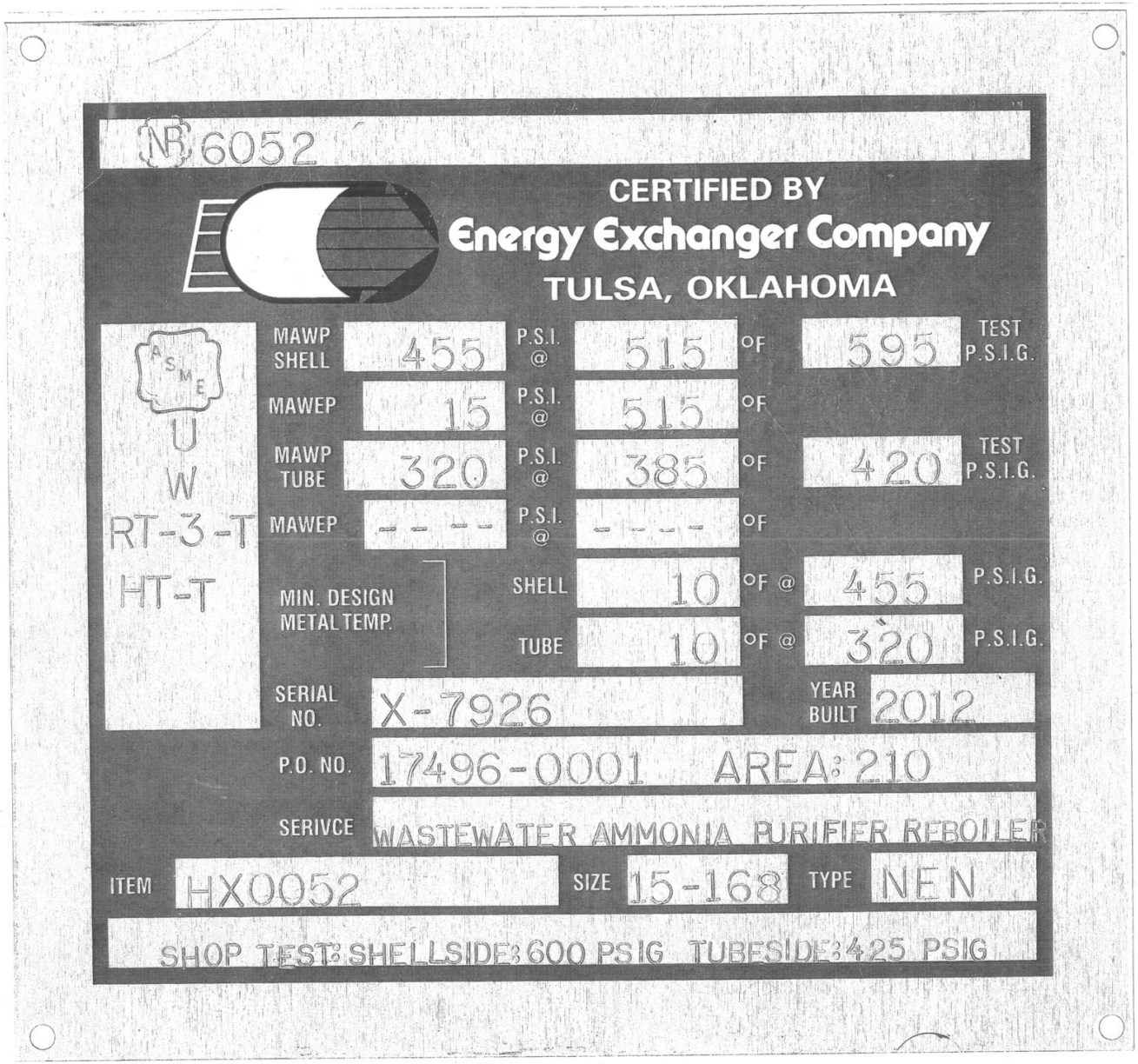
Date Name (Assembler) Signed (Representative)

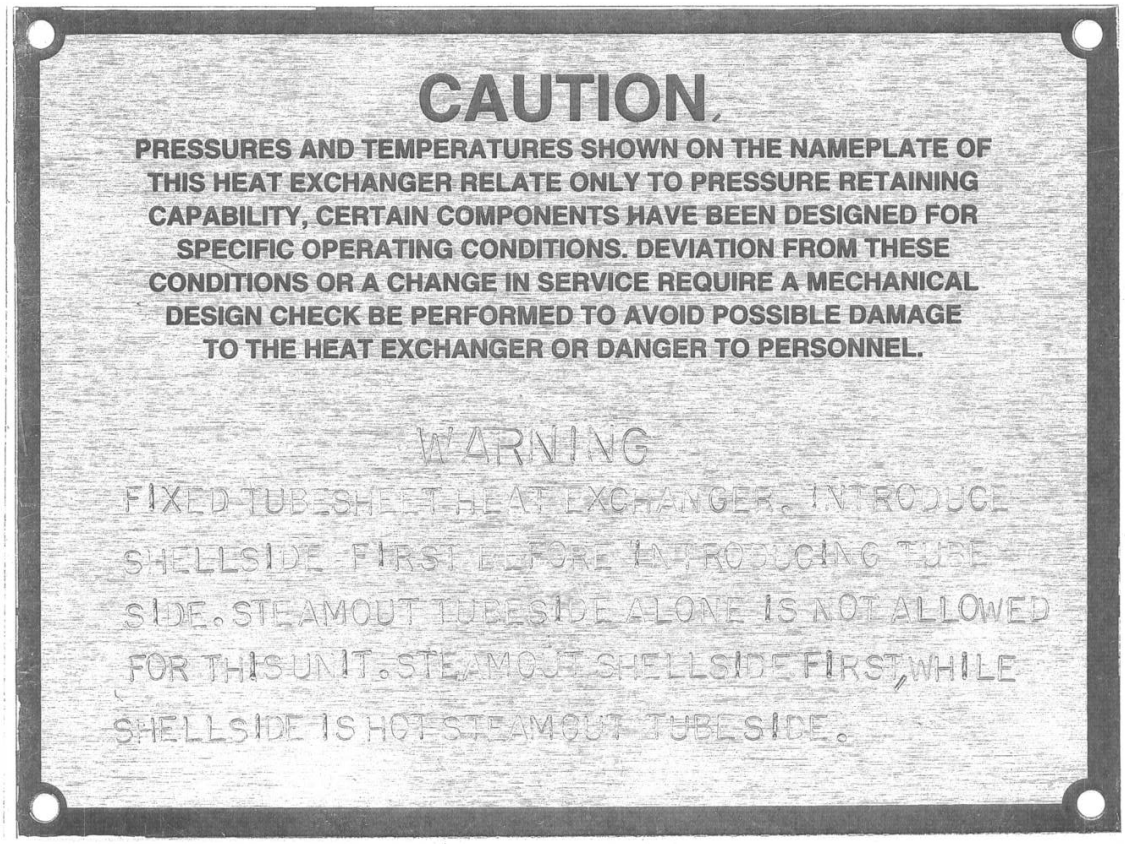
CERTIFICATE OF FIELD ASSEMBLY INSPECTION

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 items , not 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 BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. The described vessel was inspected and : psi.

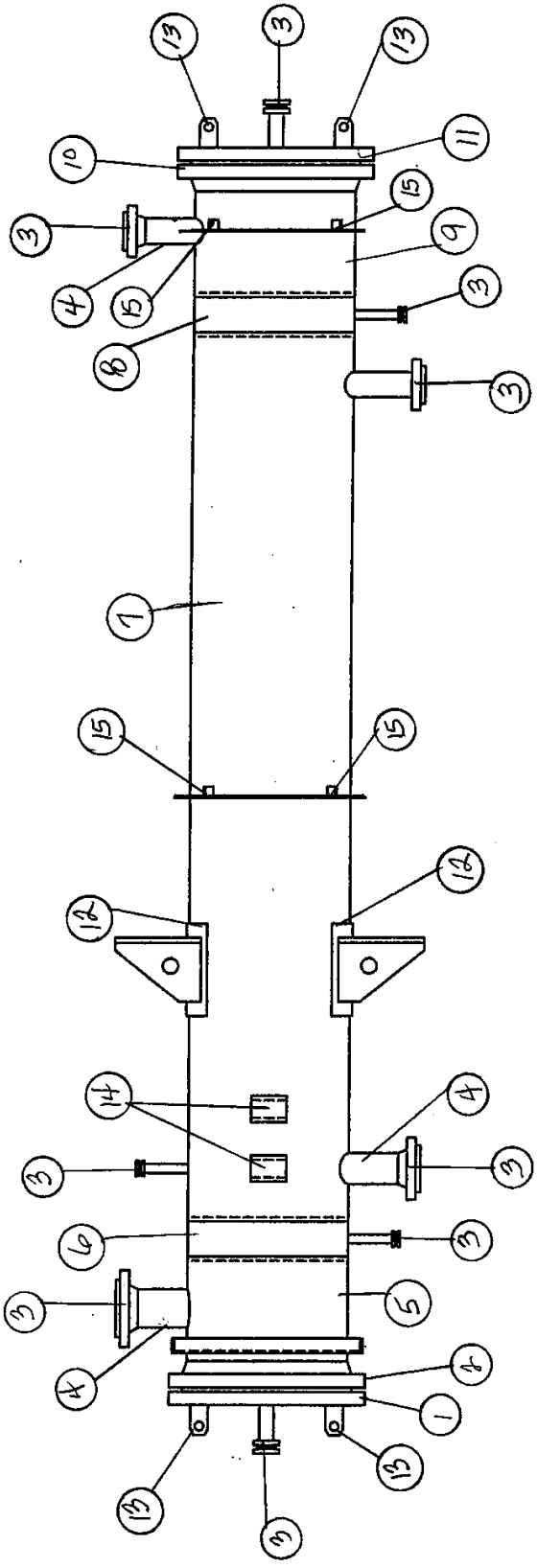
By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date Signed (Authorized Inspector) Commissions (Nat'l Board incl. endorsements, State, Province, and No.)




CAUTION
PRESSURES AND TEMPERATURES SHOWN ON THE NAMEPLATE OF THIS HEAT EXCHANGER RELATE ONLY TO PRESSURE RETAINING CAPABILITY, CERTAIN COMPONENTS HAVE BEEN DESIGNED FOR SPECIFIC OPERATING CONDITIONS. DEVIATION FROM THESE CONDITIONS OR A CHANGE IN SERVICE REQUIRE A MECHANICAL DESIGN CHECK BE PERFORMED TO AVOID POSSIBLE DAMAGE TO THE HEAT EXCHANGER OR DANGER TO PERSONNEL.
WARNING
FIXED TUBESHEET HEAT EXCHANGER. INTRODUCE SHELLSIDE FIRST BEFORE INTRODUCING TUBE SIDE. STEAMOUT TUBESIDE ALONE IS NOT ALLOWED FOR THIS UNIT. STEAMOUT SHELLSIDE FIRST, WHILE SHELLSIDE IS HOT STEAMOUT TUBESIDE.

SECTION 4


16 TUBES
17 STUDS
18 NUTS

ENERGY EXCHANGER COMPANY
MATERIAL HEAT NUMBER INDEX

Project; Kemper County 1 - IGCC

CUSTOMER:	**Southern Co. (for) Mississippi Power Company**	**ITEM NO:**	**HX0052**	**PAGE:**	**1 of 3**
DESTINATION:	**DeKalb, Mississippi**	**SERVICE:**	**Wastewater Ammonia Purifier Reboiler**	**DATE:**	**June 4, 2012**
P.O. No:	**17496-0001**	**DESCRIPTION:**	**1-15" x 168" NEN Exchanger**	**JOB NO:**	**X-7926**
Req. No:	**MC202**				

PART NO.	HEAT NO.	SLAB NO.	STEEL PRODUCER	GRADE	DESCRIPTION	PCS.	SIZE
1	227N568		ArcelorMittal	SA-266-4N	**(#1 Channel Cover)**	1	21 1/8" OD x 1 5/8" thk.
2	103467		Nucor	SA-266-4N	**(#2 Channel Flange)**	1	21 1/8" OD x 15 1/4" ID x 3 1/4" thk.
3	C845AN		FVC	SA-105-N	**(Nozzle Flange V-1)**	1	2" 300# RF LWN x 9" lg.
3	3019785		Galperti	SA-105-N	**(Nozzle Flange V-1)**	1	2" 300# RF Blind
3	30642/02		Galperti	SA-105-N	**(Nozzle Flange T-2)**	1	6" 300# RF WN Sch 120 Bore
3	A606AF		FVC	SA-105	**(Nozzle Flange V-2)**	1	3/4" 300# RF LWN x 9" lg.
3	79209		Galperti	SA-105-N	**(Nozzle Flange V-2)**	1	3/4" 300# RF Blind
3	32534R/02		Galperti	SA-105-N	**(Nozzle Flange S-1)**	1	4" 300# RF WN Sch 120 Bore
3	A606AF		FVC	SA-105	**(Nozzle Flange S-3)**	1	3/4" 300# RF LWN x 9" lg.
3	79209		Galperti	SA-105-N	**(Nozzle Flange S-3)**	1	3/4" 300# RF Blind
3	B834		FCI	SA-105-N	**(Nozzle Flange S-2)**	1	2" 300# RF LWN x 10" lg.
3	A606AF		FVC	SA-105	**(Nozzle Flange D-2)**	1	3/4" 300# RF LWN x 9" lg.
3	79209		Galperti	SA-105-N	**(Nozzle Flange D-2)**	1	3/4" 300# RF Blind

I hereby certify that the above information is correct to the best of my knowledge and belief.

ENERGY EXCHANGER COMPANY

By: Lynda Patterson

ENERGY EXCHANGER COMPANY
MATERIAL HEAT NUMBER INDEX

Project; Kemper County 1 - IGCC

CUSTOMER:	**Southern Co. (for) Mississippi Power Company**	**ITEM NO:**	**HX0052**	**PAGE:**	**2 of 3**
DESTINATION:	**DeKalb, Mississippi**	**SERVICE:**	**Wastewater Ammonia Purifier Reboiler**	**DATE:**	**June 4, 2012**
P.O. No:	**17496-0001**	**DESCRIPTION:**	**1-15" x 168" NEN Exchanger**	**JOB NO:**	**X-7926**
Req. No:	**MC202**				

PART NO.	HEAT NO.	SLAB NO.	STEEL PRODUCER	GRADE	DESCRIPTION	PCS	SIZE
3	3022384		Galperti	SA-105-N	**(Nozzle Flange T-1)**	1	3" 300# RF WN Sch 160 Bore
3	C845AN		FVC	SA-105-N	**(Nozzle Flange D-1)**	1	2" 300# RF LWN x 9" lg.
3	3019785		Galperti	SA-105-N	**(Nozzle Flange D-1)**	1	2" 300# RF Blind
4	U82073		U.S.S.	SA-333-6	**(Nozzle Pipe T-2)**	1	6" Sch 120 x 6 3/4" lg.
4	574171		Ipsco	SA-106-B	**(Nozzle Pipe S-1)**	1	4" Sch 120 x 7" lg.
4	320369		V&M	SA-333-6	**(Nozzle Pipe T-1)**	1	3" Sch 160 x 7" lg.
5	A03724		U.S.S.	SA-333-6	**(Top Channel Cylinder)**	1	16" OD x 3/8" thk. x 1'-2 11/16" lg.
6	227N568		ArcelorMittal	SA-266-4N	**(#4 Tubesheet)**	1	16" OD x 3" thk.
7	WA1176		U.S.S.	SA-106-B	**(Shell Cylinder)**	1	16" OD x 1/2" thk. x 13'-6 3/8" lg.
8	227N568		ArcelorMittal	SA-266-4N	**(#9 Tubesheet)**	1	16" OD x 3" thk.
9	A03724		U.S.S.	SA-333-6	**(Bottom Channel Cylinder)**	1	16" OD x 3/8" thk. x 1'-0 13/16" lg.
10	100646		Nucor	SA-266-4N	**(#2A Channel Flange)**	1	21 1/8" OD x 15 1/4" ID x 3 1/4" thk.
11	227N568		ArcelorMittal	SA-266-4N	**(#1A Channel Cover)**	1	21 1/8" OD x 1 5/8" thk.

I hereby certify that the above information is correct to the best of my knowledge and belief.

ENERGY EXCHANGER COMPANY

By: Lynda Patterson

ENERGY EXCHANGER COMPANY
MATERIAL HEAT NUMBER INDEX

Project; Kemper County 1 - IGCC

CUSTOMER:	**Southern Co. (for) Mississippi Power Company**	**ITEM NO:**	**HX0052**	**PAGE:**	**3 of 3**
DESTINATION:	**DeKalb, Mississippi**	**SERVICE:**	**Wastewater Ammonia Purifier Reboiler**	**DATE:**	**June 4, 2012**
P.O. No:	**17496-0001**	**DESCRIPTION:**	**1-15" x 168" NEN Exchanger**	**JOB NO:**	**X-7926**
Req. No:	**MC202**				

PART NO.	HEAT NO.	SLAB NO.	STEEL PRODUCER	GRADE	DESCRIPTION	PCS.	SIZE
12	0505315	03	Nucor	SA-516-70	**(Support Pads)**	2	11" x 3/8" thk. x 10 1/4" lg.
13	B1T7537	03	Nucor	SA-516-70	**(Lifting Lugs)**	4	3 1/2" x 1/2" thk. x 6 1/2" lg.
14	W0H543	0024	SSAB	SA-516-70	**(Name Plate Bracket)**	2	7 1/2" x 3/16" thk. x 22" lg.
15	3018892		CMC Steel	SA-36	**(Insulation Clips**	8	1 1/2" x 1/4" Thk. x 3" lg.
16	181073		Benteler	SA-179	**(Tubes)**	185	3/4"OD x .083" (min) x 14'-0" lg.
17	11881890		Vulcan Thrd. Prod.	SA-193-B7	**(Studs)**	32	1" (8 Thd) x 6" lg.
18	SN392		Unytite	SA-194-2H	**(Nuts)**	64	1" (8 Thd)

I hereby certify that the above information is correct to the best of my knowledge and belief.

ENERGY EXCHANGER COMPANY

By: Lynda Patterson

OKLAHOMA FORGE, INC.

Certification of Analysis and Tests

INVOICE NUMBER: 111-66965

Date: 6/20/11

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
ENERGY EXCHANGER COMPANY 1844 N. GARNETT ROAD TULSA, OK 74116 USA	Number: 1199 By: JIM ELDER Dated: 5/17/2011	Number: 111-51903 Shipped Via: DELIVERY Ship Date: 6/20/2011

Item	PART DESCRIPTION / Chemical Analysis / Physical Properties	Charpy Impact (ft-lbs)	Quantity

1 X-7926-4/9 — 111-51903-01 — DISC — 16.000"OD x 3.000"TH — Part # 6+8 — Qty 2
ARCELOMITTAL 227N568 — SA266-10 GR4 NORMALIZED

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.18	1.16	.014	.008	.23	.10	.09	.27	.027	.017	<.001	.021		.42	SN-.011; B-.0003

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
49,600	75,500	34	68	146			FINE	CVN	-50F	114	127	137	80

2 X-7926-1/1A — 111-51903-02 — DISC — 21.125"OD x 1.625"TH — Part # 1+11 — Qty 2
ARCELOMITTAL 227N568 — SA266-10 GR4 NORMALIZED

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.18	1.16	.014	.008	.23	.10	.09	.27	.027	.017	<.001	.021		.42	SN-.011; B-.0003

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
49,600	75,500	34	68	146			FINE	CVN	-50F	114	127	137	80

3 X-7930-4 — 111-51903-03 — DISC — 22.000"OD x 3.000"TH — Qty 2
ARCELOMITTAL 227N568 — SA266-10 GR4 NORMALIZED

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.18	1.16	.014	.008	.23	.10	.09	.27	.027	.017	<.001	.021		.42	SN-.011; B-.0003

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
49,600	75,500	34	68	146			FINE	CVN	-50F	114	127	137	80

4 X-7930-1 — 111-51903-04 — DISC — 27.875"OD x 3.250"TH — Qty 2
ARCELOMITTAL 227N568 — SA266-10 GR4 NORMALIZED

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.18	1.16	.014	.008	.23	.10	.09	.27	.027	.017	<.001	.021		.42	SN-.011; B-.0003

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
49,600	75,500	34	68	146			FINE	CVN	-50F	114	127	137	80

8 X-7930-2 — 111-51903-08 — RING — 27.875"OD x 20.500"ID x 4.188"TH — Qty 2
NUCOR 110786 — SA266-10 GR4 NORMALIZED

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.17	1.17	.010	.002	.20	.10	.10	.19	.03	.016	.003	.024		.41	SN-.008;TI-.002

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
48,800	73,500	35	74	143			FINE	CVN	-50F	85	85	104	67

9 X-7929-2/2A — 111-51903-09 — RING — 28.188"OD x 23.000"ID x 3.063"TH — Qty 2
NUCOR 110786 — SA266-10 GR4 NORMALIZED

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.17	1.17	.010	.002	.20	.10	.10	.19	.03	.016	.003	.024		.41	SN-.008;TI-.002

Yield Lb/Sqin	Tensile Strength Lb/Sqin	Elong%in 2in	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
48,800	73,500	35	74	143			FINE	CVN	-50F	85	85	104	67

Notes:

VERIFIED BY

JUN 27 2011

Page 1

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 MANUFACTURED IN THE UNITED STATES OF AMERICA.

EEL-UG DEPT

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 2000-2050 degrees F and Water Quenching.

L Patterson

OKLAHOMA FORGE, INC.

Certification of Analysis and Tests

111-66822

Date: 6/10/11

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

ENERGY EXCHANGER COMPANY 1844 N. GARNETT ROAD TULSA, OK 74116 USA	1199 JIM ELDER 5/17/2011	111-51903 DELIVERY 6/10/2011

PART DESCRIPTION

7 A	X-7926-2	111-51903-07A	RING	21.125"OD x 15.250"ID x 3.250"TH	1
		NUCOR	103467	SA266-10 GR4 NORMALIZED	

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.17	1.19	.013	.001	.18	.07	.14	.16	.04	.029	.001	.029		.430	SN-.007;TI-.001

Yield Lb/SqIn	Tensile Strength Lb/SqIn	Elong%in 2In	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
46,000	71,500	36	75	146			FINE	CVN	-50F	103	92	88	130

Part #2

7 B	X-7926- 2A	111-51903-07B	RING	21.125"OD x 15.250"ID x 3.250"TH	1
		NUCOR	100646	SA266-10 GR4 NORMALIZED	

C	Mn	P	S	Si	Ni	Cr	Cu	Mo	V	Cb	Al	Pb	Ce	Other
.17	1.18	.015	.0036	.23	.06	.11	.23	.02	.020	.002	.028		.42	SN-.009;TI-.001

Yield Lb/SqIn	Tensile Strength Lb/SqIn	Elong%in 2In	Red of Area%	Brinell	Rckwl C	Bend Test	Grain Size	Type	Temp	Average	#1	#2	#3
48,800	73,500	36	75	146			FINE	CVN	-50F	99	78	118	101

Part #10

VERIFIED BY
JUN 13 2011
EEC QC DEPT

Notes: L. Patterson [signature]

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 MANUFACTURED IN THE UNITED STATES OF AMERICA. [signature]

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 2000-2050 degrees F and Water Quenching.

GALPERTI, INC.
160 Southbelt Industrial Drive
Houston, Texas 77047
PH 713-433-0700 – FAX 713-433-5580
Email: galpmail@galperti-am.com

TEST/CERTIFICATE: 3.1B — EN 10204
INTERNAL JOB: 091351

PROGRESSIVE SUPPLY
P. O. BOX 470748
TULSA OK 74145

Part #2
This MTR applies to your PO# 1221

M.T.CERTIFICATE N.	DATE	YOUR P.O.	DATE
013947/B	06/12/2009	098331 X-7926-81	05/15/2009

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°	#
019/019	6" 300 WN RF 120 A105 B1 F	10	B	ASTM A/SA105 03c	30642/02	A
022/022	12" 600 WN RF XS A105 B1 F	2	B	ASTM A/SA105 03c	10354W/02	B
036/036	24" 150 SO RF A105 B1 F	2	B	ASTM A/SA105 03c	10092W/02	C

Noz. T2

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CB%	B %	FL%
A		0.180	1.130	0.250	0.012	0.010	0.070	0.080	0.010	0.230	0.0001		0.025	0.001	0.002	0.012	0.001		0.40
A	C	0.170	1.150	0.230	0.015	0.013	0.060	0.070	0.020	0.220	0.0001		0.036	0.001	0.002	0.012	0.001		0.39
B		0.180	1.160	0.190	0.010	0.008	0.100	0.120	0.020	0.190	0.0140			0.0004	0.001	0.006	0.0004	0.0001	0.42
B	C	0.170	1.140	0.160	0.015	0.003	0.120	0.090	0.030	0.160	0.0090			0.0004	0.001	0.006	0.0004	0.0001	0.40
C		0.160	1.170	0.270	0.020	0.001	0.110	0.190	0.030	0.170	0.0200	0.012	0.030	0.0010	0.003	0.010	0.0010		0.41
C	C	0.150	1.190	0.290	0.018	0.001	0.120	0.180	0.020	0.180	0.0150	0.012	0.050	0.0010	0.003	0.010	0.0010		0.40

NOTES
FL=Carbon Equivalent Long Formula

C = CHECK ANALISYS

MECHANICAL PROPERTIES

#		TENSILE TYPE	Ø DIAMETER mm.	AREA mmq.	LENGHT mm.	TEMP. F	TENSILE PSI	YIELD PSI	ELONG %	REDUCT. %	CHARPY TEST TYPE	TEMP.	VALUES	HB HARDNESS (AVERAGE)
A	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
A	O		12.50	122.70	50.00	68	78,744	47,971	27.5	66.5				160
B	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
B	O		12.50	122.70	50.00	68	78,510	47,333	29.6	69.2				160
C	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
C	O		12.50	122.70	50.00	68	78,184	47,844	30.0	68.5				153

NOTES
LINE 019 COUNTRY OF ORIGIN ITALY

O = OBTAINED
S = STANDARD

#	HEAT TREATMENTS
A A	Normalized at 900 dgr.C for 1.1/2 h.-Cooling from 900 dgr.C in still air
B B	Normalized at 900 dgr.C for 3 h.-Cooling from 900 dgr.C in still air
C C	Normalized at 900 dgr.C for 2 h.-Cooling from 900 dgr.C in still air

GENERAL NOTES
VERIFIED BY
ROUGHNESS
F =STOCK FINISH 125-250 microinch
JUN 16 2011
EEC QC DEPT
STANDARD
B1 = ASME B16.5

NOTES
Material I.A.W. Nace MR-0175-2002

TRADE MARK / LOGO	INT. INSPECT DATE	INT. INSPECTOR
Stamped on product	06/12/2009	D.RUZICKA

INSPECTION AUTHORITY
Dion Ruzicka

GALPERTI, INC
An ISO 9001/2000 certified company.
Certification issued by:
Lloyds register quality assurance
Certificate No. UQA 0110391

Part #3

160 Southbelt Industrial Drive
Houston, Texas 77047
PH. 713-433-0700 – FAX 713-433-5550
Email: galpmail@galperti-am.com

PROGRESSIVE SUPPLY
P. O. BOX 470748
TULSA OK 74145

This MTR applies to your PO# 1221

TEST/CERTIFICATE	EN 10204	INTERNAL JOB
3.1B		110100

M.T.CERTIFICATE N.	DATE	YOUR P.O.	DATE
001307/B	02/14/2011	11-9480 X-7426-71	01/10/2011

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°		#
001/001	12" 150 WN RF STD A105 B1 F	15	B	ASTM A/SA105 03c	3018256		A
005/005	4" 150 WN RF 120 A105 B1 F	25	B	ASTM A/SA105 03c	258121		B
007/007	4" 300 WN RF 120 A105 B1 F	40	A	ASTM A/SA105 03c	32534R/02	←	C
008/008	4" 300 WN RF 160 A105 B1 F	50	B	ASTM A/SA105 03c	32534R/02		D

Noz. #1

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CB%	B %	FL%
A		0.190	1.070	0.240	0.010	0.021	0.100	0.090	0.030	0.260	0.003			0.001			0.001		0.41
A	C	0.180	1.050	0.260	0.013	0.018	0.110	0.100	0.040	0.250	0.003			0.001			0.001		0.40
B		0.200	0.900	0.210	0.012	0.019	0.140	0.100	0.029	0.280	0.001			0.002			0.002		0.40
B	C	0.190	0.920	0.230	0.015	0.022	0.130	0.090	0.039	0.270	0.001			0.002			0.002		0.40
C		0.170	1.160	0.260	0.013	0.009	0.120	0.060	0.010	0.170	0.012		0.022	0.001	0.012		0.001	0.0001	0.40
C	C	0.160	1.180	0.280	0.010	0.006	0.130	0.050	0.020	0.160	0.007		0.032	0.001	0.012		0.001	0.0001	0.40

NOTES
FL=Carbon Equivalent Long Formula

C = CHECK ANALISYS

MECHANICAL PROPERTIES

#		TENSILE TYPE	Ø DIAMETER mm.	AREA mmq.	LENGHT mm.	TEMP. F	TENSILE PSI	YIELD PSI	ELONG %	REDUCT. %	CHARPY TEST TYPE	TEMP.	VALUES	HB HARDNESS (AVERAGE)
A	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
A	O		12.50	122.70	50.00	68	76,615	49,169	28.7	69.6				154
B	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
B	O		12.50	122.70	50.00	68	77,631	46,875	28.0	68.0				152
C	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
C	O		12.50	122.70	50.00	68	77,810	47,793	30.4	68.8				154
D	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
D	O		12.50	122.70	50.00	68	78,206	46,505	29.6	67.6				150

NOTES

O = OBTAINED
S = STANDARD

#	HEAT TREATMENTS
A A	Normalized at 900 dgr.C for 1.1/2 h.-Cooling from 900 dgr.C in still air
B B	Normalized at 900 dgr.C for 1 h.-Cooling from 900 dgr.C in still air
C C	Normalized at 900 dgr.C for 1.1/2 h.-Cooling from 900 dgr.C in still air
D D	Normalized at 900 dgr.C for 1.1/2 h.-Cooling from 900 dgr.C in still air

GENERAL NOTES

ROUGHNESS
F -STOCK FINISH 125-250 microinch

VERIFIED BY
STANDARD
B1 = ASME JUN 16 2011

NOTES
Material I.A.W. Nace MR-0175-2003 COUNTRY OF ORIGIN USA

EEC QC DEPT
La Patterson

TRADE MARK / LOGO	INT. INSPECT DATE	INT. INSPECTOR
Stamped on product	02/14/2011	D.RUZICKA

INSPECTION AUTHORITY
Dan Ruzicka

GALPERTI, INC
An ISO 9001/2008 certified company.
Certification issued by:
Lloyds register quality assurance
Certificate No. UQA 0110391

04/08/2009 From: MATTSCO SUPPLY CO. To: ENERGY EXCHANGERS
Our# :31620 Line# :2 QTY: :6
To: :ENERGY EXCHANGERS
CPO# :4326

X-7926-73, 74, 75 Part #3

MATERIAL TEST REPORT

MTR # A183731

Forged Vessel Connections
2525 De Soto St. (77091)
P.O. Box 38421 (77238-8421)
Houston, Texas
A DIVISION OF AMERI-FORGE GROUP INC.

http://www.fvc.cc
QA@fvc.cc

TEL: (713) 688-9705 FAX: (713) 688-7954

Noz. V2, D2, S3

S.O. No: 8-02434 Date: 10/21/2008 REV #
Purchaser: Mattsco Supply Co. Distributor:
P.O. No.: 853-S-08 Distributor's Order No: Page 1

ITEM NO	QTY	DESCRIPTION	SPEC	HEAT #	HEAT TREAT
6	1	LWN,SA105, 300#,.75 x 9",RF&D J55433-0 J55433-1	SA105 2007 Edition, 2008a Adden	A606AF	As-Forged

(C + (Mn / 6)) + ((Cr + Mo + V) / 5) + ((Ni + Cu) / 15) = .442

CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES

Heat #: A606AF 11789240

Chemical values below represent percentage of weight

C (Carbon)	Mn (Manganese)	P (Phosphorus)	S (Sulphur)	Si (Silicon)	Cr (Chromium)	Ni (Nickel)	Mo (Molybdenum)
.19	1.05 *CAS # 7349-96-5	.018 *CAS # 7723-14-0	.022	.26	.19 *CAS # 7440-47-3	.11 *CAS # 7440-02-0	.05 *CAS # 1313-27-5
Cu (Copper)	**Al (Aluminum)**	**V (Vanadium)**	**As (Arsenic)**	**Sb (Antimony)**	**Sn (Tin)**	**Co (Cobalt)**	**N (Nitrogen)**
.32 *CAS # 7440-50-8	.006	.002 *CAS # 7440-62-2			.013		
Ti (Titanium)	**Ta (Tantalum)**	**Cb (Columbium)**	**O (Oxygen)**	**H (Hydrogen)**			
		.013					

TENSILE (PSI)	YIELD (PSI)	ELONG (IN 2")	R.A. (%)	CHARPYS (FT - LBS)	TEMP ° F
82988	58388	28.0	66.0		

SHEAR %	LATERAL EXPANSION (MILS)	BHN
		< 187

COMMENTS
Test Bar: 187-187 BHN

FVC STANDARD MANUFACTURING PRACTICES:

1) FLANGE DIMENSIONS & BOLTING COMPLY - ASME B16.5
2) SELF-REINFORCING NOZZLES COMPLY WITH SPECIFICATION OF SECT. VIII DIV. 1 OR DIV.2 PER CUSTOMER DESIGN/FVC DESIGN.
3) MATERIAL SPECIFICATION COMPLIES WITH ASME SECT. II. PART A.
4) ALL FVC MATERIAL MANUFACTURED PER FINE GRAIN PRACTICE.
5) ALL FVC MATERIAL CERTIFIED PER EN 10204, 3.1.B UNLESS OTHERWISE SPECIFIED
6) CERTIFICATE OF INSURANCE AVAILABLE UPON REQUEST.

CHECKED APR 15 2009

L Patterson

EPCRA Supplier Notification:

* This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with an asterisk (*) under the chemical's name and percent-by-weight value, followed by a Chemical Abstract Service (CAS) registry number for that chemical. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Lina Robles
Quality Assurance

04/08/2009 From: MATTSCO SUPPLY CO. To: ENERGY EXCHANGERS
Our# :31620 Line# :1 QTY: :6
To: :ENERGY EXCHANGERS
CPO# :4326

X-7986 - 73D, 74D, 75D

Part #3

GALPERTI, INC.
160 Southbelt Industrial Drive
Houston, Texas 77047
PH. 713-433-0700 - FAX 713-433-5560
Email: galpmail@galperti-am.com

TEST/CERTIFICATE EN 10204: 3.1B

INTERNAL JOB: 083305

MATTSCO SUPPLY
P.O.BOX 2925
TULSA OK 74101

Noz. V2, D2, S3

M.T.CERTIFICATE N.: 011219/B DATE: 10/21/2008

YOUR P.O: 946-S-09A DATE: 10/13/2008

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°		#
024/024	3" 600 WN RF 160 A105 B1 F	15	A	ASTM A/SA105 03c	252597		A
024/024	3" 600 WN RF 160 A105 B1 F	5	B	ASTM A/SA105 03c	3832/02		B
026/026	6" 150 BL RF A105 B1 F	20	B	ASTM A/SA105 03c	30469/02		C
027/027	0.75" 300 BL RF A105 B1 F	25	B	ASTM A/SA105 03c	79209		D

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CB%	FL%
A		0.200	0.910	0.200	0.010	0.023	0.140	0.090	0.028	0.320	0.0001			0.002			0.002	0.41
A	C	0.190	0.930	0.180	0.013	0.020	0.150	0.100	0.018	0.330	0.0001			0.002			0.002	0.40
B		0.175	1.140	0.190	0.009	0.010	0.095	0.210	0.036	0.220	0.0010	0.014	0.020	0.001		0.009	0.001	0.42
B	C	0.165	1.160	0.170	0.012	0.013	0.105	0.220	0.046	0.230	0.0010	0.014	0.040	0.001		0.009	0.001	0.41
C		0.180	1.190	0.250	0.011	0.009	0.100	0.060	0.010	0.180	0.0230	0.009	0.025	0.002	0.021		0.002	0.42
C	C	0.170	1.210	0.230	0.014	0.012	0.110	0.070	0.020	0.190	0.0180	0.009	0.039	0.002	0.021		0.002	0.41
D		0.185	1.120	0.220	0.013	0.013	0.090	0.060	0.010	0.200	0.0240						0.001	0.41
D	C	0.195	1.140	0.240	0.010	0.010	0.100	0.070	0.020	0.190	0.0340						0.001	0.43

NOTES
FL=Carbon Equivalent Long Formula

C = CHECK ANALISYS

MECHANICAL PROPERTIES

#		TENSILE TYPE	Ø DIAMETER mm.	AREA mmq.	LENGHT mm.	TEMP. F	TENSILE PSI	YIELD PSI	ELONG %	REDUCT. %	CHARPY TEST TYPE	TEMP.	VALUES	HB HARDNESS (AVERAGE)
A	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
A	O		12.50	122.70	50.00	68	76,790	50,217	27.6	67.6				151
B	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
B	O		12.50	122.70	50.00	68	77,987	50,277	31.0	68.5				157
C	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
C	O		12.50	122.70	50.00	68	76,572	49,075	29.0	66.0				157
D	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
D	O		12.50	122.70	50.00	68	77,220	50,301	29.0	69.8				164

NOTES

O = OBTAINED
S = STANDARD

#	HEAT TREATMENTS
A A	Normalized at 900 dgr.C for 1.1/2 h.-Cooling from 900 dgr.C in still air
B B	Normalized at 900 dgr.C for 1.1/2 h.-Cooling from 900 dgr.C in still air
C C	Normalized at 900 dgr.C for 1 h.-Cooling from 900 dgr.C in still air
D D	Normalized at 900 dgr.C for 1 h.-Cooling from 900 dgr.C in still air

GENERAL NOTES

ROUGHNESS
F =STOCK FINISH 125-250 microinch

STANDARD
B1 = ASME B16.5

NOTES
Material I.A.W. Nace MR-0175-2002

TRADE MARK

INT. INSPECT DATE: 10/21/2008

INT. INSPECTOR: D.RUZICKA

INSPECTION AUTHORITY

CHECKED APR 15 2009

LLOYD'S REGISTER QUALITY ASSURANCE ISO9001

Noz. V1+D1

This MTR applies to your PO# 1221 Part #2

Material Test Report

Heat Code: C845AN

ISO 9001:2008 Certified

An Ameri-Forge Group Company
2525 De Soto Houston, TX 77091
Sales: (713) 868-4421 Fax: (713) 455-8366

Progressive Supply	PO: 11-9503	Sales Order: 1-00542	Line: 4
Attn: Accounts Payable	Item Code: LWN020300090A002A1	Qty Shipped: 10	
P.O. Box 470748	Item Desc: LWN,SA105N,300#,2"x9",RF		
Tulsa, OK 74147	Supplier: STEEL DYNAMICS, INC	Supplier Heat: A103136	
Spec: ASME SA105N: 2007 Edition, 2009 Addenda	X-7926-82+84		

Element	(%wt)	Ladle	Product	EPCRA	CAS#
C	Carbon	0.19 ✓			
Mn	Manganese	1.15 ✓		✓	7439-96-5
P	Phosphorous	0.006 ✓			
S	Sulphur	0.004 ✓			
Si	Silicon	0.27 ✓			
Cu	Copper	0.16 ✓		✓	7440-50-8
Ni	Nickel	0.06 ✓		✓	7440-02-0
Cr	Chromium	0.09 ✓		✓	7440-47-3
Mo	Molybdenum	0.02 ✓			
V	Vanadium	0.021 ✓			
Cb	Columbium	0.002 ✓			

Element	(%wt)	Ladle	Product	EPCRA	CAS#
Sn	Tin	0.009			
B	Boron	0.000			
Ti	Titanium	0.001		✓	7440-02-0
Al	Aluminum	0.022			
Ca	Calcium	0.0017			
N	Nitrogen	0.0079			
O					
As	Arsenic	0.007		✓	7440-38-2
Sb	Antimony	0.006		✓	7440-36-0
CE	C+Mn/6+(Cr+Mo+V)/5	0.423			
H ppm wt		2.0			

Mechanical Testing	
HBW	141 ✓
Elg (%)	35.40 ✓
RA (%)	71.20 ✓
Tensile (ksi)	74.686 ✓
Yield (ksi)	47.669 ✓

Heat Treat

Heat Treatment	Normalized ✓

Other	
Country of Origin	USA ✓
Manufactured In	USA
Production Method	EAF
Reduction Ratio (Mill) x:1	3.5/1
Gr.Sz.	5
Calcium Treated	YES

VERIFIED BY
JUN 16 2011
EEC QC DEPT
S. Patterson

PO# 100483
NACE MR0175 & MR0103 (hardness only), CE=C+(Mn/6)+((Cr+Mo+V)/5)+((Ni+Cu)/15), Elongation in 2" round
FVC STANDARD MANUFACTURING PRACTICES:
1) FLANGE DIMENSIONS & BOLTING COMPLY - ASME B16.5
2) SELF-REINFORCING NOZZLES COMPLY WITH SPECIFICATION OF SECTION VIII DIV. 1 OR DIV. 2 PER CUSTOMER DESIGN/FVC DESIGN
3) MATERIAL SPECIFICATION COMPLIES WITH ASME SECT. II PART A
4) ALL FVC MATERIAL MANUFACTURED PER FINE GRAIN PRACTICE
5) ALL FVC MATERIAL CERTIFIED PER EN 10204, 3.1.B UNLESS OTHERWISE SPECIFIED
6) CERTIFICATE OF INSURANCE AVAILABLE UPON REQUEST

EPCRA Supplier Notification: This product may contain one or more toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) and 40 C.F.R. Part 372. Potentially reportable chemicals are indicated with a checkmark in the "EPCRA" column and a Chemical Abstract Services (CAS) registry number is provided for each such chemical in addition to the percent by weight of the chemical present in this product. It is your responsibility alone to determine whether your facility is required to submit a Toxic Release Inventory Report under EPCRA Section 313.

Certification No.: 1002717
Certification Date: 5/5/2011
Issued By: Stephanie Kobs
This report is issued in compliance with the requirements of EN10204 3.1 / ISO 10474 3.1.b

Estela Cuellar
Estela Cuellar - Quality Manager

Part #3

GALPERTI, INC
160 Southbelt Industrial Drive
Houston, Texas 77047
PH. 713-433-0700 – FAX 713-433-6680
Email: galpmail@galperti-am.com

TEST/CERTIFICATE: EN 10204 — 3.1B

INTERNAL JOB: 111166

PROGRESSIVE SUPPLY
P. O. BOX 470748
TULSA OK 74145

This MTR applies to your PO# 1221

M.T.CERTIFICATE N.: 003083/B — DATE: 04/07/2011

YOUR P.O.: 11-9523 X-7926-82D +89D — DATE: 03/31/2011

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°		#
004/004	12" 600 WN RF 80 A105 B1 F	4	B	ASTM A/SA105 03c	102817N/02		A
005/005	8" 150 WN RF XS A105 B1 F	50	B	ASTM A/SA105 03c	100506N/02		B
006/006	2" 300 BL RF A105 B1 F	200	B	ASTM A/SA105 03c	3019785 ←		C

Noz. V1 + D1

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CB%	FL%
A		0.170	1.170	0.190	0.008	0.002	0.080	0.080	0.030	0.150	0.017		0.026	0.002			0.002	0.40
A	C	0.160	1.190	0.210	0.005	0.002	0.090	0.070	0.040	0.160	0.012		0.037	0.002			0.002	0.40
B		0.170	1.150	0.260	0.011	0.001	0.110	0.070	0.040	0.200	0.016		0.028	0.003			0.003	0.41
B	C	0.160	1.130	0.280	0.014	0.001	0.100	0.060	0.050	0.210	0.011		0.048	0.003			0.003	0.39
* C		0.190	1.050	0.230	0.006	0.017	0.050	0.090	0.020	0.190	0.003			0.001			0.001	0.39
C	C	0.180	1.070	0.250	0.009	0.020	0.060	0.100	0.010	0.180	0.003			0.001			0.001	0.39

NOTES
FL=Carbon Equivalent Long Formula

C = CHECK ANALISYS

MECHANICAL PROPERTIES

#		TENSILE TYPE	Ø DIAMETER mm.	AREA mmq.	LENGHT mm.	TEMP. F	TENSILE PSI	YIELD PSI	ELONG %	REDUCT. %	CHARPY TEST TYPE	TEMP.	VALUES	HB HARDNESS (AVERAGE)
A	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
A	O		12.50	122.70	50.00	68	77,523	50,416	28.1	66.0				162
B	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
B	O		12.50	122.70	50.00	68	77,993	49,943	30.0	68.0				152
C	S		12.50	122.70	50.00	68	70,000	36,000	22.0	30.0				187
* C	O		12.50	122.70	50.00	68	77,474	49,259	27.0	70.0				155

NOTES

O = OBTAINED
S = STANDARD

#	HEAT TREATMENTS
A A	Normalized at 900 dgr.C for 3 h.-Cooling from 900 dgr.C in still air
B B	Normalized at 900 dgr.C for 1.1/2 h.-Cooling from 900 dgr.C in still air
C C	Normalized at 900 dgr.C for 1 h.-Cooling from 900 dgr.C in still air

GENERAL NOTES
ROUGHNESS
F =STOCK FINISH 125-250 microinch

VERIFIED BY
STANDARD
B1 H ASME B16.5

JUN 16 2011

NOTES
Material I.A.W. Nace MR-0175-2003 COUNTRY OF ORIGIN:USA ✓

EEC QC DEPT
L. Patterson

TRADE MARK / LOGO
Stamped on product

INT. INSPECT DATE: 04/07/2011

INT. INSPECTOR: D.RUZICKA

INSPECTION AUTHORITY

GALPERTI, INC
An ISO 9001/2008 certified company.
Certification issued by:
Lloyds register quality assurance
Certificate No. UQA 0110391

Part #3

FCI FORGED COMPONENTS INC.

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

REPORT NUMBER 48290
DATE 5/2/2011
FCI ORDER NUMBER 52051
Processed I.A.W. EN10204 3.1

CUSTOMER ORDER NUMBER 119533
SOLD/SHIPPED TO PROGRESSIVE SUPPLY
P.O. BOX 470748

TULSA OK 74147 USA

Item	Quantity	Description
6	15	2" X 300 X 12" LG RF LWN

X-7926-72 Noz. 5-2

HEAT NUMBER:	MATERIAL TYPE:	Material Origin:	Manufactured in
B834	SA105N	USA ✓	USA ✓

I.A.W. ASME 2010 ED.

CHEMICAL ANALYSIS

C	.190 ✓
Mn	1.030 ✓
P	.0090 ✓
S	.0200 ✓
Si	.220 ✓
Cr	.090 ✓
Mo	.030 ✓
V	.004 ✓
Cu	.230 ✓
Ni	.080 ✓
Cb	.002 ✓
Al	.023
C E	.41

PHYSICAL PROPERTIES

Yield PSI	57,400 ✓
Tensile PSI	79,200 ✓
Elongation	31 ✓
Reduction of Area	72 ✓
Hardness	152 HBW ✓

VERIFIED BY
JUN 16 2011
EEC QC DEPT
K Patterson

Heat Treatment	NORMALIZED ✓
Temperature	1650°F
Time at Temperature	1/2 HR / IN THK MIN
Cooling Media	AIR

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

Prepared by

Name: Janie Garcia Title: QA Representative

Date printed: 5/13/2011 12:22:09 PM

Part #3

GALPERTI, INC.
160 Southbelt Industrial Drive
Houston, Texas 77047
PH. 713-433-0700 – FAX 713-433-5580
Email: galpmail@galperti-am.com

TEST/CERTIFICATE EN 10204: 3.1B

INTERNAL JOB: 110699

PROGRESSIVE SUPPLY
P. O. BOX 470748
TULSA OK 74145

This MTR applies to your PO# 1221

M.T.CERTIFICATE N.	DATE	YOUR P.O.	DATE
003382/B	04/14/2011	119502 X-7926-87	02/23/2011

ITEM	DESCRIPTION	QUANTITY	B/P	MATERIAL	HEAT N°	#
012/012	3" 300 WN RF 160 A105 B1 F	25	B	ASTM A/SA105 03c	3022384	A

Noz. T1

CHEMICAL ANALYSIS

#		C %	MN %	SI %	P %	S %	CR %	NI %	MO %	CU %	V %	SN %	AL %	NB %	TI %	N %	CB%	FL%
A		0.200	1.060	0.250	0.011	0.016	0.100	0.100	0.030	0.250	0.003		0.002	0.001			0.001	0.42
A	C	0.190	1.080	0.270	0.008	0.013	0.090	0.110	0.040	0.240	0.003		0.021	0.001			0.001	0.41

NOTES: FL=Carbon Equivalent Long Formula

C = CHECK ANALISYS

MECHANICAL PROPERTIES

#		TENSILE TYPE	Ø DIAMETER mm.	AREA mmq.	LENGHT mm.	TEMP. F	TENSILE PSI	YIELD PSI	ELONG %	REDUCT. %	CHARPY TEST TYPE	TEMP.	VALUES	HB HARDNESS (AVERAGE)
A	S		12.50	122.70	50.00	68	70,000	36,000	22.0	38.0				187
A	O		12.50	122.70	50.00	68	77,228	50,270	28.8	69.0				161

NOTES

O = OBTAINED
S = STANDARD

#	HEAT TREATMENTS
A	Normalized at 900 dgr.C for 1.1/2 h.-Cooling from 900 dgr.C in still air
A	

GENERAL NOTES

ROUGHNESS
F = STOCK FINISH 125-250 microinch

VERIFIED BY
JUN 16 2011
EEC QC DEPT

STANDARD
B1 = ASME B16.5

NOTES: Material I.A.W. Nace MR-0175-2003 COUNTRY OF ORIGIN: USA ✓

D. Patterson

TRADE MARK / LOGO	INT. INSPECT DATE	INT. INSPECTOR
Stamped on product	04/14/2011	D.RUZICKA

INSPECTION AUTHORITY

GALPERTI, INC
An ISO 9001/2008 certified company.
Certification issued by:
Lloyds register quality assurance
Certificate No. UQA 0110391

UNITED STATES STEEL

TUBULAR PRODUCTS
CERTIFIED TEST REPORT
(IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 "type 3.1")

DATE: 12/02/09
TIME: 09:34:37
SERIAL NO: F0056226

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	VEHICLE I.D
DR47536.03		102543-00	

SOLD TO ADDRESS
PROGRESSIVE SUPPLY, INC.
7615 E. 42 ND. PL.
TULSA, OK. 74145

X-7926-81A

MAIL TO ADDRESS
This MTR applies to your
PO# 124

VENDOR
USS TUBULAR PRODUCTS
USS FAIRFIELD WORKS
P.O. BOX 599
FAIRFIELD ALABAMA 35064

SPECIFICATION AND GRADE

PRESSURE PIPE CARBON SMLS HF ASTM A333-*05 GRADE 1 ASTM A333-*05 GRADE 6 ASME SA333-*2007 EDITION GRADE 1 ASME SA333-*2007 EDITION GRADE 6 ASTM A106-*08 GRADE B ASME SA106-*2007 EDITION GRADE B DUAL STENCIL BLK REG MILL COAT PE BEV 30 DEG MEETING ALL THE APPLICABLE REQUIREMENTS OF NACE STANDARD MR-01-75 *:2003/COR.1:2005 AND MR0103-2007

Noz. T2

MATERIAL COND: QUENCH & TEMPER

O.D.: 6.625 (168.275) in (mm)

WALL: 0.562 (14.274) in (mm)

PRODUCT IDENTIFICATION	TEST TYPE/ ORIENTATION	TEST COND.	GAUGE WIDTH IN	YIELD PSI	EXT % .50	TENSILE PSI	Y/T	ELONG % (IN 2")	HARDNESS SCALE: HRB	MIN HYDRO PSI	DWELL (SEC)
				MIN: 35,000 ✓		MIN: 60,000 ✓		MIN: ✓ 30.0	MIN:	2800 ✓	5 ✓
				MAX: ✓		MAX: ✓	MAX:		MAX: 99.5 ✓		
U82073	STRIP/L/B	HT	1.5	73,000	.50	94,500	0.77	46.0	86.8	2800	5
U82073	STRIP/L/B	HT	1.5	60,000	.50	77,500	0.77	48.6			
		**	END OF DATA THIS		SHEET	**					

LEGEND: L - LONGITUDINAL, U - UPSET; T - TRANSVERSE, NM - NORMALIZED; QT - QUENCH & TEMPERED, SR - STRESS RELIEVED; AR - AS ROLLED, TR - THERMOMECHANICAL ROLLED; B - BODY; W - WELD

PRODUCT IDENTIFICATION	TYPE	C ✓	MN ✓	P ✓	S ✓	SI ✓	CU ✓	NI ✓	CR ✓	MO ✓	AL ✓	N	V ✓	B	TI	CB	CO	C.E.* MAX .43
U82073	HEAT	16	106	008	006	19	04	01	04	05	029	006	00					.36
U82073	PROD	18	100	008	008	18	04	01	06	05	026	008	00					.37
U82073	PROD	17	99	007	007	18	04	01	05	05	026	007	00					.36
		** END OF DATA THIS SHEET **																

*C.E. IS BASED ON THE FOLLOWING EQUATION(S): C.E. = C + MN/6 + (CR+MO+ V)/5 + (CU+NI)/15 <= 0.43

DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT.

VERIFIED BY
JUL 11 2011
EEC QC DEPT
K. Patterson

Part #4

UNITED STATES STEEL

TUBULAR PRODUCTS
CERTIFIED TEST REPORT
(IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 "type 3.1")

DATE: 12/02/09
TIME: 09:34:37
SERIAL NO: F0056226

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	
DR47538 03		102543-00	

MATERIAL COND: QUENCH & TEMPER

O.D.: 6.625 (168.275) in (mm)

WALL: 0.562 (14.274) in (mm)

PRODUCT IDENTIFICATION	FLAT	BEND	GRAIN SIZE	MIN COLLAPSE	CHARPY V-NOTCH IMPACT TESTING												
					DIR	TEST LOC.	TEMP	SIZE	TEST COND.	FT-LBS 1	FT-LBS 2	FT-LBS 3	FT-LBS AVG	% SHEAR 1	% SHEAR 2	% SHEAR 3	% SHEAR AVG
							DEG F			10	10	10	12				
U82073	OK			** END OF DATA THIS SHEET **	L	B	- 60	2/3	HT	127	143	136	135	✓			

LEGEND L - LONGITUDINAL T - TRANSVERSE B - BODY W - WELD HAZ - HEAT AFFECTED ZONE

TESTING / INSPECTION INFORMATION

TEST / INSPECTION	YES	RESULTS / COMMENTS
FULL LENGTH VISUAL	X	
FULL LENGTH EMI	X	OD X OD/ID ____ L ____ L/T X 10.0% NOTCH
FULL LENGTH MPI		
FULL LENGTH UT	X	ID ____ OD/ID X L ____ L/T X 10.0/10.0% NOTCH
END AREA INSPECTION (PLAIN END)	X	MPI X UT ____
SPECIAL END AREA (SEA) INSP		MPI ____ UT ____
FULL LENGTH DRIFT		DRIFT MANDREL SIZE:

ADDITIONAL NOTES/COMMENTS

ALL MELTING AND MANUFACTURING TOOK PLACE IN THE USA.
MANUFACTURED IN AN ISO 9001 CERTIFIED FACILITY - CERTIFICATE #30727.
NO REPAIRS BY WELDING. NO MERCURY OR MERCURY COMPOUNDS ARE ADDED TO THE STEEL AND ALL MERCURY
** END OF DATA **

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, SAMPLED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS THE REQUIREMENTS IN SUCH RESPECTS.

PREPARED BY THE OFFICE OF: J. MAJKRZAK - MANAGER, Q.A.

DATE 12/02/09

Part #4

**

Part #4

TUBE TEST REPORT

Form QA-003 12/02/09 - Rev 2

IPSCO

STOCK #73

ORDER: 031595 009	HEAT: 574171 ← P.O.: 6419	PART NO.

SOLD TO:
PROGRESSIVE SUPPLY, INC.
7615 E. 42 ND. PL.
TULSA, OK. 74145

Noz. S-1

SHIP TO:
This MTR applies to your
PO# 19010

SPECIFICATION(S): ASME ASTM SA53/A53-10 GR B, SA106/A106-10 GR B/C,
API 5L PSL1 GR B/X42 FORTY - FOURTH EDITION
CERTIFIED NACE MR -01-75 DATED 10/15/2009 X-7926-71A

GRADE: 1023M	SIZE: 4.500 X 0.438 DRL	WPF: 19.02	QUALITY: SEAMLESS HOT FINISH

CONDITION (SPECIAL): ELECTRIC FURNACE
FINE GRAIN MELT PRACTICE
TEST METHODS USED: ASTM E415

TEST RESULTS CONFORM TO THE STANDARDS AND SPECIFICATION LISTED ABOVE.

	C	Mn	S	P	Si	Cr	Ni	Mo	Cu	Al	V	Cb	Ti	B
L	.23	.58	.005	.009	.28	.14	.11	.03	.30	.014	.003	.001	.0020	.0001
P	.23	.57	.001	.008	.26	.13	.10	.03	.26	.013	.002	.001	.0020	.0001
P	.23	.58	.001	.009	.27	.13	.10	.03	.27	.012	.001	.001	.0020	.0001

MATERIAL 100% MELTED AND MANUFACTURED IN THE USA.

Specimen ASTM E8	Yield KSI	Tensile KSI	ELNG 2 "	R/A	C.E.	Rockwell ASTM E18 Avg	Hydrotest
1.000 " STR	48.9	75.6	41.0		.39	77.6 80.1 75.6 77.8 RB	3000 PSI 5 Sec Hold

EN 10204 TYPE 3.1b DATED 01/2005
FLAT(S) - SATISFACTORY
EMI INSPECTION - SATISFACTORY

VERIFIED BY

EEC QC DEPT

L Patterson
Melinda Ambriale

9/28/11

DATE QUALITY ASSURANCE/KOPPEL

MATERIAL WAS NOT EXPOSED TO MERCURY DURING PROCESSING.
NO WELDING OR WELD REPAIR PERFORMED ON THIS MATERIAL.
MATERIAL IS FREE OF HARMFUL RADIATION.

IPSCO KOPPEL WORKS
P.O. BOX 750
BEAVER FALLS, PA 15010

IPSCO AMBRIDGE WORKS
P.O. BOX 410
AMBRIDGE, PA 15003

IPSCO BAYTOWN WORKS
2600 SPUR 55
BAYTOWN, TX 77523

Part #4

(A01) V&M FRANCE TUBERIE SAINT SAULVE SAINT SAULVE ZONE INDUSTRIELLE 59880 SAINT SAULVE	VALLOUREC & MANNESMANN TUBES Vallourec Group	MATERIAL TEST REPORT - INSPECTION CERTIFICATE (A02) 3.1 EN 10204 : 2004 No. : 16328Sv07 (A03) Page: 1 / 5 Date: 31.10.2007

X-7926-87H Noz. T1

(A01) V&M FRANCE This MTR applies to your PO# 1221	(A06.1) V&M-Order-No. VL0610 (A06.2) Suborder 856/4818 7
(A06.1) Customer PROGRESSIVE SUPPLY, INC. 7615 E. 42 ND. PL. TULSA, OK. 74145	(A07.1) Order-No. 41-046815
(A06.2) Orderer V & M TUBES CORPORATION / 77056 HOUSTON (TEXAS) 77056	(A07.2) Order-No. 41-046815 Date 06.09.2007
	(A07.3) Order-No. F3033000

(B01, B02, B04) Description of the product	Hot finished seamless pipes for low-temperature service Ends bevelled, angle 30° (+5 / -0), root face 1.6 mm (± 0.8) Inside without rust protection - Outside dry varnish ASTM A 333 - 04 A ASTM A 999 - 04 A ASME SA 333, Edition 2004 ASME SA 999, Edition 2004, Addenda 2005 ASME Boiler and Pressure Vessel Code, Sect. II, Part A, Edition 2004, Addenda 2006 Nace MR 0175 / ISO 15156-2:2003 / COR.1:2005 / EN ISO 15156-2:2003, Annex A.2.1.2 Spec. Wius-2, Rev. F, dated 04.2006 Grade 6 Grade 1
ROCKWELL C HARDNESS <= 22 GUARANTEED MERCHANDISE IS FREE OF MERCURY CONTAMINATION AND NO WELD REPAIR WAS PERFORMED	

(A13) V&M Item	(A09) Cust. Item	(B14) Item text	(B09) Dimensions	(B10) Single length
4			NPS 3 SCH 160 OD-Tolerance + 0.031 in - 0.031 in WT-Tolerance + 15 % - 12.5 %	Random length from 38 to 42 Ft

(A13) V&M Item	(A09) Cust. Item	(B07.1) Heat	(B06) Quantity	(B11) Total length ft	(B13) Weight lb
4		320369	52	1.990,29	28.720

VERIFIED BY
JUL 11 2011
EEC QC DEPT
R. Patterson

(C71)
HEAT CHEMICAL ANALYSIS

Part #4

V&M FRANCE (A01) TUBERIE SAINT SAULVE SAINT SAULVE ZONE INDUSTRIELLE 59880 SAINT SAULVE	VALLOUREC & MANNESMANN TUBES Vallourec Group	MATERIAL TEST REPORT - INSPECTION CERTIFICATE (A02) 3.1 EN 10204 : 2004 No. : 15328Sv07 (A03) Page: 2 / 5 Date: 31.10.2007

(C71)

HEAT CHEMICAL ANALYSIS

For each reduction of 0,01% carbon below 0.30 %, an increase of 0,05% manganese above 1.06 % would be permitted to a maximum of 1,35% manganese.

(B07.1) Heat	(B15) Process	C %	Si %	Mn %	P %	S %	Cr %	Mo %	Ni %	Cu %	V %
min	-	-	0,10	0,40	-	-	-	-	-	-	-
max	-	0,22	-	1,06	0,025	0,025	-	-	-	-	-
320369	Oxygen (BOF)	0,13	0,17	1,02	0,011	0,002	0,110	0,010	0,030	0,020	0,004

(B07.1) Heat	1003 %											
min	-											
max	0,40											
320369	0,33											

1003	CE = C+MN/6+(CR+MO+V)/5+(NI+CU)/15

Heats fully killed

(B04)

HEAT TREATMENT

NORMALIZED CONDITION MIN 920°C (1688 F) COOLING AIR

TENSILE TEST RESULTS

Type (C10.1)	Tube strip specimen
Test temperature (C03)	Room temperature
Direction (C02)	longitudinal

Part #4

V&M FRANCE (A01) TUBERIE SAINT SAULVE SAINT SAULVE ZONE INDUSTRIELLE 59880 SAINT SAULVE AFAQ ISO 9001	VALLOUREC & MANNESMANN TUBES Vallourec Group	MATERIAL TEST REPORT - (A02) INSPECTION CERTIFICATE 3.1 EN 10204 : 2004 No. : 16328Sv07 (A03) Page: 3 / 5 Date: 31.10.2007

TENSILE TEST RESULTS

(B07.1) Heat	(C00.1) Test Piece	(C10.2) Dimension	(C11) YS	(C12) TS	(C13.2) Elong.						
		In / sq in	$R_{p0.2}$ psi	R_m psi	2" %						
min		-	34984	60063	35						
max		-	-	-	-						
320369	01MM697	0,74x0,42 0,31	41783	65666	41						
320369	02MM697	0,74x0,43 0,32	42073	66592	41						
320369	03MM697	0,74x0,47 0,35	42073	66011	42						

(C10.2)	
Dimension	Test piece dimensions Test piece area

IMPACT TEST RESULTS

Type (C40)	Charpy V
Test temperature (C03)	-60 °F
Direction (C02)	longitudinal

(B07.1) Heat	(C00.1) Test Piece	(C41) Dimension	(C42.1) Impact1	(C42.1) Impact2	(C42.1) Impact3	(C43.1) Mean	(C42.2) Shear fr1	(C42.2) Shear fr2	(C42.2) Shear fr3		
		In / sq In	ft-lbf	ft-lbf	ft-lbf	ft-lbf	%	%	%		
min		-	10,3	10,3	10,3	13,3	-	-	-		
max		-	-	-	-	-	-	-	-		
320369	01MM697	0,39x0,39 0,12	208,4	222,5	244,1	225,0	100	100	100		

Part #4

V&M FRANCE (A01) TUBERIE SAINT SAULVE SAINT SAULVE *ZONE INDUSTRIELLE* 59880 SAINT SAULVE	VALLOUREC & MANNESMANN TUBES **Vallourec Group**	MATERIAL TEST REPORT - (A07) INSPECTION CERTIFICATE 3.1 EN 10204 : 2004 No. : 16328Sv07 (A03) Page: 4 / 5 Date: 31.10.2007

IMPACT TEST RESULTS

(B07.1) Heat	(C00.1) Test Piece	(C41) Dimension	(C42.3) L.Exp1	(C42.3) L.Exp2	(C42.3) L.Exp3						
		in / sq in	mm	mm	mm						
min		-	-	-	-						
max		-	-	-	-						
320369	01MM697	0,39x0,39 0,12	1,3	1,5	1,7						

(C41)	
Dimension	Test piece dimensions Test piece area

(C50)

TECHNOLOGICAL AND OTHER TESTS ON SPECIMENS

Test	Conditions	Test rate	Result
Flattening test			Satisfactory ✓

(D54)

OTHER TESTS ON PIPE

Test	Conditions	Test rate	Result
Hydrostatic test	2500 PSI 5 SEC	100% each lot	Satisfactory ✓
Appearance & Dimensions		100% each lot	Satisfactory

(A04, B06)

MARKING, IDENTIFICATION

Paint stenciled on one side	V & M FRANCE A/SA333 1+6 HF SCH 160 S LT 60 F 3 0.438 HT HEAT NUMBER 41-046615 F3033000

(Z01)

The supplied products are in compliance with the requirements of the order

Part #4

V&M FRANCE (A01) TUBERIE SAINT SAULVE SAINT SAULVE ZONE INDUSTRIELLE 59880 SAINT SAULVE	VALLOUREC & MANNESMANN TUBES Vallourec Group	MATERIAL TEST REPORT - (A02) INSPECTION CERTIFICATE 3.1 EN 10204 : 2004 No. : 16328Sv07 (A03) Page: 5 / 5 Date: 31.10.2007

(A05, Z02, Z03)

Date	31.10.2007
Validated by	Inspection Representative
	Valérie DELACROIX
☎	+ (33) 3 27 23 14 56
🖷	+ (33) 3 27 23 15 25
@	valerie.delacroix@vmtubes.fr
Stamp	

1224

UNITED STATES STEEL

TUBULAR PRODUCTS
CERTIFIED TEST REPORT
(TYPE B - IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 3.1.b)

DATE: 12/20/05
TIME: 10:24:16
SERIAL NO:

MILL ORDER/ITEM NO.	SHIPPERS NO.	P.O. NUMBER	VEHICLE ID.	
DR33040 04		3255		

SOLD TO ADDRESS	MAIL TO ADDRESS	VENDOR
PROGRESSIVE SUPPLY, INC. P.O. Box 470748 Tulsa, OK 74147	X-7926-124 17	USS TUBULAR PRODUCTS 2199 EAST 28TH ST. LORAIN, OH 44055

SPECIFICATION AND GRADE

PRESSURE PIPE CARBON SMLS HF ASTM A333-×04A GRADE 1 ASTM A333-×04A GRADE 6 ASME SA333-×2004 EDITION GRADE 1 ASME SA333-×2004 EDITION GRADE 6 ASTM A106-×04B GRADE B/C ASME SA106-×2004 EDITION GRADE B/C DUAL STENCIL BLK REG MILL COAT PE BEV 30 DEG MEETING ALL THE APPLICABLE REQUIREMENTS OF NACE STANDARD MR-01-75 ×2002

MATERIAL COND: FULL BODY NORMALIZED — O.D.: 16.000(406.400) in (mm) — WALL: 0.375 (9.525) in (mm)

PRODUCT IDENTIFICATION	TENSILE TEST TYPE/ ORIENTATION	TEST COND.	GAUGE WIDTH	YIELD PSI	EXT % .50	TENSILE PSI	Y/T	ELONG % (IN 2")	HARDNESS SCALE: HRB	MIN HYDRO PSI	DWELL (SEC)
			IN	MIN: 40000 MAX:		MIN: 70000 MAX:	MAX:	MIN: 35.0	MIN: MAX: 99.0	1100	5
A03724 G112NA	STRIP/L/B	NM	1.500	52500	.50	77000	0.69	43.0	B 83.0	1100	5
A03724 G112NA	STRIP/L/B	NM	1.500	54000	.50	77500	0.69	41.0			
		××	END OF DATA THIS	SHEET	××						

LEGEND: L - LONGITUDINAL, U - UPSET; T - TRANSVERSE, N - NORMALIZED; QT - QUENCHED & TEMPERED, SR - STRESS RELIEVED; AR - AS ROLLED; B - BODY; W - WELD

PRODUCT IDENTIFICATION	TYPE	C	MN	P	S	SI	CU	NI	CR	MO	AL	N	V	B	TI	CB	CO	C.E.* MAX .50
A03724	HEAT	.20	1.10	.008	.005	.22	.04	.07	.06	.02	.030		.003	.0001	.001	.002		.41
A03724 G112NA	PROD	.20	1.12	.007	.007	.22	.05	.07	.05	.01	.031		.003	.0001	.001	.001		.41
A03724 G112NA	PROD	.20	1.12	.007	.008	.22	.05	.07	.05	.00	.031		.003	.0002	.001	.001		.41
		××	END OF DATA THIS	SHEET	××													

VERIFIED BY
JUL 11 2011
EEC QC DEPT

*C.E. IS BASED ON THE FOLLOWING EQUATION(S): CE=C+(MN/6)+(CR+MO+V)/5+ (NI+CU)/15

DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT.

K. Patterson

Part #549

DATE: 12/28/05
TIME: 10:24:16

UNITED STATES STEEL

TUBULAR PRODUCTS
CERTIFIED TEST REPORT
(TYPE B - IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 3.1.b)

SERIAL NO:

MILL ORDER/ITEM NO.	SHIPPERS NO.	P.O. NUMBER
DR33040 04		3255

MATERIAL COND: FULL BODY NORMALIZED

O.D: 16.000(406.400) in (mm) WALL: 0.375 (9.525) in (mm)

PRODUCT IDENTIFICATION	FLAT	BEND	GRAIN SIZE	MIN COLLAPSE	CHARPY V-NOTCH IMPACT TESTING											
					DIR	TEST LOC.	TEMP	SIZE	TEST COND.	FT-LBS 1	FT-LBS 2	FT-LBS 3	FT-LBS AVG	% SHEAR 1	% SHEAR 2	% SHEAR 3	% SHEAR AVG
							DEG F										
A03724 G112NA	OK				L	B	- 60	2/3	NM	32	40	48	40	20	40	30	30
					THIS SHEET												

LEGEND: L - LONGITUDINAL T - TRANSVERSE B - BODY W - WELD HAZ - HEAT AFFECTED ZONE

TESTING / INSPECTION INFORMATION

TEST / INSPECTION	YES	RESULTS / COMMENTS
FULL LENGTH VISUAL	X	
FULL LENGTH EMI	X	OD X OD/ID ____ L ____ L/T X 10.0% NOTCH
FULL LENGTH MPI		
FULL LENGTH UT		OD ____ OD/ID ____ L ____ L/T ____
END AREA INSPECTION (PLAIN END)	X	MPI X UT ____
SPECIAL END AREA (SEA) INSP.		MPI ____ UT ____
FULL LENGTH DRIFT		DRIFT MANDREL SIZE:

ADDITIONAL NOTES/COMMENTS

MELTED AND MANUFACTURED IN THE USA. NO REPAIRS BY WELDING. NO MERCURY OR MERCURY COMPOUNDS ARE ADDED TO THE STEEL AND ALL MERCURY BEARING EQUIPMENT IS PROTECTED BY A DOUBLE BOUNDARY OF CONTAINMENT.

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, SAMPLED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS THE REQUIREMENTS IN SUCH RESPECTS.

PREPARED BY THE OFFICE OF: J. MAJKRZAK - MANAGER, Q.A.

DATE 12/26/05

Part #4545

UNITED STATES STEEL

TUBULAR PRODUCTS
CERTIFIED TEST REPORT
(IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 "type 3.1")

DATE: 02/09/11
TIME: 04:52:32
SERIAL NO: L0034839

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	VEHICLE I.D
DR00278 04	R83324	D1706000	SOU63174

SOLD TO ADDRESS
PROGRESSIVE SUPPLY, INC.
7615 E. 42 ND. PL.
TULSA, OK. 74145

MAIL TO ADDRESS
This MTR applies to your
PO# 1221

VENDOR
USS TUBULAR PRODUCTS
2199 EAST 28TH ST.
LORAIN, OH 44055

SPECIFICATION AND GRADE

PIPE CARBON SMLS STD PIPE API 5L-*44TH ED DTD OCT 2007 AND ISO 3183:2007 MOD PSL-2 GRADE B AND GRADE X42 R N OR Q AND ANNEX C & E ASTM A53-*07 ASTM A106-*08 GRADE B QUAD STENCIL SPECIAL OD TOLERANCE ASME SA53-*2010 EDITION ASME SA106-*2010 EDITION GRADE B BLK REG MILL COAT PE BEV 30 DEG MEETING ALL THE APPLICABLE REQUIREMENTS OF NACE STANDARD MR-01-75 *:2003/COR.1:2005 AND MR0103-2007

X-7436-15

MATERIAL COND: AS ROLLED
O.D.: 16.000 (406.400) in (mm)
WALL: 0.500 (12.700) in (mm)

PRODUCT IDENTIFICATION	TENSILE TEST TYPE/ ORIENTATION	TEST COND.	GAUGE WIDTH IN	YIELD PSI	EXT % .50	TENSILE PSI	Y/T	ELONG % (IN 2")	HARDNESS SCALE: HRB	MIN HYDRO PSI	DWELL(SEC)
				MIN: 42100		MIN: 70000	MAX:	MIN:	MIN:		
				MAX: 71800		MAX: 110200	0.93	29.0	MAX: 99.0		
WA1175 S399AA	STRIP/L/B	AR	1.500	60000	.50	78000	0.77	42.0	B 81.8	2240	5
WA1176 S400AA	STRIP/L/B	AR	1.500	58500	.50	78000	0.75	44.0	B 82.0	2240	5
		**	END OF DATA THIS SHEET **								

LEGEND: L - LONGITUDINAL, U - UPSET; T - TRANSVERSE, NM - NORMALIZED; QT - QUENCH & TEMPERED, SR - STRESS RELIEVED; AR - AS ROLLED, TR - THERMOMECHANICAL ROLLED; B - BODY; W - WELD

PRODUCT IDENTIFICATION	TYPE	C	MN	P	S	SI	CU	NI	CR	MO	AL	N	V	B	TI	CB	CO				C.E.* MAX .43
WA1175	HEAT	20	102	010	003	24	12	04	08	02	023		03	0001	001	000					.41
WA1175 S399AA	PROD	19	103	010	004	26	12	05	08	02	027		03	0001	002	002					.40
WA1175 S399AA	PROD	19	103	012	005	26	12	05	08	02	026		03	0001	002	002					.40
WA1176	HEAT	20	104	008	004	24	12	05	04	02	032		03	0001	002	000					.40
WA1176 S400AA	PROD	18	105	011	007	28	12	05	04	02	036		03	0007	002	003					.39
WA1176 S400AA	PROD	19	105	010	007	26	12	05	04	02	034		04	0005	002	003					.40
			** END OF DATA THIS SHEET **																		

VERIFIED BY
JUL 11 2011
EEC QC DEPT
K Patterson

*C.E. IS BASED ON THE FOLLOWING EQUATION(S): CE=C+MN/6+(CR+MO+V)/5+(NI+CU)/15

DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT.

Part #1

UNITED STATES STEEL

TUBULAR PRODUCTS

CERTIFIED TEST REPORT

(IN ACCORDANCE WITH ISO 10474/EN10204/DIN50049 "type 3.1")

DATE: 02/09/11
TIME: 04:52:32
SERIAL NO: L0034839

MILL ORDER/ITEM NO	SHIPPERS NO.	P.O. NUMBER	
DR00278 04	R83324	D1706000	0020014

MATERIAL COND: AS ROLLED

O.D.: 16.000 (406.400) in (mm)

WALL: 0.500 (12.700) in (mm)

PRODUCT IDENTIFICATION	FLAT	BEND	GRAIN SIZE	MIN COLLAPSE	CHARPY V-NOTCH IMPACT TESTING											
					DIR	TEST LOC.	TEMP	SIZE	TEST COND.	FT-LBS 1	FT-LBS 2	FT-LBS 3	FT-LBS AVG	% SHEAR 1	% SHEAR 2	% SHEAR 3	% SHEAR AVG
							DEG F										
WA1175 S399AA	OK				T	B	+ 32	FULL	AR	85	73	80	79	65	50	60	58
WA1176 S400AA	OK				T	B	+ 32	FULL	AR	84	101	105	96	60	75	75	70
			** END OF DATA THIS SHEET **														

LEGEND L - LONGITUDINAL T - TRANSVERSE B - BODY W - WELD HAZ - HEAT AFFECTED ZONE

TESTING / INSPECTION INFORMATION

TEST / INSPECTION	YES	RESULTS / COMMENTS
FULL LENGTH VISUAL	X	
FULL LENGTH EMI	X	OD X OD/ID ____ L ____ UT X 10.0% NOTCH
FULL LENGTH MPI		
FULL LENGTH UT	X	ID X OD/ID ____ L X UT ____ 10.0% NOTCH
END AREA INSPECTION (PLAIN END)	X	MPI X UT ____
SPECIAL END AREA (SEA) INSP		MPI ____ UT ____
FULL LENGTH DRIFT		DRIFT MANDREL SIZE:

ADDITIONAL NOTES/COMMENTS

MELTED AND MANUFACTURED IN THE USA. NO REPAIRS BY WELDING. NO MERCURY OR MERCURY COMPOUNDS ARE ADDED TO THE STEEL AND ALL MERCURY BEARING EQUIPMENT IS PROTECTED BY A DOUBLE BOUNDARY OF CONTAINMENT.
PRODUCT WAS HOT ROLLED AND HOT FINISHED
PIPE ALSO MEET THE REQUIREMENTS OF ASTM A106 GRADE C & ASME SA106 GRADE C

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, SAMPLED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS THE REQUIREMENTS IN SUCH RESPECTS.

PREPARED BY THE OFFICE OF: R. HARRIS - MANAGER, Q.A.

DATE 02/09/11

**

Part #7

12/28/2010 From: AMERICAN ALLOY STEEL
P.O.# :0808 S.O.# :380743
Item :5 (1 PC) 3/8" X 96" X 240" AA PL#:5103345
:TAG: STOCK
To: ENERGY EXCHANGERS

NUCOR
PLATE MILL

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

Mill Test Report

Page 1

AMERICAN ALLOY PLATE 5103345 292

NUCOR It's our Nature.

Issuing Date : 07/30/2010 B/L No. : 288541 Load No. : 270193 Our Order No. : 83431/1 Cust. Order No. : 82626-OK

Vehicle No: TTPX 806485

Specification : 0.3750" x 96.000" x 240.000"
ASTM A516 70-06/ASME SA516 70 PVQ 2009 Addenda Normalized
Test Coupons at 1650F Hold 30 Min per Inch of thickness Air Cooled

Sold To : AMERICAN ALLOY STEEL, INC.
6230 NORTH HOUSTON ROSSLYN RD.
NORTH HOUSTON,TX 77091

Ship To : AMERICAN ALLOY STEEL, INC.
C/O SAND SPRINGS RAILWAY COMPANY
TRANS LOAD FACILITY
TULSA,OK 74116

Marking : 2450/29400 82626-OK X-7926-120

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
0505315	0.19	1.04	0.015	0.002	0.17	0.32	0.10	0.13	0.02	0.024	0.005	0.003	0.002		0.0013	0.0002	0.011	0.42	0.27

Tensile Test

Plate Serial No	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"	
0505315-03	12	14.70	T	51,600	77,000		21.6	
			T	50,100	74,100		24.8	N

Charpy Impacts

Dir.	1	(%) shear	2	(%) shear	3	(%) shear	Ave.	(%) shear	Size	Temp	Min Ave.

CHECKED JAN - 3 2011
K. Patterson

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL
Reviewed by:
Date 12/28/10

Part # 19

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

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.

Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/6)+((Cr+Mo+V)/5)+((Cu+Ni)/15)

Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B

Melted and manufactured in the USA. ISO 9001:2000 certified (#006461) by SRI Quality System Registrar (#0985-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant. DIN 50049 3.1.B/EN 10204 3.1B(2004), DIN EN 10204 3.1(2005) compliant. For ABS grades only, Quality Assurance certificate 08-MMPQA-383

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

T. A. Deprelis, Metallurgist

08/02/2010 11:50:54 AM

Kemper County MM209778

NUCOR
NUCOR STEEL TUSCALOOSA, INC.

MILL TEST CERTIFICATE

1700 HOLT RD N.E.
Tuscaloosa, AL 35404-1000
800-827-8872

STOCK LIFTING LUGS

Load Number	Tally	Mill Order Number	P.O. Number	Part Number	Certificate Number	Date
389976	00000000417856	N-106993-003	32981		L333877-1	07/23/2011 04:48

Grade

Customer:

Order Description:
A516 70, 0.5000 IN x 96.000 IN x 480.000 IN
Quality Plan Description:
A/SA516-70: ASTM A516-70-10/ASME SA516-70 2009 ADDENDA

Sold TO:
STEEL SERVICE COMPANY CLAREMORE OK
Ship TO:
STEEL SERVICE COMPANY Catoosa OK

1/2" x 3 1/2" x 8 3/4" LG.

Shipped Item	Heat/Slab Number	Certified By	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Cb	V	Al	Ti	N2	B	Ca	Sn	CEV
1G1767D	B1T7537-03 ***	B1T7537	0.23	1.11	0.010	0.007	0.20	0.20	0.07	0.07	0.011	0.000	0.002	0.037	0.001	0.007	0.0001	0.0031	0.007	0.45
1G1767E	B1T7537-03 ***	B1T7537	0.23	1.11	0.010	0.007	0.20	0.20	0.07	0.07	0.011	0.000	0.002	0.037	0.001	0.007	0.0001	0.0031	0.007	0.45

Shipped Item	Certified By	Heat Number	Yield ksi	Tensile ksi	Y/T %	ELONGATION % 2"	ELONGATION % 8"	Bend OK?	Hard HB	Charpy Impacts (ft-lbf) Size mm	1	2	3	Avg	Shear % 1	2	3	Avg	Test Temp
1G1767D	S1G1767BTT	B1T7537 ***	54.5	72.7	75.0	33.7													
1G1767D	S1G1767FTT	B1T7537 ***	55.5	76.3	72.7	34.2													
1G1767D	S1G1767MTT	B1T7537 ***	52.5	72.7	72.2	33.4													
1G1767E	S1G1767BTT	B1T7537 ***	54.5	72.7	75.0	33.7													
1G1767E	S1G1767FTT	B1T7537 ***	55.5	76.3	72.7	34.2													
1G1767E	S1G1767MTT	B1T7537 ***	52.5	72.7	72.2	33.4													

X-7926-62 Cut to 6 1/2" LG.

Name PIONEER
PO# 767386
Count 1
Size 1/2 X 96 X 240 A516-70
Heat# B1T7537-03

PIONEER STEEL INC.
DATE 2.21.12 QTY. 100
PO# 1874
PART# STOCK
BY

Items: 2 PCS: 6 Weight: 39205 LBS

Mercury has not come in contact with this product during the manufacturing process not has any mercury been used by the manufacturing process. Certified in accordance with EN 10204 3.1. No weld repair has been performed on this material. Manufactured to a fully killed fine grain practice. ** Produced from Coil **
ISO 9001:2008 Registered, PED Certified

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

VERIFIED BY
JUL 23 2012
EEC QC DEPT
K. Patterson

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

April Pitts
April Pitts - QA Engineer

Part #13

SSAB

Test Certificate

Form TC1: Revision 1: Date 31 Oct 2000

13609 Industrial Road, Houston, TX 77015

Customer:
METALS USA PLATES & SHAPES SOU
P.O. BOX 3528
141 EAST ILLINOIS
ENID
OK 73702

Customer P.O. No.: MUS-231893 | Mill Order No.: 41-277716-01 | Shipping Manifest : HT864418

Product Description: ASTM A516-70(06)/ASME SA516-70(09A)

STOCK NB BRACKETS

Size: 0.188 X 96.00 X 480.0 (IN)

Ship Date: 07 Sep 10
Cert Date: 07 Sep 10

Cert No: 631110772
(Page 1 of 1)

X-7926-61

Tested Pieces				Tensiles						Charpy Impact Tests								
Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (PSI)	UTS (PSI)	%RA	Elong % 2in	Tst Dir	Average Hardness	Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
W0B789	0051	0.187 X 96.00 (T.L.C)	L	58000	75000		27	T							
			C	59000	75000		26	T							
			T	61000	74000		25	T							
W0H543	0024	0.187 X 96.00 (T.L.C)	L	55000	70000		28	T							
			C	56000	71000		27	T							
			T	54000	70000		31	T							

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	CEV	ORGN
W0B789	.19	1.11	.014	.005	.20	.019	.017	.28	.14	.12	.05	.003	.006	.012	.44	USA
* W0H543	.19	1.10	.009	.003	.21	.030	.029	.26	.14	.09	.05	.003	.005	.014	.42	USA

MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED
DURING THE MANUFACTURE OF THIS PRODUCT
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15
MATERIAL MARKED WITH AN ASTERISK IS PRODUCED FROM COIL
MTR DIN EN10204:2004 TYPE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA.
PRODUCTS SHIPPED:
* W0B789 0051 PCES: 6, WGT: 14741 * W0H543 0024 PCES: 12, WGT: 29482

ENERGY EXCHANGER
PO#1462
SO#203277

HT#W0H543 SL#0024
ITEM#1 65PCS

VERIFIED BY
SEP 19 2011
EEC QC DEPT

Cust Part # :

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

Jason Thomas
SENIOR METALLURGIST

Part #14

We hereby certify that the test results presented here

We hereby certify that the test results presented here
are accurate and conform to the reported grade specification

Daniel J. Schacht
Daniel J. Schacht
Quality Assurance Manager

CMC STEEL TEXAS
1 STEEL MILL DRIVE
SEGUIN TX 78155-7510

CERTIFIED MILL TEST REPORT

For additional copies call
830-372-8771

X-7926-65 STOCK

HEAT NO.:3018892 SECTION: FLAT 1/4x1-1/2 20'0" A36/52950 GRADE: ASTM A36-08/A529-05 Gr 50 ROLL DATE: 09/03/2010 MELT DATE: 08/24/2010	S O L D T O	Steel Service Co - OK 24412 Amah Pkwy Claremore OK US 74019-4304 9183416322 9183416390	S H I P T O	Steel Service Co - OK 24412 Amah Pkwy Claremore OK US 74019-4304 9183416322 9183416390	Delivery#: 80441928 BOL#: 70155381 CUST PO#: 33419 CUST P/N: DLVRY LBS / HEAT: 9216.000 LB DLVRY PCS / HEAT: 362 EA

Characteristic	Value	Characteristic	Value	Characteristic	Value
C	0.19%				
Mn	0.67%				
P	0.013%				
S	0.040%				
Si	0.17%				
Cu	0.30%				
Cr	0.12%				
Ni	0.09%				
Mo	0.023%				
V	0.009%				
Cb	0.001%				
Sn	0.013%				
Al	0.002%				
Carbon Eq A529	0.39%				
Yield Strength test 1	52.5ksi				
Tensile Strength test 1	72.5ksi				
Elongation test 1	26%				
Elongation Gage Lgth test 1	8IN				

THIS MATERIAL IS FULLY KILLED, 100% MELTED AND MANUFACTURED IN THE USA, WITH NO WELD REPAIR OR MERCURY CONTAMINATION IN THE PROCESS.

REMARKS :

MEETS THE REQUIREMENTS OF ASME SA36-2008A

01/28/2011 14:51:32
Page 1 OF 1

CHECKED FEB 2 4 2011
L Patterson

Part #15

Kemper County MM209778

Benteler Stahl/Rohr GmbH
Postfach 13 40
33043 Paderborn
Deutschland
Tel.: +49.5254.81-0 Fax: +49.5254.13666

X-7926 (185 pcs.)

BENTELER
Stahl/Rohr

ABNAHMEPRÜFZEUGNIS EN 10204-3.1

INSPECTION CERTIFICATE EN 10204-3.1
CERTIFICAT DE RECEPTION EN 10204-3.1
EN 10204:2005-01

Benteler Stahl/Rohr GmbH - Postfach 1340 - 33043 Paderborn - Deutschland

Webco Industries, Inc.
9101 West 21st Street
SAND SPRINGS, OK 74063
USA

Dokument-Nr.: **Document No.:** No. du document: 41-488044/001/P

Prüf-Nr.: **Inspection No.:** No. du certificat:

Blatt: 1 / 6
Page:
Page:

Kunden-Bestell-Nr.: **Purchase Order No.:** No. de commande du client: BST 08-7130 / Webco 10013786

Hersteller: Warmrohrwerk/Zieherei
Manufacturer: ISO/TS 16949 (ISO 9001) DNV CERT-11674A-2003
Producteur: PED 97/23/EC TÜV CERT 07-202-5635 WZ-0606/07

Benteler Auftrags-Nr.: **Benteler Order No.:** No. de commande Benteler: 1530657

Herstellerzeichen: **Manufacturer's brand:** Marque du producteur:

Versandanzeigen-Nr.: **Dispatch Note No.:** No. d'avis d'expédition: 4128151

Stempel des Abnahmebeauftragten: WA
Stamp of the inspection representative:
Timbre du contrôleur:

Produkt: NAHTLOSE STAHLROHRE
Product: SEAMLESS STEEL TUBES
Produit: TUBES D' ACIER SANS SOUDURE

Stahlerschmelzungsverfahren: ELEKTROSTAHL
Steelmaking process: ELECTRIC FURNACE
Procédé d'élaboration de l'acier: FOUR ELECTRIQUE

Lieferbedingungen: **Terms of delivery:** Conditions de livraison: ASTM-A 179-1990a, ASME SA-179, ASME Section II Part A Edition 2007

Maße - Toleranzen: **Dimensions-tolerances:** Dimensions-tolérances: ASME SA-450-CD, ASME Section II Part A Edition 2007, ASTM-A 450-2004a-CD

Stahlsorte: **Steel grade:** Nuance d'acier: A 179, SA 179

Lieferzustand: **Delivery condition:** État de livraison: Normalized

CHECKED FEB 2 2 2010

Produktkennzeichnung: **Product marking:** Marquage du produit: see attachment product marking

Pos. Item Poste	Stück Number Nombre	Maße Dimensions Dimensions	Länge Length Longueur feet	Gewicht Weight Poids lbs	Schmelzen-Nr. Heat No. No. de coulée	Prüfdruck Test pressure Pression d'épreuve	Rohr-Nr.-Gruppe Tube number group Série de no. des tubes	Vielfachlängen Multiple lengths Longueurs multiples
0001	318	0.750" O.D. * 0.083" MW 29 FT 1 "	9247,90	5851	181070			
0002	385	0.750" O.D. * 0.083" MW 30 FT 1 "	11581,59	7291	181070			
0003	244	0.750" O.D. * 0.083" MW 31 FT 3 "	7625,00	4815	181070			

Heat # 16

Benteler Stahl/Rohr GmbH
Postfach 13 40
33043 Paderborn
Deutschland
Tel.: +49.5254.81-0 Fax: +49.5254.13666

BENTELER
Stahl/Rohr

ABNAHMEPRÜFZEUGNIS EN 10204-3.1

INSPECTION CERTIFICATE EN 10204-3.1
CERTIFICAT DE RECEPTION EN 10204-3.1

Dokument-Nr.: **Document No.:** No. du document: 41-488044/001/P

Prüf-Nr.: **Inspection No.:** No. du certificat:

Pos. **Item** Poste	Stück **Number** Nombre	Maße **Dimensions** Dimensions	Länge **Length** Longueur feet	Gewicht **Weight** Poids lbs	Schmelzen-Nr. **Heat No.** No. de coulée	Prüfdruck **Test pressure** Pression d'épreuve	Rohr-Nr.-Gruppe **Tube number group** Série de no. des tubes	Vielfachlängen **Multiple lengths** Longueurs multiples
0004	153	0.750" O.D. * 0.083" MW 37 FT 1 "	5673,75	3583	181069			
0005	187	0.750" O.D. * 0.083" MW 38 FT 1 "	7121,10	4497	181069			
0006	262	0.750" O.D. * 0.083" MW 40 FT 2 "	10523,03	6706	181073			
0007	427	0.750" O.D. * 0.083" MW 41 FT 1 "	17542,36	11158	181073			
0008	472	0.750" O.D. * 0.083" MW 42 FT 1 "	19863,39	12606	181073			
0009	491	0.750" O.D. * 0.083" MW 43 FT 1 "	21152,70	13395	548853			
0010	195	0.750" O.D. * 0.083" MW 44 FT 1 "	8595,87	5423	548853			
0011	139	0.750" O.D. * 0.083" MW 45 FT 1 "	6266,40	4001	548853			
0012	140	0.750" O.D. * 0.083" MW 46 FT 1 "	6451,58	4123	548853			
0013	231	0.750" O.D. * 0.083" MW 51 FT 6 "	11896,39	7571	549318			

185 Pcs. Cut 14'0" lg.

Schmelzenanalyse [%] / **Heat analysis [%]** / Analyse sur coulée [%]

Pos. **Item** Poste	Schmelzen-Nr. **Heat No.** No. de coulée	C	Si	MN	P	S
0001	181070	0,100	0,160	0,48	0,008	0,003
0002	181070	0,100	0,160	0,48	0,008	0,003
0003	181070	0,100	0,160	0,48	0,008	0,003
0004	181069	0,100	0,160	0,48	0,008	0,003
0005	181069	0,100	0,160	0,48	0,008	0,003
0006	181073	0,100	0,170	0,47	0,010	0,003
0007	181073	0,100	0,170	0,47	0,010	0,003
0008	181073	0,100	0,170	0,47	0,010	0,003
0009	548853	0,100	0,160	0,47	0,007	0,002
0010	548853	0,100	0,160	0,47	0,007	0,002
0011	548853	0,100	0,160	0,47	0,007	0,002
0012	548853	0,100	0,160	0,47	0,007	0,002

Lot #10

Benteler Stahl/Rohr GmbH
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33043 Paderborn
Deutschland
Tel.: +49.5254.81-0 Fax: +49.5254.13666

BENTELER
Stahl/Rohr

ABNAHMEPRÜFZEUGNIS EN 10204-3.1
INSPECTION CERTIFICATE EN 10204-3.1
CERTIFICAT DE RECEPTION EN 10204-3.1

Dokument-Nr.: / **Document No.:** / No. du document: 41-488044/001/P

Prüf-Nr.: / **Inspection No.:** / No. du certificat:

Schmelzenanalyse [%] / **Heat analysis [%]** / Analyse sur coulée [%]

Pos. / **Item** / Poste	Schmelzen-Nr. / **Heat No.** / No. de coulée	C	Si	MN	P	S
0013	549318	0,100	0,150	0,46	0,013	0,003

Prüfergebnisse / **Test results** / Résultats des essais

Die Rohre sind auf Dichtheit geprüft durch: / **The tubes have been submitted to a leak tightness test by:** / Les tubes ont passé un contrôle d'étanchéité par:	Hydrostatic test: eddy current testing instead of hydrostatic test	PASSED ✓
Die Rohre wurden zerstörungsfrei geprüft: / **The tubes are non destructive tested:** / Les tubes ont passé un essai non destructif:	ET-test: acc. to ASME SA-450, ASTM-A 450; acc. to ASTM-E 309; Imperfections	PASSED ✓

Augensichtkontrolle: / **Visual inspection:** / Examen visuel:	PASSED	Aufweitversuch: / **Drift expanding/flare test:** / Essai d'évasement:	PASSED ✓	Maßkontrolle: / **Dimensions examination:** / Vérification des dimensions:	PASSED
Ringfaltversuch: / **Flattening test:** / Essai d'aplatissement:	PASSED ✓				

Ergebnisse der mechanischen Prüfung / **Results of mechanical testing** / Résultats des essais mécaniques

Die Probennahme erfolgte an Vielfachlängen.
The sampling was carried out on multiple lengths.
L'echantillonage etait realise aux longueurs multiples.

Härteprüfung / **Hardness test** / Essai de dureté

Pos. / **Item** / Poste	Proben-Nr. / **Specimen No.** / No. de l'éprouv.	Schmelzen-Nr. / **Heat No.** / No. de coulée	Härte / **Hardness** / Dureté				
Anforderungen / **Requirements** / Exigences			HRC	HB	HV	HRB MAX 72	HBW
0001	000001	181070				064	
0001	000002	181070				065	

Benteler Stahl/Rohr GmbH
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33043 Paderborn
Deutschland
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BENTELER
Stahl/Rohr

ABNAHMEPRÜFZEUGNIS EN 10204-3.1
INSPECTION CERTIFICATE EN 10204-3.1
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Dokument-Nr.: 41-488044/001/P
Document No.:
No. du document:

Prüf-Nr.:
Inspection No.:
No. du certificat:

Härteprüfung / **Hardness test** / Essai de dureté

Pos. **Item** Poste	Proben-Nr. **Specimen No.** No. de l'éprouv.	Schmelzen-Nr. **Heat No.** No. de coulée	Härte **Hardness** Dureté				
Anforderungen **Requirements** Exigences			HRC	HB	HV	HRB MAX 72	HBW
0001	000003	181070				065	
0001	000004	181070				063	
0002	000001	181070				064	
0002	000002	181070				065	
0002	000003	181070				065	
0002	000004	181070				063	
0003	000001	181070				064	
0003	000002	181070				065	
0003	000003	181070				065	
0003	000004	181070				063	
0004	000001	181069				064	
0004	000002	181069				064	
0005	000001	181069				064	
0005	000002	181069				065	
0006	000001	181073				063	
0006	000002	181073				064	
0006	000003	181073				063	
0006	000004	181073				063	
0007	000001	181073				063	
0007	000002	181073				063	
0007	000003	181073				064	
0007	000004	181073				063	
0008	000001	181073				063	

Part # 10

Benteler Stahl/Rohr GmbH
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33043 Paderborn
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Tel.: +49.5254.81-0 Fax: +49.5254.13666

BENTELER
Stahl/Rohr

ABNAHMEPRÜFZEUGNIS EN 10204-3.1
INSPECTION CERTIFICATE EN 10204-3.1
CERTIFICAT DE RECEPTION EN 10204-3.1

Dokument-Nr.: **Document No.:** No. du document: 41-488044/001/P

Prüf-Nr.: **Inspection No.:** No. du certificat:

Härteprüfung / **Hardness test** / Essai de dureté

Pos. **Item** Poste	Proben-Nr. **Specimen No.** No. de l'éprouv.	Schmelzen-Nr. **Heat No.** No. de coulée	Härte **Hardness** Dureté				
Anforderungen **Requirements** Exigences			HRC	HB	HV	HRB	HBW
						MAX 72	
0008	000002	181073				064	
0008	000003	181073				064	
0008	000004	181073				065	
0008	000005	181073				063	
0008	000006	181073				063	
0009	000001	548853				064	
0009	000002	548853				065	
0009	000003	548853				065	
0009	000004	548853				064	
0010	000001	548853				064	
0010	000002	548853				065	
0011	000001	548853				064	
0011	000002	548853				065	
0012	000001	548853				064	
0012	000002	548853				065	
0013	000001	549318				065	
0013	000002	549318				064	

Vermerk / **Remark** / Remarque

Certificate remarks: Steel and tubes manufactured by Benteler Stahl / Rohr ✓

Part # 1

Benteler Stahl/Rohr GmbH
Postfach 13 40
33043 Paderborn
Deutschland
Tel.: +49.5254.81-0 Fax: +49.5254.13666

BENTELER
Stahl/Rohr

ABNAHMEPRÜFZEUGNIS EN 10204-3.1
INSPECTION CERTIFICATE EN 10204-3.1
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Dokument-Nr.: **Document No.:** No. du document: 41-488044/001/P

Prüf-Nr.: **Inspection No.:** No. du certificat:

Beiblatt Produktkennzeichnung / **Attachment product marking** / Supplément marquage du produit

Pos. / **Item** / Poste	Produktkennzeichnung / **Produktkennzeichnung** / Marquage du produit
0001, 0002, 0003, 0004, 0005, 0006, 0007, 0008, 0011, 0012	FS: BENTELER A179-SA179 HEAT-NO. DIMENSIONS TUBES-LENGTH FEET 2008 WA MADE IN GERMANY
0009, 0010	FS: BENTELER A179-SA179 HEAT-NO. DIMENSIONS TUBES-LENGTH FEET 2108 WA MADE IN GERMANY
0013	FS: BENTELER A179-SA179 HEAT-NO. DIMENSIONS TUBES-LENGTH FEET 2408 WA MADE IN GERMANY

AEZ = Ätztintenbeschriftung, Etching ink marking, Gravure à l'encre FK = Farbkennzeichnung, colour marking, marquage par couleur FS = Farbschablonierung, paint stencilling, marquage par peinture FSD = Farbstrahldrucker, Colour jet printer, Imprimante à jet d'encre de c LS = Längsschablonierung, longitudinal stencilling, marquage longitudinal par peinture PKE = Etikettenkennzeichnung, tag marking, marquage sur étiquette PS = Prägestempel, die stamp, marquage par poinçonnage TS = Tintenstrahlkennzeichnung, ink jet spray marking, imprimante à jet d'encre

Verkäufer(in) / **Salesman/ woman in charge** / Personne chargée : Mr Buerger, Tel.: 05254/81-4266, Fax: 4299

Paderborn Schloß Neuhaus, 24.06.2008, TEL.: 05254.81-1767 FAX: 05254.81-1752

Abnahmebeauftragter
Inspection representative
Contrôleur
ALWIN PANKRATZ / TEM

Es wird bestätigt, daß die gelieferten Erzeugnisse den techn. Lieferbedingungen des Auftrages entsprechen.Dieses Dokument wurde mittels EDV erstellt und ist ohne Unterschrift rechtsgültig.
We certify that the supplied products comply with the order specification.This document was prepared by means of electronic data processing and is valid without signature.
Nous attestons que les produits livrés sont conformes aux stipulations de la commande.Ce document a été établi par traitement électronique de l'information et est valide sans signature.

DATE: 11/16/11

W. M. HEITGRAS COMPANY
P.O. BOX 2044
1316 N. OSAGE DRIVE
TULSA, OKLAHOMA 74101
(918) 583-3131

Part #17

CERTIFIED MATERIAL TEST REPORT

ENERGY EXCHANGERS
1844 N. GARNETT RD.
TULSA OK 74116

LOT # 11881890
HEAT # 11881890
STOCK # B7S100C600
1-8 X 6 ASTM A-193 B-7 STUD
CUS PO# 1618
ORDER # 280518

X-7926.41+42

SPECIFICATIONS:

ASTM A193 B7 ALL THREAD ROD

VENDOR: VULCAN THREADED PRODUCTS, INC. QTY SOLD 32

- CHEMICAL COMPOSITION -

C %	MN %	P %	S %	SI %	NI %	CR %
00.4200	00.8600	00.0110	00.0110	00.3100	00.0600	00.9600

MO %	CU %	CO %	V %	AL %	FE %	TA %
00.2040			00.0050	00.0350		

TI %	ZN %	SE %	CB %	W %	N %	SN %
						00.0060

- CHARPY IMPACT -

FIRST: 0 SECOND: 0 THIRD: 0 AVERAGE: 0

- MECHANCIAL PROPERTIES -

TENSILE STRENGTH: 136,500 Psi
YIELD : 116,600
ELON : 20.00
RA : 59.00

HARDNESS : 28 HRC
PROOF STRESS: 0 Psi

COMMENTS:

MELTED & MFG IN THE USA
TEMPERING TEMP 1420 F
META S1/R1/C1

VERIFIED BY
NOV 17 2011
EEC QC DEPT

W.M. HEITGRAS COMPANY

L. Patterson

QUALITY CONTROL MANAGER

INSPECTION CERTIFICATE

STOCK

Customer	Specification	Size	Lot No.	Date
	ASTM A-194 GRADE 2H HEAVY HEX NUT	1 - 8 UNC	SN392	Mar. 28,'11

UNYTITE, INC.
One Unytite Drive
Peru, Illinois 61354
815-224-2221 — FAX# 815-224-3434

Mechanical properties tested in accordance to ASTM F606/F606M, ASTM A370, ASTM E18

X7926-43

Chemical Composition (%)

Mill Maker	Material Size	Heat No. / Spec.	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	
			MIN.	MAX.	MAX.	MAX.	MAX.					
GERDAU AMER	CARBON		0.40	0.40	1.00	0.040	0.050	-	-	-	-	-
ISTEEL(NC	STEEL	M662635	0.44	0.21	0.66	0.008	0.024	0.24	0.07	0.11	0.02	

Mechanical Property Inspection

Item	Proof Load	Cone stripping	Hardness	After Heat Treatment Hardness	Absorbed Energy
Spec.	106,000 lbf	- kN·kgf·lbf	24 -38 HrC	MIN. 89 HrB·HB	J·kgfm·ftlbf
	n	n	28.2	5 Piece Average After Heat Treament	
	5	-	28.2 28.6 28.8 28.5	103.8	
Results	Results	Results	28.5		
	GOOD	-		Hardness Treatment 1000	
				After 24 Hr.X °F(°C)	at °F(°C)

VERIFIED BY JUN 2011 EEC QC DEPT

OFFICIAL SEAL
JEAN MARGHERIO
NOTARY PUBLIC - STATE OF ILLINOIS
MY COMMISSION EXPIRES:10/8/13

03-29-11

Heat Treatment

T:MIN. 850 F

Q: FORGING Q (W.Q.)

T:1211 F/45M. (W.C.)

Q : Quenching
T : Tempering
ST: Solution Treatment

Shape & Dimension Inspection	ANSI B18.2.2 GOOD
Thread Precision Inspection	ANSI B1.1 CLASS 2B GOOD
Appearance Inspection	GOOD

Remarks:

" 2H U "

Production Quantity
25,897 pcs.

Part #18

Material used for the nut was melted and manufactured in the USA. The nut was manufactured in the USA to the above specification.

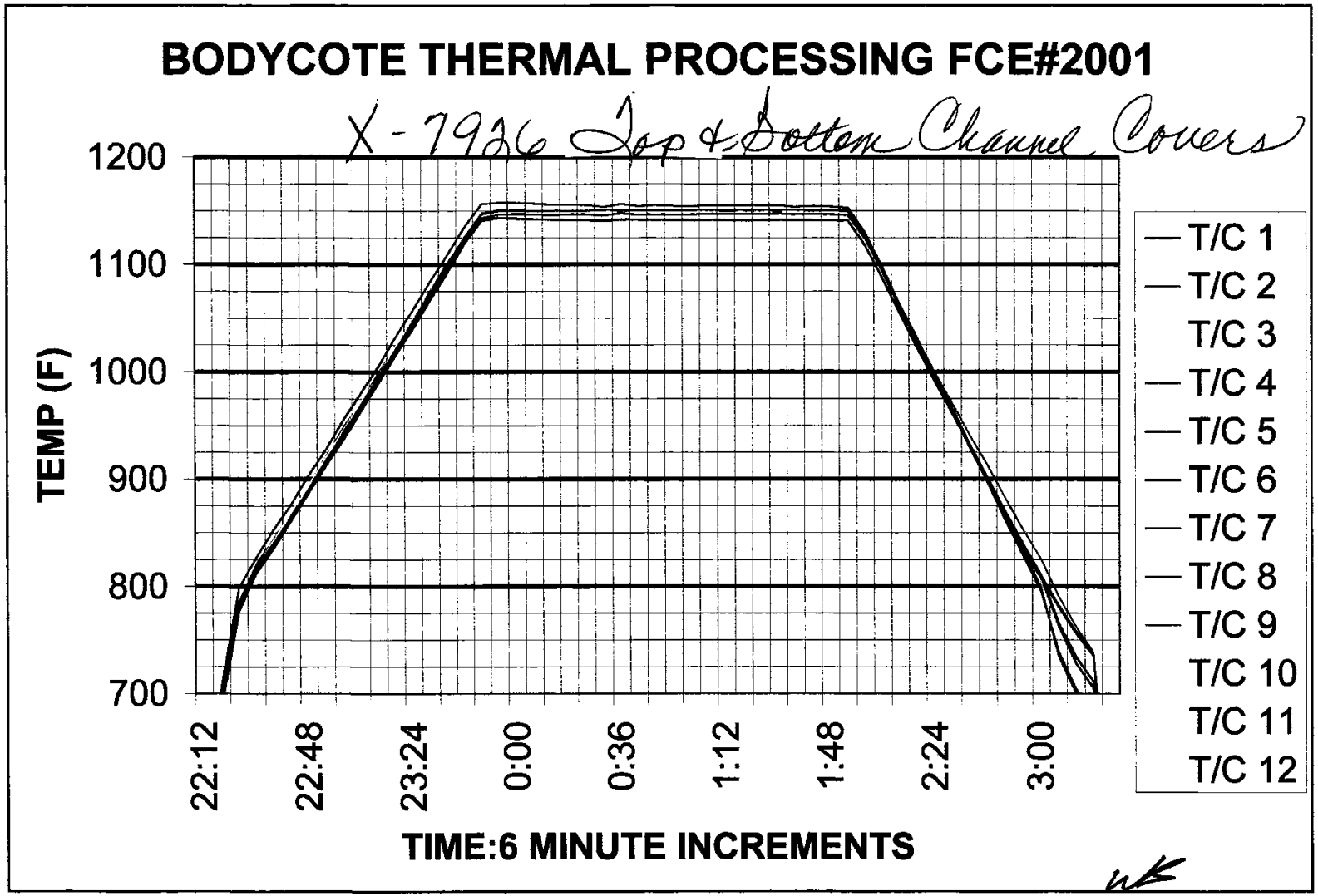
We hereby certify that the material described has been manufactured and inspected satisfactorily with the requirement of the above specification.

Chief of Quality Assurance Section

SECTION 5

ENERGY EXCHANGER
JOB# 54800
PO#PX9589

7-13-12



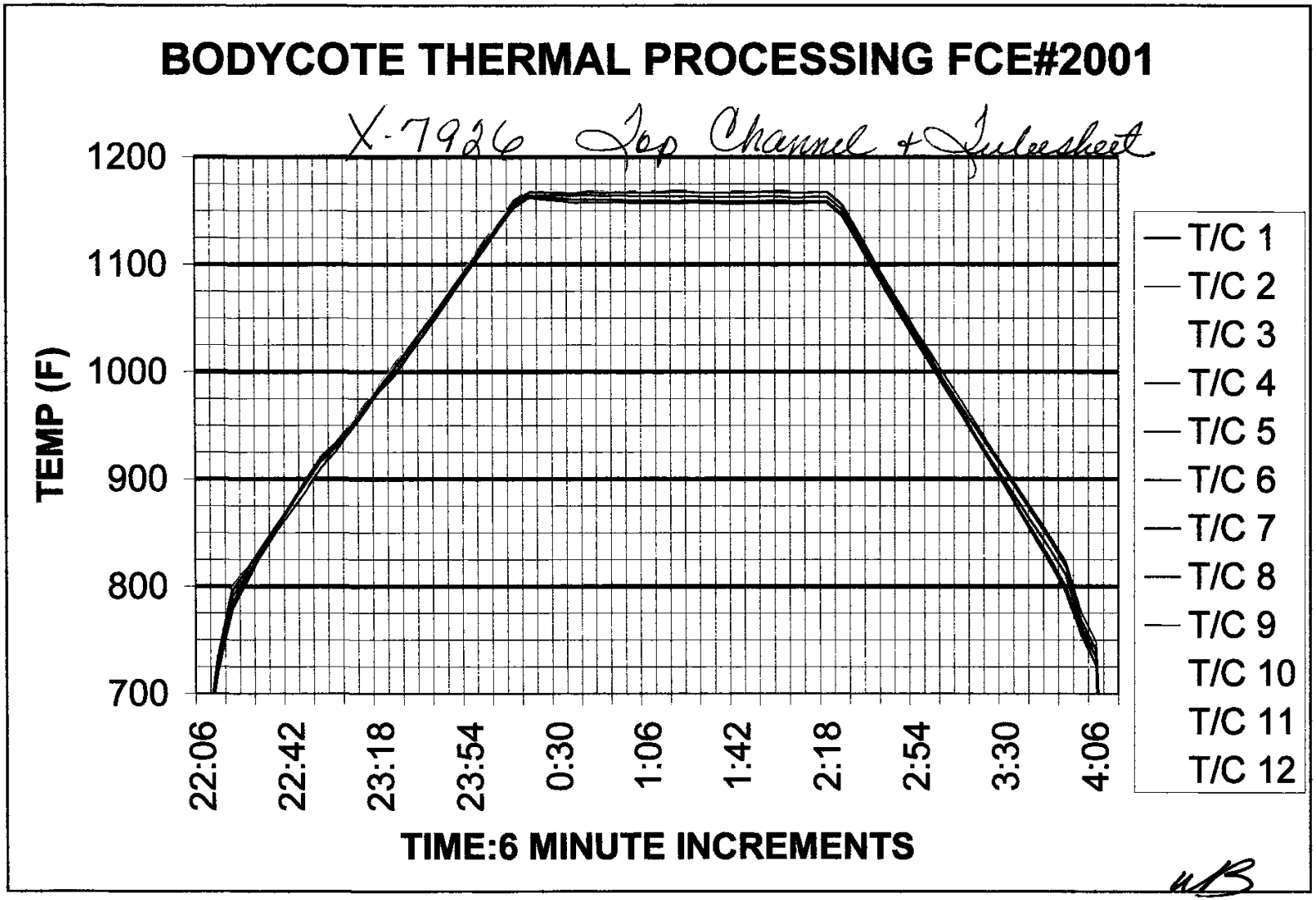
CALIBRATION DATE 5-10-12
CALIBRATION DUE DATE 8-10-12

SIGNED BY CECIL HESTER

Kemper County MM209778

ENERGY EXCHANGER
JOB# 54617
PO# X-7926

6-30-12



CALIBRATION DATE 5-10-12
CALIBRATION DUE DATE 8-10-12

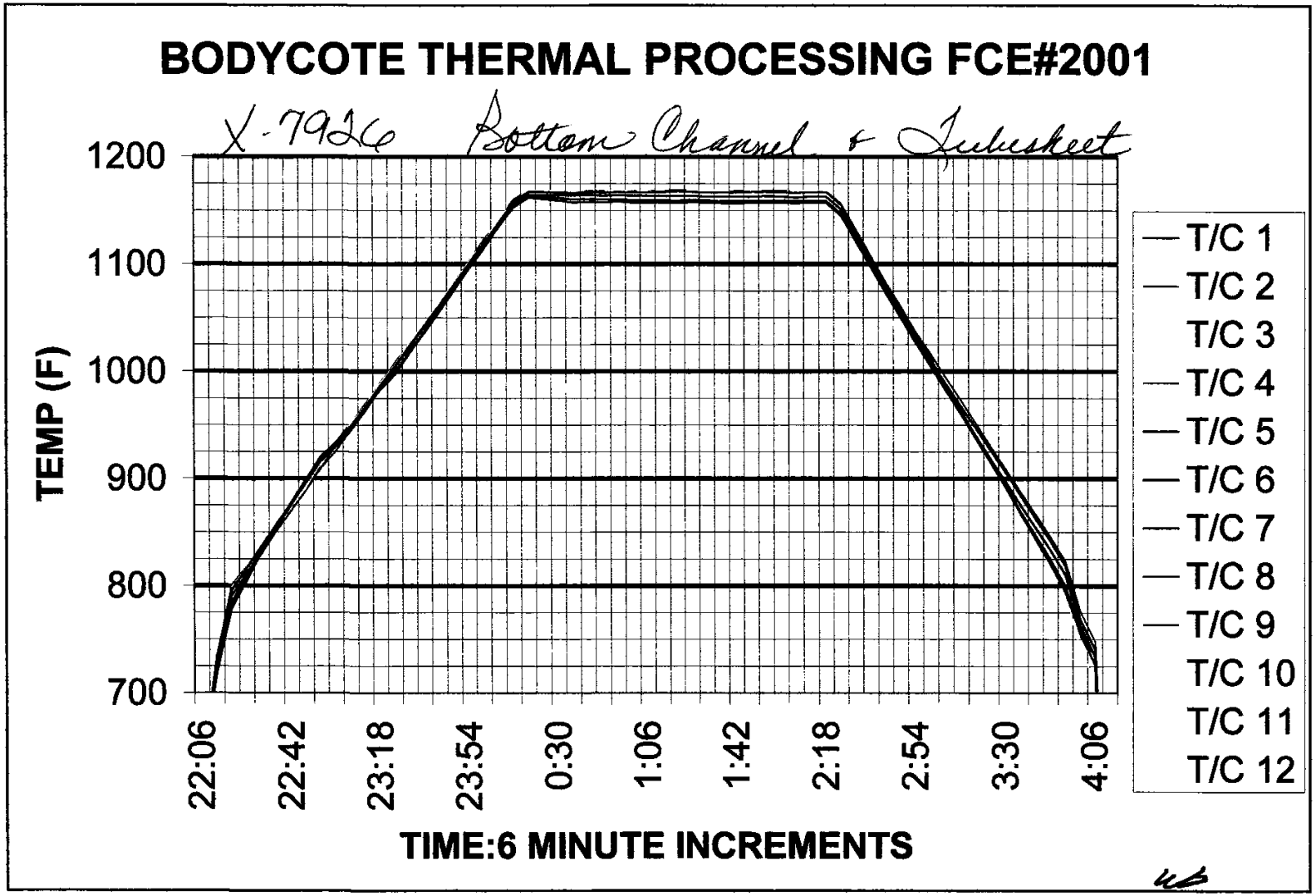
SIGNED BY CECIL HESTER

Cecil Hester

Kemper County MM209778

ENERGY EXCHANGER
JOB# 54619
PO# X-7926

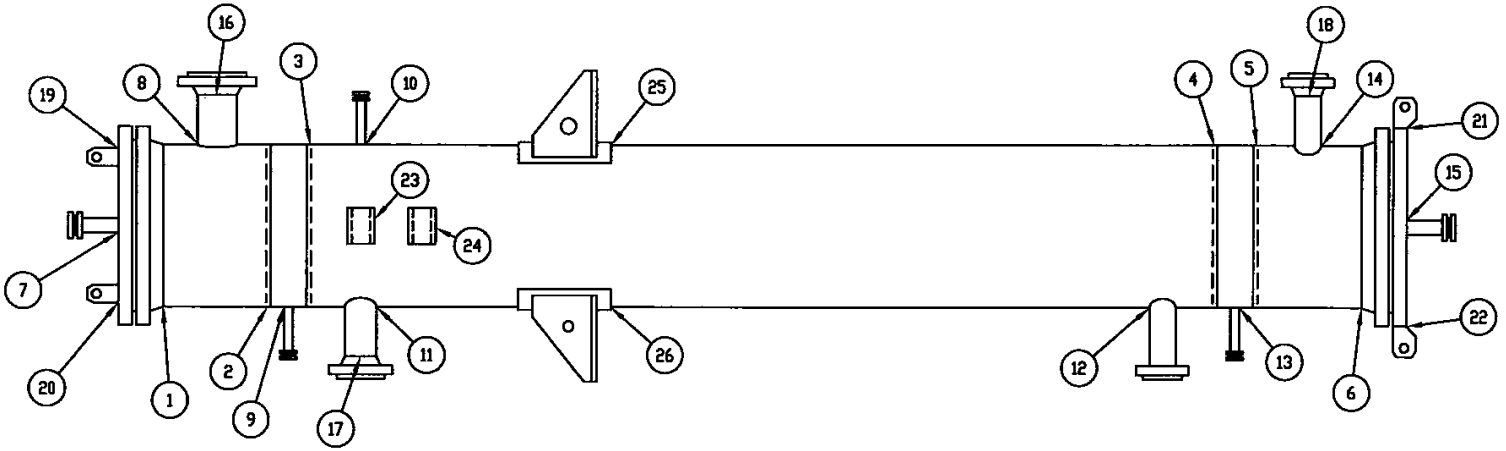
6-30-12



CALIBRATION DATE 5-10-12
CALIBRATION DUE DATE 8-10-12

SIGNED BY CECIL HESTER

Kemper County MM209778



CUSTOMER: MISSISSIPPI POWER/SOUTHERN COMPANY SERVICES
P.O. NO: 17496-0001 REQ No.: MC202
SERVICE: WASTEWATER AMMONIA PURIFIER REBOILER
ITEM NO: HX0052

NO.	DATE	REVISIONS
6		
5		
4		
3		
2		
1		

NDE/WELD MAP

DWN. BY: MD
DATE: 7/26/12
CKD. BY:

Energy Exchanger Co.

DWG. NO. X-7926-NDE
REV 0

ENERGY EXCHANGER COMPANY

CUSTOMER: SOUTHERN COMPANY SERVICES **P.O.#:** 17496-0001
TAG: HX0052 **ENERGY JOB #** X-7926

NDE / WELD INDEX

Part #	Consumable	WPS	Weld Stamp	NDE Procedure	NDE Technician
1	L56	A-62-H	J	MT / RT	MW / BC
2	L56	A-62-H	J	MT	MW / BC
3	ER70S-2	M-6	K	MT	MW / BC
4	ER70S-2	M-6	K	MT	MW / BC
5	L56	A-62-H	J	MT	MW / BC
6	L56	A-62-H	J	MT / RT	MW / BC
7	ER70S-2	M-79-H	O	MT	MW / BC
8	E7018-1	M-76-H	O	MT	MW / BC
9	E7018	M-1	H	MT	MW / BC
10	E7018	M-1	O	MT	MW / BC
11	E7018	M-1	O	MT	MW / BC
12	E7018	M-1	R/O	MT	MW / BC
13	E7018	M-1	H	MT	MW / BC
14	E7018-1	M-76-H	O	MT	MW / BC
15	ER70S-2	M-79-H	L	MT	MW / BC
16	ER70S-2	M-79-H	J	MT	MW / BC
17	ER70S-2	M-5	O	MT	MW / BC
18	ER70S-2	M-79-H	O	MT	MW / BC
19	E7018-1	M-75-H	O	MT	MW / BC
20	E7018-1	M-75-H	O	MT	MW / BC
21	E7018-1	M-75-H	L	MT	MW / BC
22	E7018-1	M-75-H	L	MT	MW / BC
23	E7018	M-1	O	MT	MW / BC
24	E7018	M-1	O	MT	MW / BC
25	E7018	M-1	O	MT	MW / BC
26	E7018	M-1	O	MT	MW / BC

ENERGY EXCHANGER COMPANY

JOB # X-7926

P.O.# 17496-0001 APWHT

PART IDENTIFICATION Channels Spot UW-51

TYPE OF MATERIAL SA-333-6 MATERIAL THICKNESS 16" X 3/8"

SPECIFICATION NO: Q.C. WELDMENT CODE/STANDARD: ASME SEC. VIII, DIV. 1, A-

FILM IDENTIFICATION	ACCEPTABLE	REJECTED	FILM ARTIFACTS	SURFACE INDICATIONS	POROSITY	SLAG INCLUSIONS	CRACKS	INCOMPLETE FUSION	INADEQUATE PENETRATION	UNDERCUT	BURN THROUGH	REMARKS
Ch R1 Top T-2	✓											
Ch R1 Btm T-2	✓											

RADIOGRAPHIC DATA

1. RT DATE 6-30-12
2. MATERIAL EXAMINED:
   - (✓) WELDMENT
   - ( ) CASTING
   - ( ) OTHER
3. METHODS:
   - (✓) SINGLE EXPOSURE
   - ( ) MULTIPLE EXPOSURE
   - ( ) DOUBLE WALL TECHNIQU
   - ( ) SINGLE WALL TECHNIQU
   - ( ) DOUBLE WALL VIEWING
   - ( ) SINGLE WALL VIEWING
   - ( ) SINGLE FILM LOADING
   - ( ) DOUBLE FILM LOADING
4. IQI (PENETRAMETER) DATA:
   - DESIGNATION 0.014
   - SENSITIVITY LEVEL 0.013
   - LOCATION (FS) (SS)
5. FILM DATA:
   - FILM TYPE fuji 80
   - FILM DENSITY MAX. 2-4
   - FILM DENSITY MIN. 2-4
6. SOURCE DATA:
   - ISOTOPE Ir192 SIZE 0.145
   - CURIES 80 E.T. :13
   - S.O.D. 18 S.S.O.F. 3/8

RADIOGRAPHER J. Howard

INTERPRETER EEW III 193332 DATE REVIEWED 7-2-12

CUSTOMER INSPECTOR WB DATE REVIEWED

readersheet(A99).doc

ENERGY EXCHANGER COMPANY

JOB # X-7926

P.O.# 17496-0001

PART IDENTIFICATION Chamels Spot UW-51

TYPE OF MATERIAL SA-333-6 MATERIAL THICKNESS 16" OD x 3/8"

SPECIFICATION NO: Q.C. WELDMENT CODE/STANDARD: ASME SEC. VIII, DIV. 1, A- 09

FILM IDENTIFICATION	ACCEPTABLE	REJECTED	FILM ARTIFACTS	SURFACE INDICATIONS	POROSITY	SLAG INCLUSIONS	CRACKS	INCOMPLETE FUSION	INADEQUATE PENETRATION	UNDERCUT	BURN THROUGH	REMARKS
Ch R1 BTM												
1-2	✓											
Ch R1 Top												
1-2	✓											

RADIOGRAPHIC DATA

1. RT DATE 6-2-12

2. MATERIAL EXAMINED:
   - (X) WELDMENT
   - ( ) CASTING
   - ( ) OTHER _____

3. METHODS:
   - (✓) SINGLE EXPOSURE
   - ( ) MULTIPLE EXPOSURE
   - ( ) DOUBLE WALL TECHNIQUE
   - ( ) SINGLE WALL TECHNIQUE
   - ( ) DOUBLE WALL VIEWING
   - ( ) SINGLE WALL VIEWING
   - ( ) SINGLE FILM LOADING
   - ( ) DOUBLE FILM LOADING

4. IQI (PENETRAMETER) DATA:
   - DESIGNATION 0.014
   - SENSITIVITY LEVEL 0.013
   - LOCATION (FS) (SS)

5. FILM DATA:
   - FILM TYPE Fuji 80
   - FILM DENSITY MAX. 2-4
   - FILM DENSITY MIN. 2-4

6. SOURCE DATA:
   - ISOTOPE ~~Ir192~~ SIZE 0.106
   - CURIES 92 E.T. :11
   - S.O.D. ~~168~~ S.S.O.F. 3/8

RADIOGRAPHER J. Howard

INTERPRETER R. Carson DATE REVIEWED 6-3-12

CUSTOMER INSPECTOR _____ DATE REVIEWED _____

readersheet(A99).doc

Energy Exchanger Company
1844 N. Garnett Rd. • Tulsa, OK 74116 • www.energyexchanger.com
office (918) 437-3000
fax (918) 437-7144
info@energyexchanger.com

DATE: 6/5/12

CERTIFICATION OF EXAMINATION
BY
MAGNETIC PARTICLE (DRY POWDER METHOD)
(Procedure MT-1 Rev. 6)

P.O. # 17496-0001

TAG # HX0052

ENERGY JOB # X-7926

MT LIFTING LUG WELDS, NOZZLE BACK CUTS, ALL EXTERNAL WELDS, ARC STRIKES & TEMPORARY ATTACHMENTS.

This certification is made to document that all Magnetic Particle Examinations have been performed on X-7926 **in accordance with the requirements of ASME Section VIII, Division I, Appendix VI, ASME Section V, Article 7, customer specifications and Energy Exchanger Company drawings.**

TEST INSTRUMENT: ESC-Y400 / ESC MS-27D

PARTICLE TYPE & COLOR: DRY / GRAY **Lot:** 17748

MATERIAL AND THICKNESS: SHELL: SA-106-B (3/8")
CHANNEL: SA-106-B (1/2")

LIGHTING: 100 FT CANDLES MIN. @ SURFACE

ENERGY EXCHANGER COMPANY

Brent Wilson
Quality Control Manager
ASNT NDT Level III, #193332
CWI # 10082731

BRINELL HARDNESS REPORT

JOB NO: X-7926

COMPONENT	LOCATION	WELD METAL	BHN HEAT AFFECTED ZONE	BHN PLATE	WELD PROCEDURE NUMBER
TOP CHANNEL	R1	185	181		A-62-H
	R2	185	180		A-62-H
	T2	183	175		M-76-H
SHELL	R1	190	183		M-6
	R2	185	177		M-6
	S1	186	177		M-1
	S2	189	172		M-1
BOTTOM CHANNEL	R1	178	170		A-62-H
	R2	177	171		A-62-H
	T1	181	176		M-76-H

SECTION 6

Energy Exchanger Company
1844 N. Garnett Rd. • Tulsa, OK 74116 • www.energyexchanger.com

office (918) 437-3000
fax (918) 437-7144
info@energyexchanger.com

DATE: 7-9-12

CERTIFICATE OF WELD/SUPPORT PAD AIR TEST

P.O. NO: 17496-0001

TAG NO: HX0052

ENERGY JOB NO: X-7926

This is to certify all weld/support pads on the above referenced equipment were air tested @ 15 P.S.I. and found to be satisfactory.

ENERGY EXCHANGER COMPANY

Brent Wilson
Quality Control Manager

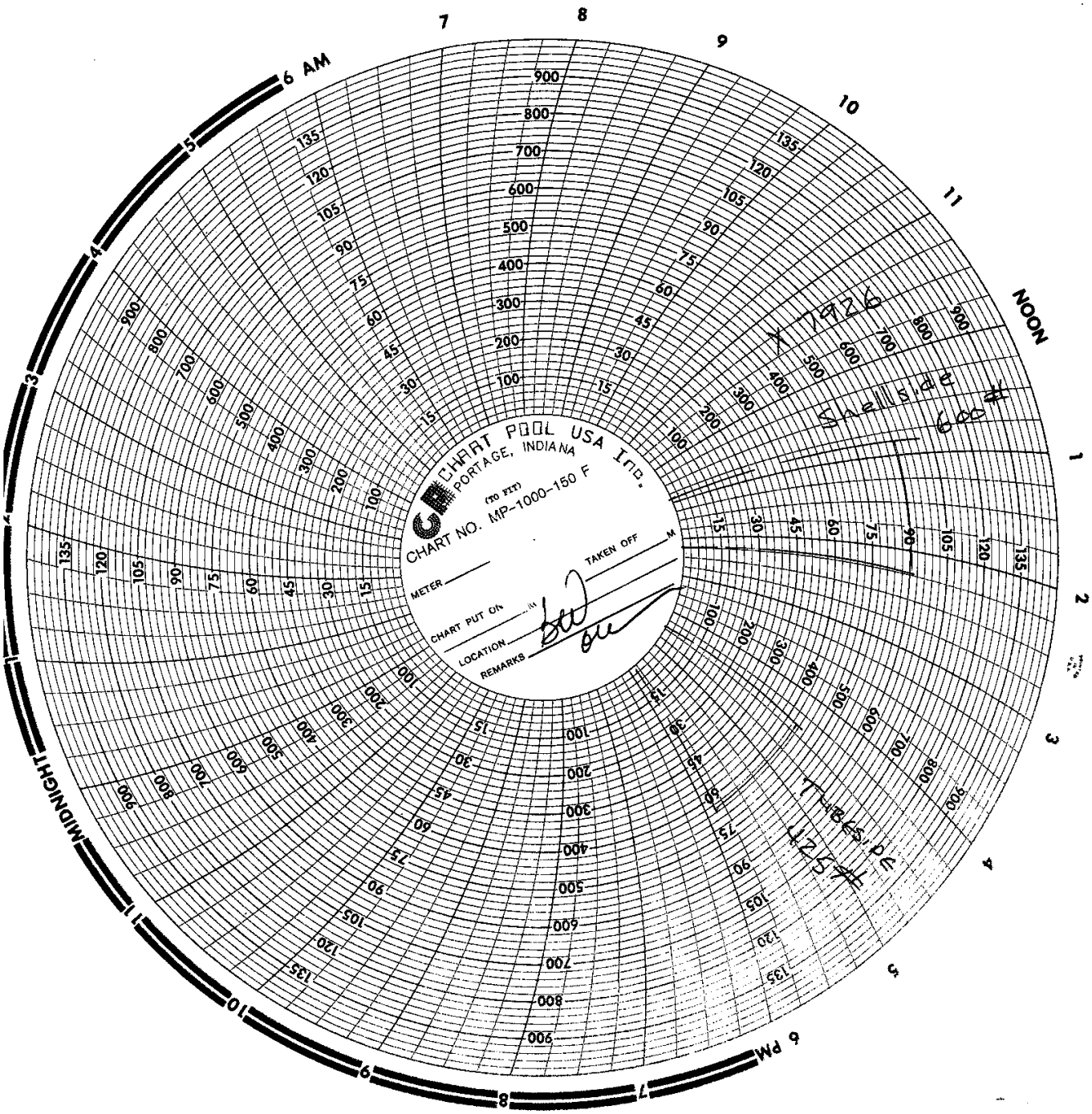


CHART POOL USA Inc.
PORTAGE, INDIANA
(10 FT.)
CHART NO. MP-1000-150 F
METER
TAKEN OFF
CHART PUT ON
LOCATION
REMARKS
MIDNIGHT
6 AM
NOON
6 PM

Energy Exchanger Company
1844 N. Garnett Rd. • Tulsa, OK 74116 • www.energyexchanger.com
office (918) 437-3000
fax (918) 437-7144
info@energyexchanger.com

DATE: 7-23-12

CERTIFICATE OF HYDROSTATIC TEST

P.O.# 17496-0001

TAG# HX0052

ENERGY JOB # X-7926

This is to certify the above referenced equipment was hydro tested at the following pressures:

600 PSIG SHELL SIDE

425 PSIG TUBE SIDE

ENERGY EXCHANGER COMPANY

Brent Wilson
Quality Control Manager

/lt

Energy Exchanger Company
1844 N. Garnett Rd. • Tulsa, OK 74116 • www.energyexchanger.com
office (918) 437-3000
fax (918) 437-7144
info@energyexchanger.com

Date: 8-4-12

CERTIFICATE OF NITROGEN PURGE

P.O. NO: 17496-0001

TAG NO: HX0052

ENERGY JOB NO: X-7926

This is to certify the above referenced equipment was purged with 15 **PSI dry nitrogen after hydro test.**

ENERGY EXCHANGER COMPANY

Brent Wilson
Quality Control Manager

Reviewed / Accepted
I.Q.S. # 3
William Brenaugh

ENERGY EXCHANGER COMPANY

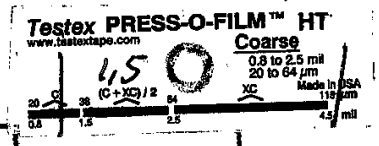
PAINT CHECK LIST

Contractor: EATON INDUSTRIAL CASTINGS

Unit Serial No: X-7926 Customer Specification No: _____

Paint Required: 3-4 mils D-9 Primer; _____ mils _____ Intermediate;

(Supports) → 1-2 mils 892 Finish



	Satisfactory	Date
1. Paint Shelf Life A. Materials in accordance with Project Specifications & Drawings	ME	7/23/12
2. Notify Energy Exchanger Company		
3. Weather Conditions: 97 temperature; 52% humidity; 95 substate, 77 dew point, EEC verify _____		
4. Surface Prep: (Req'd) SSPC-SP- 10 1-2 mils; (Actual) SSPC-SP- 10 1.5 mils	ME	7/23/12
5. Surface Contamination	ME	7/23/12
6. Surface Imperfections		
7. Paint Contractor Re-check above		
8. Storage, Mixing, Application		
9. Masked Surfaces		
10. Check Compressed Air for Contamination		
11. Wet Film Thickness: (Req'd) — (Actual) —	MC	7/26/12
12. Dry Film Thickness: SHELL (Req'd) 3-4 (Actual) 4 SUPPORTS " 4-6 " 6	MC	7/26/12
13. Tie Down/Shipping Preparation		

2nd COAT (SUPPORTS)
TEMP 88
S.TEMP 85
HUMIDITY 54%
DEWPOINT 69

SECTION 7

SPL-7926

ENERGY EXCHANGER COMPANY

SPARE PARTS LISTS

CUSTOMER: Southern Company Services (for) Mississippi Power							EEC QUOTE: 11-7309			
DESTINATION: DeKalb, Mississippi			P.O. No.: 17496-0001				EEC JOB NO.: X-7926			9/11/2012
		SPARE GASKETS								
TAG NO.	EEC JOB NUMBER	QTY. SETS	NO. GASKETS PER SET	EEC DWG. NUMBER	UNIT $ PRICE *	SHIPMENT				
HX0052	X-7926	**	2	X-7926-O	$385.00	2-3 Weeks				

* 1) PRICES ARE F.C.A. ENERGY SHOPS, TULSA, OK.
* 2) SHIPPING TERMS ARE PREPAY AND CHARGE.
* 3) PRICE ARE VALID FOR TWELVE (12) MONTHS.
* 4) UNIT PRICES ARE PER SET OF SPARE GASKETS.

** 1) ENERGY EXCHANGER COMPANY RECOMMENDS ONE SET OF SPARE GASKETS PER EXCHANGER PER YEAR OF OPERATION.

Energy Exchanger Company

Installation, Operation and Maintenance Manual for SHELL AND TUBE HEAT EXCHANGERS

A Member of the
Tubular Exchanger
Manufacturers Association

Energy Industrial Park/1844 North Garnett/Tulsa, Oklahoma 74116-1698
918 437-3000 / FAX 918 437-7144

FOREWORD

Included in this manual are Tables and Figures which are reprinted in their entirety 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 Tubular 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 INSTRUCTIONS 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.

ROUTINE 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 sides 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 advise 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

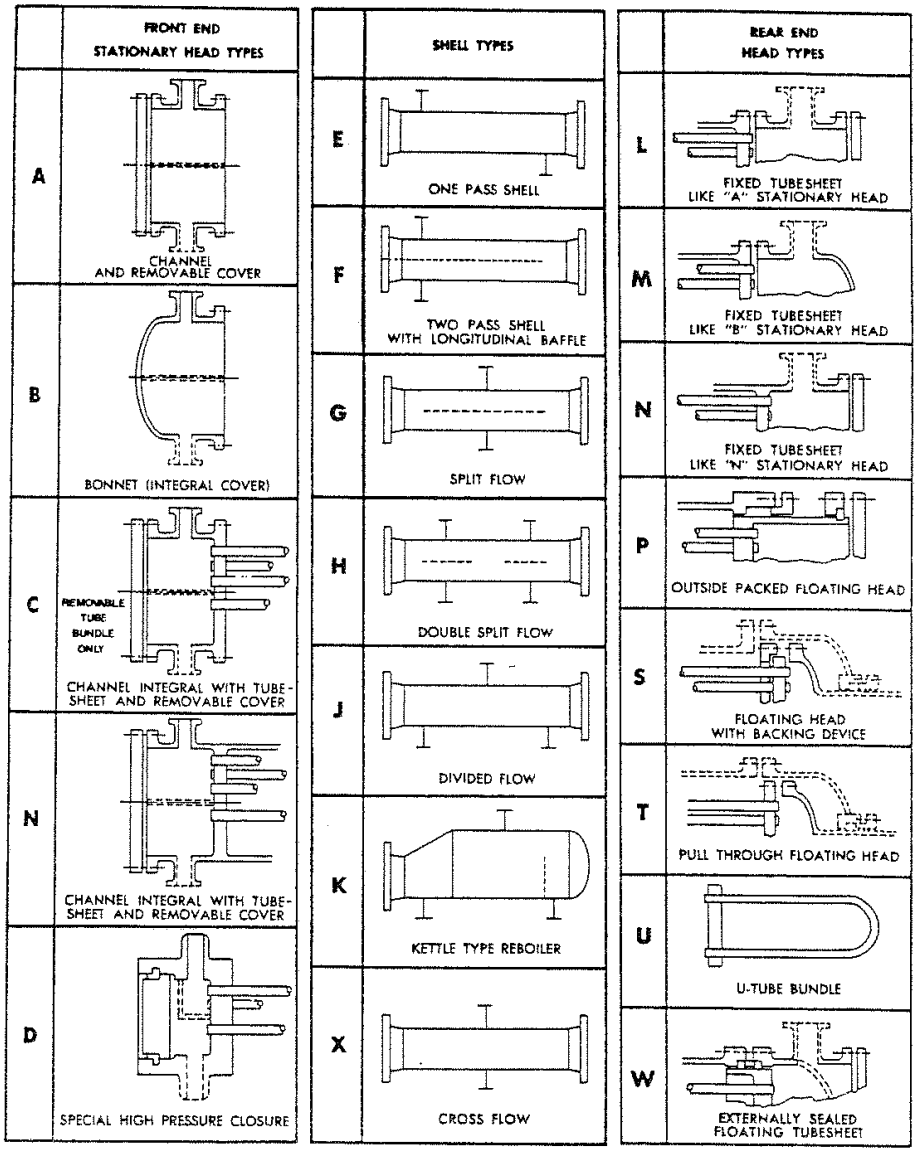
N-1 TYPE DESIGNATION-RECOMMENDED PRACTICE

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 Flange
21. Floating Head Cover — External
22. Floating Tubesheet Skirt
23. Packing Box
24. Packing
25. Packing Gland
26. Lantern Ring
27. Tierods 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

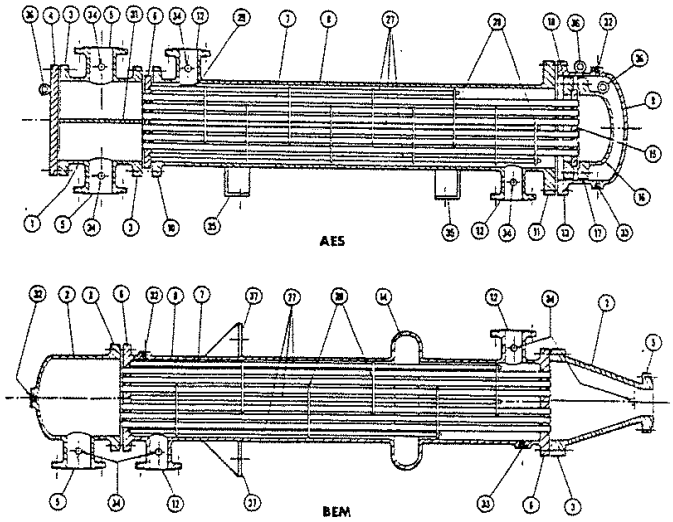
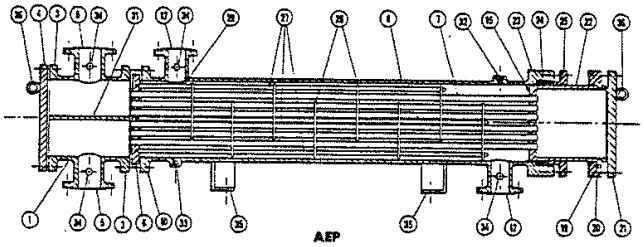
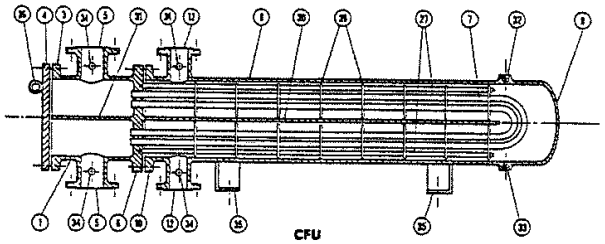


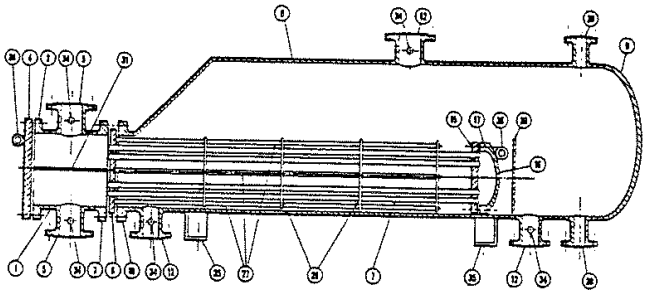
Figure N-2 (Continued)



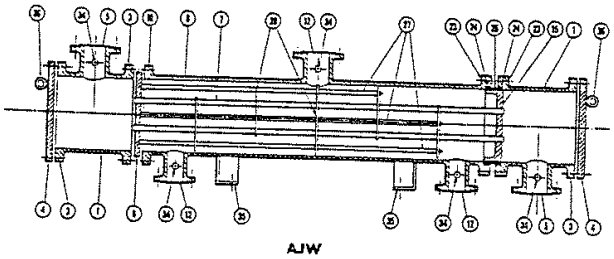
AEP



CFU



AKT



AJW

SECTION 2
HEAT EXCHANGER IDENTIFICATION AND DEFINITIONS

D-2.1 EXCHANGER IDENTIFICATION

D-2.11 COMPLETE EXCHANGER

Manufacturers normally assign 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 conditions 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 SHUT-DOWN CONDITIONS

The conditions of operation which exist from 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.

SECTION 3
INSTALLATION OF HEAT EXCHANGERS

E-3 INSTALLATION

E-3.1 INSTALLATION PLANNING

E-3.11 CLEARANCE FOR DISMANTLING

For straight tube exchangers fitted 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 end 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-3.131 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 for 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 unit to allow free expansion of shells. Slotted holes in supports are provided 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.

SECTION 4
OPERATION OF HEAT EXCHANGERS

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 preventive 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) Maldistribution 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 operation, 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 shut-down 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 fixed tubesheet exchangers the unit must be shut down in a manner to minimize differential expansion between shell and tubes, (Refer E-4.24). When shutting down the system, all units should be drained completely when there is the possibility of freezing or corrosion damage. To guard against water hammer, condensate should be drained from steam heaters and similar apparatus during start-up or shut-down. To reduce water retention after drainage, the tube side of water cooled exchangers should be blown out with air.

E-4.24 START-UP AND SHUT-DOWN PROCEDURES FOR FIXED TUBESHEET EXCHANGERS

When start-up and shut-down 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 name plates. 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 of 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 name plate or on a supplemental plate attached to the exchanger at the name plate 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 temperatures more severe than those shown on the heat exchanger specification sheet.

E-4.362 For fixed tubesheet exchangers 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

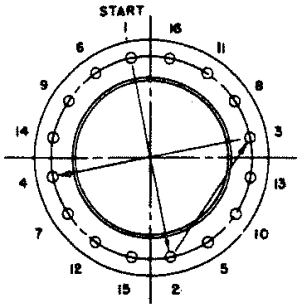
E-4.41 RECOMMENDATIONS FOR RETIGHTENING

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-4.42 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-4.42 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 indicates 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 PREVENTIVE 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 and scheduling down-time.

(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, remove 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

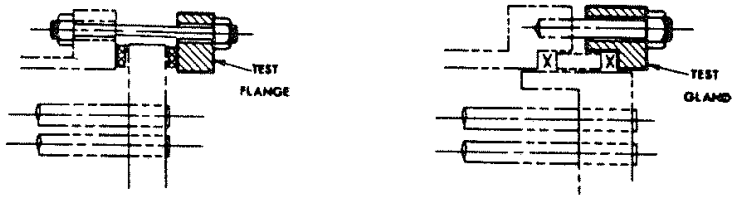
The following procedures may be used to locate perforated or split tubes and leaking joints between tubes and tubesheets. In most cases, the entire front face of each tubesheet will be accessible for inspection. The point where water escapes indicates a defective tube or tube-to-tubesheet joint.

(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 it was considered in the design of the tubesheets.

Figure E-5.14-1

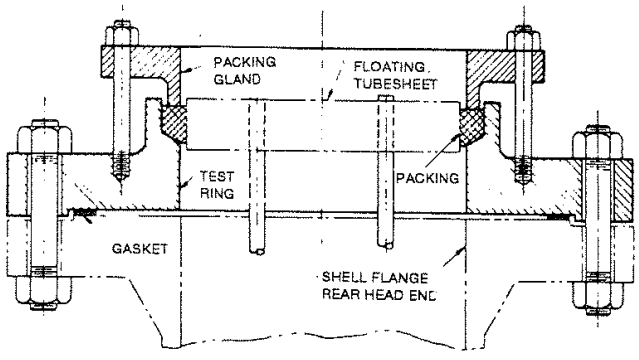


(3) Units with type S or T floating head:
Remove channel cover or bonnet, shell cover and floating head cover. Install test ring and bolt in place with gasket and packing. Apply hydraulic pressure in the shell. A typical test ring is shown in Figure E-5.14-2. When a test ring is not available it is possible 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-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 must 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 BUNDLES

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 slings. 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 of the operator of the plant and will depend on the type of deposit and the facilities available in the plant. Following are several cleaning procedures 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) 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-tube sheet 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 for 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 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 the 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 smoother 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 repairs 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

The instructions of the heat exchanger manufacturer should be followed when provided.

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 rerating 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.